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Aesthetics of Sustainable Architecture

Edited by Sang Lee

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Foreword

On behalf of the City of Eindhoven and the TU Eindhoven Faculty of Architecture, we would like to express our pleasure in supporting the publication of *Aesthetics of Sustainable Architecture*. For both the city and the faculty, the issues of sustainability in architecture and urban design have been important for many years. With the publication of this book, we believe that we will start a meaningful debate on sustainable practice and its economically and culturally appropriate role in shaping the aesthetics of a society. To this end, we finally have a volume that will help us understand the substance of what it means to design and build in a sustainable way, one that will contribute to the aesthetic constructs of the twenty first century.

As we are all familiar, it is rather straightforward to assemble mechanical equipment and facilities in a way that supports our comfort while addressing energy consumption to some degree. However, it is difficult to comprehend how the principles of sustainable living could provide a new aesthetic framework to help us transform the built environment and our relationship to the natural one. For the first time, this volume brings together a series of writings by architects and scholars that specifically addresses sustainable architecture from an aesthetic perspective. We believe that this volume presents a valuable means to explore the theoretical aspects and design approaches of the field.

We are confident that this volume will serve as a meaningful source for architects and designers, as well as for anyone who is interested in the aesthetic potentials of sustainable development.

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Introduction

As the issue of sustainable design and development has emerged as one of the most compelling in the architecture of our time, as well as in society and politics at large, it is important to explore the changes that have occurred in the architectural profession as a result. Given the sensitivity and attention that is paid to sustainable design and development today, it is relevant to ask whether sustainability has become a new, specialized branch of the discipline, or an intrinsic part of the discipline as a whole. Accordingly, we may ask if the heightened awareness of sustainability functions simply as an addendum to the practice of architecture, or if it affects the discourse of the profession in a more fundamental way. And finally, we may ask how these trends have changed the way we situate the built environment in relation to the natural one.

As a first step toward addressing these questions, *The Aesthetics of Sustainable Architecture* attempts to trace the key concepts and theories that underlie what it means to design in a sustainable way. At their very core, the principles of sustainable design are rooted in the building's relationship to the site and its environmental conditions such as topography, vegetation and climate. These principles are common to the discipline as a whole, and to a large extent, architecture as praxis already includes strong propositions of how the artificial, man-made environment may be designed and constructed in relation to the natural environment. What varies from project to project is how well, and to what degree, these relationships are maintained.

The discipline of architecture is not static; not only what we call the disciplinary discourse but also the techniques of design and construction have undergone rapid, extensive transformations in terms of sophistication as well as complexity. These transformations are linked to the rapid pace of industrial and technological development that has characterized the current age and its prevailing market economy model. These developments underlie many of the world's most serious environmental problems, and have greatly impacted our approach to the design of the built environment and its operations in ways that have moved us farther away from a sustainable relationship to nature. However, these same trends may be harnessed to offer new approaches to sustainable design. What then is the role of architecture in responding to current environmental problems? The chapters in this collection will present historical and theoretical positions in order to address this question, and address how the renewed consciousness of environmental concern in architecture may develop, given the challenges of the current age.

At the same time, as the overarching title of this book may suggest, the aesthetic dimension is intrinsic to any impetus that brings about great transformations in the design of the built environment. If one were to consider sustainability as such an impetus, would it transform the aesthetics of architecture and the built environment in any substantive way? Or is sustainability simply incongruous to, and to be shunned by, the aesthetic apparatus of architecture? The chapters in this collection will attempt to address these questions while proposing thoughts on how sustainability is indeed an aesthetic issue, and how the notion of sustainability may provide a form of aesthetic thinking that is fundamentally implicit to the discipline. Therefore, this book is intended to offer a reference on how the issues of sustainability and aesthetics may be related together in architecture.

In recent years, the so-called *greening* of architecture has produced a new class of experts and professionals. Sometimes they work in parallel with architects, while other times they work in the background, effectively *greening* a building design after the architect's work is done. Given these trends, it is important to ask if sustainability is indeed an area that is best left to this new class of experts and professionals. Or, is sustainability such an important part of design that every architect should engage it as an integral part of their work? Alternately, should every architect become familiar with sustainability simply in order to become more marketable and to get more work? Current trends – including the implementation of evaluation standards such as LEED, BREEAM and C2C certification, and the increasing commodification and marketing of anything green as sustainable – suggest that it is an opportune moment to reconsider and reevaluate what sustainability means to the discipline of architecture, while clarifying some of the core issues that surround it. Therefore, this book is an attempt to retrace the reference on which sustainable thinking in architecture and aesthetics could be based, helping to define the role of architects in relation to sustainability in the process.

Any one of these questions could form a substantial volume in itself, in order to do justice to the weight and scope of the subject matter. Despite the danger of becoming superficial and glossing over crucial issues, this collection is meant to function as an opening or a springboard, so to speak. As the title suggests, the book draws together a collection of diverse articles that relate to *aesthetics* while dealing with sustainability and the underlying thoughts that connect the two. In many instances, it is clear that the central ideas behind the environment, sustainability and the design of architecture have often been oversimplified and increasingly misrepresented, hampering discussion and debate in the field.

This trend may be attributed to the extremely rapid commodification of everything green, a development motivated by the kind of economic opportunities that tend to appear with new, desirable technology in the current age. On one hand, environmental problems are increasingly viewed within a narrow set of lifestyle *choices,* and on the other hand, in reference to our prevailing market economy model that is taken for granted as the *de jure* standard. Environmental problems are seen in aggregates that are composed of parts to be improved upon and replaced, while the structure or the kind of complex, intertwined compositions that make up the problems are often not considered. The fundamental position underlying sustainable development appears to be that the current model of unbridled production and consumption may be *sustained* as long as we do not destroy our environment in the process. In a sense, it appears that sustainability is increasingly becoming part of the apparatus that is dedicated to the maintenance of the status quo, ultimately playing an active role in the maintenance of a wasteful, consumption-intensive economy.

Many debates on sustainability and environmental issues center around the suggestion that we can alleviate our problems by replacing a selection of materials and technological components, such as the fuels for electricity and transportation, the kind of engines in our cars or the kind of light bulbs in our homes, swapping them out with more efficient versions. Certainly these changes would help in some respect, but fundamental questions remain in regard to architecture: What are the structural issues of sustainable development and how do we address them in architectural design? Can we simply replace the bits and pieces that go into the built environment in order to achieve a more sustainable future? And what kind of aesthetic changes and opportunities could we find in a true revision of the industrial capitalist model, a model where architecture and design are often at the receiving end of the causal relationship?

In order to address these questions, we can turn to the work of various institutes, thinkers and advocates who have been frontrunners in the field of sustainability. For example, the Rocky Mountain Institute (RMI) founded by L. Hunter Lovins and Amory Lovins in 1982 proposes a design intensive, productivity-oriented approach emphasizing maximized efficiency of the systemic structure under the framework of *Natural Capitalism* (NC).[1] The RMI declares that its vision is "a world thriving, verdant, and secure, for all, for ever." Furthermore its mission is "to drive the efficient and restorative use of resources" in a manner that is "non-adversarial and trans-ideological, emphasizing integrative design, advanced technologies, and mindful of markets."[2] Implementing the visions of NC would have real, concrete implications for the discipline of architecture, as well as for the society and the economy at large. It is important to ask, what would architecture *look* like, what would the aesthetics of architecture be when it is produced under such a framework?

In addition to NC, another recent highly influential contribution to the sustainability debate is the book by William McDonough and Michael Braungart, "Cradle to Cradle" (C2C).[3] In this book, the authors examine and illustrate the inherent problems in the existing industrial economy which they call a "cradle to grave" model and attempt to propose an alternative that is centered on closed-loop *services* of production, delivery and reclamation.[4] Both NC and C2C propose a fundamental revision of our current model of industrial development, moving away from the patterns of disjunctive production and consumption toward a cyclical process where nothing is discarded or wasted. The idea of a cyclical system of production, use and re-production, as opposed to a linear, dead-end process of production, consumption and discard, is a key consideration of both propositions. With NC and C2C, we can glimpse what is means to address the structure of the complex, intertwined compositions that underlie today's environmental problems instead of addressing them on an ad hoc basis.

Then there are the advocates of the vernacular who profess returning to the kind of living that used to be more intimate and less intrusive to nature as the way to mitigate our current environmental problems. In line with the vernacular traditions, there are those who argue for *localization* and *self-sufficiency* of production and consumption. In this scenario, the built environment will sustain itself within what would be considered a local scope, however, one crucial issue is whether or not the vernacular traditions – said to date back as far as the time of Vitruvius[5] – are indeed applicable and even relevant to today's context. Or for that matter, is it feasible to simply pick and choose the kind of useful elements from the vernacular *catalogue* regardless of their cultural and environmental origins? In regard to the vernacular being equated with the sustainable, proponents contend that the vernacular maintained a harmonious existence in relation a region's natural resources and climate, and therefore, that the vernacular building process was local, thereby sustainable. Given today's outstanding global problems – including the ideological, political, economic and climatic problems that have been generated over the past one hundred fifty years – the arguments for the vernacular appear nostalgic, offering few viable strategies. Many times, pursuit of the vernacular will result in the *fake authentic*, not unlike the Prince Charles' call for an *authentic* English village that culminated in the development of Poundbury in southwestern England.

Against such a complex backdrop, many of the articles in this collection discuss emerging models of design and production that incorporate ideas for replacing existing technologies with more efficient ones, as well as ideas for new innovations, and inventions. However, they are not purely technological, and attempt to locate themselves within the broader discourse of the field. While it is undeniable that we must develop appropriate technological means to address the environmental problems attributable to architecture, there is a danger in this approach. Typically, it has overlooked the kind of research and investigation needed to situate sustainable innovations within the wider aesthetic framework of the discipline, a framework which, in itself, has become a moving target with rapid changes in the discipline's technological and economic superstructure. This approach has also overlooked the structure of today's complex environmental problems while focusing on the development of single components and elements. Therefore, this volume deals with the question of how to place sustainable thinking – as well as sustainable technology, innovations and mechanical systems – in perspective within the discipline of architecture, while absorbing them in such a way that they become concurrent with disciplinary aesthetics.

For this book, the notion of aesthetics – a vast area for which this is no adequate venue – starts with a general question: How do we sense and perceive our world and further develop an appreciation of it? Departing from this very basic question, one could say that aesthetics in itself is a (scientific) discipline of reflecting on art as mediation between culture and nature. Without extending the question of what aesthetics means in general terms, it would be useful to mention a couple of key notions that may be pertinent to architecture and sustainability; these notions address the relationship between sensory perception (the subjective) and quantifiable measures (the objective), and furthermore, they address the role of architectonics in informing the relationship between the expression of material culture and the environment.

According to Alexander Gottlieb Baumgarten, the 18th century philosopher who coined the term aesthetics,[6] it can be described as a form of knowledge that is gained from that which is sensed. Baumgarten first develops a position that sensory perception can produce a valid form of *knowledge*, and later formulates aesthetics as an investigative work on art and beauty. In essence, Baumgarten proposes that what we sense and perceive, the exteriority of an object, is a manifestation of the invisible or intangible qualities of its interiority, and therefore, that studying the union of the two presents a meaningful approach to gain a certain kind of knowledge. Subsequent to Baumgarten, with the work of Immanuel Kant, we find the artist who exercises his freedom of material and technical choice in producing a work of art that leaves an imprint on nature. And this way, a work of *free art* does not possess an end other than to itself. Here the beauty is found in the work's *purposiveness*, and the experience of beauty is found in the *sense* that a given object serves and *fits* a given purpose.[7]

In the 19th century, Karl Bötticher and Gottfried Semper provide tectonics as a form of aesthetics.[8] For Bötticher (a student of Schinkel) architectonics is an interplay of social and cultural as well as material and physical forces. The amalgamation of these forces determines the purpose of architecture. For Bötticher, the balance of such forces is embodied in the structural order (*Werkform* or *Kernform*) and expressed by the spatial enclosure (*Kunstform*).[9] After Bötticher, Semper (a student of Gauss) discusses "Four Categories of Raw Materials" and the kind of construction that is inherent in each one, categorized in four classes of "textiles, ceramics, tectonics (carpentry) and stereotomy (masonry)." For example, he describes the textiles combined with plasticity (ceramics) and lattices (tubular construction) as *giving shape*.[10] Here, the weaving of narrative, structural, material and environmental aspects serves the purpose of architectural enclosure as mediation that is indivisible from its composition.

In the 20th century, from the work of Louis Sullivan, Adolf Loos, Frank Lloyd Wright and subsequent modernist masters, most notably Le Corbusier and Mies, to the work of today's theorists and practicing architects, the scope and the depth of aesthetics in architecture can indeed be characterized as overwhelming. Without delving into the aesthetics of architecture in this dense century, for the purpose of this book, let us suffice it to propose that:

Aesthetics refers to the expressions in built form that closely relate to the way in which the form is not only conceived but also produced in relation to a certain purpose and its context. In the relationship between form and function as subscribed to by modern architecture, a built form should inform and express the principles of its programmatic, structural, material and spatial qualities. And an aesthetic is supposed to emerge from, as well as be embodied in, the order that ties them together as an indivisible whole. Therefore, in short, if a building or an environment is designed and built to be sustainable, it should inform how it was conceived, and what makes it be so, under what kind of conditions. And in the presence of such a work, it should be perceivable and/or understandable that it serves and fits a certain purpose.

With this limited scope of architectural aesthetics in mind, in this book, the idea of environmental consciousness is framed by two complimentary concepts: *sustainability* and *durability*. Sustainability refers to a *process* that can be maintained and continued for a certain duration, or hypothetically speaking, indefinitely. Being sustainable means that the conditions needed to drive the process can be met, allowing the process to continue into the future.

Durability refers to the *state* of an object. Being durable means that the way an object is made allows it to function for the duration of the purpose it is intended to serve (and possibly beyond) without breaking down irreparably.

Being sustainable, ideally, means that the structures and relations necessary to sustain the process will be available so that it does not exhaust itself or come to a halt due to degradation or some form of failure. On the other hand, durability stands for a method of building that maximizes an object's span of usefulness. In this case, durability is more focused on materials, techniques and assemblies of production in relation to the supposed use of the object. Obviously, the two distinctions, while contrasting, are also complimentary. They may even be characterized as one and the same: a process cannot be sustainable if one cannot foresee how well and how durably the aggregate of various constituents will perform over the course of the supposed lifespan, while no durable measures can be accomplished if one cannot sustain the continuity of materials and techniques without interruption.

In order to provide a concrete and substantive approach for designing architecture in a sustainable and durable manner, these concepts may be combined with the three main strategies of ecological thinking, namely, conservation, efficiency and regeneration.[11] First, conservation attempts to reduce the amount of resources and materials that are spent in the processes of production and consumption, thereby extending the reserves of limited resources. In architecture as well as in daily life in general, this translates to minimizing waste and saving materials through the strategies of reclamation and recycling.

Next, efficiency is directed at maximizing the output or production that can be obtained from a given unit supply of materials, resources or energy. With a strategy of efficiency, we can expect to extract more use from each unit that we consume. In architecture, efficiency may be expressed in the kinds of machines and devices that we use in buildings, such as the boilers or radiators for heating, that are designed to output more heat energy per unit of energy spent. Another common example of efficiency is the km/liter rating for cars. By definition, the strategies of conservation and efficiency form a duality, and they serve a common goal: that of slowing down the depletion – and therefore extending the useful lifespan – of our existing supplies of materials and resources.

The third strategy, that of regeneration, attempts to return materials and energy back to the sources from whence they came in order to compensate for what we extract, use and consume in our industrial processes, thereby replenishing limited natural reserves. This strategy includes, for example, the regeneration of such resources as forests for timber, aquifers for water and other natural resources that are necessary for farming and food supplies. Obviously all three aspects – conservation, efficiency and regeneration –must be seen as complimentary to one another and dealt with simultaneously on a comprehensive scale in order to produce architecture that is both sustainable and durable.

Ultimately this book offers a look at the connective territories that exist in current design practice, including its aesthetics, material economic logic and the quality of life, it is supposed to provide. All design practices, however small or large they may be, attempt to create certain values by situating their production within a context of users and their cultures. These values also spring from social, political and economic environments in place among private businesses and are imprinted in public policies and directives. These two parallel value tracks influence many levels of design, from small ordinary objects to the scale of urban or regional planning. While the work of individual architects or designers may be focused on the practice of aesthetics and the functionality of the everyday objects and buildings they produce, in this collection, the primary question is placed on how such practice may be situated within the principles of designing for sustainability. Given the current debates on sustainability in the design of the built environment, how can one approach the question of what we consider beautiful and useful, and how do we evaluate and judge such objects or processes? In essence, what value track is created with the pursuit of sustainable design?

Published within the past few years, one can easily find countless books dedicated to sustainable design and sustainability. The topics they deal with range from ethical and philosophical issues, to technical manuals and DIY guides for sustainable lifestyles. However, by and large, these publications address only select interests without pursuing fundamental and underlying questions. For example, what are the actual ramifications of sustainable design on the aesthetics of architecture and how we construct our built environments? Is sustainable design adequately represented by technical issues and devices that are supplementary, to be hidden and covered? Can sustainability be implemented as a patchwork of remedies on an ad-hoc basis as we move on? Is the urgency for sustainable design perhaps a call to Arcadia, for a return to a kind of simplicity in our civilization and way of living in tune with the laws of nature? Or as some do argue, does sustainability have little to do with the aesthetics of architecture?

One major obstacle to the understanding of sustainability concerns in architecture is the dominant perception – generated through media snapshots and certification processes such as LEED – that sustainable design may be accomplished by putting together a set of prescriptive parts and measures. There is no doubt that media exposure, evaluation and certification measures have helped to raise a general awareness and consciousness of sustainable design. However, this has promoted an intense marketing of the *sustainable* before the actual substance of the term could establish a firm footing in common architectural practice. In today's culture of commodification, the *appearance* of sustainability has become as important, if not more important, than the actual performance of a given design. Therefore, one of the most fundamental challenges in the practice of sustainable architecture is to develop content that emphasizes a more holistic construct of sustainability, to replace the current construct that has produced only marketable bits and pieces, that as a whole, do not add up.

Today, the common view of sustainable design assumes that a range of mechanistic parts and measures can be put together in a way that is similar to selecting appliances from a catalogue. These may be thought of as *environmental appliances*. The problem with this appliance logic is that, in reality, it is isolated and detached from the consideration of the production-delivery-consumption chain that is currently in place, which has clear environmental problems. After all, the production of environmental appliances relies on the overall infrastructure of energy and material supply. In this sense, the widespread view that sustainable design can be accomplished through a form of mechanistic assembly presents yet another obstacle to approaching a more substantive perspective of the subject matter.

The chapters in this book deal with a set of interrelated and fundamental issues, based on our approach to the use of energy, materials and technology. The first issue, regarding the kind of energy we use and how we use it, has remained at the forefront of environmental and sustainability debates since their inception. It is well understood that our current environmental problems arise, by and large, from the extensive use of fossil fuels such as coal and petroleum, and from the resulting mass emission of greenhouse gases such as carbon dioxide, nitrous oxide and methane that occur with their use. In addition, the release of solid particles, the byproducts of energy consumption and industrial production, pollute the atmosphere and pose health threats to humans and all living organisms. Due to the atmospheric changes that have occurred as a result of our energy use, it is expected that catastrophic climatic events will occur more frequently, the most serious of which will be an increase in the temperature and acidity of ocean waters. Clearly, the connection between design and energy use is evident in the production and operation of individual buildings, and in the larger built environment with its extensive networks for utilities and transportation. If we were successful in changing our patterns of energy use on a widespread scale, how would this affect the practice of architecture from a design standpoint? What role could architecture play in making these changes come about? And what aesthetic potentials are present in the consideration of sustainable or renewable energy, its use and conservation for the field of architecture?

The second issue concerns the extraction, production and assembly of various materials that are used in architecture, detailing the span of their useful lifecycles. As the issue of materials is directly connected to that of energy use, concepts such as embodied energy and potential recyclability represent two energy-related aspects that are important in determining material qualities. Aesthetic features and potentials have come to be measured in relation to materials' visual qualities, but also in relation to their performance, durability and potential hazards. Within the context of the propositions in C2C, for example, the use of certain materials represents a selection process that includes a given material's prospects to fit within a cyclical model of use and reuse: its production and use should foresee and incorporate the potential for continued iterations in the future. And furthermore, in relation to materiality, recent technological developments have made it possible for architecture to incorporate various so-called high-tech materials with attractive performance properties – such as those with high strength-weight ratios and insulating capabilities, and those that are environmentally inert. As the selection and assembly of materials is intimately tied to the aesthetics of architecture, what aesthetic potentials can be found in these current trends of materiality? How can materials be used and approached in a way that improves the sustainability of architectural design? And in the end, can architecture have a positive impact on the way that materials are extracted and produced?

The third issue concerns water sources and consumption, directly translated in terms of drinking water, sanitation and irrigation. Obviously, the way our buildings and cities are designed has immediate impacts on the amount of water we use, how our aquifers, rivers and streams are diverted and how rapidly we deplete or pollute our supplies. Many regions of the world are faced with diminishing aquifers, leading to food shortages from declining crop production, as well as health impacts attributed to water pollution. These include the spread of water-born diseases due to poor sanitation, and the desctruction of fish and wildlife due to the release of industrial chemicals and everyday urban run-off. In some geographical contexts, the lack of clean water for drinking, bathing and agriculture poses perhaps a more immediate and serious threat to human life than the threat posed by greenhouse gases. In order for architecture to be sustainable, it must regard water renewal cycles from a conservation standpoint. Can architecture and urban development be designed in a way that conserves water, using as little as possible, while ensuring that clean water is returned to replenish our aquifers, rivers and streams?

The fourth issue deals with technology and its role in the design process, touching on how the latest design technologies and tools affect architectural thinking, approaches toward a new materiality and architectural aesthetics. Given the recent advances in software and hardware engineering, we have access to more rigorous and accurate means of design and simulation. We use advanced technologies in order to design more efficiently, to produce designs that are optimized for specific uses and performance as well as for the discovery of previously unknown forms. However, the codification schemes and procedures inherent in these technologies not only impact how efficiently we design and produce, but perhaps more importantly, how the historical canons of architecture may change in regard to the discipline's aesthetic foundations. Whether the latest means of design and simulation are implemented in order to increase the efficiency of labor, to increase economic return or to maximize the pure performance of the project, it appears certain that *what* we use to design has changed the way we *conceive* of the design process and its objectives in a profound way.

In this regard, what is the relationship between the use of new technologies in design and environmental consciousness? Do we simply use these tools in order to design and manufacture more products, more cheaply, in less time? Do we fuel and accelerate the rampant excesses in consumerism as a result? What potential does the latest digital technology offer for the design and production of both space and objects in regard to the sustainability of our built environment? Is there an inherent logic in the relationship between efficiency and form, as for example the proponents of the biomimetic process would suggest? For this category, the chapters are focused on the fundamental changes in design, manufacturing and use brought on by technological advances, and how such changes influence and reinforce the practice of sustainable design and its aesthetics.

While addressing this set of set of interrelated and fundamental issues, the chapters in the book can be grouped in terms of historical cases (Nezar Alssayad, Gabriel Arboleda and Vinayak Bharne); theoretical positions (Glenn Hill, Kenneth Frampton, Sang Lee, Stefanie Holzheu, Daniel Jauslin and Matthew Skjonsberg); design and use (Ralph L. Knowles, John Brennan, Keith N. Bothwell, Marie Antoinette Glaser, Minna Sunikka-Blank and Elisabetta Pero); emerging technologies (Luca Finocchicaro, Anne Grete Hestnes, Giancarlo Mangone, Patrick Teuffel and David Briggs); and personal reflections (Matthias Sauerbruch, Louisa Hutton, Kengo Kuma and Harald Røstvik).

In the first chapter of the book, **The Aesthetics of Architectural Consumption,** Glenn Hill argues that the modern era has ushered in an environmentally damaging approach to architecture and development: one that is grounded in the consumption of *architectural opulence* on a mass scale. With larger houses, private amenities and new appliances and fixtures being called for at ever-increasing rates, we see a concomitant decline in the quality our environment. Hill finds that ecologically sustainable architecture has increasingly participated in the aesthetics of mainstream architecture in a process of *normalization*. It is now common to claim that *all* architecture should be sustainable, and with this claim, the potential radicalism of sustainable architecture is blunted; it is now annexed and commodified within the mainstream aesthetic economy while missing the underlying and fundamental issues of what it means to develop in a truly sustainable way. In this context, Hill argues that sustainable architecture is promoted and traded for praise and for the fabrication of positive identities among architects, individuals and corporate clients alike. Following the propositions made in this chapter, Hill looks to the potentials inherent in the *poetic aspect* of architecture that is ecologically sustainable, allowing it to re-gain a sense of radicalism by unveiling the very unsustainable ground of the wider discipline of which it is a part.

In **What Does Sustainability Look Like?** Matthias Sauerbruch and Louisa Hutton, who have focused their practice on environmentally engaging yet aesthetically rigorous buildings, present their views on the state of architecture in relation to environmental problems and on how to approach them. They open the discussion by stating that the West, with its culture of excessive consumption, is largely responsible for the state of ecological damage on the planet. In response they suggest that developed countries have to lead in the creation of efficient energies, and at the same time, to change their wasteful patterns of behaviors and lifestyles. They argue that changing lifestyles is the most effective way to reduce energy and carbon emissions, and suggest producing the kind of carbon-free products that are so attractive that people will want to use them. In their view, people will accept such products when they demonstrate that a reduction in consumption does not necessarily mean a reduction in quality. This approach might be an opportunity "to create a new rapport with society at large and to respond to the needs and imaginations of *normal* people without falling into the traps of cliché and kitsch" while addressing environmental problems.

Sauerbruch and Hutton call for architects to express this changed paradigm by using an appropriate and positive architectural language that signifies a new beginning in relation to the environment. They believe that the challenge for architects is to develop a language in order to create spaces that communicate with people on an intuitive level. To this end, they argue, when architects employ space, surface and light intelligently, they will be able to fulfill more than just the goals of efficiency and economy, while moving toward the creation of architecture that is both sensuous and sustainable.

In the chapter entitled **Solar Aesthetic**, Ralph L. Knowles, a pioneer of what is known as the solar envelope zoning method, chronicles and reflects on the experiments and research projects he has focused on for the past fifty years. His chapter begins with the idea that solar cycles can inform the production of “natural” forms for building, while Knowles introduces his pioneering work on the solar envelope zoning method. He argues that solar cycles have shaped human civilization and its rituals for millennia, and that designing around these cycles and their rhythms presents one way to create architecture that is engaged “in a dialogue with nature.”

The chapter, composed of three parts, demonstrates how building forms can be derived from observing the sun’s path and how such forms can be applied in different contexts and configurations. In the first part, Knowles describes the experiments conducted at Auburn University in 1962. These experiments plotted the formal potentials of sunlight, gravity and the combination of the two. In the second part, Knowles explains the subsequent developments from his work at the University of Southern California. In this phase, he explains how the study focused on “the aesthetic consequences of generating uniquely adaptive forms by following the sun's path to satisfy specified conditions of incident solar energy” by working “directly with earth-sun geometry to generate form.”

In the third part of the chapter, Knowles introduces the concept of “Interstitium” that is the culmination of his work on finding the space formed by the sun’s trajectory. The concept, he explains, "supports the design of dynamic architectural elements that connect directly to the rhythms of nature."

In **The Architecture of the Passively Tempered Environment**, Keith N. Bothwell discusses how buildings that work passively to regulate the environment have historically provided comfort for living and a haven against the extremes of the natural climate. He argues that the principles of the passive approach were established as far back in history as the Renaissance architectural treatises, and that even today, they provide a valid basis for the design of sustainable architecture. Despite this legacy of passively conditioned architecture, Bothwell finds that the knowledge and principles that underlie the approach are regularly compromised by unnecessary aesthetic and personal prejudices with no apparent rational foundation. This results in buildings that do not perform as well as they are supposed to in terms of regulating the environment and climate, while expending more energy than expected. Therefore in his article, Bothwell explores the field of passive environmental design, focusing on the fault lines that occur between knowledge, understanding, intention and achievement in the process of designing sustainable buildings, fault lines that prevent recent buildings from reaching their full capacity to reduce carbon emissions.

Next, John Brennan positions his article **Qualitative and Quantitative Traditions in Sustainable Design** from the perspective of the *home* where he finds a historically definable narrative for ecologically conscious domestic design, approaching the topic with theoretical discussions and examples from his own practice. Brennan's article addresses the relationship between architecture and the deployment of technology, as underscored by sustainable principles. At the core of his article is a differentiation between scientific reason and technological control, citing the work of the social theorist Jürgen Habermas. Based on these propositions, he seeks to situate the so-called trends of *eco-design* within the quantitative traditions of domestic architecture.

In the context of his article, Brennan sketches out some persistent and fundamental questions: What *exactly* constitutes sustainable architecture? Should the definition be divorced from the notion of technical performance? Can any kind of architecture be sustainable if it meets defined quantitative, technical benchmarks? He states that he has come to believe that external variables such as landscape, climate and response to social and economic criteria for sustainability are more important than measurable performance and stylistic appearance. Based on his understanding of established scholarship, Brennan attempts to determine how the quantitative and qualitative traditions may exist together in sustainable architecture in both historic and practical terms. The article concludes with the notion that there is no seamless clarity from theory to practice, and that sustainable design should discount neither scientific empiricism nor the rich, qualitative experience in architecture.

In his chapter, **Urbanization and Its Discontents: Megaform and Sustainability**, Kenneth Frampton regards the fundamental environmental problems that are inherent in our current patterns of automobile-based suburban sprawl, and in our current model of architectural academia. In response, he proposes the theory of the *megaform*. His argument begins with a criticism of the excess typical of contemporary societies, especially in the US, and of the subsequent failure to create more equitable, environmentally coherent urban conditions. In his criticism, he cites a series of apparent problems and dangers that the current model of development faces, and sets out the basis of sustainability as a nature-culture interplay. This interplay may be established through the place making potentials of the *megaform*, and here, Frampton distinguishes between *object-forms* and *place-forms*. He continues with the idea that the current model of architectural academia is detrimental to the discipline's full engagement with the issues of sustainability, due to its emphasis on individual creativity. This may led to the production of forms that, while aesthetically pleasing, tend to miss the potentials of sustainability on a fundamental level.

In the end, Frampton concludes that there is no inherent disconnect between environmentally responsive and sustainable design, from design that is culturally stimulating and aesthetically expressive. Sustainability can be framed as an inspiration to enrich and deepen the aesthetics of architecture, rather than as a restriction upon its aesthetic potentials.

Daniel Jauslin, a practicing architect and researcher focused on landscape, opens his chapter **Landscape Aesthetics for Sustainable Architecture** by citing three of the most prominent architects today. They express their skepticism as to whether or not there is such a thing as aesthetics in sustainable architecture, or for that matter, if architecture can indeed be sustainable. Against such a backdrop, Jauslin illustrates what he believes to be the landscape perspective's inherent relationship to the natural environment, the principles behind it as well as the potentials that the landscape perspective holds for sustainable design.

In this chapter, Jauslin first discusses the kind of professional and political impetuses that have made sustainability one of the most compelling changes to face the profession of architecture. He argues that the mandate for a sustainable environment did not come about by choice of the architects and planners, but rather, that sustainability is imposed on the profession by the necessary, external forces that influence it. To bridge the gap that exists from current practice to sustainability, Jauslin traces the thoughts and principles of landscapes and territories that have developed since the 1960's, highlighting how they are indeed highly pertinent to sustainable architecture. This approach views the landscape as a *human interface with nature*, as a basis for the design of sustainable architecture and a new context for sustainable aesthetics.

In the chapter **Building Envelope as Surface,** Sang Lee and Stefanie Holzheu first trace the role that building envelopes play in terms of their functional and presentational qualities, while drawing from a deep historical perspective of what enclosure has meant from the earliest times. They cite three models of building envelopes, namely, the modernist, the Venturian and the mimetic as examples of how the notion of building envelopes has evolved over time, with changes in the architectural discourse. Next, they propose a conceptual construct of building envelopes as *surface.* This discussion is based on the *Leonardo* Surface, a concept proposed by the analytical philosopher Avrum Stroll along with the theory of direct perception by the ecological psychologist James Jerome Gibson.

Subsequently, Lee and Holzheu discuss the philosophical and theoretical dimensions of surface as a concept in relation to Hans-Georg Gadamer and Jacques Derrida. Here, they introduce the notions of mimesis presented by the two philosophers as exemplary in considering the sustainability of architecture, while at the same time, analyzing and critiquing the current mechanistic practice of mimetics in architecture. They propose that being sustainable is, in essence, being mimetic of nature's mediations and relations, while the concept of surface provides a way to establish intimate relations between nature and built environment.

In the chapter entitled **The Sustainable Indigenous Vernacular: Interrogating a Myth**, Nezar AlSayyad and Gabriel Arboleda, in response to the advocates of vernacular architecture, argue that vernacular and indigenous traditions are often *assumed* to be grounded in the types of practices that produce sustainable built environments. They describe how the theoretical tradition that connects climate and the vernacular has often held that architecture originated as a product of necessity and not as a product of aesthetic requirements. It was this tradition that nurtured the *myth* that vernacular architecture is sustainable per se, while contributing to the maintenance of this myth to the present day.

They recognize the need to learn from vernacular traditions that optimize local building materials to provide culturally specific climate comfort, while simultaneously finding an ecological balance of appropriate resource consumption. It is true that many vernacular buildings provide effective and cheap ways of dealing with climate, and that the use of natural and local building materials has been the most distinguished element of these traditions. However, AlSayyad and Arboleda argue that the widely held claim that equates the vernacular with sustainability by default warrants a critical re-evaluation.

To further understand what sustainability means within the regional and historic context of the present day, they analyze a series of case studies that focus on vernacular buildings in different continents, citing four distinct vernacular building techniques. They suggest that the contemporary fascination with the vernacular and its equation with sustainability may be simply characterized as an appreciation of its superficial appearances rather than of its actual sustainable qualities.

In relation to AlSayyad and Arboleda, in the article **The *Qanat*: The Dilemmas of Sustainability & Strategic Conservation in Yazd, Iran**, Vinayak Bharne discusses the situation in the ancient city of Yazd in Iran, proposing that the *re-emergence* of sustainable prerogatives in architecture and urban design has *re-surfaced* the potential importance of vernacular infrastructure traditions. While metropolitan regions rely on modern infrastructure and rural habitats continue to depend on indigenous systems for economic reasons, it is in the transitional layer of expanding historic towns such as Yazd where the issue becomes explicit. Overall, the spread of modern conveniences and modern approaches for water extraction, including dams and mechanized pumps, has contributed to the abandonment of vernacular systems, and to the abandonment of their strategic preservation and reuse.

In this chapter, Bharne explores the dilemmas of sustainability and strategic conservation surrounding the historic *qanats* (subterranean water channels) and *ab anbars* (reservoirs) of Yazd in Iran. He includes the traditional roles of this 3,000-year old arid water system and the reasons for its decline within the socio-political changes of the country. Furthermore, he speculates on the alternatives for preserving *qanats* and *ab anbars*, weighing them against the realities of Yazd today. In so doing, Bharne's article addresses the cultural, ethical and practical dimensions of conserving vernacular infrastructure in a time of looming global water crisis, while seeking to locate a place for such infrastructure within the context of contemporary city making.

With the provoking title, **The Vernacular, the Iconic and the Fake**, Harald Røstvik presents his personal observations and reflections as they relate to sustainable architecture. In this chapter, Røstvik criticizes the state of what he characterizes as indifference and misrepresentation in the profession of architecture in relation to sustainability, as well as the kind of romantic views of the vernacular and the celebration of the iconic that, taken together, may limit a true engagement with sustainability. He argues that despite the palette of advanced digital design tools at hand, architects often resort to repeating and replicating familiar aesthetic forms instead of pursuing innovations toward sustainability; he finds that the very coding systems of these tools encourage repetition. Røstvik goes on to discuss sustainability in the context of various aesthetic traditions including the tight box, the glass box and timber construction. He finds that such trends often miss the substantive issues, and furthermore, that their continued application hinders the search for aesthetic potentials that are inherently present in designing buildings in a sustainable manner.

In **Natural Architecture**, Kengo Kuma provides personal reflections on some of the pointed question he comes across often. First, his central position as a practicing architect is that it is not meaningful to discuss whether a given material is good or bad for the environment without considering the context within which it is used. Therefore, for him, being natural does not automatically mean that a material is good or for that matter sustainable. And being artificially produced or petroleum-based does not automatically mean that a material is bad.

Originally written as part of a collection of his essays sharing the same title, Kuma discusses a few examples of his own work and argues that the materiality and the so-called scientific measures in sustainable design are meaningless if they are not considered in the context of cultural differences. A given culture determines the way certain material parameters are set up and therefore affects the way they are understood; the approaches, materials and designs that may lead to energy conservation and other sustainability measures in one context may not be applicable in another. This is the complex background in which the concept of sustainable architecture should be framed.

Minna Sunikka-Blank, in her chapter drawn from her research work, **The Concept and Aesthetics of Sustainable Building in Japan,** sets up a question: If most environmental technologies are not visible or relate to a building envelope only, which sustainability measures really do have an impact on architecture? Based on her policy analysis and research visit to Japan, Sunikka-Blank describes the concept and aesthetics of sustainable building in the Japanese context. This includes the *material-as-concept* approach, based in terms of timber, structure and adaptability in both vernacular and contemporary architecture. This also includes her finding that despite the lack of insulation typical in Japanese homes, the average household consumes around a third as much energy for heating and cooling compared to that in the UK or Germany. Here Sunikka-Blank describes the energy strategies of Japan in relation to the passive approach and in relation to the behaviors of home energy use, discussing how these may inform sustainability.

In her chapter, Sunikka-Blank goes on to discuss the conceptual differences that exist between the Western and Japanese principles of sustainable building. She speculates whether the Japanese examples, based on the use of raw materials, minimalist aesthetics, passive solar strategies, filigree construction and visual connections to nature, could offer contrasting ideas to our usual ways of sustainable building. Her argument in this regard is framed in contrast to the more prevailing Western model that calls for excessive insulation and capsule-like buildings, isolating themselves from the environment.

Marie Antoinette Glaser, a social anthropologist, discusses in **Durability in Housing – The Aesthetics of the Ordinary,** the case of a housing complex in Zürich where it is evident that the notions of durability, conservation and long-term use are crucial in the development of a sustainable environment. She begins with the idea that housing is an everyday cultural practice, and it is not possible to separate aesthetics from the perspective of use in a residential building. Use is defined as a physical situation of being, located in a place of specific identity. Glaser argues that enduring, sustainable buildings are dynamic and durable, able to change and adapt over time rather than being limited to one kind of use. With her study of the housing complex in Zürich, Glaser observes that residents enter into a relationship and identify with the living space, potentially changing it, while simultaneously, there are constants that remain little changed over the course of time, namely, the building elements, spatial structures, and some usages and functions. She states that peoples' lives leave traces in the houses they occupy, and these traces of usage can provide important information about the prerequisites and conditions for the longevity of residential buildings. In her view, therefore, usage forms the primary *modi* of architecture, as we perceive architecture through use in a way that is synonymous with tactile engagement. Glaser proposes an aesthetic position that defines beauty as a process of long-term use and *habitualization*. Therefore, through durability, a specific kind of beauty in residential buildings can be sustained over time, as they are used and re-used over multiple generations.

In **Environmental Issues as Context**, Elisabetta Pero attempts to reevaluate the term *context* from the viewpoint of environmental issues concerning sustainable architecture. She argues that the idea of sustainability is determined not as much by the technological elements of building design, as those originating from a building's appropriate insertion into the environment. This appropriate situating is carried out by the intelligent and critical application of building traditions. She goes on to state that such an application means thinking in terms of the notion of beauty that is shared among the kind of buildings that are built to last and to remain durable.

In this chapter, Pero contends that a building should be able to accommodate the contemporary needs that are placed on it while also staying flexible. However, within this perspective, the crucial factor is how to design buildings in such way that the construction is durable not only in the physical sense but also in the contextual sense. Pero contends that in order for this to happen, architects must incorporate the environment's concerns as a legitimate part of the notion of context. By citing the works of notable architects in Milan, Pero illustrates past approaches that have been exemplary in their use of contextual composition and technical articulation toward addressing environmental issues.

Matthew Skjonsberg opens his chapter, **Magic, Inc. – Reframing the City,** by asking if the time has come to *reframe* the city. He begins with the reevaluation of our senses of what the city should be, based on the idea that the Greek root of the term aesthetics indicates the cumulative input of all our senses. Furthermore, he argues that the intuitions such as justice, wellbeing and satisfaction are all included in our sensorial sphere. Skjonsberg bring these two streams of thought together with the idea that aesthetics inherently includes a sense of ethics, a position that should inform city making. He continues with the idea that in the current city, the relationship between our sensory (or sensual) experience and the underlying reality is often strained; we do not recognize the real dangers that exist, while perceiving hazards that in reality, are not so. Skjonsberg proposes that architects have the ability to reframe the city in such a way as to emphasize the hidden cause and effect of things, essentially using architecture to unveil a hidden reality. To enact this approach, he calls for a new strategic alchemy in the context of architecture as a discipline, one that uses clever combinations to produce powerful beneficial effects. This approach constitutes a kind of faith on the part of scholars' and practitioners' ability to work within and yet to subvert the systems of governance, economics and construction in which they are situated. In such works of faith, Skjonsberg argues that success will be evidenced by both the work's evolutionary nature and its demonstrable relationship to context and precedent.

Giancarlo Mangone and Patrick Teuffel in their collaboration, **Constructing Sensuous Ecologies: Beyond The Energy Efficiency And Zero-Carbon Argument** propose that designing for the sensuous aspect of human interaction with the environment is a key issue in sustainable architecture. In their view, contemporary buildings are designed in a static way with respect to the ecosystem, typically unable to respond to dynamic environmental changes. As a result, they develop detrimental and parasitic relationships to the ecosystem. This condition leads in significant performance losses for the local natural environment, productivity and creativity, communal and individual wellbeing, as well as for the overall fiscal costs of the building itself. Mangone and Teuffel assert that a more productive approach is to redefine buildings as constructed habitats that engage the local ecosystem and its dynamic processes in an active and interconnected way. This perspective shifts the focus from designing an object, to developing and optimizing the ecological processes of a constructed environment as habitat.

In this chapter, Mangone and Teuffel argue that the concept of sensuous ecologies helps produce innovative and optimally performing designs. The sensuality-based design approach encourages the exploration of intrinsic performance potentials and results in the development of multi-sensory and engaging constructed habitats, where the built environment can sustainably evolve the social, economic and natural ecologies of the contextual site.

In **Symbiosis and Mimesis in the Built Environment**, Luca Finocchiaro and Anne Grete Hestnes explore thoughts surrounding the application of advanced digital modeling technology in architecture. They emphasize that digital tools have modified the creative process in which architecture is conceived, influencing the aesthetics of the resulting project. In their view, the quantitative comparison between the exterior and the desired internal conditions determines the spatial composition and thermal behavior of the building. In this comparison, nature can inspire new models of environmental behavior and form through biomimetics. The forms of nature express aesthetic manifestations of specific needs, while helping to establish the building's symbiotic relations with the exterior environment.

On the basis of physical principles, Finocchiaro and Hestnes assert that the aesthetics of sustainable design can be captured as an equation of forms and dimensions in relation to environmental variables. Constructing based on such equations contains in itself the notion of beauty; and in order to access these equations, mimesis and symbiosis can play crucial roles in informing the internal logic of the artificial environment. They conclude that the aesthetics of sustainable design is an evolving process in which biomimetics points to a coherent evolution of both form and function. This embodies the processes of evolution, and ultimately, may allow architecture to achieve symbiosis with nature.

In the last chapter of the book, **Aesthetic Potentials in an Open Network Inventory System**, David Briggs proposes that there is an opportunity to explore the aesthetic choices that architects make in the design process, and to understand the way that global and local environmental systems are impacted. To this end, and to help mitigate environmental problems, Briggs argues that architects must aggressively find ways to influence industrial processes. This includes taking responsibility for various building materials and their measurable impacts on the environment, with the idea that ultimately, architectural design can feed back and shape the systems of resource extraction, manufacture and supply. Briggs argues that architects are responsible for the materials they use; they do not just sit at the receiving end of the line.

In this perspective, the chapter proposes integrating the creative process with an open network that responds to market forces and environmental consequences, so that the architect can incorporate both creativity and the conditions that define a building's sustainability. With poor oversight of manufacturing processes in developing nations, as well as the challenges inherent in resource management and extraction worldwide, this article is aimed at highlighting the technical and software tools that are currently available – and those that could be developed further – in order to reach a more comprehensive approach to sustainable design.

In this time of heightened environmental consciousness, it is crucial to rethink our material existence for which architecture is indeed a large measure. As we shall see in the discussions that follow, sustainable and durable architecture does not simply consist of discrete changes and replacements that can be checked off of a punch list. It is apparent that architecture as the most distinctive form of human work will only be able to contribute to the sustainability of the built and natural environment by changing its fundamental position within the apparatus that defines the present model of material culture and economy. In this, architecture occupies a unique place as not only an expression of human civilization and its aspirations but also as what situates us in the natural world. This is inherently a position of aesthetics. I hope that this book will serve in the effort to attempt a closer look at the relationship between sustainable architecture and its aesthetics.

NOTES

1 Paul Hawken, Amory B. Lovins & L. Hunter Lovins, *Natural Capitalism* (London: Earthscan, 1999).

2 For more on this, see the vision and mission of the Rocky Mountain Institute, available at http://www.rmi.org/rmi/Vision+and+Mission. Accessed June 5, 2011.

3 William McDonough and Michael Braungart, *Cradle to Cradle: Remaking the Way We Make Things* (New York: North Point Press, 2002).

4 Ibid. p. 111-113.

5 Vitruvius wrote of a certain foreign tribe's use of an indigenous mud building technique that "makes their winters very warm and their summers very cool." However he also concludes that the mud and thatch architecture is a "reminder of the fashions of old times" (Ten Books of Architecture, Book II, p. 39-40).

6 Alexander Gottlieb Baumgarten published Aesthetica in 1735. It was coined after his construction in Greek, episteme aisthetike, the kind of knowledge that is gained through the senses. For more on this, see Patrick Healy, *Beauty and the Sublime* (Amsterdam: Sun Publishers, 2003), 7-8.

7 Immanuel Kant, *Critique of Judgment* (New York: Cosimo Classics, 2007) 121.

8 As an introduction to both, see Kenneth Frampton, "Chapter 8: Botticher, Sepmer and the Tectonic: Core Form and Art Form," in *What Is Architecture?* ed. Andrew Ballantyne (New York: Routledge, 2002), 138-152.

9 For more on this see Mitchell Schwarzer, "Ontology and Representation in Karl Bötticher's Theory of Tectonics," *Journal of the Society of Architectural Historians* Vol. 52, No. 3 (Sept. 1993): 267-280.

10 Gottfried Semper, *Style in the Technical and Tectonic Arts*, trans. Harry Francis Mallgrave and Michael Robinson (Los Angeles: Getty Publications, 2004), 110.

11 The three strategies literally refer to those outlined in the book by Reyner Banham, *The Architecture of the Well-tempered Environment, 2nd Edition* (London: The Architectural Press, 1984), 22-25.

9.318 words

The Aesthetics of Architectural Consumption

Glen Hill

Architectural Consumption

Since the inception of modernity, architecture has increasingly become both a primary site of commodity accumulation, *and* one of its most significant commodities. This process has implicated architecture in ever-increasing patterns of energy and resource use, contributing significantly to what is now viewed as a global condition of unsustainability.

The exponential increase in architecture's contribution to unsustainable consumption is starkly illustrated in the shift in housing requirements from the beginning of the twentieth century to the present. [1] In Australia, although household size almost halved over the course of the twentieth century, [2] the floor area of the average home more than doubled, [3] resulting in a dramatic increase in per capita resource consumption. As house size grew, so did the material "quality" of the domestic environment. The first wave of mass domestic technologization – following the provision of service infrastructure at the beginning of the twentieth century – saw the introduction of internal bathrooms and laundries and "labor-saving" appliances such as refrigerators and washing machines. Kitchen size and the standard of kitchen appointments increased, and the number of bathrooms per house proliferated. Energy consumption multipliers, such as the number of light fittings and power outlets per room, also increased incrementally. The thermal environment of internal spaces was more closely controlled by supplementary heating and cooling, and by the end of the century, domestic air conditioning became commonplace. [4]

The privatization of previously shared public facilities also had a dramatic impact on resource consumption. Outdoor recreational services previously provided by public parks and playgrounds were duplicated by the basketball hoops, soccer practice nets and play equipment that populated private suburban backyards. A proliferation of backyard swimming pools, replicating the services previously provided so efficiently by public swimming pools, not only multiplied the consumption of resources required for pool construction but also created an ongoing burden of energy use for a vastly underutilized commodity. Previously shared indoor recreational facilities, such as social clubs, pool halls and cinemas, were also privately replicated, appearing as pool rooms, bar areas, and cinema and media rooms within the home. Exacerbating all of these new trajectories of domestic consumption, the frequency of home renovation and replacement also increased. And (as if it could be worse) rather than renewing only deteriorated or non-functional portions of the home and reusing existing furnishings and appliances, the so-called "Diderot effect" [5] meant that with each home renovation or new home purchase, home occupiers aspired to acquire a "total look" of new matching suites of home furnishings and fittings, multiplying consumption, redundancy and waste.

The Freedom to Consume

While in pre-modernity, overt consumption was often displayed in the architectural opulence of a small number of elites, modernity brought the unprecedented and environmentally calamitous phenomenon of the mass consumption of architectural "opulence." Here a critical *inversion* in the conventional understanding of the relation between modernity and consumption must be highlighted. It was not simply that greater numbers of individuals gained a greater capacity to consume because of burgeoning technological and economic development that allowed increasing resource consumption. I suggest the reverse is true. Technological development, and the momentously changed lifestyles of modernity, had, at their very foundations, the necessity for individuals to consume. To appreciate this, it is critical to understand the fundamental difference between the project of modernity and the condition of pre-modernity. [6]

In the pre-modern view, one's place within a given social order was immutable. In the traditional Hindu caste system, for example, there was an acceptance that the caste one was born into was fixed for life. Shifting between castes – from a Vaishya (merchant caste) to a Brahmin (priestly caste) for instance – would not just be impossible, it would simply not show itself as a possibility. The only sanctioned way to gain the regard of one's peers was to be as good a member of one's caste as possible. [7] Whether in Asia, Europe or elsewhere, the pre-modern world defined itself by adherence to a fixed, often god-given order, binding all parts of society: ruler and ruled, master and servant, husband and wife, child and parent.

In contrast to the inertia of the pre-modern world, in modernity we find ourselves, as Marshall Berman recognised, "In an environment that promises adventure, power, joy, growth, transformation of ourselves and the world – and at the same time, that threatens to destroy everything we have, everything we know, everything we are." [8] Modern life, David Harvey argues, is "Suffused with the sense of the fleeting, the ephemeral, the fragmentary, and the contingent . . . modernity can have no respect for its own past, let alone that of any pre-modern social order." [9] In modernity, there is neither commitment to a geographic place nor acceptance of placement within a social order. We are physically migratory, readily relocating ourselves, our family, our home, and our workplace. And we are socially migratory, changing our occupation, our level of education, our bodies, our friends, our spouse, and with that even our children.

In terms of Martin Heidegger's concept of the "projectedness" of being, [10] it can be argued that in the shift from the pre-modern to the modern, the project of being itself has shifted. I refer here not to one project among many that society hands over to us, but rather, to the overarching project within which all other projects of everyday life are nested, and in terms of which all other projects make sense. In the pre-modern world, the overarching project might be described as "an acceptance and a commitment to the place one has been given." In line with Heidegger's conception that the projects already projected ahead of us are normally unnoticed, this central project of pre-modernity would not be thematically pursued as we might pursue a goal. Instead, it would be so self-evident, so ubiquitous as to be transparent. Only in the event of transgression would it disclose itself. [11]

The enlightenment eroded and eventually supplanted this pre-modern commitment to "the given." As Harvey points out, in contrast to the stability of the pre-modern world:

> Enlightenment thinkers welcomed the maelstrom of change and saw the transitions, the fleeting, the fragmentary as a necessary condition through which the modernising project could be achieved. Doctrines of equality, liberty, faith in human intelligence (once allowed the benefits of education), and universal reason abounded. [12]

The removal of a (god-) given place as the ground for being left a void which each individual in modernity must now build over. Where in pre-modernity our place was given, in modernity we are free to make our own place. This has brought with it both the freedom and the anxiety that is the condition of modern life. To slightly misuse Jean-Paul Sratre's words, "we are condemned to be free." [13]

The Consumption of Aesthetics

How then have we proceeded with the project of making our place within the radical freedom of modernity? One dominant way in which an individual's place has been constructed is through *consumption bound to aesthetics*. This is certainly not the route advocated by enlightenment thinkers, and yet aesthetically organized consumption has shadowed the enlightenment project from its outset.

Georg Simmel noted that from the early Renaissance, the aesthetic qualities of a person's mode of dress increasingly operated to construct the public face of their personal identity. [14] In mediaeval Europe, dress styles were relatively stable, and played a role in communicating a person's place within the fairly fixed social order. From the latter half of the fourteenth century, the "lower" social ranks began imitating the style of dress of the "upper" social ranks, though difference was still maintained through variation in the quality of fabric and detailing. [15] By the sixteenth century, servants were attempting to follow more closely the style and quality of their masters' dress. Resentment was aired in the claim that if servants were allowed to be "fashionable", it would become impossible to tell "who was the mistress and who was the maid." [16] The only recourse the upper social ranks had for this incursion onto their public identity was to keep changing dress style in order to maintain difference. The (now familiar) result was the ever-quickening cycle of fashion transformations.

Like clothing, buildings in pre-modernity played a role in communicating the occupant's place within the social strata of a community. Rules dictating the aesthetic qualities of buildings not only maintained the legibility of the occupant's station, but also helped suppress consumption associated with aesthetic competition. Transformations during the early modern period – such as the growing wealth of the merchant class and the dissemination of concepts of egalitarianism and individualism – saw the weakening of the commitment to a (god-) given social order, the erosion of the notion of decorum in buildings and clothing, and the reversal of previously powerful prejudices against unnecessary consumption. [17] With these changes, architectural aesthetics, like sartorial aesthetics, was freed to become a commodity in the struggle for place and the regard of others. [18]

Modernity's dissolution of the decorous relation between building form and use(r) not only allowed those aspiring to social mobility to exploit traditionally established relationships between aesthetics and status (by dressing or building like an aristocrat for example), it also made possible the invention of new aesthetic trajectories for both traditional and non-traditional building types. Jean Nicholas Durand's use of a mathematized classicism at the close of the eighteenth century is often identified as a key moment in undermining the meaning and authority of the classical tradition. In the nineteenth century, the arbitrary relation between form and program was highlighted in the historicist application of a smorgasbord of styles to potentially any building type. In the early twentieth century, the cubist forms of heroic modernism managed to briefly cloak the arbitrary relation between aesthetics and function. [19] But in the latter part of the twentieth century the full potential of a capricious relation between form and program was revealed in the playful aesthetics of post-modernism. The aesthetic economy of late modernity, freed from any necessary relation with program or context, now offers a vast range of aesthetic trajectories that can be exploited in the constant search for place and the regard of others.

In this way, the epochal shift from pre-modernity to modernity did not merely set free the genie of consumption previously held in place by traditionally accepted relations between form, use and user, and by instruments such as sumptuary laws. Rather, faced with the void left by the removal of one's given place, modernity had at its very foundations, the necessity for individuals to consume in order to construct their place. If the overarching project of being for the pre-modern world was "to be in a way that is appropriate to one's (ascribed) place" then in modernity the overarching project of being is "to be in another('s) place." In other words, in modernity we have always already projected ahead of us the possibility that we can — and indeed should — be other than we are, in another place than we are. Consumption, bound to an economy of aesthetics, is the most expeditious way to try to be in "another('s)" place.

The Aesthetics of Modernity

The term "aesthetics" arrives with modernity. The pre-modern world did not have a conception of aesthetics as it is now understood. There was certainly a conception of beauty, but beauty was not a matter of sensory affect or taste, as it became in modernity. For pre-modernity, for a thing to be beautiful it must appropriately reflect the given-ness of the moral order of a tradition or of God. Hans-Georg Gadammer says simply that for the pre-modern, to be beautiful was to be good. [20] Thus when Vitruvius insists that architectural beauty is achieved through "proportion", he is referring not only to the proportional system embodied in the classical orders, but to spatial use, spatial layout and ornamentation being "in proportion" to its context and to the station of its occupants.. Likewise, a medieval church was beautiful not because of the sensory pleasure invoked by its vertical spatiality, rich statuary and stained glass, but because of its didactic capacity to orient mortals toward heaven and and provide a visually legible moral education to an illiterate congregation.

Sir Henry Wotton's now familiar seventeenth century translation of the Vitruvian term *venustas* (Latin, meaning beauty) as "delight" is symptomatic of the shift toward the modern sensorial notion of aesthetics. [21] The Shorter Oxford Dictionary captures the evolution of the modern meaning of *aesthetics* as: "Received by the senses" (1798); "Of or pertaining to the appreciation or criticism of the beautiful" (1831); and "Having or showing refined taste; in accordance with good taste" (1871). [22] This transformation of meaning reflects a larger shift in self-understanding that occurred at the outset of modernity, where, for the first time, the perceiving subject was conceptualised as separate from the surrounding world of objects. Once separated, for a subject to have knowledge of an object, the subject needed to receive sense data from the object, hence the 1798 definition of aesthetics. With the separation of subject from object, the object itself could be conceived as having particular "aesthetic" qualities that made it appear beautiful, hence the 1831 definition of aesthetics. Finally, once it was conceived that beauty arrives from the objective qualities of the object, then those subjects capable of perceiving these qualities were deemed to have "taste", hence the 1871 definition of aesthetics.

The current discourse of aesthetics reflects the confusion caused by modernity's separation of subject and object. In contemporary texts on aesthetics, the term aesthetics may refer either to subjective experience (the sensation of encountering beauty) or the qualities of the object (the characteristics that give rise to the sensation of beauty). The complexity arising from this fluidity of meaning, combined with differences of use in multiple disciplines, leads to unwieldy definitions of aesthetics such as the following:

> The term 'aesthetic' has been used to designate an experience, the quality of an object, a feeling of pleasure, classicism in art, a judgment of taste, the capacity of perception, a value, attitude, the theory of art, the doctrine of beauty, a state of the spirit, contemplative receptivity, an emotion, an intention, a way of life, the faculty of sensibility, a branch of philosophy, a type of subjectivity, the merit of certain forms, and an act of expression. [23]

Dalibor Veseley's critique of architectural aesthetics recognizes how the subject-object dichotomy has created an apparent opposition between objectively quantifiable domains such as science and mathematics, and the subjective realms of feelings, imagination and beauty – the domain now occupied by aesthetics. Veseley argues that this is a false dichotomy, as it is the experience of subjectivity that simultaneously discloses the possibility of objectivity:

> This [opposition] . . . is a misconception, and in fact a contradiction. Science, technology, and aesthetics belong together. The development of scientific objectivity depends . . . on the subject responsible for the project of science. In other words, the more objective reality becomes, the more subjective must be the position of the individual who encounters in modern science by definition, as it were, only his or her own projection of reality. One might conclude that objectivity in science is in fact the product of human subjectivity. [24]

Other post-structuralist scholars have also been critical of attempts to discuss aesthetics either in terms of an objective set of characteristics that account for the beauty of a thing, or as a subjective sensation of beauty that arises in the encounter with a beautiful object. Alternative interpretations, such as those offered by Martin Heidegger (which shall be returned to at the end of this chapter), not only disclose the weaknesses in the subject-object account of aesthetics, but also demonstrate how the subject-object account itself belongs to a metaphysical understanding that has led to modernity's reduction of the earth to a mere resource.

The Production of Aesthetics

If, as an interim position, we accept Wotton's intuitive insight that the character of modern aesthetic experience is "delight" rather than classical notions of "goodness" or "appropriateness," then aesthetics in modernity defines itself in relation to the sensorial. Delight, as a *noticed* pleasurable sensorial affect, also implies the possibility of its other, the noticing of a negative sensorial affect. Accordingly, aesthetic experience in modernity could be said to be the noticing (as pleasure, repulsion, elation, and so on) of the look, feel, sound, taste, or smell of something, where "the look" has become hegemonic.

But *noticing* architectural aesthetics is not our primary experience of architecture. On the contrary, architecture has a tendency to withdraw into the background of daily life. [25] Walter Benjamin, concurring that architecture is seldom noticed thematically in everyday experience, contrasted the experience of architecture with that of art. Art, Benjamin observed, is most commonly encountered in what he described as a state of "absorption" – a deliberate and thematised noticing of the art. [26] Whereas architecture is most often encountered in what he described as a state of "distraction" – where the architecture is not the focus of thematic attention, but forms the background for other focal activities. [27] Considered in terms of Heidegger's insight that we are pressing toward nestings of generally unnoticed projects, architecture encountered in a mode of distraction can be seen to be the facilitator of these projects rather than their theme. [28] For example, the architecture of a domestic living room (now dominated by the presence of the TV screen) provides the unnoticed background conditions – the appropriate weather protection, acoustic insulation and thermal comfort – to allow us to undistractedly attend to a TV show.

Yet when architecture is reflected upon, noticing, particularly noticing "the look" of architecture, is given prominence in the architectural imagination. It is here that Cynthia Davidson recognizes architecture's envy of art. [29] Architects, she suggests, desire their architecture to remain noticed, like art, and not disappear into the background of habit. In modernity, not just the architect's but also the client's cachet is dependent upon maintaining their architecture's aesthetic presence. However, because it is inevitable that with everyday use architecture will eventually withdraw into the background, then the most effective way for an architect to ensure their work remains noticed is to maintain the production of difference; that is, to keep producing fresh work. This opens a path toward an aesthetic economy of architecture in which the need for constant production of "the new" is matched to the need for its endless consumption.

While in pre-modernity, architectural form was guided by the authority of tradition, the shift from pre-modernity to modernity removed the authoritative architectural vocabulary of the past – including the canons of the Western Classical tradition – and left a void in the guidance of architectural form. The ever-changing aesthetic trajectories of the modern aesthetic economy filled that void, and facilitated the ongoing construction and reconstruction of identity of both the consumers and producers of architecture. A multitude of aesthetic trajectories now constitute the aesthetic economy. In the Australian architectural context, there currently exist numerous intersecting, overlapping and competing aesthetic trajectories in various states of prosperity or decay. Aesthetic trajectories that might be identified include: minimalist and modernist 'bar-code' architecture, digitally generated 'mesh,' 'filigree' and 'media screen' architecture, 'folding' architecture, and occasional remnants of Deconstructivist architecture, among others.

The suggestion that architects today draw from, and contribute to, an aesthetic economy constituted by the circulation of multiple aesthetic trajectories is clearly opposed to the conception of aesthetics as the organic outcome of the socio-cultural, economic, environmental and technological possibilities of a particular architectural context. While context-specific contingencies such as functional requirements, available technologies and site conditions, will circumscribe the range of aesthetic outcomes that are possible, they do not determine them. Even within the boundaries of what, at any historical moment, is technologically possible and culturally thinkable, there is still an unlimited number of aesthetic trajectories that might be brought into being in the development of a design outcome. [30] An architect would for example have little problem developing a number of different aesthetic outcomes for the same project brief. Likewise, design competitions provide evidence of contemporaneous architects deploying different aesthetic trajectories for an identical program, in an identical technological, cultural and environmental context.

Interpreting the Aesthetic Economy

Contemporary architectural theorists have suggested that the proliferation of ever-changing styles that now populate the aesthetic economy has resulted in the irrelevance of style itself. [31] However, the discussion to date would suggest that the reverse is true: that the ever quickening pace of aesthetic change is a manifestation of the *importance* of the competitive positioning of both architect and client within the aesthetic economy. Significantly, while the aesthetic trajectories that proliferate in late modernity no longer carry *traditionally* agreed meanings, they nevertheless still carry meaning. Each “look” has a significance that can be interpreted with precision by a particular community in a particular context. Regardless of whether it is clothes, architecture, or any other aestheticised commodity, there exists a refined capacity to recognize what is new or old, what is “cool” or passé, what will (make us) “fit in” or (make us) “stand out” in a given context.

Stanley Fish's concept of "interpretive communities" offers a theoretical frame for understanding the differing valuations of aesthetic trajectories, and how they transform over time. An interpretive community is a group who shares a particular interpretation in a particular interpretive context. But, as Fish points out, an interpretive community is "not so much a group of individuals who shared a point of view, but a point of view or way of organizing experience that shared individuals." [32] Interpretive communities are ephemeral and fluid, with individuals disaggregating and re-aggregating around different interpretations in different contexts. An individual may at one moment be part of one community in their political orientation, and at another moment be part of a quite different community in their sporting or sexual orientation. As well as changing their interpretive communities in relation to each different issue, individuals can be seen to change interpretive communities in relation to the same issue over time: as they age, mature, change interests and affiliations, or as they respond to the transformation of interpretive communities themselves. In terms of aesthetics, an *aesthetic interpretive community* would be an ephemeral aggregation of interpreters who share a similar interpretation of a particular aesthetic trajectory in a context in which aesthetics was at issue. This might be as simple as a shared like or dislike for a particular aesthetic in a particular context.

An interpretive community's shared aesthetic interpretation is never simply the product of the material qualities of the object being interpreted, but is instead constructed by the authority of the discursive formations of the context of interpretation. [33] Considering again Simmel's illustration of the maid and the mistress in early modernity, it is evident that the aesthetic attraction of the mistress' clothes is not a natural outcome of the quality of the clothes themselves. [34] From our context in the twenty-first century, we might agree that the clothes used fabrics or colours in interesting ways, that they were well made, or that they had good thermal properties. But we would be unlikely to think, "I want to wear those clothes!" So too the maid's desire for the clothing is authorised by aspects that exceed the quality or performance of the clothing. In terms of the earlier discussion, it might be said that the maid desires the regard of others that she anticipates she will receive when wearing the clothes. The clothing's form, authorised by its association with the station of the mistress, constructs the anticipation of the regard of others for the maid and her peers. As previously argued, deploying aesthetics to secure the regard of others is integral to the necessity of constructing one's place in modernity.

In the early modern period, the maid's understanding of the world of the mistress as a site of desire would have been gained through an intimate involvement with that world. In late modernity we now have a smorgasbord of places that might show up as desired, but few of these would be understood from first-hand experience. Actual understanding of places of desire has been *augmented*, and often entirely replaced, by the authority of multitudinal forms of media. In an architectural context, an interpretive community of, for example, home buyers might have their aesthetic preferences organised by lifestyle television programs, home-maker magazines, or the media portrayal of suburban life itself. [35] Similarly, the aesthetic preferences of a particular architectural interpretive community might be constructed through the authority of a narrow range of architectural journals, professional architectural awards and competitions, or the discourse of "star" architects. And an interpretive community of avant-garde architects might look beyond architecture, and find authority in the discourse and practice of art, as was historically the case with modernism.

Authority relations among interpretive communities generate flows of aesthetic influence. In the sartorial fashion industry for example, an interpretive community of off-the-rack fashion designers may find authority in the aesthetic innovations of haute couture fashion collections. The aesthetic trajectory of a couture collection might therefore be reinterpreted and appear in an off-the-rack line in a later season. In a more everyday context, a teenager's fashion choices might be little influenced by their parents' interpretive communities, but greatly influenced by their own peer group. In an architectural context, authority might cascade from the interpretive communities of avant-garde architects, to mainstream architectural interpretive communities, to non-architectural interpretive communities. In the Australian context, it is evident that the proliferation of faux-historic project home styles, particularly Queen Anne style (or Federation style as it is referred to in Australia) is the outcome of reinterpretation by successive strata of interpretive communities: first the valorizing of postmodernism by international avant-garde architects in the 1980's, followed by the historicist post-modern house designs of mainstream Australian architects, and ending in the faux historicism of a multitude of suburban homes.

The imperative of belonging to contextually appropriate aesthetic interpretive communities is revealed in everyday situations where allegiance to particular interpretive communities could result in outcomes ranging from unspoken acceptance or rejection to vocal admiration or ridicule. The consequence of not belonging to appropriate, authorized and normalized interpretive communities ranges from personal discomfort to tangible disadvantage. Dressing "inappropriately" might, for example, impede securing a job or advancing in employment, while designing in an "outdated" architectural style might result in less saleable or rentable buildings, or fewer future commissions,. From Vitruvius to Venturi, Corbusier to Koolhaas, the ubiquity within architectural history of attempts to promote one aesthetic position over others evidences the importance of belonging to successful aesthetic trajectories.

The appearance of ever-new aesthetic trajectories within the aesthetic economy mitigates against long term alignment with any particular trajectory. In modernity, the valorizing of new aesthetic trajectories, which in the same movement is a marginalizing of existing trajectories, is evident in every authorising discourse: from professional architectural journals which almost exclusively celebrate the new, to architectural histories which focus on inflection points where new aesthetic trajectories emerge from the midst of the old. The continual arrival of new aesthetic trajectories within the aesthetic economy may be seen as a potential threat or opportunity, as new trajectories may burgeon and old trajectories may wane. Survival – and I use this word without hyperbole – not only involves navigating existing aesthetic trajectories, but occasionally jumping ship to new trajectories when existing trajectories are devalued by the new.

The constant devaluation of the "old" in the flux of the aesthetic economy is the engine of aesthetically grounded consumption. Not just success, but everyday survival, depends on temporary alignments with contextually appropriate aesthetic trajectories. This formulation rejects aesthetic theories that contend that objects have "inherent beauty," that some subjects might have special faculties of "taste", or that some designers might have special gifts of creative "genius." Instead, this argument posits that the immediate, potent and visceral response to an encountered aesthetic trajectory is the result of already belonging to an interpretive community aligned with that trajectory or that the aesthetic arrives as part of a discourse that has authority for that interpretive community. Either way, the valuation of the aesthetic can be seen as constructed, subject to variation from one interpretive community to another, and subject to change over time. Modernity's valorization of the new, bound to the perception that creating and adopting the new can bring the regard of others, ensures the constant appearance of the new within the aesthetic economy. But as new aesthetic trajectories come into being and are adopted, older aesthetic trajectories lose their capacity to engender regard (and might even bring stigma) and as such, they are devalued.

The continual creation and adoption of new aesthetic trajectories is far from innocuous, as the environmental impacts are significant. On one hand, the acquisition of the "new stuff" that arrives with each new aesthetic, accelerates resource consumption and ecosystem destruction. On the other hand, "older stuff" is forced to become waste long before its functional life is over. This burgeoning "aesthetic obsolescence" means that human waste is increasingly "aesthetic waste". Aesthetics, as it manifests in modernity, has thus become the driver of the reciprocal conditions of consumption and waste.

The Aesthetic Economy of Sustainable Architecture

Because "sustainable architecture" is most often considered in terms of technical performance, discussion of the ways in which aesthetics relates to sustainability has been limited. Where the role of aesthetics in relation to sustainable architecture is discussed, the arguments often prove slippery.. For example, Edward Winters' recent book, *Architectural Aesthetics*, which proposes positive possibilities for architectural aesthetics, uses a particular work of sustainable architecture as a key illustration. Winters begins with a big claim for the architecture he is about to discuss:

> Let us conclude this chapter with an example of a work of architecture which I take to be as important as any in the contemporary world. Its importance lies in the fact that it establishes an aesthetic by instantiating a moral view. [36]

This seems promising, as Winters is linking aesthetics to a moral position and not to the potentially problematic notions of taste, genius or inherent beauty. Winters continues:

> The building is the house designed and owned by Jeremy Till and his partner Sarah Wigglesworth. It is an energy-efficient, sustainable building. But what is remarkable about the building is that its sustainability and its energy efficiency are not merely the kind of additional features that are unsightly and merely functional clutter. [37]

Here Winters has, at least momentarily, set aside the promising "moral view" of the building's significance in favour of a "formal view" that the building's significance lies in its ability to subsume the sustainable technologies within the visual order of the architecture (rather than exposing them as "clutter"). However, by valorizing this formal strategy it would seem that Winters is simply articulating a perhaps unrecognized prejudice in favor of one aesthetic, "order", and against another, "disorder". The next step in Winters' argument reintroduces the moral aspect of his claim:

> This house, built of bails of straw and sand bags, among other things, takes the political and moral strand of energy and makes a work of architecture in which we find aesthetic pleasure. [38]

With this assertion, the moral and aesthetic dimensions of Winters' argument appear to have been separated. As I understand him, Winters appears to be saying firstly that the architects have been morally responsible in their choice of sand bags and straw bails (local materials with low embodied energy and good thermal performance), and secondly they have used these materials to create architecture in which "we find aesthetic pleasure". Besides the obvious problem that the author cannot know whether or not "we" find aesthetic pleasure in the building , the argument seems to have been reduced to the rather bland claim that the strategies of sustainable architecture, such as energy and resource conservation, should be used in a way that is aesthetically pleasing. Winters concludes his assessment of the house with the assertion that:

> It is the fact that the house is built with authority and responsibility that we engage with it at an aesthetic level. Its beauty resides in the political and moral objectives that it rightly pursues. [39]

The first sentence reiterates the previous claim that the building's pleasing aesthetic arises from the deft control of architectural form, thus demonstrating the "authority" of the architect, combined with the use of morally appropriate sustainable design strategies, demonstrating the "responsibility" of the architect. The final sentence however contradicts the previous argument that the building's pleasing aesthetic arises from formal manipulation of the materials and passive design strategies, and suggests instead that the building's "beauty" is the outcome of its moral stance, that is, its use of sustainable design strategies.

Winters' discussion leaves us with two irreconcilable claims. The first, that the building's beauty is an outcome of its "moral objectives", aligns with the pre-modern view that to be beautiful is to be good. The second, that the "aesthetic pleasure" engendered by the building is the outcome of the formal disciplining of the sustainable technologies to produce "order" rather than "clutter", implies that "moral objectives" are insufficient to produce beauty. The implication is that if "moral" strategies and materials are integrated into one aesthetic trajectory ("order") they produce beauty, but if they are integrated into a different aesthetic trajectory ("clutter") they do not. This evidences a forgetting, common to modernity, that the positions we hold to be "truths" are instead the parochial product of belonging to particular interpretive communities.

Winters' argument has not been rehearsed simply because it contains contradictions. His claims are important because they mirror significant tensions that have arisen in the discussion of aesthetics in relation to sustainable architecture over its short history. In the 1960's, responses to the ecological crisis were most prominently manifested in movements advocating radical alternatives to the establishment order that was identified as the source of the crisis. Architectural manifestations of these reactionary positions, such as "Drop City" at the level of the community, and the "Autonomous House" at the level of the individual, were radical departures from the normalized ways of living of the time. [40] Because this architecture was often produced through incremental, "bottom-up" processes, the aesthetics of these movements could be one of disorder, or to use Winters' term, "clutter." For example, in 1974 the first Australian autonomous house, influenced by the early work of Brenda and Robert Vale, [41] was built on marginal land on the campus of the University of Sydney by students and staff of the faculty of architecture. [42] It was demolished only a few years later. The reason cited by the university administration was its "unsightliness". [43]

From the beginning of the 1970's, when a spate of professional architectural conferences around the world focused on the environmental crisis, [44] environmental architecture was promoted within the profession. One promotional strategy was to introduce a new category of design awards for environmentally considerate architecture. A separate category was considered necessary because it was feared that the environmental architecture of the time would not be of a design quality that would be competitive within mainstream award categories. [45] While these strategies were genuine attempts to bring environmental considerations to "mainstream" architectural production, they also had the effect of drawing radical or marginal environmental architectural practice into the normalizing regime of the architectural establishment. Aesthetically, the architecture awarded under the new environmental categories tended not to be disordered and cluttered. [46] Thus, Winters' tacit advocacy of a particular aesthetic prejudice can be seen as a manifestation of a longer history of the aesthetic normalizing, and perhaps also the de-radicalizing, of environmental architecture.

The deployment of sustainable strategies and technologies is now so commonplace in architectural practice that there are often calls for the removal of the conceptual separation between architecture and sustainable architecture. All architecture, it is argued, should be sustainable architecture. In terms of aesthetics, the authority of sustainability is now such that the formal attributes of particular active and passive strategies are generating their own influential aesthetic trajectories. Examples include the extensive use of twin glass facades to create a ventilated cavity housing shading devices and maintenance walkways , and the use of fixed and dynamic sun control louvers and screens to an extent where they become the dominant external aesthetic of the building.

The integration of sustainable strategies and technologies into global architectural practice gives the appearance that architecture is becoming more sustainable. However, it might instead be argued that sustainable architecture has been captured by the commodifying forces of late modernity of which the aesthetic economy is a driver. Rather than instantiating a sustainable way of living, as significant early environmental architecture attempted, sustainable architecture now focuses on technological strategies to maintain an arguably unsustainable way of being for the least energy and resource cost. By drawing sustainable architecture into the aesthetic economy, sustainable architecture is subject to the process of endless aesthetic devaluing and aesthetic obsolescence. Inversely, the authority of the formal strategies of sustainable architecture now contributes to the devaluing and revaluing of aesthetic trajectories generally. Thus through its incorporation within the aesthetic economy, sustainable architecture participates in the burgeoning cycle of consumption and waste that underlies the environmental crisis.

The Sustainable Art of Subverting Aesthetics

In her recent article discussing the place of aesthetics in sustainable landscape architecture, Elizabeth Meyer reviews competing professional attitudes to sustainability in current landscape architectural practice. [47] As an outcome of reviewing these stances on sustainability, Meyer suggests that a new aesthetic sensibility is emerging, and with it a new *role* for aesthetics. The new aesthetic, she suggests, is not pretty or ordered. On the contrary, she argues that: “Antiquated conceptions of landscape beauty as generic, balanced, smooth, bounded, charming, pleasing and harmonious persist and must be re-examined.” [48] The new aesthetic instead requires “framing messy landscapes.” [49] Its “sustainable beauty” Meyer argues “will be of its place whether an abandoned brownfield site, an obsolete naval shipyard, or a lumbered forest.” [50] The new aesthetic thus reflects an understanding of nature not as "balanced, ordered and harmonious," but instead as "dynamic", manifesting "resilience, adaption and disturbance." [48]

But if this were the limit of Meyer's claim for aesthetics it would amount to little more than Winters' position except that the aesthetic prejudice has been reversed, with disorder being privileged over order. However Meyer has a strategic reason for promoting this new, confronting aesthetic. Concurring with Benjamin's understanding that in everyday experience architecture is generally not the focus of attention, Meyer claims that "designed landscapes are usually experienced while distracted, in the course of everyday urban life." [49] Mirroring the architects' previously described wish to resist this withdrawal into the background, Meyer suggests that landscape architecture should be designed "so that it draws the attention of an urban audience distracted by daily concerns of work and family, or the over-stimulation of the digital world." [50] The opportunity opened by resisting withdrawal from presence and encouraging "a spatial practice of noticing" [51] is that landscape architecture might then be able to reveal the ecological ground of human dwelling, or in Meyers words, "lead to new awareness of the rhythms and cycles necessary to sustain and regenerate life." [52] For Meyer, the way in which landscape architecture could gain the attention necessary to perform this act is through the deployment of this grittier, messier aesthetic. As Meyer states, such "new challenging forms of beauty can lead to attentiveness." [53]

The call for an aesthetic that will be *noticed*, returns the discussion full circle to the earlier theme of this chapter. The difference though is that the earlier discussion presented aesthetics as seeking to be noticed as part of an unending quest for the regard of others in the context of an ever-changing aesthetic economy. Now however it is being suggested that architecture might be capable of revealing something beyond the "social standing" of the owner, the "pleasure" of the viewer, or the "genius" of the maker. Referring to the revelatory potential of landscape design as its "art", Meyer points to the possibility that this art might contribute to the revealing of something foundational in relation to the environmental crisis itself. In Meyer's case, this is the revealing of ecological systems as the ground for human existence.

The rejection of modernity's aesthetic categories and the claim that art has the capacity to reveal the "ground of being" is central to Heiddeggers' stance in relation to art. Discussing both Heidegger and Benjamin's rejection of modern aesthetics, Krzysztof Ziarek suggests that:

> Moving the discussion beyond aesthetic categories means not only relinquishing the paradigm of the subject as the governing cognitive scheme, with its corollary notions of beauty, taste and genius, but, and primarily, exploring the link between the poetic in art and the poetic in experience. [54]

In this view, art, or more precisely the poetic dimension of art, is not a passive thing to be looked at. It is instead active it "works". The work that a work of art does is *to reveal its world*. All of the arts, including architecture, have the potential of a poetic dimension that might do this work. But what does it mean for a work of art to reveal its world? Marcel Duchamp's artwork, entitled "Fountain", from his Readymade series, provides one example of this possibility. The work, a factory-made urinal placed into an art gallery, reveals that it is not the quality of the work but its context within an art museum that makes it art. The work thus discloses the constructed ground of art itself. It subverts the very world of modern art making, art collection and art display, of which it is a part, and thereby brings into question the (commodity) value that is placed on all art.

Following the arguments in this chapter, what might be hoped for from sustainable architecture, or more properly its poetic aspect, is the capacity to reveal the unsustainable ground of our world, [55] and architecture's role within it. If sustainable architecture is to be truly sustainable it cannot simply be an assemblage of energy reducing technologies, wrapped in a “delightful” aesthetic package. This approach simply draws architecture back into the world of the aesthetic economy, a world of endlessly competing interpretive communities, commodification, and ultimately the environmental cost of aesthetic obsolescence and waste.

Examples of architecture that might have the capacity to reveal their world in such a way were hinted at earlier. “Drop city”, whose confronting presentation of an alternative way of living, housed within an architecture constructed of human detritus, cannot help but invoke its other the squandering affluence of “developed” cultures. A more recent illustration, that fits more comfortably into contemporary aesthetic trajectories, might be the series of projects from Samuel Mockbee’s Rural studio. The Mason’s Bend Community Center for example, with its sweeping walls of recycled car tyres below, and its fish scales of recycled car windscreens above, not only reveals a world of prematurely wasted human artefacts but also a world of prematurely wasted human lives.

The aesthetic dilemma of sustainable architecture can have no simple resolution. The discussion to date, and the illustrations provided, leave many questions unanswered. How, for example, can architecture that stands forward from its context in order to reveal its world, avoid being transformed into yet another “spectacular” aesthetic trajectory competing for attention in the commodified aesthetic economy? The danger seems unavoidable. Nevertheless, the glimmer of hope remains that architecture may still have some capacity, in a world overwhelmed by the forces of commodification, to reveal those very forces.

NOTES:

1 While overall growth in consumption related to housing during this period has been profound, it has not necessarily been uniform. Consider for example Germany's *Existenzminimum* movement of the late 1920's or, more generally, the period of austerity in much of the West during and immediately after WWII.

2 " . . . households have consistently declined in average size, so that by 1996 there was an average 2.64 persons compared with 4.53 in 1911 . . ." See Australian Bureau of Statistics: *A Century of Population Change in Australia, Catalog No. 1301.0* (2001). http://www.abs.gov.au/ausstats/abs@.nsf/94713ad445ff1425ca25682000192af2/0b82c2f2654c3694ca2569de002139d9!OpenDocument (accessed January 15, 2011).

3 "In 1900, the average house was around 150 square metres. But by 1950 it had grown to 200 square metres, by 1990 to 250 square metres and by 2005 it had reached 325 square metres."

See Ross Elliott: "Myth # 4 Increasing House Sizes Mean Urban Sprawl" in *Residential Development Council: Property Council of Australia* (Sept. 2007)

http://www.propertyoz.com.au/Article/Resource.aspx?media=461(accessed January 15, 2011).

4 "Refrigerated air conditioner sales in Australia had a distinct increase over the past 25 years from less than 100,000 units per year in 1980 to more than 900,000 units per year in 2006."

See Wasim Saman, Frank Bruno and Ming Liu: "Technical Background: Research on Evaporative Air Conditioners and Feasibility of Rating their Water Consumption" in the *Water Efficiency Labelling and Standards (WELS) Scheme*, Department of the Environment, Water, Heritage and the Arts, by the Institute for Sustainable Systems and Technologies, University of South Australia (Sept. 2009).

5 Grant McCracken: *Culture and Consumption: New Approaches to the Symbolic Character of Consumer Goods and Activities* (Bloomington and Indianapolis: Indiana University Press, 1988) pp. 118-129.

6 "Pre-modern" and "modern" are interpreted here not as historical periods, but as interpretive perspectives that appear and disappear within history, and may co-exist at the same time. This differentiation takes its cue from Martin Heidegger's thinking on the change in the mode of deployment of technology and science in modernity. Modern science and technology are taken here as those "enframed" by the "essence of technology." See Martin Heidegger: *The Question Concerning Technology and Other Essays*, translated by William Lovitt (New York: Harper Torchbooks, 1977) pp. 3-35.

7 Gaining status through ritual performance appropriate to one's caste for example. See Himadri Roy Chaudhuri and Sitanath Majumdar: "Of Diamonds and Desire: Understanding Conspicuous Consumption from a Contemporary Marketing Perspective" in *Academy of Marketing Science Review, Vol. 11* (2006) http://www.amsreview.org/articles/chaudhuri08-2005.pdf (accessed January 15, 2011).

8 Marshall Berman: *All That is Solid Melts into Air: The Experience of Modernity* (London: Versa, 1983) pp. 14-15.

9 David Harvey: *The Condition of Postmodernity: An Enquiry into the Origins of Cultural Change* (Oxford: Basil Blackwell, 1989) p.11.

10 For an explanation of Heidegger's existential projectedness, see Hubert L. Dreyfus: *Being-in-the-World: A Commentary on Heidegger's Being and Time, Division I* (Cambridge Mass.: MIT Press, 1991) p. 186ff.

11 Such transgressions would show up as "disturbances" to our unfolding projects. See Hubert L. Dreyfus: *Being-in-the-World: A Commentary on Heidegger's Being and Time, Division I* (Cambridge Mass.: MIT Press, 1991) p. 70ff.

12 David Harvey: *The Condition of Postmodernity: An Enquiry into the Origins of Cultural Change* (Oxford: Basil Blackwell, 1989) p. 13.

13 Jean-Paul Satre: *Being and Nothingness: A Phenomenological Essay on Ontology* (New York: Washington Square Press, 1992).

14 Georg Simmel: "Fashion" in *American Journal of Sociology, 62* (1957) pp. 541-58. First published 1904.

15 Diana De Marly: *Working Dress: A History of Occupational Clothing* (New York: Holmes & Meier, 1986). See also Efrat Tseelon: *The Masque of Femininity: the Presentation of Woman in Everyday Life* (London: Thousand Oaks, 1995).

16 Diana De Marly: *Working Dress: A History of Occupational Clothing* (New York: Holmes & Meier, 1986) p. 41.

17 For an account of the overturning of European prejudices against consumption in the early eighteenth century, see Michael Kwass: "Ordering the World of Goods: Consumer Revolution and the Classification of Objects in Eighteenth-Century France" in *Representations*, *no. 82* (Spring 2003) p. 90.

18 Discussing the recognition by eighteenth century Western thinkers of the significance of gaining the regard of others, Michael Kwass notes that "luxury was by definition subject to display, its very purpose in contemporary society to draw the regard of others." Michael Kwass: "Ordering the World of Goods: Consumer Revolution and the Classification of Objects in Eighteenth-Century France" in *Representations*, *no. 82* (Spring 2003) p. 90.

19 For a discussion of the Modern Movement in architecture as the manifestation of an aesthetic, see Mark Wigley: *White Walls Designer Dresses: The Fashioning of Modern Architecture* (Cambridge Mass.: MIT Press, 1995).

20 Hans-Georg Gadamer: *Truth and Method,* translated by Joel Weinsheimer and Donald G. Marshall (New York: Continuum, 1994).

21 Henry Wootton: *The Elements of Architecture* (Farnborough: Gregg, 1969). First published 1624.

22 William Little: *The Shorter Oxford English Dictionary on Historical Principles*, *Third Edition Revised with Addenda* (London: Oxford University Press, 1968).

23 What this large heterogeneous list clearly indicates is that aesthetics has not been able to define its object. In some cases it refers to certain characteristics of the subject or effects on them. In others, it deals with the qualities of the object, the qualities of an act, or the analysis of a social practice such as art and even of a certain period or style of that practice. See Katya Mandoki: *Everyday Aesthetics, Prosaics, the Play of Culture and Social Identities* (Aldershot: Ashgate, 2007) p. 3.

24 Dalibor Vesely: *Architecture in the Age of Divided Representation: The Question of Creativity in the Shadow of Production* (Cambridge Mass.: MIT Press, 2004) p. 249.

25 For a discussion of the "transparency" of everyday things in the world, see Hubert L. Dreyfus: *Being-in-the-World: A Commentary on Heidegger's Being and Time, Division I* (Cambridge Mass.: MIT Press, 1991), p. 63ff.

26 Art, it might be argued, is also noticed because it is infrequently encountered and is framed (quite literally) as separate from the everyday. See Walter Benjamin "The Work of Art in the Age of Mechanical Reproduction" in *Illuminations* (London: Fontana Press, 1992) pp. 211-44. First published 1936.

27 Indeed it might be claimed that in this capacity architecture has to be habituated, to become background, allowing the essential possibility of focusing on important things: the new, the different, the flux of life itself.

28 One aesthetic encounter with architecture that is, however, akin to the aesthetic appreciation of art is, as Benjamin himself noted in *The Work of Art in the Age of Mechanical Reproduction* a tourist's encounter with architecture. Here the architecture is the focus of attention. The tourist accumulates views and snapshots of the architecture as memories and mementos of the look, sounds, tastes and smells of alien places. In Heidegger's terms, architecture becomes the theme of the tourist's project rather than its unnoticed facilitator. It is the encounter with the new and the different that draws the attention of the tourist, as the brevity of the tourist's stay does not allow time for the architecture to disappear into habit.

29 Cynthia Davidson: "The Placeless Anyplace" in Cynthia Davidson (ed.): *Anyplace* (New York: Anyone Corporation, 1995) p. 8.

30 It is impossible to achieve architecture whose form is solely determined by functional considerations. Without exception, every step of architectural production also requires aesthetic decisions, minor or major.

31 Concern over the irrelevance of style may indicate some anxiety on the part of both architectural historians and aspiring avant-garde architects as their projects are threatened by this myriad of styles: firstly because the diversity of architectural styles does not allow the historian any total position from which to catalog, and secondly because the avant-garde architect cannot establish a position of difference (and thus leadership) within the disjunctive diversity of extant styles. See for example Bart Lootsma's discussion of the impact of the explosion of styles in the wake of postmodernism: *Insiders, the Style of Choice* (Oct. 2009)

http://www.architecturaltheory.eu/index.php?lang=EN&id=staff&sub_id=4&det_id=archive&PHPSESSID=1d7948527733b78b75f67aedf13e93a6&archive_id=331&PHPSESSID=1d7948527733b78b75f67aedf13e93a6 (accessed January 15, 2010).

32 Stanley Fish: *Doing What Comes Naturally: Change, Rhetoric, and the Practices of Theory in Literature and Legal Studies* (Durham, NC: Duke University Press, 1989) p. 141.

33 Discursive formations, as the historical ground upon which something is or is not sayable or knowable, are described by Michel Foucault: *The Archaeology of Knowledge* (New York: Pantheon, 1972).

34 Even images we might assume to be universally beautiful, such as aspects of nature, can be shown to be historically and culturally contingent.

35 For an extended discussion of an example of the deliberate construction of desire for modernist commodities, see Greg Castillo: "Domesticating the Cold War: Household Consumption as Propaganda in Marshall Plan Germany" in *Journal of Contemporary History, Vol: 40, No. 2*. April 2005. pp. 261-288.

36 Edward Winters: *Aesthetics and Architecture* (New York: Continuum, 2007) p. 161.

37 Ibid.

38 Ibid.

39 Ibid.

40 Indicating the importance of changing one's way of being in this early ecological architecture, the occupants of the Autonomous House built in 1974 at the University of Sydney stated that, "Perhaps true autonomy also means freedom from commercial radio, television, daily papers and advertising which do much to determine what people think they need. Entertainment in this house has been largely self-generated, this has meant making

conversation and music which was found to be more personally productive than accepting external stimulation. People can be extremely adaptable to new situations, the absence of former comforts seems to be quickly forgotten, a good indication of how non-essential they actually are. The curtain divided sleeping lofts of the autonomous house, although lacking aural privacy, are in some respects more private than conventional bedrooms. The extremely small size of the spaces means that they are rarely visited, even by other members of the house and so they remain a space 'sacred' to the occupant . . . The house, then, is not so much a showplace of alternative technology, but more the physical manifestation of a particular lifestyle." Anonymous, possibly Colin James, University of Sydney academic in "54 Alma Street Darlington" (c.1977) http://sydney.edu.au/architecture/documents/research/autonomoushouse.pdf (accessed January 15, 2011).

41 Brenda Vale: *The Autonomous House*, Dissertation (Cambridge: University of Cambridge, Department of Architecture, Technical Research Division, 1972). The catalog date indicates that microfiche of the dissertation became available to Sydney University researchers shortly after it was completed.

42 Alternative Technology Unit, Department of Architecture, University of Sydney: "Alternative Technology: Australian Autonomy" in *Architectural Design, vol.1, n.1* (1977) pp. 15-17; http://sydney.edu.au/architecture/documents/research/autonomoushouse2.pdf (accessed January 15, 2011); See also Anonymous: "54 Alma Street Darlington."

43 Jim Dale (director): "Autonomous House" 25 minute color film (c.1980) Catalog: http://fmx01dhs.ucc.usyd.edu.au/fmi/iwp/res/iwp_auth.html (accessed January 15, 2011).

44 The 1972 RIBA conference for example was entitled "Designing for Survival, Architects and the Environmental Crisis." These conferences were part of a larger movement

of growing awareness and concern over the perceived state of the environment: in 1971 Greenpeace was formed; in 1972 the first United Nations Conference on the Human Environment was held in Stockholm, Sweden from June 5-16.

45 By 1978 the Victorian Chapter of the Royal Australian Institute of Architects (RAIA) had introduced “Environmental Awards” as an architectural award category according to *Architecture Australia, Vol. 67, no. 5* (Nov. 1978) p. 64. In 1980 the Victorian Chapter awarded an “Energy Efficient Building Medal” according to *Architecture Australia, Vol. 69, No. 6* (Jan. 1981) p. 39.

“The National Award for Sustainable Architecture” still exists as a separate category in the Australian Institute of Architecture National Architecture Awards. For current and previous award winners in this category see

http://www.architecture.com.au/i-cms?page=14552 (site January 15, 2011).

46 Jury citations indicate that there has been a focus on aesthetics and technological innovations, rather than on the way of life instantiated. See current and past jury citations for “The National Award fro Sustainable Architecture”

http://www.architecture.com.au/i-cms?page=14552 (accessed January 15, 2011).

47 Elizabeth K. Meyer: “Sustaining Beauty: the Performance of Appearance: A Manifesto in Three Parts” in *Journal of Landscape Architecture* (Spring 2008) pp. 6-23.

48 Ibid. p. 19.

49 Ibid. p. 16.

50 Ibid. p. 19.

48 Ibid. pp. 16-20.

49 Ibid. p. 17.

50 Ibid. p. 17.

51 Ibid. p. 20.

52 Ibid. p. 15.

53 Ibid. p. 21.

54 Krzysztof Ziarek: "After Aesthetics: Heidegger and Benjamin on Art and Experience" in *Philosophy Today, 41:1* (1997) p. 5.

55 This ground is for Heidegger a groundless ground or 'unground' (*Un-grund)*. For a discussion of the nature of 'unground' see Hubert L. Dreyfus: *Being-in-the-World: A Commentary on Heidegger's Being and Time, Division I* (Cambridge Mass.: MIT Press, 1991) p. 155ff.

4552 words

What Does Sustainability Look Like?

Matthias Sauerbruch and Louisa Hutton

It is clear that the central issue at the beginning of the 21st century is the question of climate change and the foreseeable scarcity of resources. All other global problems are by and large connected to this core challenge. Only if we can find ways to cope with the rising demand of an expanding global population do we have a chance to maintain life, as we know it. Western societies have been leading the way in the establishment of relatively stable, democratic and free political systems but they have also been leading the culture of excessive consumption that is largely responsible for the ecological damage on the planet. The North has become an ecological debtor to the less developed South. And while the less developed countries are fast catching up in terms of democratization as well as the consumption-based economic model, it is undoubtedly the North that has to accept its leading role emphatically and demonstrate that fair societies can be sustained without exhausting the planet.

Generally speaking, the two options that bring us forward in the campaign to reduce our oversized ecological footprint are a reduction in demand and technological innovation. Only with considerable innovation in the technologies of energy production and/or carbon capture will we be able to meet demands in a sustainable way: thus, highly developed countries have to research the efficient use of (renewable) energies at every level and they have to reduce energy consumption at the same time. However, the latter will require behavioral change; that is, people will have to review their lifestyles.

Construction as a field obviously has to contribute to this change and hence the most pressing question for architects right now is how they can help, and how this activity may affect their thinking and professional habits and conventions. Again, the same two directions seem worth considering: the passive reduction of unnecessary energy consumption through intelligent design and the active application of energy-saving or energy-producing technology. One of the key questions in this is the scale of operation: does it make sense to apply these technologies on the level of individual buildings? Should one try to harvest energy in a decentralized system on every roof or should one concentrate on the optimization of centralized power plant systems? The figures suggest that the latter option is clearly more efficient and effective, but experience also shows that the former is faster and much more adaptable. So, as we proceed through the years of experimentation and learning, it is probably wise to explore all possible options simultaneously on all scales.

The new paradigm has to affect our conception of buildings beyond the understanding and application of these new technologies. We have to learn to think in life-cycles; we have to rediscover climate as a generating factor for design; we have to understand how our buildings operate and we have to see them as living entities. In this there are obviously quantifiable aspects, which are being explored everywhere with increasing intensity. How much insulation, what percentage of glazing, what type of solar protection, what type of ventilation, what heating or cooling system – all of these questions can be answered with the appropriate calculations. However, beyond the quantifiable there is an agenda for quality.

Architecture, more than any other cultural medium, is an expression of its time. Once a new building has been erected, it is likely to last for generations; the sites we know today bear the hallmarks of the past in which they were created. If architecture is consciously or unconsciously a receptacle and expression of the culture of a society at a particular time, then each new concept or design for a building holds both its present and its *futurepast*. Naturally, this also means that an interest in these contents and a critical relationship to them is necessary for one's own work; if the product of our activity manifests into what future generations will measure our present age by, then we ought to give it some thought.

It is futile to ask whether the social and cultural phenomena of an age are reflected in its architecture, or whether architecture and its architects to some extent give an age its form. We would consider that the former case is more likely, although in some fortunate cases a form may develop as a thought gains currency, so that they become almost synonymous with one another.

We must see buildings as things that ought to last at least fifty years or longer, and one of the questions that we therefore ask ourselves is what may guarantee this longevity. *Solidity* seems the obvious answer and, indeed, well-chosen materiality and appropriate detailing help in this respect. However, when you observe which buildings are maintained, kept and cherished by people, it will not just be the solid ones but also those that are loved for what they are: buildings that are practical, spacious, that surprise and delight; buildings that form a positive part of people's lives; buildings that are more than mere scientific constructions. After all, our general aim in the preservation of the environment is about wellbeing for this and future generations. Wellbeing is largely judged subjectively by every individual according to his or her sensual perception. Hence we deliberately try to address the senses with our buildings, and aim to stimulate a condition of bodily response. Our work with volume and color – at least partly – follows this agenda, as does the manipulation of material, light and space. It is here that we hope to be able to influence the behavioral aspect of sustainability. A change of lifestyles is still the easiest way to reduce energy and carbon emissions: if we were to walk and use bicycles; if we reduced air travel; if we were happy with one house and one car; if we ate local food and less meat. The chances that these behavioral changes will happen voluntarily are slim, though.

One phenomenon of our age's culture that cries out to be physically manifested, since it is so present in everyone's consciousness, is without doubt our interest in sustainability and ecology. This interest stems from a concern regarding the wasteful and careless treatment of the natural environment, as well as a worry about the survival of the planet and its population. Disaster scenarios about the imminent overpopulation of the world, the exhaustion of natural resources, about climate changes and their resulting natural catastrophes are all familiar accompaniments to any consideration of this subject. Building as such is affected by this without a doubt: for one thing, built structures are the greatest enemy of the natural environment, contributing to the waste of land and resources, as well as the excessive use of fossil fuels and pollution of the atmosphere. Carefully thought out buildings can indeed slow down the catastrophic change of our environment.

The alternative is to create a carbon-free product that is so attractive that people will want to have it. If something can really be shown to be consuming less, after considering the whole life-cycle, while being highly attractive at the same time, people would accept it. Architecture is a perfect area where one could apply such a combination of reason and seduction. Architecture can literally be an advertisement for these alternative lifestyles and show that reduction in consumption does not necessarily mean a reduction in quality. Architecture itself, in its capacity to create places with sensuous atmospheres, will be a convincing compensation for the loss of old-style luxuries, and can thus be the avant-garde of a different world through the physicality of its buildings.

This is a very refreshing perspective for a profession that has all but disappeared from the mainstream of cultural engagement – partly because its own discourses seem to have detached themselves so much from people's everyday lives. This might therefore be an opportunity to create a new rapport with society at large and to respond to the needs and imaginations of *normal* people without falling into the traps of cliché and kitsch.

For another thing, architecture is present everywhere; it is more suitable than any other discipline to act as a medium to express a change in the antagonistic relationship between nature and civilization in a visually comprehensible way. Architecture could become an agent of a changed attitude and practice in dealing with nature and its resources. Besides serving the purposes of their owners and users, buildings have to fulfill a fundamental duty toward society, that is, toward the urban environment in which they are located. If this built environment that constantly surrounds everything changes, the people within it will change as well.

That a turn of this sort would become necessary was clear at the latest after the publication of *The Limits of Growth* sponsored by the Club of Rome in 1968.[1] However, another twenty years or so were to pass until the majority of society really responded to the book's conclusions. In the meantime, a variety of fringe groups had prepared the ground. Consequently, *eco-architecture* was difficult to integrate in its early years. It tended to be practiced by apolitical loners, and was anti-establishment, anti-industrial, anti-urban and characterized by a yearning for some vague notion of a pre-civilization state. Another twenty years since then, the world has become digital and global; the rate of technological progress has accelerated enormously and inexorably; and climate change is well on its way. At the beginning of the 21st century, architecture also started to react significantly to the paradigm change. In this context, it is possible to identify three main trends in Europe.

First, the orthodox green groups of the late 1960's still exist. The ideas that tended to be propagated by hippies in the past are now the domain of *experts* who want to come to grips with them in a scientific manner. This approach emphasizes the quantifiable aspects of building rather than the qualitative ones. In Germany, the main result of their activities has been the enactment of energy-conservation laws, which drastically reduce the permissible energy consumption of buildings. In Britain and the US similar organizations have also set up schemes to evaluate and list what is sustainable in building, awarding credits according to listed criteria so that buildings fulfilling enough of these criteria can be BREEAM (UK) or LEED (US) certified. Among the aspects for which credits can be awarded are the use of recyclable materials, the use of renewable energies, integration with public transport, the provision of bicycle parking and neighborhood support. These lists are very useful as planning aids, even though they include some items taught in first-year design seminars: solar orientation, adequate natural lighting of all work areas and massing the building to reduce surface area.

Beyond that, these lists are of little use as blueprints for a new type of architecture: they are no more than compilations of functional requirements, directives on ways of working, summaries of measurable quantities that ultimately give no information about the architectural quality of a building. On the contrary, architecture and its aesthetics tend to be looked at skeptically in such circles. And with a heavy focus on the technical and quantifiable aspects of building, we already see a tendency in German municipalities that a building may be reduced to a temporary storage of materials that will become building waste in the future.

Second, the political movements that sprang up in the late 1960's initially included ecology in their programs only as a topic of secondary importance. The Left revered the city of the 19th century and supported numerous initiatives to preserve it. This reverence was often linked to criticism of the excessive property speculation at the time, and to criticism of a post-war policy that – owing to its almost naïve trust in technology and progress and its desire to change and improve (almost) everything that had gone before it – destroyed much of what deserved to have been kept. This reverence for the 19th century city increased along with criticism of capitalist society in general, and of its mistakes in the areas of town planning and architecture in particular. And from this criticism grew the myth of a *better* past that ought to be re-established in a new urban framework. Hand in hand with this new conservatism came a deeply rooted skepticism toward progress and technology, and a yearning for an undisturbed identity, especially in Germany.

For many people, even today, the term *sustainability* is connected not just with the desire for a responsible approach to the natural resources of the planet, but also with a yearning for continuity and familiarity. In the contradiction between the momentum of global development and the wish for personal stability, the aesthetics of the past seem to promise an obvious way out of the dilemmas of the present. This is why sustainability in architecture is closely associated with the way things have always been. After all, such problems as environmental pollution, resource shortages and alienation from other people didn't exist before, so can't we simply go back to the good old days? This instinctive and erroneous conclusion is deliberately maintained by historically eclectic architecture out of sheer opportunism. It conveys the message that what looks like an old building also functions like one, and that what looks old will also last longer.

Thus people's unease about nature is assuaged, since their own willingness to accept real change is low. They would really prefer to *save* the planet without changing their habits of wasteful consumption. That is why the term *sustainability* has spread so quickly throughout the retail industry, applied to consumer goods from books to clothes, from food to cars. Everything is organically farmed, carefully processed, fairly traded, good for one's health and more ecologically safe than ever. The message this broadcasts is that you can have both: unbridled satisfaction and *ecological correctness*. Here, sustainability is not a question of doing without, but of improved quality that justifies a higher price and also placates the conscience. The classical clichés of luxury (old, monumental buildings, for example) come together with added ecological value in an iconographic *coherence* that does not require any explanation.

The third trend influencing the shape of sustainable architecture covers an entire genre, dedicated to incorporating ecological building in the tradition of a language that stands for technology and progress. In this case, the *performative* aspect of building – the fact that a building, like a car or a machine, should be judged according to its performance data – leads to the false conclusion that ecological architecture should develop exclusively from the consideration of functional form. *Form follows performance* arouses memories of the early years of functionalism and Le Corbusier's appeals to the architectural profession, in which he invoked the beauty of pure engineering construction (in contrast to the eclecticism rampant at the beginning of the 20th century) and seemed to suggest that beauty could virtually be calculated. The impression given here is that ecology is a question of cleverer technology. Progress lies in optimized systems; of course this would also include developing materials to the limits of their capacity. Today the process begun by Buckminster Fuller is looking for new models in bionics, with the idea that buildings could behave like animals or other natural organisms. Here too, iconography plays a critical role. Buildings with biomorphic forms are supposed to function like living organisms as well. Given the relatively primitive nature of building, there are few respects in which this comparison with complex living organisms can hold valid. The synergy with nature remains a mere intent, however; behind the mimicry of engineering, supposedly approaching the natural, one glimpses what in reality is the pure chauvinism of feasibility, a wishful thinking to out-maneuver nature with what are effectively its own means and thus to consolidate power over it. If the things created in the course of doing so ultimately fail to satisfy the requirement of sustainability in their performance and expression, this will be, so to speak, a *natural* side effect.

Thus it is imperative that every sustainable building carries the message of "change that we can believe in" – a quote from a different field altogether. That is not to say that buildings have to be new for newness' sake, but it is clearly the challenge for this and future generations of architects to express the changed paradigm in which we find ourselves, using an appropriate and positive architectural language that signifies a new beginning.

It is certainly correct that numerous ecological aspects are quantifiable and that therefore, the success of different architectural strategies is to some degree measurable. And it certainly is not wrong that components developed wholly on the basis of their functionality – in response to climate, for example – may develop a performance-related aesthetic. At the same time, however, in the assessment of what could be sustainable there still remains a large area that is not measurable, which is left to the subjective judgment of individuals: to the designing architect on the one hand and the subsequent user on the other. The ecological movement came into being to create a world worth living in for this generation and for those to come. It is left up to our own personal experience to determine exactly what an environment worth living in is. To put it more precisely, to a large extent the quality of life offered by the built environment can be measured only by our own personal sensory apparatus. The term *comfort* which is frequently used – even by engineers – to describe such aspects as user satisfaction at the workplace is evidence of the ambiguity of our way of looking at such things. Sustainable architecture therefore has to address and stimulate the senses of its users.

What makes the scientist feel uneasy should be a welcome challenge to the architect, because it means that a space for interpretation has opened up for architects to ply their proper trade. What is needed are built spaces where material quality, lighting and color stimulate the senses; spaces on a scale that evoke feelings of shelter and security, as well as astonishment and surprise; spaces that do not fob off the fear of an uncertain future with the same old clichés, but seek to allay it intelligently, transparently and comprehensibly. A building ought to be able to react intelligently to the needs of its occupants, but also, the occupants ought to learn to understand the building. The primary instrument in this is bodily perception, which also opens the way to an intellectual understanding of ecological concepts. That is why we should not just ask ourselves what sustainability looks like, but also what it feels, sounds and smells like, and ultimately what it really is: what is the character, the personality of sustainability?

Given our work, it is obvious that we are interested in Gottfried Semper's argument that the external wall – in its role of both enveloping and dressing a structure – takes precedence over construction regarding both the form and content of architecture.[2] Whereas Semper discusses the provision of atmosphere, accomplished as the wall defines a spatial enclosure and gives protection from the elements, we – not necessarily concerned with the discussion around tectonics – arrive at a parallel understanding of the façade's potential within the context of sustainability.

Like Semper, we hold color to be highly suitable for affecting the qualities of space. The façade of a previous project that we termed *City Dress* comes to mind – the lightness of its mantle together with the optical association of a woven textile seems to refer to Semper's starting point. Considering wellbeing to be part of the sustainable agenda, it is obvious that the contribution that a building skin can make in this respect is of prime importance. Apart from effect, however, around the discussion of a possible aesthetic of sustainability there are also performative aspects to be considered. In low-energy architecture in particular, it is the façade that acts as the mediator between the external climate and the internal environment. What only a couple of decades ago may have been a single exterior wall with some insulation and a damp-proof membrane has now become a porous, reactive and most likely layered zone between inside and out that accommodates all the elements necessary for the supply and control of natural ventilation and sun-shading. As opposed to hermetically sealed walls, these active devices encourage a user-controlled environment and make the building become more like a living organism, in allowing its inhabitants to decide for themselves the appropriate degree of air, light, shade, view and temperature.

Aesthetically speaking, such layered skins, inviting an exploration of proportion, rhythm, form, material and color, begin to provide the material to establish their own identity. Evidently for us, color again plays a prominent role in this. Using color against color, namely polychromy, and so creating a visual space out of contrasts in tone, hue or saturation that advance or retreat in relation to one another, one can manipulate surface and depth to emphasize or counteract the bas-relief that the layered façade offers. So color can serve to achieve both a heightened plasticity that invites corporeal engagement or its opposite, a flat surface that suggests mere optical involvement.

Just as Amédée Ozenfant explored in full size mock-ups the phenomenon he termed *color solidity*,[3] the use of color in architecture can support and emphasize the actual physical manifestation of space. We are interested in what could be deemed its opposite, that is, the use of color to upset both the surface and the habits of the viewer as it teases and irritates the eye to make one aware of the act of perception itself. One could call this the instability of the surface, that is, the deliberate use of optical depth that, after initial destabilization, can sharpen one's senses to ultimately reaffirm one's awareness of oneself and the space one inhabits. This may ultimately play into the agenda of sustainability again, by reaffirming the bodily being of a person within the confines of architectural space, as well as allowing an architectural point to be made. Accepting the pervasion of the two-dimensional image as a cultural convention today, it is difficult to imagine that a purely corporeal and haptic relationship to architecture may still be possible. We hence do not try to deny the conflation of three-dimensional reality onto the *screened* or disembodied view, but we strive to stimulate one's bodily – and one's intellectual – engagement through the transition from one mode of perception to another, or indeed through oscillation between the two.

A façade that has significant depth is optically reduced to a flat surface when seen from a distance. At a distance, therefore, one's engagement with such a building is similar to that with a screened image: it is purely an optical relationship, not a bodily one. Through the instabilities of color, though, which may appear as one's eyes flit over the surface, the flatness of the same may be called into question as it appears three-dimensional. However, upon closer approach and as the physical reality becomes clearer, the two-dimensionality of that surface – or of elements within that surface – becomes undeniable. On the other hand, with increasing proximity, the more three-dimensional, corporeal and scaled in relation to oneself the façade actually becomes as one's moving body and roving eye complicitly unite in the act of perception. Ultimately, one's comprehension is completely transferred from the visual to the corporeal as the eye is subsumed within the bodies of building and viewer. Architecture can be experienced again for what it is: the art of three-dimensional space that, to a large degree, actually escapes two-dimensional representation.

The Museum Brandhorst in Munich, completed in 2008, is a useful example in this regard. The façade comprises a series of vertically hung glazed ceramic sticks that are offset a small distance from a bi-colored, horizontally folded metal wall such that the flat-on and oblique views offer completely different impressions. While the former allows clear recognition of the layered façade, the latter presents a running together of the front surfaces of the sticks, transforming space and material into a fine-grained polychromatic surface that, in its iridescence, seems almost immaterial. Walking along the building with one’s eyes skimming over the glazed sticks, one's perception fluctuates between the corporeality of palpable space and touchable material on one hand, and the visuality of spectral surface on the other. The result, for us, is a new dimension of optical and corporeal engagement, an intense and not-to-be-divided entanglement of visual and bodily perception. In the search for an architectural language that is appropriate to the shifting paradigms of sustainability and today's condition, *the architectural work in the age of mechanical reproduction*, we have aimed to integrate the façade's performative role as climate conditioner with its reduction to surface into a single narrative. So the ecological relationship of the building to its (natural) environment forms a positive and non-apologetic part of the cultural relationship of the building to its (constructed) environment.

Ecological correctness is often accompanied by a sour puritanical expression, as if something has to taste bitter in order to do us good. By contrast, industrial strategies aim for a kind of harmless luxury such as the cars of the future that are supposed to travel in excess of 300 km/hour while emitting no pollutants into the atmosphere. The truth probably lies somewhere between the two. Without doubt, ecological building will have to incorporate the intelligence of technological development. On the other hand, it has to express its qualities in the intelligent economy of reduced means, because obviously the luxury of sustainable architecture cannot be bought at the price of increased consumption. Less really has to be more – variety and beauty have to be found in what is simple. However, this beauty cannot stem from clichéd images, as Le Corbusier correctly noted, nor is it born of the rigor of rational thought alone, as we have seen in the products of functionalism. The challenge presented to architects at the moment is to develop a language of their own from the various tasks they face, using the available means, their intuition and a determination to create spaces that communicate with people on an intuitive level. The architectural media available to them are the classical ones of space, surface and light, which have nothing more to offer than their concrete presence, but, if used intelligently, will do more than just create buildings that fulfill their purpose in an efficient and economic form. They can help to generate an architecture that opens up such freedom of imagination that it will be loved for generations to come.

NOTES

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1 Donella H. Meadows et al., *The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind* (New York: Universe Books, 1972). The book was

commissioned by the so-called Club of Rome, available at http://www.clubofrome.org (accessed April 2011).

2 Gottfried Semper, *The Four Elements of Architecture and Other Writings* (Cambridge: Cambridge University Press, 1989), 254.

3 Amédée Ozenfant, “Colour Solidity,” *Architectural Review* 81, no. 5 (1937): 243-246.

7.103 words

Solar Aesthetic

Ralph L. Knowles

Part I: The Auburn Study, 1962

What are the aesthetic implications of designing with nature? This question is being asked with growing insistence as architects explore the need to conserve energy. At this critical time of energy use and worldwide urbanization, architects are being challenged by such leaders in the field as Edward Mazria who has called for "a dialogue with nature"[1] to answer the problem. This paper explores some possible outcomes of such a dialogue. What might buildings look like if we accept the challenge to have an open and honest relationship with nature? What patterns would they display? Would we meet them with recognition and empathy or pass them by with indifference? Would they interest us, please us and bring us joy, or would they be ordinary and lacking in quality? These aesthetic questions hold real, practical meanings for sustainable life.

Given the awakening interest in a new architectural aesthetic, a design research project initiated at the Auburn University School of Architecture in 1962, supported by the Graham Foundation, takes on fresh meaning today. It was concerned with illustrating the force effects of natural phenomena, specifically sunlight and gravity, on form. These forces are clearly reflected in the growth and patterns of nature. The sunny sides of slopes exhibit different plants and animals than shady slopes. Natural structures, such as sand dunes, reflect the forces of wind and gravity. Buildings are subject to the same natural forces that have caused differentiation in nature, but they rarely acknowledge these forces in built form. Exploring a new architectural aesthetic was not the purpose of the 1962 work. Rather, the purpose was to test a proposition: that a building made in balanced response to natural forces will exhibit differentiation useful for crucial legibility in the city setting. The idea of urban legibility came from an earlier reading of Kevin Lynch's influential book, *The Image of the City*, in which he asserts the importance of providing vital cues for successful orientation and free movement. The Auburn study tested my belief that the essential clarity and legibility Lynch sought was to be found in designing with nature.

The study began with no prior idea of resulting form. In fact, throughout the study, novel shapes and structures seemed to emerge as if by a self-organizing process of natural growth and transformation, not by design. As it turns out, preconceptions of form would very likely have been wrong and surely would have interfered with the integrity of the work. However, simply in order to facilitate a beginning point and a reference for graphing the different effects of natural forces, the Auburn study selected five basic geometric forms with a range of surface configurations and orientations: a cube, an ellipsoid, a tetrahedron, a prism and a hyperboloid of revolution. While not actual building forms in themselves, these geometric forms provided an architectural idiom for analysis.

The Auburn study progressed in several phases. The first phase graphed the impact of sunlight on form, the second graphed the impact of gravity and the third graphed the combined forces of sunlight and gravity. The fourth phase sought to apply the concept of form differentiation to a simple program for an office building. The study, though limited to an examination of only two natural forces and completed almost fifty years ago, evokes images of differentiated form that we can identify with and understand today.

In the first phase, a technique for graphing the varied effects of sunlight uses a system of projecting planes to shield the basic form during prescribed hours, a technique applicable to daylight design. (Fig. 1) Planar generations are derived from the geometry of the basic reference form. The resulting graphs have both static and dynamic components. The planes are themselves static, but the forces they respond to are dynamic, changing the graph's aspect by the day and the season. The results are asymmetrical, horizontally differentiated graphs, applicable for a 30-degree north latitude location.

Fig. 1: Sun graph.

The gravity studies use a similar graphing technique of projecting planes. (Fig. 2) Hypothetical floor loads are applied regularly to the surface of each form in such a way that they affect each point at the same elevation equally. But unlike the sun graphs that tend to be horizontally differentiated in response to orientation, the gravity graphs are mostly symmetrical and vertically differentiated in response to accumulating loads. The gravity graphs also lack the dynamic component of the graphs produced with the sun.

Fig. 2: Gravity graph.

Although there may be a hierarchy of force action, buildings are rarely affected by a single force. Sun and gravity graphs are therefore combined to form a complex of double-acting planes describing simultaneous but differently acting forces. (Fig. 3) Both the number and the dimension of planes become adjustable graphing elements. Accordingly, longer or more numerous planes indicate greater force effects. In an ideal solution, each plane acts simultaneously to provide for sun control and gravity loads. But in the study, the more usual case is where only a portion of any plane is double acting, with either sun or gravity dominating the remainder. The graphs are compared based on their different percentages of double-acting planes.

Fig. 3: Sun-Gravity graph.

The last phase of the study applies the understanding of form differentiation that comes out of the sun-gravity studies to the design of an office building. (Fig. 4) The building program calls for public spaces at the top and street levels, with smaller private spaces in between. Unlike the previous phases of the study in which planes are presumed to have only length and breadth but no thickness, this phase assumes a concrete structural system in which thickness and material strength are varied as well as the plane dimensions. The study only looks at the building's outer support system and not at the interior spaces or the services that it would provide.

Fig. 4: Building.

While it was completed nearly fifty years ago, the implications of the Auburn study for architectural and urban design are now being rediscovered. The concept of a building as an ecological form, differentiated in response to natural forces, points to a new aesthetic. The result of this aesthetic will not be distinguished by a common expression of form as was the case with Modernism, made possible by massive injections of energy that isolate people from the natural clues in their surroundings. Instead, varied patterns and forms that engage our inherent capacity to feel the diversity of nature will characterize this new aesthetic.

Part II: The USC Study, 1967-1969

The Auburn study was followed by a second design research project that graphs the effects of sunlight in three dimensions. This project was conducted at the University of Southern California (USC) Natural Forces Laboratory between 1967 and 1969 under a grant from the National Endowment for the Arts. Accordingly, the first part of this chapter describes the aesthetic consequences of controlling sunlight on select geometric forms with the Auburn study. This second part, instead of beginning with existent forms, describes the aesthetic consequences of generating uniquely adaptive forms by following the sun's path to satisfy specified conditions of incident solar energy. The USC study works directly with earth-sun geometry to generate form. Linear elements representing the summer rays of the sun first generate a single warping surface between 8 AM and 4 PM at a 34-degree north latitude location. (Fig. 5) Similar generations for the other three seasons result in separate south-facing surfaces that are inclined at different angles toward the sun. Converting the solar lines into smooth form results in the form having a particular incident solar energy profile over the course of the year.

Fig. 5: Summer equinox, 8 AM to 4 PM; generated form.

a. Form in Nature

If we are to confront the aesthetic questions of solar form, we must begin with nature. While the establishment of a new aesthetic was not the original purpose of the studies undertaken at Auburn University and USC in the 1960's, a fresh look at the work has been prompted by a lifelong wonder and fascination with the differentiated patterns and forms of nature. Vertical differentiation of color in plankton responds to separate portions of the sunlight spectrum penetrating to different ocean depths. A similar phenomenon can be observed in a rural wood or a great redwood forest. In contrast to such vertical changes, horizontal differentiation can be observed in the feeding territories of Scottish red grouse or in the sideways ambulation of a river. To be aware of these differences is to participate in the beginning of a new solar aesthetic.

b. Patterns of Life

While moving in this direction, it is important to note that the differentiated patterns of nature were important in setting the patterns of indigenous human life; it is not alien to think that nature's patterns could be strongly entwined with today's architectural forms.

One example of indigenous life can be seen with the Piute families of the Owens Valley in California. The Owens Valley is cradled between the precipitate granite heights of the Sierra Nevada escarpment on the west, and the more gentle sedimentary slopes of the Inyo-White Mountains on the east. Vegetation changes in quick steps from sub-alpine forest at the higher elevations to grassland on the valley floor. Over the centuries, in response to this richly diversified world, Piute families migrated yearly, following exclusive pathways from one side of the valley to the other and back again, stopping in a different plant community to fish, to hunt or to forage depending on the season. While the modern face of the city is quite different than the Owens Valley, we still encounter differentiated patterns – both natural and human-made – in our surroundings on a daily, seasonal and yearly basis; how we experience and respond to these patterns has a great deal to do with architecture.

c. Patterns of Perception

Most relevant to the subject of this section, the re-examination of early studies focusing on the generation of uniquely adaptive forms, it is important to note that nature's differentiated patterns helped set the patterns of human perception over the course of time. Our understanding of the environment through physical sensation evolved in a differentiated natural world; the proof of this lies in our survival. Over evolutionary time, we learned to notice the differences essential to our orientation and free movement. Our survival required us to understand more than merely an orderly repetition of parts in a landscape, where we might have to guess to find our way. Instead, we learned to look for a structural relationship of some kind in which there was a clear choice among parts or sets of parts suggesting boundaries and directionality. Finally, we would have felt best oriented and most comfortable if we could understand the form, implied or actual, of those aspects of the environment that were critical to our survival. With that understanding, we could go beyond the tasks of mere day-to-day survival and progress to other things.

d. Laboratory Studies

A desire to learn and teach more about ecology and the differentiated natural world led to the establishment of the USC Natural Forces Laboratory in 1967. With a grant from the National Endowment for the Arts, the laboratory was first set up as an essential part of the third-year architecture design studio. Three kinds of simulation tools were designed, built and used by students as integral components of the design process. Sun machines, wind tunnels and water tables of various types occupied the studio space along with traditional drafting tables. The point of using these tools in the Natural Forces Laboratory was to answer questions such as: why do north and south slopes in the landscape look different? To understand this pattern, topographic models were built of real sites, placed on the sun machine and studied over virtual time. Why are windward and lee slopes different? To understand these effects, sand was eroded in the wind tunnel to simulate dune formation. Why do streams ambulate? To understand this and other differentiated effects of water acting on the earth, soils of different composition were eroded on water tables.

e. Synthesizing Solar Form

It is important to note that synthesizing solar form in the laboratory must begin with an explicit, underlying objective. Sand and soil will automatically transform in a laboratory wind tunnel or on a water table. But producing a solar form on a sun machine requires an objective. For example, some of the pyramids of ancient Egypt were designed with very specifically placed openings leading deep into the tomb, allowing for the penetration of a celebratory shaft of sunlight at one instant on a particular day of the year; harnessing this shaft of sunlight was one of the main objectives of the architecture itself. But in order to make a solar form that acts purposely over time, the process of generation must relate hours to days and days to seasons. The form above is generated to equalize summer and winter solar incident energy, a strategy that is inherently applicable to passive solar design. (Fig. 5)

Interestingly, the work done at the Natural Forces Laboratory in the 1960's suggests that the structure of a solar form has a favorable perceptual scale. (Fig. 6) Pure shapes can be purposely generated in relation to the dynamic geometry of the earth and sun but eventually, for habitable forms at least, architectural reference must be made to the ordering principles of construction and to the scale implications of use. Consider the hypothetical example of an oblate spheroid, a form that when inclined southward at the correct angle presents approximately the same silhouette area to the sun over time. As the size of the constructing increment decreases while maintaining a constant overall volume, an approximation of the pure form is approached. Plotting the volumetric subdivisions of space against the desired behavior of the form as a whole shows that eventually the curve stabilizes, requiring no further subdivision. It appears that this phenomenon coincides with our visual recognition of an oblate spheroid, and that an inherent scalar relationship between form and function is evident in the work on solar form.

Fig. 6: Generation drawing, generation model, pure form and incremented form.

Habitable solar forms will likely require a differentiated structuring increment. A large model of the earlier form equalizing summer and winter incident solar energy helps to demonstrate three-dimensional differentiation of the form. Structuring increments at the surface of the form are relatively small, scaled to maintain the perceptual and functional boundaries of the pure solar form. Interior increments are likely to become progressively larger for the collective use of shared space. While the structuring increments shown in the examples thus far are all based on the cube, further study might suggest alternative space-filling geometries. (Fig. 7)

Fig. 7: 1 cube, 64 cubes, 4,096 cubes and optimization.

Whether we are conceiving a single building or an entire community, constructing great frames and trusses or sculpting the earth and major landfills, today's building technology allows larger structures with greater shaping freedom than have heretofore been available to architecture. The result is an unprecedented ability to respond with subtlety to the sun's energy through form. As communities of plants and animals vary in the natural landscape, so too we might expect diverse ecological domains to evolve on the surface of large solar forms. Depending on slope and orientation, ecological domains will be systematically differentiated from each other, and each will have an overall contextual role to play. All of the following examples are shown as simple mass models but further study will likely suggest the need for systematic penetration of the masses to expose their deep spaces. (Fig. 8) Clearly, there are aesthetic consequences to the large size and shaping freedom that can be achieved with solar forms, given today's building technology.

Fig. 8: Solar form massing – southwest, west and cutaway.

Time has changed the meaning of this work, which began almost fifty years ago with a single objective: to control incident solar energy, both light and heat, through adaptive forms. As pure forms developed over the following two years, perceptual problems of scale emerged that were never resolved during the course of study. Now, with regard to the aesthetic consequences of the original work, it is clear that structuring pure form can become a nature-based way to humanize scale on several levels. First, as nature sets the patterns of our perception through differentiation, so too a repeated structuring increment provides the beginning of visual order; second, natural variations of the increment offer visual clues to ecological domains, providing directionality and choice; and finally, actual or implied visual limits provide an awareness of form, and of our place within the environment. The aesthetic implications of large size can thus be architecturally resolved by applying the scale of our evolved patterns of perception. (Fig. 9)

Fig. 9: Solar form landscape.

Part III: A Natural Architectural Language

After considering the work of the Auburn and USC studies undertaken in the 1960's, this section considers the aesthetic potentials of establishing an architectural "dialogue with nature" today. The first part of the section, *Rhythm & Ritual*, shows traditional sheltering rituals as precedents for an increasingly important and undervalued role: that of individuals maintaining comfort in their dwellings by adjusting their private living patterns to suit natural rhythms. The second part of the section, *The Solar Envelope*, shows studies of enhanced design possibilities resulting from a presumed public policy of solar access for energy and life quality. The third section, *The Interstitium*, combines these two different levels of involvement, private and public, to form a natural architectural language.

Not since Modernism has there been an architectural aesthetic with any staying power. Though exact dates are hard to pin down, and in important respects it has never gone away entirely, Modernism is generally reputed to have begun somewhere in the last decade of the 19th century with critical attacks on the eclectic and theatrical architecture of the time, and to have "died" at the beginning of the 1970's with the first oil crisis.

Since then, as Professor James Steele points out, "… the half-lives of subsequent movements seem to have diminished radically."[2] One problem may be the lack of an ethical underpinning in subsequent movements. Modernism was initially driven by a perceived moral obligation to rid the world of wasteful decoration, and by a real sense of duty to follow the stripped-down example of industrialization to house an expanding world population. Since Modernism, however, subsequent aesthetic positions such as Post-Modernism and Deconstructivism have been driven by extreme subjectivity. In the meantime, we have generally recognized the dangerous circumstance of worldwide climate change and the real need to follow a new ethic of sustainability in architecture.

However, up to the present day, architecture has not been able to find an aesthetic expression of sustainability. Surely there have been important steps taken by some design pioneers who have used the elements of building with skill and imagination to conserve energy while enhancing the quality of life. But more usually, the building industry has settled for add-ons to rooftops like photovoltaic arrays while the buildings themselves remain conventionally stylistic. Architecture has also developed energy-related, numeric standards for measuring the outcome and performance of buildings, but these steps have not been sufficient to evolve the language of natural symbols that is essential to establishing an aesthetic expression of form.

a. Rhythm & Ritual

To remedy this situation, we may look to the rhythms of sheltering rituals to supply the syntax for a new and natural language of architecture. As we occupy dwellings, we make certain adjustments for comfort in response to changes in the natural environment. We repeat these adjustments in concert with the unique rhythms of weather and climate in a particular setting. Through repetition, simple adaptive actions like moving to a shady porch or adjusting a sunscreen rhythmically connect and reconnect our experience of architectural elements in a dwelling. Ritual acts of sheltering do not permanently alter the formal order of a building. Instead, they constitute a second and less explicit order of architecture, what Professor Leonard Bachman has called "performal."[3] Over time, the development of this implicit order can free our individual thoughts, our creative imaginations and our celebrations of life within the context of a particular place. The following examples are classed under three headings: rituals of migration, transformation and metabolism.

1. Migration

Rituals of migration supply syntax for a natural language by rhythmically ordering our experiences of different parts of a dwelling. In this example, ritual migrations follow the sun to rhythmically connect different levels in a traditional courtyard house of northwestern India.[4] (Fig. 10) There is a tall central courtyard and two upper-level flanking courtyards on either side. The high summer sun enters all three courtyards at midday, but it does not enter the adjacent living spaces because of effective overhangs and sunscreens. By contrast, the midday winter sun is much lower in the sky and cannot enter the courtyards. It does, however, enter the upper spaces of the house, all the way to their back walls, lighting and heating them and keeping them comfortable in the cold, dry winter air.

Fig. 10: Indian courtyard house; left, midday in summer and right, midday in winter.

The spatial organization of the house, in concert with the sun's relative movements, supports vertical migrations. In summer, the family occupies mainly the lower spaces of the house during the hot daytime hours but in the evening, everybody moves to the roof and the upper courtyards. Here, the women of the house wet the hot surfaces to cool them and the children beg to be sprinkled. When the water games are over and the surfaces quickly dried, the family settles down for the evening to chat, to share the day's events, to tell stories and finally to sleep under the starry desert sky.

While there is a daily migration in summer, there is as well a more general migration over the course of the seasons. The lowest spaces of the house are mainly occupied in summer and the highest spaces in winter, but in between is where the greatest seasonal changes occur. While the ground level is mostly dark and the upper levels mostly light year-round, the second level experiences rapid changes as the sunlight passes quickly up and down inside the central courtyard during the fall and spring equinoxes. In a yearlong search for thermal comfort, the second level acts as what Labelle Prussin might call a "territorial passage," a spatial counterpart to a pattern of social behavior – a ritual.[5] Rituals of transformation supply syntax by rhythmically ordering our experiences of different phases of a dwelling.

2. Transformation

In addition to migration, people have ritually transformed their dwellings for comfort, temporarily changing the most basic spatial order. The Berber family adjusts tent walls, removing them to admit summer breezes and securing them in winter to resist cold blasts of air. These seasonal adjustments rhythmically connect and disconnect inside and outside life. In summer, with the tent walls removed, the family inside can look out and passing neighbors can look in. Their children can run in one side and out the other, into the next tent and out the other side of that one. But in winter, with the tent walls in place, people can no longer look in or look out. The confinement is probably most difficult for children who still want to run around, jump and play, generating chaos by stepping in the dinner being prepared on the tent floor. It is at this point that grandmothers step in for a round of stories, telling of their own childhoods and recounting the history of the group.

The traditional Japanese house, or *minka,* is probably one of the most complete examples of ritual transformation, expanding and contracting space with the seasons. With a post and beam system, the walls are free to come and go because they don't carry gravitational loads. In winter, walls divide the space of the house into relatively small compartments creating rooms that are more easily heated, where people share body heat or the warmth of a brazier. Close social gathering characterizes wintertime life.[6]

Rituals of human habitation match rhythmic changes in the formal order of the dwelling. In summer, the walls are removed and the space opens, becoming lighter and better ventilated. Space expands, even out into the garden, and the patterns of life change. The family is freer to move about. They can still see each other across the open space, but they are no longer restricted in their movements, which become more private and more individual. While these alterations are taking place in the qualities of space and behavior there is, at the same time, a symbolic change in the hanging scroll in the *tokonamo,* or the decorative alcove of the house, a change that ritually celebrates the passing seasons. Rituals of transformation supply syntax by rhythmically connecting our experiences to special places and activities in a dwelling.

3. Metabolism

The third mode of ritual adaptation is metabolism, the chemical and mechanical conversion of energy. Traditionally, this long-established sheltering ritual connects life to a central hearth. In winter, the family gathers around the warmth of an open fire where they perform small household tasks, talk of the day's events, plan for the next day, tell stories and sing songs. By contrast, in summer, the hearth looses its hold. The family's movements extend outward to other parts of the house, and to the outside world. As with migration and transformation, changes in the rituals of habitation match natural rhythms. But today we have mostly lost this ordering link with nature. Recent metabolic means have freed us from nature's rhythms, but have left us with no matching syntactic rituals to replace the ones that once connected our lives directly to a dwelling. Centralized heating and cooling mean that we no longer have to move around or sit by a fire for comfort. Our closed dwellings require no regular changes in their formal order to maintain a steady state. We no longer live by the rhythms of nature.

We now convert energy in remote power plants, distributing energy as electricity through vast, centralized systems of connecting wires. Yet these systems are highly vulnerable. They fail because machines break down and because nature destroys them. They are vulnerable to the manipulations of price and supply by unscrupulous corporations. And finally, such systems are inefficient due to the fact that the long-distance transmission of electricity wastes energy through the production of heat as electricity moves through the wires. It must be said, however, that while such systems display the problems of vulnerability, they have freed architecture to explore design ideas other than basic protection from the elements. Architects obviously have something more in mind than basic shelter. For example, glass volumes of different shapes and sizes, while thermally harmful, dramatically reflect the surrounding city. Yet their occupants are continuously and automatically protected in spite of this stylistic indifference to nature. Still, we must ask, is this freed architecture worth it?

We might justify the total energy dependence of buildings that we consider important or crucial in some way. But what about the countless unnamed other buildings in that region and around the world that are energy dependent as well? Centralized energy delivery and use has not only produced a ritual disconnect with nature; it has resulted in the development of countless buildings with representational indifference to the environment. Every building looks pretty much like every other building. No building is oriented, juxtaposed or otherwise related to its surroundings as an adaptation to weather and climate. Worldwide, the relationship to nature is irrational, chaotic and arbitrary. The result of this universal arbitrariness is not only an unprecedented and unsustainable pattern of energy consumption, but also a condition of widespread aesthetic confusion about what we see. Buildings that are indifferent to their surroundings offer no clues to orientation, left from right or up from down. We may have difficulty distinguishing places and buildings, even our special place and location within a building itself. Two buildings, one perfectly situated and another rotated 90 degrees in the wrong direction in relation to the environment can *look* alike, thus reducing the basis for aesthetic appreciation to a reading of the pure object, without the benefit of context.

The problem of arbitrariness, of architectural randomness resulting from an over-reliance on mechanical means can be answered by intentionally connecting architecture more directly to the sun, the ultimate source of our vision, our warmth, our energy and the rhythms of our lives in relation to it. This means implementing a rational zoning policy to guarantee direct access to sunshine for buildings.

b. The Solar Envelope

While private sheltering rituals offer an implicit architectural order, publicly guaranteed solar access supports an explicit order of natural symbols. The designer, without fear of future overshadowing, can purposely differentiate buildings and urban forms in graphic response to the sun's movement. One side of a building will not look like another and one side of a street will not look like another. Streets, buildings and spaces can take on directional character where orientation and cues to natural time and phenomena are clear.

The symbolic elements that especially emerge with solar access are not like columns that represent the trunks of sheltering trees or arches that represent the protecting cave. Rather they are sun and wind screens, courtyards and terraced roof gardens, clerestories, porches and atria, elements and spaces that adaptively reflect the rhythmic interplay of nature and human habitation as a basis for aesthetic appreciation.

The Solar Envelope offers one effective way of publicly guaranteeing solar access. Most existing US solar access laws use some version of a solar plane to guarantee sunshine to adjacent properties. Sloping from high on the south to low on the north, the solar plane intersects the top of an imaginary reference, a *shadow fence* that represents the height to which overshadowing to the north might be allowed without unduly restricting the neighbor's chance to use the sun. But if sunshine is to be guaranteed to neighbors on sides other than the north, the result is a solar envelope, an imaginary construction representing the largest volume that can be put on the site without casting unwanted shadows on surrounding properties above the shadow fence. (Fig. 11)

Fig. 11: Solar plane and solar envelope.

The height of the shadow fence and the period of guaranteed solar access are variable; they can differ depending on the land use and the community values. Generally, lower shadow fences and longer periods of assured access are more desirable for housing than for either commercial or industrial uses. Higher land values with greater building density might justify higher shadow fences and shorter periods of assured access, with increased building volume under the envelope. (Fig. 12)

Fig. 12: Shadow fences.

Terracing naturally results when the solar envelope is applied on a hillside. This example illustrates a site with a steep slope resulting in a density range of only 7 to 18 dwelling units per acre (17~44 du/ha). Houses closely follow the solar envelope as it slopes to protect the existing structures located further downhill; this leads to the design of natural symbols by shaping development to suit the particular land form and land uses of the site, complementing what is directly next-door. (Fig. 13)

Fig. 13: Terracing.

Higher land values require greater density, as seen in this example with a range of 38 to 72 dwelling units per acre (94~178 du/ha). Solar envelope rules can be adapted for higher density by shortening the period of winter solar access from six hours, as seen in the hillside project, to only four hours, the minimum generally required for passive design. In addition, shadow fences can be raised from 8 feet (2.4 m) to 10 feet (3 m) on adjacent housing, and raised to 20 feet (6 m) on commercial properties. In this example, solar envelopes are purposely dropped at the side property lines to provide channels for the free flow of Pacific breezes to cool and ventilate the city downwind. (Fig. 14)

Fig. 14: Density.

A third example employs solar envelopes that run continuously across the side property lines to gain volume and to achieve higher densities of 76 to 128 dwelling units per acre (188~316 du/ha). The continuous solar envelope matches the size and shape of the adjacent projects. Neighboring designs tend to contain a similar range of explicit, symbolic features: these include a consistent use of clerestories; the layering of space for summer sun-control on the east and west elevations; roof terraces that seasonally extend urban living areas for recreation and for growing small trees, fruits, vegetables and flowers that attract birds, bees and butterflies; and the inclusion of courtyards that can serve a collective function and provide room for private gardens. (Fig. 15)

Fig. 15: Continuous solar envelope.

In this way, the symbolic relationship between nature and architecture is rationally ordered by context. Two adjacent designs, one taller than the other, share an envelope that continues across a side property line. The difference in size and shape between the two buildings results from what is adjacent to each separate parcel. Over one site, the envelope is quite low because the shadow throw is only 20 feet across an alley. Over the other site, the envelope slopes sharply upward because shadows can be cast downward into a large space occupied only by light-rail train tracks. While the two projects have different designers, the solar envelope supports a continuity of form, resulting in a consistency of narrative flow. (Fig. 16)

Fig. 16: Context.

c. The Interstitium

The architect Eduardo Catalano has said, "Works that are dynamic … invite our participation in their lives."[7] His reference was to a great mechanical flower that he designed for the Plaza Naciones Unidas in Buenos Aires. By opening and closing daily with the sun, the flower suggests a different version of solar-access zoning called the *interstitium*, a term borrowed from the interstitial layer of the human lung that expands and contracts as we breathe. When applied to zoning, the interstitium makes possible the design of major architectural elements that are dynamic, ones that change our aesthetic appreciation of a building in major ways. Instead of understanding a building as a fixed part of the landscape, we can become aware of the rhythmic changes in its formal order, its silhouette and in the number and relation of its parts. The difference can provoke and intensify our awareness of the moment between what we saw the hour, day or season before, and what we see now in the present. The interstitium supports the design of dynamic architectural elements that connect directly to the rhythms of nature. (Fig. 17, 1)

An application of this dynamic concept shows two solar envelopes over a typical urban site, a low one for winter and a higher one for summer, both generated to provide 6 hours of solar access to surrounding properties. The space between them is the interstitium that pulses rhythmically, expanding and contracting, growing and decaying with the seasons. (Fig. 17, 2) The formal order of a building is not necessarily fixed under the interstitium. In an example of program change, the dark shape diagrammatically represents a basic building configuration that follows the shape of the winter envelope. But within the interstitial space, a rooftop theater and a corner marquee temporarily extend upward under the summer sky without denying year-round solar access to surrounding properties. (Fig. 17, 3) There are possibilities for adjustable climate control within the interstitium as well. The basic shape of a courtyard building follows the winter envelope. But in summer, wind scoops reach upward to capture the westerly winds coming off the Pacific Ocean, or a sunscreen rises to offer summer shade in the courtyard. The interstitium increases the likelihood of merging syntactic rituals with dynamic architectural symbols, of merging an implicit with an explicit order, in a natural aesthetic language. (Fig. 17, 4)

Fig. 17: Geometry of interstitium.

A more detailed example of how interstitium climate control might occur is shown with this example designed for a typical corner site in Los Angeles. Following the orthogonal geometry of the US Land Ordinance of 1785, the site is bounded on the north and west by streets, and on the east and south by residential properties. (Fig. 18, 1) A winter envelope for this site is high on the north and west, lower on the east and south. It rises where shadows can extend across the street toward commercial properties, with 20-foot (6 m) shadow fences, and drops toward the adjacent residential properties, with 10-foot (3 m) shadow fences. (Fig. 18, 2) The basic shape of an office building that fills the winter envelope is shown with its courtyard open to the winter sun. We might imagine places for chatting and coffee breaks surrounded by small trees, shrubbery, flowers and water features, a place where office workers can sit in the sun or in the shade depending on their preference and the time of day. To expand the available choice for comfort, they can follow rhythmic shadow boundaries, migrating east and west by day, north and south by season. This ritual extension of choice allows at least some work regularly to be done in a garden. (Fig. 18, 3) The higher summer envelope is separated from the basic building mass by the interstitial space where it is possible to design a dynamic system for climate control. (Fig. 18, 4) A movable shield transforms the courtyard with the seasons. As the shield expands and contracts, people feel and act differently in a sunlit and open space, as opposed to a shady and sheltered one. The open courtyard in winter admits the warming sun, extends the view to the sky and shrinks pupils of its inhabitants to pinpoints. Leaves of a tree or vine appear in dark outline, their shadows spreading across a patio floor. In comparison, the raised shield of summer captures west winds off the Pacific Ocean, cooling and ventilating the courtyard and protecting the space from the hot summer sunshine. It darkens and quiets the space. Sharp contrasts give way to suffuse light, sharp shadows give way to cool shade. A rhythmically changing architectural order invites our ritual celebration of the place. The interstitium extends our awareness of the moment between what we saw and what we see to the urban landscape. (Fig. 18, 5)

Fig. 18: Application of interstitium on a typical LA corner site.

If the various districts of a city are zoned using the interstitium, we can visualize a kind of landscape with a low, undulating profile in the winter. (Fig. 19, 1) A higher profile will appear in the spring and fall with an additional layer of architectural space. (Fig. 19, 2) The summer results in a still higher profile with a third layer of space. Along these lines, we can imagine an urban landscape that rises and falls with the seasons like the breathing lungs of a living thing. (Fig. 19, 3)

Fig. 19: Interstitium zoning.

In Closing

This chapter followed the idea of a solar aesthetic from its inception nearly half a century ago with two studies: the first conducted at Auburn University in 1962, concerned with illustrating the force effects of sunlight and gravity on form; and the second conducted at USC between 1967 and 1969, concerned with the aesthetic consequences of generating uniquely adaptive forms by following the sun's path. These studies take on fresh meaning today, as architects try to find practical solutions and an architectural language to underpin the development of a more sustainable life. In this search for meaning, we have filtered the idea of a solar aesthetic through the lens of traditional sheltering rituals, and through the lens of ideas related to the solar envelope and the interstitium. It is clear that in order to avoid the arbitrariness and chaos of most urban development, and to complete the aesthetic promise of a genuine dialogue with nature, architecture must ask certain basic questions. Does this place look as though people occupy it? Where is it? What is its rhythm? What is its life? If we cannot answer these questions, we must think again about our strategies for policy and for design. In this task, we can turn to the sun.

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Professor Karen Kensek generated the computer images that add to the Interstitium section.

FIGURE CREDITS

Fig. 1, 2, 3 & 4: Auburn University School of Architecture

Fig. 5: Model by M. Pearce

Fig. 6: Model by G. Togawa

Fig. 7: Ralph Knowles

Fig. 8: Models by P. Ohannesian, G. Shigamura and J. Talski

Fig. 9: M. Klingerman, D. Moser and R. Selvidge

Fig. 10: Kavita Rodrigues

Fig. 11: Karen Kensek

Fig. 12: Ralph Knowles

Fig. 13, 14, 15 & 16: USC School of Architecture

Fig. 17, 18 & 19: Karen Kensek

NOTES

This chapter was drawn from the author's previous texts. The original versions can be found at http://www-rcf.usc.edu/~rknowles.

1 Edward Mazria, "It's the Architecture, Stupid!" *Solar Today* May/June (2003): 48ff.3.

2 James Steele, *Sustainable Architecture: Principles, Paradigms, and Case Studies* (New York: McGraw-Hill, 1997), 229.

3 Leonard R. Bachman, "Thoughts Toward a Clinical Database of Architecture: Evidence, Complexity, and Impact" (paper included in the Proceedings for the 2009 Annual ARCC Spring Research Conference: Leadership In Architectural Research Between Academia and the Profession, University of Texas at San Antonio, San Antonio, Texas, April 15-18, 2009).

4 The digital model was based on a section view of a house in *Paradigms of Indian Architecture* by G. H. R. Tillotson (1998), 166.

5 Labelle Prussin, *African Nomadic Architecture: Space, Place and Gender* (Washington DC: Smithsonian Institution Press, 1995), 23-24.

6 Yukio Futagawa and Teiji Itoh, *The Essential Japanese House: Craftsmanship, Function, and Style in Town and Country* (New York: Harper & Row and Tokyo: John Weatherhill, 1967), 13-15.

7 Eduardo Catalano, *Floralis Generica* (Cambridge, MA: Cambridge Architectural Press, 2002), 2.

6.522 words

The Architecture of the Passively Tempered Environment

Keith N. Bothwell

People have always delighted in buildings that work passively to modify the interior environment, providing a haven against the extremes of the outdoor climate. The principles of this approach were enshrined in the Renaissance architectural treatises and are widely agreed to be the basis for sustainable architecture. Despite this body of knowledge, these principles are often compromised by aesthetic predilections and personal prejudices that have no apparent rational foundation, resulting in buildings that do not perform nearly as well as predicted or expected. Exploring the field of passive environmental design, this chapter focuses on the fault lines that occur between knowledge, understanding, intention and achievement during the process of designing sustainable buildings, fault lines that prevent recent buildings from reaching the full capability of passive design to reduce carbon emissions. Victor Olgyay prefaces his seminal work *Design with Climate* with the following:

> *To meet the problem of climate control in an orderly and systematic way requires a pooling of effort by several sciences. The first step is to define the measure and aim of requirements for comfort. For this the answer lies in biology. The next is to review the existing climatic conditions, and this depends on the science of meteorology. Finally, for the attainment of a rational solution, the engineering sciences must be drawn upon. With such help the results may then be synthesized and adapted to architectural expression.*[1]

These remarks may cause some discomfort for architects, who assume it to be their role to shape and form buildings. But Olgyay is careful in his choice of words and there is much room to maneuver within the *synthesis* and *adaptation* of the scientific results to achieve a particular aesthetic expression.

To some extent, this chapter is the story of two battles. The first is a battle between opposing approaches to environmental control in buildings. Olgyay and his followers in the bioclimatic tradition over the last five decades stand on one side, facing those on the other side who favor the *universal technique* of *regenerative power*. The second is an internal battle between our conscious intentions and subliminal inclinations. In this battle, our rational selves, which seek good functional performance, stand in opposition to our subconscious aesthetic predilections, which favor symmetry and repeated patterns. An awareness of these conflicts may help to illuminate why many buildings designed to be low-carbon emitters are not performing nearly as well as conceived or expected. Olgyay's bioclimatic approach is rooted in site, climate and human culture, and is more commonly known today as passive design.

Passive design is pertinent and important for a number of reasons: it is the basic foundation for sustainable building; it has evolved over time, and continues to evolve, through generations of building practices and self-conscious traditions; it is embodied in the core principles of Modern architecture's *Form follows function*; and it is found in nature, the ultimate repository of functional design, where countless biological systems have been tried and tested over millennia. Like nature, passive design has an inherent beauty, elegance and *rightness* born from adopting functional forms and the efficient and frugal use of available materials. This brings us full circle, as the characteristics of passive design are also those of sustainable systems.

Although we understand the principles of how to design environmentally sound, low-energy buildings, a rift occurs somewhere between the boardroom, the design studio and the completed building. I suggest that professional prejudices and personal preferences distort the original passive design strategies, compromising the performance of completed buildings. I will attempt to identify how and where some of the discontinuities occur.

Passive Design

The area of passive environmental design is widely acknowledged to be the foundation for genuinely sustainable buildings. Passive environmental control relates to the way in which the orientation, section, materials and envelope of a building – the form and fabric of the building itself – create *comfortable* conditions inside, without mechanical devices such as air conditioning or heat pumps. For example, a building in a temperate climate can be kept cool during a hot summer if it has good day lighting to prevent the need for heat-generating lamps, shades to guard against solar penetration, an interior lined with high thermal mass materials and a tall section with both low and high openings to flush the building with cold air at night. In practice, most buildings combine a mixture of both passive and active measures to temper the internal environmental conditions – buildings which are known as mixed-mode or hybrid. The extent to which passive features dominate the mix is a measure of the ultimate energy efficiency of the building.

Popular perceptions of what constitutes a sustainable building often center, erroneously, on embellishments like green roofs and the technologies of renewable energy, such as photovoltaic panels, wind turbines and heat pumps. These views stand in conflict with the genuine low-carbon capabilities of buildings, their passive design characteristics. The imagery associated with renewable technologies has a certain allure that passive design features – such as large south facing windows or high levels of insulation – cannot possibly acquire. Howard Liddell, a *green* architect with 30 years of work in passive design, is highly critical of the gadgets and technology, or *eco-bling*, often associated with sustainable architecture. As Fionn Stevenson explains:

Liddell tackles the worst offenders of the latest architectural fashion accessory – "eco-bling" – and offers refreshingly low-key alternatives … We are reminded that each comes at a price, and mostly are not worth paying for … Liddell articulates a cast-iron case for the economic advantages of passive building principles and avoiding eco-bling, pointing out that the use of extra insulation and the right technologies can remove the need for much of the heating and mechanical engineering services that normally go into buildings.[2]

Despite the popular misconceptions outlined above, the principles of sustainable architecture using passive design techniques are now widely understood: provide plenty of daylight, natural ventilation, cooling and free solar heating. Given the formal implications inherent in this approach, it imposes constraints on architects' freedom of expression to create whatever form of building they like. In the passive design approach, the rules and principles that guide the orientation of the façade, the depth of plan, the form of the section and the disposition of materials cannot simply be ignored – and certainly not when you lack the mechanical means for ventilation, heating and cooling. In so-called *primitive* societies, passive design is integral to the variety of indigenous architectures that have evolved to cope with different climatic conditions around the world. In hot dry climates, thick walls with small windows and narrow streets keep the sun out and provide thermal mass to dampen temperature extremes. In hot humid climates, lightweight perforated walls allow cooling breezes to pass through, and overhanging roofs prevent sunlight from entering. Passive environmental control introduces only a modicum of comfort in such extreme climates but can create ideal conditions in more moderate ones. Before the age of cheap fossil fuels, these passive design methods were about the only means by which to modify the extremes of temperature for many people. Decisions made by early societies to design buildings to work passively and to use local, low embodied-energy and biodegradable materials were not made with proto-environmentalist notions in mind. Rather, those strategies evolved out of necessity. When the resources of materials, labor and fuel were scarce and expensive, they were used frugally and deployed efficiently. Today, the cost of materials and energy, in contrast, is so low that we use far more than we actually need with little awareness of how much we actually waste.[3] The techniques adopted by vernacular builders are also characteristic of modern approaches to sustainable design that minimize the use of materials and energy, and which are grounded in climate and culture. This approach is inherent in the principles of bioregionalism and critical regionalism.

Since the time of Vitruvius and Pliny, architects have delighted in buildings that work passively, providing comfort and pleasure by virtue of the characteristics of their enclosures and orientations. Pliny, in the first century AD, was proud of the way his Laurentine villa responded to the climate:

> *It faces mainly south, and so from midday onwards in summer (a little earlier in winter) it seems to invite the sun into the colonnade ... This room is very warm in winter when it is bathed in sunshine.*[4]

Reyner Banham, in his seminal work of 1969, takes similar pleasure in the architectural expression of environmental functions. He delights in the deployment of an elegant and appropriate section and plan to temper the internal environment in John Hayward's Octagon House, and the integration of environmental control in the buildings of Earnest H. Jacob.[5] He later goes on to extol the environmental virtues of Philip Johnson's Glass House in New Canaan, somewhat surprisingly, as it is fully walled with single pane glass. This praise is partly a result of its under-floor heating – a novel feature at the time – which makes it comfortable in the depths of winter, but also a consequence of its perfect microclimatic surroundings in the summer. The house is set on the edge of a bluff to catch the breeze, with its glass walls shaded by trees to the south and west. Writing before the 1970's oil crisis and before the full flowering of the environmental movement, Banham makes little distinction between the expression of passive control in building form and the mechanical or electrical inputs which might supplement or override this. In fact, he positively celebrates the arrival of mechanical and electrical solutions in the nineteenth and twentieth centuries, as this loosens the constraints imposed on architects and engineers, who previously had to incorporate large voids in section and plan to manage the volumes of air essential for natural ventilation. Banham's tripartition of environmental management into Conservative, Selective and Regenerative modes is a useful analysis: the Conservative mode retains heat, particularly solar energy; the Selective mode provides adjustable or movable elements such as shutters and windows to exclude or include air or solar rays; the Regenerative mode uses external forms of energy to provide heat, cooling or ventilation.[6] The first two modes correspond to the passive mode of environmental control. In contrast to Banham, Dean Hawkes makes the distinction between Selective (passive) and Exclusive (mechanical) modes of environmental control:

> *During the twentieth century, mechanical and electrical service systems reached a state of development at which they could replace all of the elements of the natural environment in buildings. At this moment the essential nature of architecture was fundamentally challenged. The historical struggle of all buildings to connect inside to outside could be replaced by the flick of a switch.*[7]

Hawkes' sense of sadness at the almost universal triumph of the Exclusive mode is evident in these words. However, despite the advances in technology and the availability of cheap energy for the last two centuries, it remains the expert view that environmental design should be founded on the same basic principles as those espoused by Vitruvius and his Renaissance followers. In 1995, the German architect Thomas Herzog drafted a manifesto for sustainable design that was signed by Europe's leading architects.[8] The manifesto stressed that the passive approach should take priority over technological solutions:

> *It should be possible to meet comfort requirements largely through the design of the building by incorporating passive measure with direct effect. The remaining energy needs in terms of heating, cooling, electricity, ventilation and lighting should be met by active systems powered by ecologically sustainable forms of energy.*[9]

Other distinguished practitioners in the field have come to the same conclusion, regarding the first key design step in achieving sustainable architecture. The leading environmental engineer Max Fordham emphasizes the requirement to put passive strategies first, starting with good daylighting:

> *In a modern building the demand for heat can be reduced to almost nothing. It can be equated with the metabolism of a building. A significant share of the demand for electricity is for lighting, and natural light is passive solar energy. So good natural light, which enables the electric lighting to be switched off for daylight hours … should be a first design requirement. … Other demands for electricity should not be necessary for the building itself, but are needed to bring all the benefits we expect from industrialisation.*[10]

We have seen that according to Herzog, Fordham and others, it is far more effective to reduce carbon emissions and conserve energy by employing passive design principles first to light, heat and cool buildings. Only secondly should we employ renewable energy technologies to meet any shortfalls in energy requirements.

Our increased desire to save fuel – coupled with recent developments in mathematical, physical and software modeling capabilities – has renewed our appreciation of the traditional techniques of passive design and our understanding of the principles that underlie that approach. These principles have been widely disseminated and are generally well understood by architects and their consulting environmental engineers. However, the performance of buildings often fails to live up to expectations, even in cases where the central objective was to produce an exemplary, low-energy project. We shall see that the influence of aesthetic sensibilities may be deflecting designers off course.

Commenting on the philosophy of *Design with Climate*, after referring to Olgyay's book as "one of the wisest books ever written about the environmental function of architecture," Dean Hawkes suggests how to characterize the approach in relation to the work of Feilden Clegg Bradley:

> *This is an architecture of orientation, cross section and envelope. The principal rooms face southwards. The cross section presents a high south façade to the sun and a low one to the north. The envelope is generally highly insulated and, to the south, is elaborated by high-performance glazing and internal and external shading devices. This might appear to be analytical and reductive, a formula for literal representation of the devices of environmental management but, right at the outset, the design reveals an understanding of the primacy of inhabitation in making architecture.*[11]

The latent fear of producing a reductive architecture from the too-rigorous implementation of passive design strategies, hinted at here by Hawkes, is echoed by others. It seems that it is not enough for architects to design buildings that perform well; they must have some other special factors that make them unique and perhaps iconic. When it is suggested to Ken Yeang that architecture students are inspired not by designing for performance but by star architects, he remarks:

> *If you build in the performance well, you almost have to build the diagram ... if you build the diagram then it works, but it is also boring … so a certain amount of license has to be given for deviations … to what extent do you allow the variations to affect the performance of the building? It's a difficult aesthetic decision, and sometimes if you get too rigorous with your performance criteria your client will say, "well, you know, you've designed just a box for me!"*[12]

Peter Clegg, notable for his sustainable designs, says something similar when asked what deflects his firm from achieving low-energy buildings:

> *There is a tendency for architects to be more interested in the other aspects [not the sustainability aspects] of the design ... good architects would all subscribe to sustainability but they wouldn't put it at the top of the list and let it really drive all of the decisions … there would be compromises ... "I'd really like to get a lot more glass in that elevation because of this, that or the other" whereas you risk it being overglazed or "I want this to be a blank wall" ... aesthetics can compromise sustainability.*[13]

Aesthetic preconceptions and preferences of this kind are inherent human tendencies that can be traced all the way back to ancient Greece. John Onians, the renowned historian who introduced neurological perspectives in art and architecture, attributes the clear distinctions between the Ionic temple model from Samos and the Doric model on the mainland to the distinct cultural and military heritage of the architects who designed them. Onians argues that this was not a conscious decision of the designers, but a result of the neural programming of their brains, and their sensory perception of the given environment:

> It was the brain'*s genetically driven predisposition to pay attention to things that seemed secured or threatened its survival and its tendency to form neural networks*

> *specializing in phenomena in this area that led to the development of a tendency to see convergences in the appearances of these very different sets of objects*.[14]

Onians explains that the Samian temple's central line of columns, distinctly different front and rear elevations and the sail-like coils of the Ionic capitals are all subliminally related to the forms of ships – symbols of naval power and security for this seafaring people. On the mainland the ultimate symbol of power was a phalanx of soldiers, hence the Doric temple's serried ranks of columns with their flutes and arrises resembling the "hollow-ground blades of spear and sword."

This theory suggests that although we share some aesthetic preferences in common with all other human beings, each culture and subgroup has its own particular conception of beauty. Further down the scale, as individuals, we all have our personal, unique, aesthetic responses based on our own particular experiences. Our neural networks are thought to be in a constant state of flux, with their connections changing continuously. Familiar images form impressions which over time reinforce each other, like warm water eroding a pattern of hollows in jelly: when a new memory arrives it flows most easily into the pattern already formed.[15] The memories already laid down therefore respond more positively to similar memories and images in the future. As a result of this neuroplasticity of the brain, one set of aesthetic sensitivities will emerge in one culture, and a different set will emerge in another culture or group at a different time.

The work of neuroscientists and neuroarthistorians like Onians offers a clue to the current investigations of architecture. One cause for the failure of buildings to live up to their expectations might lie in the very nature of what it means to be human – the proclivity of the human brain to seek out patterns, to look for rhythm and symmetry and to find repeated motifs – in both the natural world and the built environment. So strong is this natural tendency that it fundamentally alters our rational aims, objectives and judgments. For example, in seeking out a mate our brains are programmed to look for symmetry and regularity, as these are indicators of good genetic stock. This tendency may explain why we also perceive and look for similar characteristics in buildings, even though they are completely unrelated to good building performance. This effect has been at work ever since mankind progressed beyond subsistence societies. In those economies, when questions of survival and the need to minimize resource use were paramount, there was little room for aesthetic sensibilities. As human societies began to flourish and surpluses of resources and time became available, people began to indulge their innate preference for aesthetic concerns – namely symmetry, proportion and pattern – when designing and making buildings and when crafting objects. Societies make a significant shift away from established patterns of building when their economies develop to become less dependent on local resources, leading them to:

> *… rely less on vernacular wisdom and increasingly consider fashion and taste as the prime motivators of their architecture. The result is increased consumption of materials from further afield and introduction of architectures that are less appropriate for the local climate.*[16]

We now occupy an extreme of that position. A large proportion of the energy we expend and the resources we consume is unnecessary for our comfort, well being or happiness – the excess *blubber* referred to by Elizabeth Farrelly in her book, *Blubberland: The Dangers of Happiness*.[17]

Treatises from Vitruvius Palladio and others outline various principles of passive design – in terms of orientation, window size and location – but the reasons for these prescriptions are often clouded by mysticism or cultural practice. For example, Vitruvius names twenty-four winds for regular points of the compass, whereas in reality, the winds are far more fickle.[18] Allusions to the health and spiritual benefits of design features obscure the genuine reasons for their use: to achieve comfort in an unfavorable climate. Barbara Kenda seems to conspire with the treatise authors, rather than to acknowledge the obvious and straightforward benefit of improved physical comfort, in ascribing medical, intellectual and other powers to the cooling effects provided by the Costozza caves and ducts.[19] "For these architects and patrons, pneuma was fundamental for establishing physical and spiritual harmony between the human body, a building, and the cosmos."[20] Palladio well understood the need to balance the size of windows to maximize comfort and optimize daylight – therefore not too large, nor too small:

> *If the windows are made smaller and less numerous than necessary, [the rooms] will be made gloomy; and if they are made too large the rooms are practically uninhabitable because, since cold and hot air can get in, they will be extremely hot or cold depending on the seasons of the year, at least if the region of the sky to which they are oriented does not afford some relief.*[21]

However, significantly, Palladio's aesthetic sensibilities, in common with architects today, override his climatic rationale when it comes to the overall composition of buildings, as "[Palladio] proceeds without further reference to orientation to rule that all the windows of a floor should be the same size as those of the largest room in the suite."[22]

Where the early treatises might have been compromised by superstition and religious belief, today, stylistic prejudices and preferences interfere with practical objectives. At both times, the imposition of a controlling order emasculates the efficacy of the original design conceptions. For example, Colin St. John Wilson claims that the Modern Movement's ostensible aims for a pragmatic and rational architecture, where form followed function, was hijacked by Le Corbusier and others who turned it into an aesthetic style:

> *It is the thesis of this book that the [Modern] Movement did not die but rather that its authority was usurped, right at the moment of its emergence into public identity, at the foundation of the International Congress of Modern Architects ... The functional has also been debased into its very opposite – once again a 'style' to prolong the old 'Battle of the Styles' by the very people who should have protected its fundamental humanity.*[23]

The establishment of particular visual and symbolic systems – Le Corbusier's *five points* – suddenly took precedence over the movement's original ideals, based on *truth to materials* and *form follows function*. Le Corbusier's ideal of a universal house is at odds not only with these tenets but also with some of his climate related work at Chandigarh and elsewhere:

> *At this moment of general diffusion, of international scientific techniques, I propose: only one house for all countries, the house of exact breathing. The Russian house, the Parisian, at Suez or in Buenos Aires, the luxury liner crossing the Equator will be hermetically sealed. In winter it is warm inside, in summer cool, which means that at all times there is clean air inside at exactly 18°C. The house is sealed fast! No dust can enter it, Neither flies nor mosquitoes. No noise!*[24]

Contrasting starkly with Le Corbusier's proposal for a universal house for all climates is the notion of the *bioregion* and its architecture – in tune with local climate, materials, culture, skills and economy. Kenneth Frampton eloquently discredits the approach of *universal technique*, with his theory of *critical regionalism*, which encourages a localized, responsive and humanistic architecture. Here, Frampton talks about how the design of openings can respond to the temporal changes in climate and light:

> *A constant 'regional inflection' of the form arises directly from the fact that in certain climates the glazed aperture is advanced, while in others it is recessed behind the*

masonry façade ... Here, clearly, the main antagonist of rooted culture is the ubiquitous air-conditioner, applied in all times and in all places, irrespective of the local climatic conditions which have a capacity to express the specific place and seasonal variations of its climate. Wherever they occur, the fixed window and the remote-controlled air-conditioning system are mutually indicative of domination by universal technique.[25]

Although many architects followed Le Corbusier's *stylistic* lead, others such as Alvar Aalto and Hans Scharoun remained firm to the Modern Movement's essential principles. Some contemporary British architects continue to develop this *other tradition of modern architecture* with buildings whose forms and sections carry forward the regionally rooted, environmental control strategies embraced by Frampton. For example, Rab Bennett's Wessex Water office building in Bath – an exemplary low-energy building – is orientated so that its long elevations face due north and south for easy solar shading. (Fig. 1)

Fig. 1: Photo of South Elevation, Wessex Water Building, Bath, UK.

The building has a restricted plan depth for good daylighting and ventilation, high thermal mass ceilings to create a thermal flywheel effect in combination with night cooling and an optimized proportion of window to insulated wall area to minimize overall energy consumption, balancing heat loss with light gain. (Figs. 2 & 3)

Fig. 2: Floor Plan, Wessex Water Building, Bath, UK.

Fig. 3: Typical Section, Wessex Water Building, Bath, UK.

The building form and architectural elements of Feilden Clegg Bradley's National Trust Headquarters in Swindon, although a deep plan building, is similarly orchestrated to optimize orientation, roof form, ceiling heights and details to minimize energy consumption. The sawtooth roof profile is aligned due east-west, despite the site's non-cardinal orientation so that the glazing, pitched to face due north, is shaded by overhanging photovoltaic panels on the south-facing slopes. The brick built north-west and north-east elevations are characterized by either deep reveals or brick nibs to provide shading from low sun angles. (Figs. 4, 5 & 6)

Fig. 4: Axonometric Sketch, Heelis Building, National Trust Headquarters, Swindon, UK.

Fig. 5: Floor Plan, Heelis Building, National Trust Headquarters, Swindon, UK.

Fig. 6: Building Section, Heelis Building, National Trust Headquarters, Swindon, UK.

Some other recent buildings, such as Michael Hopkins's Inland Revenue building in Nottingham or Norman Foster's Greater London Authority (GLA) building in London, originally trumpeted as *green*, end up performing no better than the unsustainable forms they are designed to supersede.[26] Although the Inland Revenue building was designed with passive principles in mind for cooling, daylighting and effective solar shading, some of these strategies have been compromised in the finished building. Every elevation of the building, whether facing north, east, south or west, and whether or not shaded by other parts of the same building complex, is provided with exactly the same configuration of solar shading devices – deep reveals, light shelves, louvered balustrades and inter-pane venetian blinds. (Fig. 7)

Fig. 7: Typical Façade View, Inland Revenue, Nottingham, UK.

This combination of devices serves to all but eliminate any view of the sky from large parts of the interior. This is not what one might expect in a building bioclimatically designed, which would typically exhibit variations in façade, specific to the orientation of the sun's path. To be effective against the low evening sun, the louvers should be vertically arranged on northern façades, in contrast to horizontal shades on the southern façades to exclude the sun from high angles. (Fig. 8)

Fig. 8: Plan of Building Complex, Inland Revenue, Nottingham, UK.

In this building there is clearly a great deal of redundancy, with more than three elements providing solar shading. More importantly, however, all these devices serve to significantly reduce the amount of daylight entering the building, the maximization of which was one of the major objectives of the brief.

At the design stage, Foster's GLA building located on the Thames and opposite the Tower of London, was claimed by its architects and engineers to embody the *best* principles of low-energy design. The form of the building is clearly based on passive design principles with the assembly chamber facing due north in order to benefit from natural light and to embody the *transparency* required of today's democratic institutions, while at the same time, excluding excess sunlight. The surface area of the external envelope – through which solar gain and heat loss pass – is minimized by the use of a spheroid form which is skewed southwards to reduce the solar gain. This form is further modified by overhanging successive stories of the office floors on the south side of the building in a stepped profile to provide solar shading to the office floors below. The sophisticated development of these passive strategies results in a complex arrangement of twin wall glazed cassettes, each one of unique geometry and incorporating double glazing, insulated panels, external single glazing, integrated blinds and opening vents. Following extensive computer modeling of sunlight hours and solar data, further sophistications fine-tune the glazing height of each internal panel, related to azimuth and altitude angle, in order to limit solar gain to acceptable levels. The manual operation of a low level damper by the adjacent office worker will automatically open the outlet damper in the ceiling and switch off the mechanical ventilation system in that zone. (Figs. 9, 10 & 11)

Fig. 9: Exterior View, GLA Building, London.

Fig. 10: Wall Section Detail, GLA Building, London.

Fig. 11: Building Section, GLA Building, London.

At first impression, this approach appears to be laudable and well-intentioned, but there are design choices that do not match the strategy. For example, when the proportion of glazing to insulated wall area in the inner leaf is carefully optimized to limit solar gain, one questions why the external leaf is fully glazed. In summer this will unnecessarily bring unwanted heat into the cavity between the leaves, some of which will undoubtedly make its way to the interior. And the building form is spherical, when it is far easier to exclude solar rays in rectilinear buildings with elevations facing due south. Foster claims that the overall building form contributes to consuming only 25% of the energy normally used by a high specification office building:

> *The building's unusual form, and complex geometry, has been generated as a result of thorough scientific analysis, aiming to reduce both solar gain and heat loss via the building's skin, thus reducing the building's energy needs ... The building will be naturally ventilated, with openable windows in all office spaces. Heat generated by computers, lights, and people will be recycled ... The combination of all these energy saving systems means that there will be no need for boilers or chillers in the building.*[27]

Unfortunately, following the completion and occupation of the building, it was found to perform no better than the average office building in terms of energy use and certainly nowhere near the originally touted *best practice* credentials.[28]

In the Nottingham building, it is clear that aesthetic prejudices have overridden the rational design process, with an arbitrary desire for every elevation to look identical. This is true, despite the distinctly different functions of each elevation, and despite the different solar control requirements for south-facing façades when compared to those that face west or north. Other factors are at play in the GLA building: the engineer claims that the increased energy use has been the result of a doubling of office staff working in the building, plus building managers who do not know how to control the building. Passive buildings, despite their apparent simplicity, do require a sophisticated understanding of their different modes of operation under varying ambient conditions to make them work in an optimum manner. But one cannot easily dismiss the suspicion that the building's fully glazed external skin, and its spheroidal form, may have something to do with its deficiencies.

In the work of most architects a characteristic style emerges, which evolves and changes from one project to the next. Rather than *reinvent the wheel* designers build on what they have done before, which is a normal and natural process. They are motivated by the pleasure and satisfaction they get from revisiting previous patterns and forms, and developing and refining them further over time. Just as one can immediately recognize one signature architect's buildings and distinguish them from the designs of another, the same applies to the work of the two architects and their buildings we have just examined. Hopkins' heavy masonry pier motifs in the Inland Revenue building can be seen earlier in the Lords cricket stand, concurrently in the Glyndebourne opera house and later in the Portcullis House for British members of parliament. Spheroidal forms are seen in Foster's Reichstag building, later transformed to suit the exigencies of site and program in the British Museum and Swiss Re buildings before emerging yet again on the banks of the Thames. These aesthetic themes are the visible manifestation of underlying neurological processes – processes that bring us pleasure when we reprise familiar patterns.

Conclusion

Considering the aesthetic beauty inherent in passive design – which echoes that of nature – let alone the environmental imperative of adopting its principles as widely and as deeply as possible, we should continue to seek out the fault lines that interfere with its application on a wider scale. In all periods, from ancient times to the present day, the basic principles of passive environmental design have been well understood to varying and increasing degrees. Despite common misconceptions, these principles are widely acknowledged to form the foundation for truly sustainable architecture. Buildings produced according to these principles have provided not only comfort in adverse climates, but also aesthetic pleasure for those who appreciate their fitness for purpose – buildings that are fine-tuned to respond elegantly, effectively and efficiently to their locale and to their climate over the different seasons.

Sometimes, however, the basic design principles are in conflict with the personal desires and preferences of designers and clients who want just that little bit more: the desire for an elegant plan, for consistency and order, for shiny materials like glass and metal or for repeated motifs that have become familiar *friends*. These inclinations are not just whimsical preferences but are neurologically programmed into our brains. The external and internal battles will continue, but there are indications that environmental performance will improve as the skills of architects increase and the models they use become more reliable. If a humanistic and rational approach based on passive design is rigorously and logically pursued, the resulting aesthetic should perhaps be allowed to emerge as a natural outcome of the process. And maybe that will be even more beautiful than the patterns that our neurological maps are trying to impose.

6.522 words

NOTES

1 Victor Olgyay, *Design with Climate: Bioclimatic Approach to Architectural Regionalism* (Princeton: Princeton University Press, 1963).

2 Fionn Stevenson, review of *Eco-minimalism: the Antidote to Eco-Bling*, by Howard Liddell, *Architects' Journal* (Nov. 2008): 44-45.

3 A single liter of oil contains the equivalent energy content of 35 man-days of hard labor according to Richard Heinberg. Today we think nothing of burning a liter of oil undertaking the most trivial errand, when in the past we would have very carefully weighed that expenditure of energy.

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12 From a transcript of the author’s interview with Ken Yeang on May 11, 2010.

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14 John Onians, “Greek Temple and Greek Brain,” in *Body and Building: Essays on the Changing Relation of Body and Architecture*, ed. George Dodds and Robert Tavernor (Cambridge MA: MIT Press, 2002), 50.

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18 In *Book I* of his treatise, Vitruvius describes a wind rose with 24 named winds at precise 15 degree intervals around the compass. In contrast, Vincenzo Scamozzi, in *L’idea della architettura universale* (1615), named 16 winds at 22.5 degree intervals.

19 The Costozza caves, near Vicenza, supply cool air to a number of villas via underground tunnels – a system that inspired Palladio to follow that example in his Villa Rotunda.

20 Barbara Kenda, ed. *Aeolian Winds and the Spirit in Renaissance Architecture: Academia Eolia Revisited* (Abingdon: Routledge, 2006), 18.

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26 Monitoring results published in the Energy Efficiency Best Practice Programme, *New Practice Case Study 114: The Inland Revenue Headquarters*, BRE 2000 indicates that a typical building in the complex consumed 157kWh/m^2 in 1996, which was about twice the predicted demand.

27 Statement dated June 8, 1999 from Foster and Partners' website, available at: http://www.fosterandpartners.com/News/013/Default.aspx (accessed February 2, 2010).

28 " … the Greater London Authority's City Hall is using 50% more energy than intended, consuming 376 kWh/m2 of energy a year rather than its target of 250 kWh/m^2." Alex Smith, "Ventilated Spleen," *Building* 36 (2005), available at http://www.building.co.uk/ventilated-spleen/3055845.article (accessed July 20, 2010).

FIGURE CREDITS

Fig. 1: Mandy Reynolds & Buro Happold

Fig. 2 & 3: Bennetts Associates

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Fig. 7 & 8: Keith N. Bothwell

Fig. 9: Nigel Young & Foster and Partners

Fig. 10 & 11: Foster and Partner

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Qualitative and Quantitative Traditions in Sustainable Design

John Brennan

Introduction: Mediating a Quantitative Tradition in Architecture

The notion of sustainable development has quickly become one of the defining narratives of our age. It is an expansive term, open to interpretation in an almost infinite number of ways. As architecture often holds an uncompromising mirror up to the values of the societies to which it belongs, trying to explain how architecture responds to the competing and often contradictory dimensions of sustainability in urban development presents a unique challenge.

In this exploration of sustainable development, we follow a simplified categorization put forward by Max Fordham who defines the environmental response of buildings in a way that distinguishes between buildings where people live and buildings where people work.[1] Following this approach, I propose to examine the aesthetics of sustainable architecture from the perspective of the *home*. There is a tradition of ecologically aware domestic design that spans fifty years and facilitates a narrative that can be based in a defined historical context. As sustainable theory is multi-threaded, this approach allows us to reflect on the theoretical discussions with examples from my own work as a practicing architect, mediating between theory and practice in the field.[2]

This chapter will examine the sometimes difficult relationship between architecture and the deployment of technology, and specifically, with sustainable principles in mind. At the heart of this inquiry is a differentiation between scientific reason and technological control that is well explained by social theorists such as Jürgen Habermas. Based on this foundation, I will seek to situate what is normally constituted as *eco-design* within the quantitative traditions of domestic architecture.

Many of the buildings designed by my practice over the years have engaged the question: What *exactly* constitutes sustainable architecture? Should the definition be divorced from the notion of technical performance? Can any kind of architecture be sustainable if it meets defined quantitative, technical benchmarks? In conceiving and building a series of residential projects over the years – against the backdrop of contemporary debates in sustainable design – I have come to believe that a building's measurable performance and stylistic appearance are of less importance, when compared to external variables such as landscape, climate and response to social and economic criteria for sustainability.

I will attempt to draw from an established body of scholarship in order to determine how the quantitative and qualitative traditions can, and indeed should, exist together in the field of sustainable architecture. We illustrate these relationships in both historic and practical contexts. The conclusions do not have a pristine clarity that comes from the seamless application of theory to practice, but rather, demonstrate the possibilities for sustainable design by discounting neither scientific empiricism nor the richness of the qualitative experience in architecture.

Defining the Sustainable

It is difficult to establish a meaningful narrative to describe the aesthetics of sustainable architecture without first referencing the contested nature of what we consider sustainable development. This section explores some of the critical relationships between architecture and sustainability, as both display almost infinite reserves of complexity and ambiguity. Sustainability is a term that is intensively deployed across diverse academic fields in the arts and sciences. Architectural research cultures embody a similar breadth of interpretation.

Critics and commentators often posit their own interpretation of what makes sustainable architecture from a position firmly rooted in their own disciplinary traditions.

In recent years, sustainability has become synonymous with the Bruntland definition to "meet the needs of the present without compromising the ability of future generations to meet their own needs."[3] In seeking to engage with social and economic as well as environmental realms, this definition can be interpreted across a spectrum of practice, and is almost incomprehensible in its breadth. Andrew Blowers, for instance, refers to sustainability as a "concept whose strength lies in its vagueness."[4]

We would observe that the production of architecture has much in common with the way in which we view sustainability. Both terms span diverse knowledge fields. In architecture's case, this entails reconciling the inherent tensions between the disciplinary concepts of "firmness" and "delight" since the time of Vitruvius. In *Academic Tribes and Territories*, Tony Becher posits a framework encompassing disciplinary clusters, and differentiates between bodies of "hard" and "soft" knowledge.[5] In this sense, the profession of architecture very much lies between the "hard" and "soft" while trying to negotiate a path between measurable performance and aesthetic appreciation. When discussing how architecture has endeavored to find an academic identity, Giles Oliver notes that "This yearning has centred on creating a distinct disciplinary validity and obscured the multi-disciplinary character of architecture's production and thought."[6]

How then is sustainable architecture to be described if, like Oliver suggests, we see a narrowing of the discourse in the field? To answer this question, we will examine how architecture and the environmental tradition are viewed by a selection of key critics who have contested the role of science and technology in sustainable design to varying degrees.

Simon Guy and Graham Farmer state that sustainable architecture is a "contestable concept." They observe a privileged, *techno-centric* agenda in the way in which architecture is described that offers little room for the sensibilities of culture and place. They assert that the so-called *green* building trend is entirely a social construct, and classify it as series of *eco-technic, -centric, -aesthetic, -cultural, -medical and -social* states.[7] Technology is compartmentalized within the realm of the *-technic* in the hands of architects such as Norman Foster, Richard Rogers and Renzo Piano, while it plays no part, for instance, in Guy and Farmer's exposition of an *eco-centric* architecture. Kiel Moe questions the "sustainable myths of the energy crisis." His observation that the deployment of technology is hermetic and isolating offers, to an extent, a valid critique of design practice. However, he remarks, "There is no real energy shortage – there is only a crisis of human choices as to our energy practices."[8] There are clear opportunities for writers such as Moe to find contestable elements in widely held narratives such as global warming and resource depletion, but these opportunities run the risk of seeming contrarian in the face of intensifying global pressures related to energy cost, security and supply.

Susannah Hagan's seminal book *Taking Shape* seeks to articulate architectural expression within an environmental tradition, using the typologies of symbiosis, differentiation and visibility.[9] Symbiosis describes an environmentally responsive architecture through existing forms of representation. Differentiation refers to the development of form that reflects natural processes more overtly, and which will start to produce distinctive, new architectural forms of its own. Finally, Hagan speculates that the term visibility "suggests the possibility of new forms, or the yoking of certain existing formal experiments to environmental modes of operation."[10] In this, Hagan seeks to catalyze new perceptions and practices in sustainable design with a "level of formal invention superfluous to configuring an environmental control system as efficiently as possible."[11] Unlike Moe or Guy and Farmer, Hagan observes that:

> *There is no reason why environmental design's science based inquiry and architecture's traditional concern with form should not co-exist. Indeed why architectural form should not be enriched by an environmental agenda as long as that agenda is not prescriptive.*[12]

Her careful exposition of the relationship between architectural design and the environment includes a place for both the empirical and the quantitative. In relation to wider discourses on sustainability, her terms of reference are firmly rooted within an environmental tradition. She asserts that "when applied to architecture, the term sustainable currently refers to environmental sustainability." Following the work of Hagan, the quantitative traditions in architecture can mediate design with the goals of sustainability, without necessarily dominating design through the use of technology.

<u>*A Quantitative Tradition*</u>

> *I do not like ducts, I do not like pipes. I hate them really thoroughly, but because I hate them thoroughly, I feel they have to be given their place. If I just hated them and took no care, I think they would invade the building and completely destroy it. I want to correct any notion you may have that I am in love with that kind of thing.*
>
> *– Louis I. Kahn*[13]

It is not an understatement to say that many of today's commentators distrust the controlling tendencies they find are inherent in the deployment of technology in architecture, and specifically distrustful of the impacts on design. Kahn speaks for many architects in a disdain for the technological necessities of building services, although few perhaps follow through on his advice to consider them carefully. Much is written about the contentious role of technology in society. Such a distrust of technology is recounted by Philip Bray[14] in

Theorizing Modernity and Technology where he covers how scholars such as Thomas Heidegger have described technology as enframing, to suggest it develops an internal logic, untroubled by any form of social or cultural mediation. Such a reading of technology makes it essentially antipathetic to any notion of a qualitative design process.

This section will illustrate an alternate sense of design that feeds from a long tradition of quantifying levels of consumption, with the goal of moving toward a more productive discourse on the deployment of technology in architecture.

Prior to the mid-twentieth century, overt evidence for quantifying and minimizing consumption in the design and operation of buildings was sporadic. In *Green Shift*, John Farmer lucidly examines the relationship between architecture and nature from the time of Vitruvius, seeing an inherent minimization of consumption in older building processes.[15] In recent times, the modern movement has been more concerned with the control of nature through technology than on the quantification and minimization of consumption, perhaps best described by Reyner Banham in *The Architecture of the Well-Tempered Environment*.[16] This book frames the modern movement and its antecedents not in terms of form and style, but in terms of the development of mechanical and electrical systems. It describes architecture as being driven by technical change and by the deployment of new technologies such as air conditioning. However, in *The New Eco-Architecture*,[17] Colin Porteous links the technology driven work of the modern masters to a wider environmental tradition; he traces a clear path from Banham's blanket engagement with technology to contemporary interests in low-energy and bioclimatic building. Porteous links much of the work of Corbusier and Frank Lloyd Wright with a sensibility for bioclimatic phenomena, such as harnessing sunlight and finding the best use of a site's microclimate for the benefit of the building. However, there is a sense of over-optimism in associating the *plan libre* and the *prairie style* with a high degree of sustainable probity.

The quantitative tradition in sustainable architecture engages buildings with a sensitivity toward the problems associated with an unfettered consumption of finite resources. The first book to popularize such concerns was *Silent Spring*,[18] but the seminal work is found in *Limits to Growth*.[19] A keystone of the book was the identification of exponential patterns in population growth and the impacts on what were deemed finite natural resources. The work has a Malthusian bleakness and the simulation model reflects the limits of the computational power available at the time. What was dubbed the *limits to growth* debate informed many nascent environmental movements and pressure groups.

Environmental ideologies split into distinct strands that can be referred to as "light green vs. dark green" or "environmentalism vs. ecologism."[20] A nuanced and contemporaneous reading of this can be found in Francis Sandbach's *The Rise and Fall of the Limits to Growth Debate*.[21] He outlines an environmental ideology that places significance on quantitative measurement and prediction, articulated through critical documents such as Edward Goldsmith's *Blueprint for Survival*.[22] Sandbach notes that "Ecological calculations aimed at elucidating the ecosystem's carrying capacity imply that political consensus may be achieved through a comprehensive, objective and value free scientific analysis."[23]

Much of the architecture through this tradition came in part from an "anti-establishment environmentalism" where the concern was one of "alienation and social control as a product of science and technology"[24] A fundamental ideological aim was to construct frameworks to provide a social control of technology, and this manifested itself in an imperative for non-polluting housing and the imperative to utilize renewable resources. In this, we find the establishment of a recognizable, if not entirely coherent, body of dwellings that form the first examples of a self-conscious green architecture. Publications such as *Radical Technology*[25] and journals such as *Undercurrents* bring together buildings that include Alexander Pike's unrealized Autarkic House, Robert and Brenda Vale's Autonomous House and the more anarchic counter-cultural enclosures by collectives such as the Street Farmers.

Living in Arcadia: The Autonomous Vision

> *The autonomous house on its site is defined as a house operating independently of any inputs except those of its immediate environment … In some ways it resembles a land-based space station which is designed to provide an environment suitable for life but unconnected with the existing life-support structure of earth.*[26]

The emergence of an autonomous architecture is important to contemporary design discourses because of its strong roots in the quantitative tradition. Robert and Brenda Vale's seminal work *The Autonomous House* looks back to the pioneering research undertaken at MIT with a series of demonstration buildings[27] that harnessed passive solar energy. In an age of bountiful fossil fuel, these structures remained thoroughly speculative. However, quantitative imperatives in terms of orientation and the configuration of solar collectors ensured that they displayed much of the spatial and material character that we now associate with energy conscious design. (Fig. 1)

Fig. 1: MIT Solar House 4, completed in 1959, displaying active solar technology on the roof.

The Vales' book is painstaking in its measured deconstruction of a home into a series of complex environmental systems of power generation, water consumption and re-use and waste recycling, with only a few pages of the book being devoted to the social implications of a house's autonomy. The book finishes by offering a building design, simple and compact in form, orientated to the south with a sunspace running the length of the principal elevation, and with a pitched roof that features active solar collectors and an aero generator nearby. The section is the primary way in which the behavior of the house is communicated, showing a clear relationship between the sunspace, the building envelope and the heat storage system. It displays many of the characteristics we associate with self-styled *eco-homes* that we encounter today. (Fig. 2)

Fig. 2: Project for an Autonomous House by Robert and Brenda Vale, 1975, a key design exemplar of the autonomous tradition.

It would be facile to label the Vales' autonomous house as being captive to technology; the architecture also resonates with the counter-cultural forces that shaped green architecture at the time, with an ideological aim to provide a social control of technology. I propose to explore the legacy of the autonomous tradition through the Tressour Wood house, located in the southern highlands of Scotland and designed by the author in 1992.[28] The house was completed just as a wider environmental sensibility was emerging, described by Pauline Madge and others as an "Ecological Design"[29] that embraced localism, material impact and the principles of "building biology."[30] It draws on many of the design typologies of the autonomous tradition as described earlier, and the house was conceived primarily in section, with orientation and passive solar gain as the dominant organizing principle. The enclosure is simple and compact, with heating provided by a single wood-burning stove. Ecological design methodologies were explored through local sourcing and local construction of much of the building components, which introduced a wider environmental perspective to the project. In addition, the house also incorporated issues such as material toxicity and embodied energy in its design. (Fig. 3)

Fig. 3: Tressour Wood House.

Operation of the house was an early, salutary lesson in the social challenges of pervasive technology in the home. The wood stove was designed and positioned in order to heat the whole house in conjunction with high levels of insulation, and it was placed in the center of the open plan ground floor as an aesthetic element in its own right. Even though the house was heated adequately by just the stove, within two years, the owners added electric heaters on account they were unwilling to load and fire the stove early every morning in cold seasons. This simple failure showed quite clearly a conflict between what users might expect in the use of their building and the extent to which the autonomous equipment could be deployed. The wood burner sat as the dominant focus of the open living space, but as a piece of technology, its mode of operation lacked the kind of automation the owners expected and dictated how the house was to be inhabited. Although innovative in many ways, the case of the Tressour Wood House indicates that technology, however basic, needs to be mediated and negotiated, not ignored, within the context of the inhabitants' pattern of living. (Fig. 4)

Fig. 4: Tressour Wood House, section showing the central location of the woodburner.

The Role of the Measurable

The ecological probity of a dwelling is most immediately found in what is measurable. Critically, it also confers status and value to the building as a cultural and aesthetic component embedded in its community. Rather than argue if such *eco-technical* buildings are simply social constructions, as Guy and Farmer would have it, there is a more absorbing relationship in ecological architecture that touches on the quite difficult *interface* between science, technology and architecture. In this section, I examine the theoretical basis for developing a positive engagement between the quantitative and qualitative worlds that define sustainable design.

The social theorist Jürgen Habermas provides critical insights in this field, having had a long engagement with the role of science and technology in society, as well as an interest in the ebb and flow of the counter-culture in the second half of the last century. At the heart of his investigations lies a multivalent view of science that he developed into three domains of interest. His first is the domain of technical engagement, where the measurable and the empirical have roles in predicting and responding to our environment; this corresponds to what we normally understand as the rational pursuit of science. His second domain is that of practical engagement where social knowledge is constructed through consensus and agreement. Finally, Habermas refers to the third domain of emancipatory knowledge that is based on self-reflection.[31]

In the context of understanding the currents that mold sustainable architecture, the critical attraction to Habermas' three domains lies in their inclusive and connective qualities. The role of science to explain the natural world, and the role of technology to intervene in it, are both mediated through social engagement. Habermas accepts the fundamental role of science to identify and explain phenomena such as climate change, which is then to be mediated by social experience. Habermas' work responds effectively to a public discourse around sustainable development, which is significantly framed in quantitative terms of consumption and conservation. This is the intellectual climate in which architecture should operate.[32]

In reflecting on how architecture relates to Habermas' three domains of interest, the first step is to engage design methodologies within scientific and empirical fields of knowledge. This provides a foundation for architecture to assess the needs of the society in which it is situated, and to seek strategies that promote sustainable development within it. The resulting *practical* engagement relates to Habermas' second domain, where social knowledge is constructed through consensus and agreement. Herein lies the challenge of mediating technology in the realm of architecture and sustainability. As sustainable architecture can be defined by its engagement with technology, many commentators seek to codify it as a spatial and aesthetic response. However, for a building to be *sustainable*, I argue that it needs to respond *empathically* to preconditions that are assessed through both the technical and practical domains. Habermas' state of emancipatory knowledge lies beyond the control of either technology or the building designer. Here, the limits of context and culture must be recognized to allow us as individuals to meditate on what sustainability actually means, providing room for knowledge and self-reflection. (Fig. 5)

Habermas' work resonates with the inherent complexity of the many narratives that endeavor to explain sustainable strategies in architecture. His emphasis on the mediation of technology through both society and the individual encourages a pluralistic and multivalent approach to the field. It thus allows discourse to at least co-exist across what are often strictly defined academic territories. We should accept that Habermas' definition of a *technical* engagement and the rational pursuit of science is a progenitor of what he refers to as *practical* engagement. At this stage, social knowledge is constructed through debate and an arrived consensus.

The environmental behavior of buildings can be described as a series of measurable physical phenomena. Social discourses in sustainability, themselves informed by scientific imperatives, then dictate how the manipulation of the physical processes inherent in a building should manifest themselves in architectural expression. I would contend that the nature of sustainability narratives are so embedded in the qualitative world, that for a building to be *sustainable*, it must be empathic to Habermas' technical and practical domains. Such an approach does not negate the experiential or the phenomenal as Habermas' state of *emancipatory* knowledge lies firmly embedded in the individual. There is thus an inherent freedom for us all to make our own constructions of the sustainable, but Habermas also recognizes that social and practical engagement requires a role for the quantitative.

Fig. 5: Habermas' domains of knowledge.

Living in a Quantitative Climate

The different streams of thought and traditions inherent in the discipline of architecture are often seen as divisive, where the relation between technology and design is subject to constant attrition. Habermas again offers ways of moving past this condition of binary opposites. Theories and positions that often appear contradictory are in fact legitimate when viewed in relation to one other, while privileging scientific knowledge not merely as a social construct but as a foundation for many social frameworks, including the practice of architecture. Habermas sees a "practical engagement" with reality where we act with a degree of confidence based on empirical investigations and frameworks. Viewing technology with suspicion – as an instrument and agent of control in nature and society – often negates the role of the quantifiable and empirical in shaping architectural discourse.

Many *eco-design* traditions have, at their core, a measure of autonomy that has clearly found ways of expressing itself as architecture, often with a distinctive style that very much represents the ideology of the designer and the owner. When we look at the Vales' first autonomous house, technology is certainly dominant. A distinctive characteristic of many *green* dwellings has been an ideological commitment by the owner to the building in terms of the systems for heating and cooling, lighting and the re-use of resources in certain defined ways in order to meet quantifiable standards. In addition, the consumption of energy in the design, construction and occupancy of *green* dwellings has been at the heart of defining their architectural identity.

How do the descendants of the autonomous tradition reveal themselves today? The Vales' first house was self-consciously experimental, yet it influenced the form of what we would recognize today as a stereotypical *eco-home*. The BRE (Building Research Establishment) Innovation Park lies in Watford at the northeastern edge of London and holds a collection of prototype homes to research how the emerging UK Code for Sustainable Homes can be realized.[33] A total of four dwellings were erected, sponsored by contractors and building product manufacturers. Quite divergent design methodologies are found in two of the buildings, the ecoTech Organics House sponsored by ecoTECH Swedish Sustainable Homes Ltd., and the Kingspan Lighthouse sponsored by the Kingspan Group and designed by Sheppard Robson with ARUP engineering. (Fig. 6)

Fig. 6: BRE Innovation Park showing the Lighthouse building to the left and the ecoTech building to the right.

The ecoTech building is starkly utilitarian with its form and detail making no effort to hide its modular nature. The Lighthouse home is much more expressive while working within the same plot area. Here, a clear degree of ambition on the part of the architect employs distinctive forms and materials that suggest a measure of environmental probity. Although the ecoTech building contains more accommodation, the Lighthouse provides a spatial richness both internally and externally. It is, as Hagan would describe, a *differentiated* building in that its design communicates its sustainable intent and functionality. The dwelling's form is informed by a ventilation strategy that uses stack effect and mechanical heat recovery. The internal volume is designed to optimize air movement, whilst the stack is carefully articulated and made transparent to privilege the environmental response of the building through its architectural expression. Externally the building is clad predominantly in natural finish timber, certainly not to respond to any context but to communicate a narrative of low environmental impact. Its clear finish seeks to convince us of a benign journey from raw material to building component. In contrast, the ecoTech building is simply finished in a white render that obscures any effort toward an environmental probity.

Looking to their empirical behavior and performance, the more formally expressive Lighthouse is in fact designed to the higher level 6 CSH (Code for Sustainable House) than the starkly functional ecoTech home with the level 4 CSH rating. This suggests that even when built as a research platform, an ambition toward making distinctive architecture does not need to be compromised by the goals of environmental credentials. It seems more likely that uninspiring utilitarian housing design is driven more by financial motives than by the notion of technological or environmental conviction. In this sense, there is substantial room for architectonic and aesthetic ambition in sustainable design strategies today that were in many ways not possible within the autonomous tradition, which held technology and quantitative performance at the forefront.

This is not to say that architectural form and style are not mediated by quantitative standards. In the UK CSH system, credit points are awarded for the "efficient use of building footprint"[34] that refers to operational energy use in indirect proportion to the compactness of form and to the exposed surface area of the building envelope. Some emerging typologies such as the PassivHaus[35] of Darmstadt, Germany, place great emphasis on the compactness of form and performance of the building envelope, especially with respect to air infiltration. This emerging typology often operates according to its own accreditation standard that interrogates building design through the criteria of operational energy use in a way that is both rigorous and exclusive, setting the parameters so narrow that freedom and flexibility in design are highly circumscribed.

Mediating Technology

The autonomous tradition has had a strong influence on the expression and form of the sustainable architecture we see today. One of the strengths of the autonomous tradition is its clear design elements: visible placement of renewables and active power systems, section as the primary design generator, compactness of form and the use of raw materials such as planted roofs and untreated timber. These characteristics of the autonomous tradition have made it easy to dismiss it as being technically deterministic, limiting architects' freedom in design and aesthetics. In addition, the means of production in the autonomous tradition are in themselves hermetic, with little dialogue with wider visual and cultural architectural narratives that engage matters such as context, composition and proportion. This concluding section reflects on how buildings designed today in the environmental tradition can mediate between the quantitative and qualitative narratives. In part, this is a journey through some of my own practice, moving on from an autonomous tradition to strategies that use more diverse cultural agendas to develop sustainable architectural design.

A required starting point for this dialogue is to move beyond an autonomous mindset. The idea of a closed, self-sufficient world often expresses itself in architecture that is essentially introspective in character. Here, form is dictated by performance criteria and a mechanistic interpretation of site and climate as vehicles to harvest natural forms of energy and reduce exposure. In breaking away from such architectures of utility, Dean Hawkes' exposition of "exclusive" and "selective" modes of building behavior offers clear direction.[36] An exclusive form of operation describes a building in which the environment is fully controlled and "artificial." Building forms are compact to reduce exposure to the external environment, and the operation of windows and doors are closely controlled. Although originally meant to describe the operation of sealed, conditioned workplaces, such characteristics could be directed at many zero-carbon methodologies, and in particular, at the emerging standards of PassivHaus. On the other hand, the concept of selective forms places more emphasis on passive energy collection, a variety of means of ventilation and building form that is mediated to *maximize* a relationship with the external environment.[37] In short, the selective mode of building is necessarily rooted in an intimate understanding of the given site context and its climate.

In the windy northwest corner of Scotland, the making of protective environments is embedded in the vernacular, where a clear threshold between the inside and outside worlds undoubtedly provides the exclusive modes of design. However, the importance of intangibles such as view and outlook depends on a more porous relationship between the external and the internal. Corrieburnwood House, completed in 2000[38] was designed in the selective tradition, even though the original program essentially called for an autonomous building. It is set in a site of high wind and sea exposure where severe wind speeds and low summer temperatures make it easily favor a hermetic approach to the building envelope. (Fig. 7)

However, the site offers exceptional views up and down a steep sea inlet, and thus the building seeks an open relationship with the external sphere. Seemingly intrinsic to the site, the design called for a protected external terrace, partly with a sunspace that acts as a semi-climatic buffer for the building interior. The house design thus offers four mediating stages: from the outside, to the sheltered courtyard, to the semi-climatic sunspace and to the interior. There is little in the way of sophisticated technologies such as heat recovery, with passive solar gain being distributed about the house through the manual operation of opening windows. (Fig. 8)

Fig. 7: Corrieburn Wood House, Ullapool, internal-external response and protection.

Fig. 8: Corrieburn Wood House, Ullapool, protected western face and outlook down the valley.

The house form is derived from a subjective need to relate the site and its vistas toward the natural elements, rather than from a position of hermetic volume according to the performance criteria alone. It hovers around Hagan's definition of a *differentiated* building, in which form is informed by an environmental sensibility that is both subjective and objective. The building was designed with integral passive solar collection spaces, photovoltaics, high levels of insulation and low impact construction materials. However at the same time it is not utilitarian, being mediated by what Habermas refers to as *practical* engagement. Instead of reducing exposed surface area, it curls around itself to produce a protected external social space. It turns its back to the wind, but in a way that is as much symbolic as it is quantifiable in measurable benefit.

The discourse that revolves around site responsive architecture can be opened to include a dialogue with both the physical and cultural landscapes. This can be described as a series of frameworks that Margaret Somers calls "dimensions of narrativity."[39] In the context of the Scottish Highlands where my practice is located, the landscape includes the remote beauty that was fashioned from precipitous economic and social decline as well as from nature. Instead of a diverse human ecosystem, the attraction of the Highlands depends very much on a countryside emptied of people. The perception of a landscape's beauty is what Somers refers to as "public narratives" whose role it is to record and recount shared memory. In this case, the dominant public narrative revolves around an embedded perception that the area's traditional cottages of the past should be literally interpreted to define vernacular building in the Scottish Highlands.

Margaret Somers talks additionally of "metanarrative" where considerations of expansive cultural and philosophical contexts are used to engage with the particularities, in this case, of site and location.[40] Our work on the Urray House, located north of Inverness,[41] was a conscious attempt to connect environmental performance with a deep reading of landscape and context. It starts with an interaction with an almost universal metanarrative, that of the relationship of light to building. A traditional Scots vernacular dwelling engages primarily with shelter and protection, to create an internal world that is insulated from the harshness of the external world. As Peter Davidson notes in *The Idea of North*, "One element of life that Scottish writers take for granted is that the weather needs to be constantly negotiated."[42]

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However, the long reach of light on a midsummer's night would do well to penetrate the protective depths of a traditional Scots home. Therefore, in the design of the Urray House, we tried to recognize the specific qualities of the sunlight from high latitudes: its low, dissecting qualities in midwinter and its high altitudes of longevity in midsummer. Internally, the environment of the Urray House is the antithesis of a dark, vernacular interior, as it is drenched in northern light. (Figs. 9 & 10)

The house embodies a design strategy that seeks to tie environmental agendas to environmental context and to the subjective qualities of northern light. Sustainable building form does not need to differentiate itself through the overt use of environmental iconography (exposed solar collectors, for instance) as Hagan would perhaps have it, but instead, can differentiate itself with an almost intangible response to place and environmental phenomena. The Urray House illustrates that buildings designed to maximize compactness of form and constructed of highly energy efficient assemblies can resonate with cultural sensibilities as well.

Fig. 9: The Urray House, external massing and interior variations.

Fig. 10: The Urray House, exterior view.

"Long-Life, Loose-Fit" Revisited

Along with a rediscovered sensibility toward landscape, the social nature of emerging discourses in sustainable architecture can be seen as the mediator between the quantitative and qualitative worlds. In *Flexible Housing*, Tatjana Schneider and Jeremy Till[43] make the case for adaptability in the design of homes as fundamental for achieving the elusive goals of social and economic sustainability.[44] According to them, a home that is able to change and adapt over time will lead to the formation of more stable communities. Although still an evolving field, the concept of "super adaptability" in housing is recognized by regulatory authorities as a future driver for sustainable and low carbon developments.[45]

Sustainable architectures are often profoundly influenced by the technologies that are incorporated in them. Therefore, it may be sensible to return to Habermas' work at this time. Many of the buildings examined in this chapter illustrate a close relationship between the designer and client that reflects Habermas' interest in how we all search for a sense of personal, *emancipatory* understanding in relation to how we construct our personal environments. However, many architectural commissions do not have such close, symbiotic relationships that can result in the bespoke homes becoming truly emancipatory. In most cases, it can be seen that the relationship between the owner and the architect does not reach a close symbiotic state. As a result, the architect bases the design on anticipation and prediction as to how the house will be lived in. To quote Stewart Brand's adage, "all buildings are predictions and all predictions are wrong."[46]

A critical design framework for achieving adaptability in sustainable design lies in Stewart Brand's model for "shearing levels of change." In *How Buildings Learn*, he describes how architecture should not be seen as static, but rather as a series of interconnected systems such as structure, skin and services that change and mutate at different rates. Till and Schneider, in respect to adaptability, speak of "hard" and "soft" modes of flexibility. Hard flexibility lies in an architectural language of, for example, sliding doors and folding partitions, allowing for almost instantaneous changes in function. For an architect, this allows a more proactive, and some would remark, more controlling role in the way that housing is actually used. This approach produces distinctive forms, such as the Schröder House by Rietveld, and remains a persuasive design methodology for architects today. More difficult to define is the term soft flexibility. It is, to an extent, an admission of the obvious yet undiscussed point that architects cannot and should not control how a house is occupied. But rather, their role is to provide space that can change and adapt over time. For this to be facilitated, a “relaxed attitude” to planning and technology is called for,[47] where adaptability is enabled through the generous provision of spatial definition rather than through the specifics of technological solutions.

The WholeLife House, designed and constructed for Scotland’s Housing Expo,[48] is an example of how the basics of spatial organization can produce dwellings that anticipate changes through the application of soft flexibility. (Fig. 11) The form of the house is divided in two: a core dwelling with living, kitchen and sleeping accommodation and an annex block that allows varying degrees of interdependence with the core building. Deliberately, the functions of the annex are not clearly defined. It can be entered directly from the lobby of the building, with services provided for kitchen and bathroom facilities. None of the partitions are load bearing so that the annex can be opened or subdivided easily. Some uses of the annex could include extra bedrooms for a large family, a home office or a living space for young adults and elderly relatives. The permutations and combinations of such a building are complex; they are intentionally un-predictive as to how a family would choose to use the space. (Fig. 12)

Fig.11 WholeLife House for Scotland’s Housing Expo 2010.

Fig. 12: WholeLife House, adaptable annex block.

Even though the WholeLife House includes elements such as a passive solar sunspace, this element is integrated within the main body of the house rather than being displayed as a singular, applied element. What we learned from this example is that energy reduction strategies that prioritize compact building forms do not necessarily engage with wider drivers for sustainable development, including the social drivers of sustainability.

Looking back to the time of the Autonomists, Alex Gordon, President of the Royal Institute of British Architects, coined the term "long life, loose fit" in 1972[49] to describe a way of designing low energy, low impact buildings.[50] As a definition of where we might see the form and expression of sustainable architecture developing over the long term, it is an observation that is as relevant today as it was then.

Conclusion

This chapter establishes a framework to engage positively with a quantitative tradition in sustainable design. Architecture shares a challenge that is also inherent in many other disciplines: that of mediating the tension between the rational and intuitive worlds, where the role of technology is neither negated nor privileged. To an extent, this challenge lies at the boundary and intersection of disciplines for those who are involved in the production of sustainable buildings. To work within dominant public narratives that define low-carbon architecture, designers must be empathic to how buildings are simulated, measured and benchmarked for their technical performance, and how they interface with technology. The autonomous tradition became significant in environmental discourses in 1970's, and the tradition is formally expressed in architecture that is predicated on the elimination of unnecessary consumption. The descendants of the autonomous tradition today, such as those we see at the BRE Innovation Park, still reflect a dominant role for technology in sustainable architecture.

Through my practice, I have found that it is difficult to classify sustainable buildings according to form and style. The buildings presented in this chapter follow a chronological development, from the autonomous tradition of the Tressour Wood House to the more complex and nuanced readings of what sustainable architecture should represent today; in many ways, I believe this development mirrors the progress of wider debates in the field. All of the homes embrace the quantitative tradition, in that they are founded on a sensibility to reduce resource impacts. However, they go beyond the quantitative tradition to explore relationships between internal and external space, light and landscape, and space and adaptation; all of these elements are essential in developing a meaningful and sustainable tradition in architecture.

Technology can hold a tight grip on the boundaries within which architecture can freely express its aesthetic purpose. When the quantitative and qualitative worlds that architecture inhabits are seen as mutually exclusive, this lies in opposition to the transdisciplinary nature of sustainable development. Buildings that might call themselves sustainable while following a hermetic design process will find it difficult to engage the field of sustainability in a meaningful way.

Jürgen Habermas' work on empirical knowledge – and its mediation through the realms of practical and emancipatory knowledge – helps define a formal framework to reconcile some of the fault lines that exist between scientific and cultural practices. While a Vitruvian reading of architecture revolves around the ideas of firmness, commodity and delight, Habermas has something to contribute. He provides a fundamental view of science as underpinning cultural discourse, bringing the certainty of resource consumption and the environment to the consideration of building behavior; in other words, he contributes to the sense of firmness in architecture. The way that buildings are programmed and designed as social objects is mediated through Habermas' domain of practical engagement, embodying much of what we refer to as commodity in architecture. And finally, Habermas discusses the way our personal engagement with architecture lies within the domain of emancipatory knowledge, as we find within ourselves delight in the built environment.

Making architecture that responds to the many sustainable narratives that flow through contemporary society cannot easily reside in defined professional or academic traditions. It does not make for simple theoretical constructs with which to frame design processes. Instead, it follows the same paradoxical and sometimes counterintuitive path as sustainable development does within our wider social and cultural environments.

NOTES

1 Max Fordham, "Natural Ventilation," *Renewable Energy* 19, no.1 (2000): 18. Max Fordham is a building services engineer with a lifelong interest in the relationship between architecture, environmental services and sustainability.

2 The author is a partner in the firm of Brennan and Wilson Architects who specialize in rural and sustainable design in Scotland.

3 Gro Harlem Bruntland and World Commission on Environment and Development, *Our Common Future* (Oxford: Oxford University Press, 1987).

4 Andrew Blowers, "Environmental Policy: Ecological Modernisation or the Risk Society," *Urban Studies* 34, no. 5 (1997): 845-871. This is an excellent paper that sets out some of the complexities and contradictions to be found in sustainable theory.

5 Tony Becher, *Academic Tribes and Territories: Intellectual Inquiry and the Culture of Disciplines*, *2nd ed.* (Buckingham: Open University Press, 2001).

6 Giles Oliver, "Responsive Practice" in *Architecture and its Ethical Dilemmas*, ed. Nicholas Ray (London: Taylor & Francis, 2005). In part, Oliver's work engages with the

challenges that the architectural profession faces in the UK, in dealing with discipline specialization and new construction procurement methods.

7 Simon Guy and Graham Farmer, "Reinterpreting Sustainable Architecture: the Place of Technology," *Journal of Architectural Education* 54, no. 3 (2001): 140-147. This paper attempted, for the first time, to identify and codify sustainable design typologies.

8 Kiel Moe, "Compelling yet Unreliable Theories of Sustainability," *Journal of Architectural Education* 60, no. 4 (May 2007): 24-30. This article seeks to question the techno-centric stance of sustainable architecture, with reference to cultural commentators such as Giles Deleuze.

9 Susannah Hagan, *Taking Shape: A New Contract Between Architecture and Nature* (Oxford: Architectural Press, 2001).

10 Ibid. p. 3.

11 Ibid. p. 163.

12 Ibid. p. 97.

13 Louis I. Kahn, "Not for the Fainthearted," in *Louis I. Kahn, Writings, Lectures, Interviews* (New York: Rizzoli, 1991), 258.

14 Philip Bray, *Modernity and Technology* (Cambridge, Mass: MIT Press, 2003), 56.

15 John Farmer, *Green Shift: Changing Attitudes in Architecture to the Natural World, 2nd ed.* (Oxford: Architectural Press, 1999).

16 Reyner Banham, *The Architecture of the Well-Tempered Environment* (London: Architectural Press, 1969). This was the first book to explain architecture through the

development of building services, and how it affected and molded the emergence of new building typologies.

17 Colin Porteous, *The New Eco-Architecture: Alternatives from the Modern Movement* (London: Spon, 2001).

18 Rachel Carson, *Silent Spring* (London: Hamish Hamilton, 1963). Although seen as a precursor to the key texts that define the environmental movement, it was concerned primarily with the effects of pollution on wildlife.

19 Donella Meadows, Dennis Meadows, Jorgen Randers and William Behrens III, *The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind* (London: Earth Island Ltd., 1972). This publication was commissioned by the Club of Rome, and established an early computer simulation that worked through twelve global development scenarios that were modeled over two centuries.

20 Andrew Dobson, *Green Political Thought, 4th ed.* (London: Routledge, 2007). This is a definitive and critical overview of the political ideologies of the green movement.

21 Francis Sandbach, "The Rise and Fall of the Limits to Growth Debate," *Social Studies of Science* 8, no. 4 (1978): 495–520. This paper makes an excellent recent history of the various strands that constituted the environmental movement.

22 Edward Goldsmith, "Blueprint for Survival," *The Ecologist* 2, no. 1 (1972).

23 Francis Sandbach, "The Rise and Fall of the Limits to Growth Debate," *Social Studies of Science* 8, no. 4 (1978): 503.

24 Ibid. p. 504.

25 P. Harper and G. Boyle, *Radical Technology* (London: Wildwood House, 1976).

26 Brenda Vale, *The Autonomous House Design and Planning for Self-Sufficiency* (London: Thames and Hudson, 1975), 7.

27 Maria Telkes, "Space Heating with Solar Energy," *The Scientific Monthly* 69, no. 6 (1949): 394-397.

28 The Tressour Wood House was designed by the author while working at Gaia Architects in Scotland.

29 Pauline Madge, "Ecological Design: A New Critique," *Design Issues* 13, no. 2 (1997): 44-54.

30 Peter Schmid, *Bio-logische Baukonstruktion* (Koln: Rudolf Mueller, 1986). Peter Schmid and others have formulated strategies of "building biology" whereby the design, form, construction and materials of a building were held to have profound consequences for the health and well-being of the building user. Schmid's book is perhaps the best overview of the theoretical underpinnings and architectural outcomes of this approach.

31 Jürgen Habermas, *The Theory of Communicative Action* (London: Heinemann, 1984). This is the key work by Habermas in relation to this field of inquiry.

32 At a "top down" level, international treaty obligations drafted in respect to addressing climate change are translated into "national outcomes." In Scotland's case, this includes the reduction of carbon emissions by 80% by 2050, and specific targets for the construction industry through legislation and statutory standards. Although techno-centric in its operation, the statutory obligations and the commercial imperatives provide a "top down" approach, affecting how building design develops and mutates. In a Scots context, standards for housing have moved from regulating fabric loss to include air-tightness and the use of renewables.

33 Christopher Gaze and Mike Clift, *Applying the Code for Sustainable Homes on the BRE Innovation Park* (Watford: BRE Trust, 2008).

34 Department for Communities and Local Government, *Code for Sustainable Homes: Setting the Standard in Sustainability for New Homes* (Watford: Communities and Local Government Publications, 2008), 65. Credit scores are given if the building has a ratio of internal floor area to footprint of greater than 3:1.

35 See the BRE PassivHaus primer, available at http://www.passivhaus.org.uk/filelibrary/BRE-PassivHaus-Primer.pdf (accessed January 2011). This document gives a good overview of PassivHaus methodologies applied in a UK context.

36 Dean Hawkes, *The Selective Environment* (London: Spon Press, 2002), 7.

37 Max Fordham, "Natural Ventilation," *Renewable Energy* 19, no. 1 (2000): 17-37.

38 The design of the building structure was undertaken by the author while working at Gaia Architects. Construction and fit-out was undertaken by Brennan and Wilson Architects.

39 Margaret R. Somers, "The Narrative Constitution of Identity: A Relational and Network Approach," *Theory and Society* 23 (1994): 605-649.

40 Ibid.

41 This building and its relationship with landscape narrative is explored in much greater detail in John Brennan, "The Use of Narrative in Contemporary Rural Architecture," *Architectural Research Quarterly* 10, no. 1 (2006): 13-23.

42 Peter Davidson, *The Idea of North* (London: Reaktion, 2000), 242. This book explores the literary tradition of describing "the north" in cultural terms.

43 Tatjana Schneider and Jeremy Till, *Flexible Housing* (Amsterdam: Architectural Press, 2007). This book is an excellent overview of a design tradition in adaptable housing.

44 Although researching non-domestic environments, “Adaptable Futures” is conducting useful research into flexible building and its benefits for sustainable development. A good publication is: Katy Beadle, Alistair Gibb, Simon Austin, Fuster Alumdena and Peter Madden, “Adaptable Futures: Setting the Agenda,” *Adaptable Futures* (2008) available at http://www.adaptablefutures.com/downloads/Beadle_et_al_2008.pdf (accessed March 2010).

45 Milton Keynes Development Corporation, *Tattenhoe Park Development Framework Chapter 7: Super Flexible Housing*. Available at http://www.miltonkeynespartnership .info/DocLibrary/Tattenhoe_Park_Development_Framework_Chapter_7.pdf (accessed June 2010). This document gives a good overview of current best practice and innovation in this field.

46 Stewart Brand, *How Buildings Learn: What Happens After They're Built* (New York: Viking, 1994), 178.

47 Tatjana Schneider, *Flexible Housing* (Amsterdam: Architectural Press, 2007), 7.

48 Scotland’s Housing Expo ran in August 2010 in Inverness. It included 40 exemplar dwellings selected by open competition to illustrate and encourage innovation in the housing sector.

49 “Designing for Survival, the President Introduces His Long Life/Loose Fit/Low Energy Study,” *RIBA Journal* (1972). No author cited

50 Ibid.

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FIGURE CREDITS

Fig. 1: MIT Museum

Fig. 2, 4 to 10: John Brennan

Fig. 3: Colin Wishart

Fig. 11: Nigel Rigden

Fig. 12: Nick Sharp

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Urbanization and Its Discontents: Megaform and Sustainability

Kenneth Frampton

Since the opening of the twenty-first century and its highly intensified globalization, the cultural and ethical dimensions of sustainability have emerged as a compelling impetus for architecture to mediate the contradiction between the drive for economic maximization and the fragility of the natural environment. Today, we are only too aware of the so-called greenhouse effect resulting from the excessive emission of carbon dioxide and other heat trapping gases into the atmosphere, largely caused by our profligate dependency on fossil fuels. The concomitant phenomenon of global warming has surely become one of the more traumatic transformations in the otherwise seemingly progressive trajectory of industrialized society. This negentropic predicament is accompanied by other equally intractable contradictions: among them, our capacity for technological, most notably digital, control of every conceivable aspect of our daily lives while remaining incapable of adequately recycling waste; our excessive commodification of everything and our ever-escalating inability to control the consumption of non-renewable resources, while remaining unable to create a more equitable distribution of wealth. The profession of architecture alone cannot be held responsible for such dysfunctional circumstances at the level of public policy. However, it is nonetheless clear that it can only benefit the quality of life when environmentally intelligent design helps to cultivate a discourse of architecture, so that architecture may begin to approach the environment in a more responsible and responsive manner.

Although we are aware that some 5 percent of the world's population – namely the current population of the United States – consumes 25 percent of the world's energy,[1] we are generally less cognizant of the fact that in the United States, buildings, both residential and commercial, consume nearly half of all energy that is produced each year,[2] while the various modes of transportation account for roughly one quarter[3] in terms of automobile, rail and air transportation. In our buildings much of this unrestrained consumption of energy is obviously attributed to artificial lighting, heating and cooling and to the universal deployment of digital equipment that is left running at all times. It is equally sobering that a large part of our landfill is made up of building waste: this type of waste supposedly accounts for 60 percent of the non-industrial waste stream in the United States.[4] Statistics of this kind – more than any other type of information – bring home the need for establishing a more nuanced, symbiotic approach to the design of architectural form.

In the United States, there remains a strong tendency to deny the reality of the environmental impacts of global warming and to continue with the maximized consumption of non-renewable energy. This denial is evident in the reluctance of the United States government to introduce and enforce progressive environmental regulations with respect to all forms of production and consumption; their general, reactionary obtuseness is accompanied by architects taking the position that sustainable design has no place in the disciplinary aesthetics of architecture. Such an attitude is categorically perverse, given that responding symbiotically to the exigencies of both climate and context has invariably served as a mainspring for significant tectonic invention since time immemorial. Despite this recalcitrance, the last few decades have seen the emergence of a completely new breed of environmental engineers who are becoming as essential today for the refinement and articulation of architectural forms as structural engineers were during the first half of the twentieth century.

One can hardly reflect enough on the paradoxical, critical polemic by the ecological advocate Peter Buchanan. He insists that there is no such thing as sustainable architecture or an aesthetic of sustainability, and that instead, sustainability arises out of a subtle, often imperceptible interaction between built form and the ambient forces that impinge upon its surface.[5] What this assertion posits is a nature–culture interplay in the deepest possible sense that looks to establish a continuous system of feedback and modification, not only with respect to each individual building but also with regard to the discipline as a whole. Needless to say, it is exactly at this juncture that the issue of sustainability begins to unsettle many of our more cherished views of the discipline with regard to the nature of architectural design and the current scope and mandate of architectural education. The hallowed ground of our so-called creativity and the aestheticized stronghold of architectural academia may well require nothing less than a direct frontal assault if we are ever to establish an effective antidote to the status quo of professional practice that it largely serves to legitimize.

In regard to aesthetic implications and sustainability, there exists an enormous divide between the digital camp that looks to natural systems for so-called *form-finding* or *generative* strategies, and the other, more open-ended line that looks to nature to determine how a building and its environment should work together symbiotically. As Susannah Hagan has characterized the gap between the latter day aesthetic avant-garde and the committed environmentalists, "The intellectual pyrotechnics of the former are missing in the latter. The intellectual consistency of the latter is missing in the former."[6] This divide stems from a difference between the avant-garde belief that genuine tectonic creativity is solely dependent on arbitrary forms of individual, subjective expression, however much they may be derived from scientific procedures, and the environmentalist conviction that architecture must, on the contrary, be grounded in a deeper commitment to finding a homeostatic balance, requiring more restraint toward an individual's *will-to-form*. This latter view is contingent on the cultivation of a material culture that is not only ecologically grounded but also self-effacing in its concern for an ethically and critically consistent position.

Sustainable structures cover a wide range of technical means and environmental forms. These include such high-tech, high performance, energy-conserving structures as Norman Foster's Commerzbank headquarters realized in Frankfurt, Germany in 1997, as well as low-tech, low-cost assemblies such as the Australian firm Clare Design's (Lindsay and Kerry Clare) Cotton Tree Housing realized in Queensland, Australia in 1994. It is significant that the low-tech approach presupposes a more collective socio-cultural *modus vivendi*, and at the same time, depends upon interstitial elements as though they are both part and parcel of the same ecologically sensitive approach. The built *ecosystem* is seen to function as an active artificial interface with nature. The idea that a building should respond to its surrounding natural environment and to the local mores of construction brings us back to the wider socio-cultural dimensions of the sustainable approach, particularly as they may engage with the universal *placelessness* of the megalopolis.

The competition among the world's megalopoli to erect skyscrapers of excessive height for the dubious honor of realizing the world's tallest building has certainly been one of the most pronounced architectural phenomena of the past few decades. This competition is related to the branding of cities, as is the case with the spectacular *instant* city of Dubai with its 160-story, 800-meter high Burj Tower designed by Skidmore, Owings and Merrill. As a context for such extravagance, we know that global megalopoli are ever more burdened with debt, poverty and human misery compounded by burgeoning pollution, particularly in the Third World. Such strange anomalies occur in relation to the explosive and unsustainable growth of urbanized populations. To this we may add the alarming prediction that by 2020 in China alone, some 300 million of the rural population will migrate to new or existing urban areas.[7] A transfiguration on such a scale will only exacerbate the fact that many Third World cities are among the most polluted in the world. With equally wasteful consequences as far as petrol consumption is concerned, cities in the United States continue to lose population in their centers while constantly expanding their suburban hinterlands with little or no provision for public transport. The negative socio-ecological nature of such settlement patterns is only too familiar.

Despite the dystopic prospect of an ever-expanding horizontal *motopia* and vertical megalopoli, we have to acknowledge the positive effects associated with the increased use of digital technology, which seems to have raised the general quality of current architectural production in terms of efficiency, materiality and techniques. Although urban sprawl remains as prevalent and uncontrollable as ever, the one-off architectural work today is of higher quality than it was some twenty years ago. In the meantime, even though architects increasingly assess their work against a constantly improving global standard of technical and cultural sophistication, the principles of sustainability in design have remained largely restricted to the *ad hoc* assembly of various mechanical devices and surfaces for energy conservation (including exhaust heat exchangers, plantable roofs and air-tight insulation) and energy extraction (including geothermal heat pumps, solar heat collectors, photo voltaic panels and wind turbines).

Within this present realm, where technology has generally improved architectural works while the principles of sustainable design remain far from holistic, it is important to examine the ideas of *topography, sustainability, morphology* and *materiality*. The vagaries of fashion notwithstanding, the terms topography and sustainability allude to practices that in some measure resist the commodification of the environment, while morphology and materiality, on the other hand, allude to practices that arbitrarily mimic the biomorphic processes in nature or those that emphasize the expressivity of superficial affectation as an end in itself. Both syndromes occur frequently, at the expense of forging an appropriate articulation of architectural form in terms of space, structure, orientation, function and environmental implications.

Between the topographic approach to architecture, which pertains to the contours of the earth's surface, and the morphologic approach, which seeks to emulate the structures of biological and botanical forms, there exists a plastic affinity that has been of consequence for architecture ever since the Baroque period. It is obvious that the Frank Gehry's Guggenheim Museum in Bilbao exists quite independently of anything that takes place within the interior. In other words, it is paradoxically detached from any kind of interstitial biomorphic organization that is as much a formative presence in architecture as it is in nature. This is apparent in the disjunctive and inelegant conditions that the shape engenders, from the perverse, inconvenient system of pedestrian circulation that leads from the river walk to the main entrance, to the total indifference the building displays toward the topographic context in which it is situated. We may count among its infelicities not only the ill-proportioned top-lit galleries, but also the wasteful and crude steel frame that had to be devised in order to prop up the extravagant configuration of the titanium skin.

In contrast, even though as preoccupied with sculptural shape as Gehry, in Zaha Hadid’s car park and public transport terminus at Hoenheim-Nord on the outskirts of Strasbourg completed in 2001, the topographic dimension takes precedence over the sculptural, and the tectonic nature of this exceptionally sensitive intervention presents a three-dimensional megaform that is as poetic as it is efficient. Hadid’s three other recent projects, namely the Afragola high-speed train station projected for Naples, the BMW assembly plant in Leipzig and the Phaeno Science Centre at Wolfsburg could all be said to be works of a similar kind: the sculptural aspect of the form animates the exterior while the horizontal topographic dimension is largely reserved for the disposition of the internal space.

Fig. 1: Site Plan, Hoenheim-Nord Terminus and Car Park, Strabourg, France, Zaha Hadid Architects, 2001.

Likewise, the London-based Foreign Office Architects (FOA) (Alejandro Zaera Polo and Farshid Moussavi) developed their design for Yokohama International Port Terminal of 2002 on the basis of a topological interplay between earthwork and roofwork. The superstructure provides not only for a precise spatial articulation of the interior but also for its phenomenological character. Here, the tectonic interplay between earthwork and roofwork is so symbiotic as to become a multi-layered topography, rising and falling along the length of the pier. Here it is the superstructure, rather than the earthwork, that lends itself most readily to being treated as a topological surface. Here one encounters a hybrid program that in addition to being a ferry terminal it also serves as a promenade-pier and a public park, while housing an auditorium within its cavernous internal space.

Fig. 2: Transverse Sections, Yokohama International Port Terminal, Yokohama, Japan, Foreign Office Architects, 2002.

According to Robert Somol in his *12 Reasons to Get Back into Shape*,[8] the gratuitous adoption of amorphous shape distinguishes itself from the structural generation of form. Despite the exuberant sophistry with which he elaborates on the attributes of shape-making, what Somol presents is an unabashed, value-free advocacy of shape as an end in itself, irrespective of the content or context of the work at hand. The main theoretician of the morphological cult of shape, rather than form, has been the architect Greg Lynn. He appropriately recognized the fundamental role to be played by such morphological paradigms as the invention of differential calculus and the evidence of dynamic indeterminacy in nature as revealed through mathematical modeling. However, as far as architecture is concerned, certain unavoidable problems arise out of this kind of analogical reasoning. The problems center on the dubious stratagem of positing the metabolic processes of nature as the basis of a new architecture, and on the implicit repudiation of building culture as it has emerged over time as a pragmatic response to the constraints of climate, topography and available resources, not to mention the implacable forces of nature that always undermine the durability of the man-made environment.

The space-endless[9] megalopolis, often taking the form of a rather chaotic, suburbanized land settlement, had already become a de facto universal reality in the second half of the twentieth century. This form of development was clearly accelerated in the United States by the federal subsidization of the interstate freeway system in conjunction with the deliberate depletion of the transcontinental railroad system. That it was carried out at the behest of the oil and automotive lobbies is common knowledge, as was the gutting of the sustainable, electric, suburban railroad system that once fed a large part of the greater Los Angeles area. At the same time, this enforced dispersal of freestanding objects would lead to a totally unintelligible environment.

The French urbanist Françoise Choay recognized early on that space-endlessness was a universal aspect of worldwide megalopolitan development, and one which, were it not for the graphic signs distributed throughout its labyrinthine systems, would not be negotiable.[10] The placelessness megalopolis, particularly where it is flat, tends to be bereft of any significant landmark, so that unlike the traditional city or the nineteenth century metropolis in its prime, we would not be able to find our way around its miasmic substance were it not for graphic coding. This is the fundamental difference between the metropolitan city of the nineteenth century and megalopolitan urbanized region of the twentieth.

All of this makes us recognize that today the field of urban design manifests itself primarily as a theoretical discourse. As a result, it is largely *non sequitur* when it comes to spontaneous urban development and the rather unsustainable form that it normally assumes. The paradox is that urbanization, or rather sub-urbanization, continues its unremitting expansion across the surface of the earth with hardly any attempt to check its expansion through the implementation of rational design. This stands apart from the instrumental realization of necessary infrastructures without which the urban and sub-urban fabric could not be sustained including sewerage, water, power and above all, highways. Apart from infrastructural planning and the seemingly spontaneous sub-division, piecemeal development and wholesale proliferation of ill-assorted freestanding objects that follows in its wake, no form of culturally significant place-creation emerges. The proliferation of random and incoherent objects – no matter how *green* each individual object may purport to be – in an uncontrollable sprawl is at the core of the unsustainable situation. This is true in terms of material continuity but also, and more crucially, in terms of social and cultural urban form. Sustainability in this regard is tied to a strategy that integrates the built form into its specific context of climate, topography and vegetation, as well as its specific culture.

This brings us to the potential of the *megaform* as *place-form* as opposed to *object-form* that is to say it is an antidote to the unsustainable placelessness. The term megaform refers to the form-giving potential of certain kinds of horizontal urban fabric capable of effecting some kind of topographic transformation in the megalopolitan landscape. While the term may read as synonymous with the term megastructure coined by Reyner Banham in his highly influential 1976 study *Megastructure: Urban Futures of the Recent Past*, the two may be differentiated in terms of the relative continuity of their forms. Thus while a megaform may incorporate a megastructure, a megastructure is not necessarily a megaform. The main difference resides in the emphasis placed on the overall form and its intrinsic spatial order. What is more, much of the essential attribute of the megaform is based in the overall horizontal thrust of its profile taken together with the programmatic place-creating character of its spatial aspect.

The megaform may be defined as: (1) a large form that extends horizontally rather than vertically; (2) a complex form that is not articulated into a series of structural and mechanical subsets; (3) a form that is capable of inflecting the existing urban landscape in terms of its strong topographic character; (4) a form that is not freestanding but rather one that insinuates itself as a continuation of the surrounding topography; and last but not least, (5) a form that is oriented toward a densification of the urban fabric.

Beyond the dense historical core, a megaform may be identified as an *urban nexus* set within the *space-endlessness* of the megalopolis. Henri Ciriani's concept of *une pièce urbaine*, as first formulated in his so-called Barre à Marne or Noissy I complex in Marne la Vallée in 1980, certainly seems to have been conceived along these lines. And something similar may be claimed for Rafael Moneo and Manuel de Sola Morales' L'Illa Block in Barcelona in 1997. This project is typical of a megaform in that, apart from its predominantly horizontal profile, it is a mixed-use development comprising a shopping frontage on the Avenida, a three-story central mall running down the entire 800 meters of the building, a rental office, a hotel and a school. It is perhaps crucial that the office space is fenestrated in such a way that it could in theory be converted into residential use. The L'Illa block is well served by multi-story parking below grade so that as a commercial strip, it is able to attract consumers living in the inner suburbs and even further afield just as much as those living in the center of the city.

Fig. 3: Sketch for Barre à Marne, Marne la Vallée, France, Henri Ciriani, 1980.

Fig. 4: Transverse Section, L'Illa Complex, Barcelona, Spain, Rafael Moneo and Manuel de Sola Morales, 1992.

In this regard, we may say that the L'Illa block manifests a quasi-catalytic function in as much as it appears to be capable of stimulating further, unforeseen consequences in the surrounding urban fabric, corresponding in this sense to Manuel de Sola Morales' concept of urban acupuncture. That is to say, a topographic but limited and realizable civic intervention that is inserted into the fabric in such a way as to fulfill the double function of healing existing dysfunctional conditions in the urban structure, while going on to stimulate positive future activity and development. This concept suggests that the horizontality of the megaform should be capable, by virtue of its program, of serving as a civic microcosm. One may suggest types that have the potential for engendering such forms, with great applicability, within the contemporary megalopolis: shopping malls, air terminals, transport interchanges, hospitals, hotels, sports facilities and universities.

The idea of megaform on a more regional scale was first elaborated as a strategy by Vittorio Gregotti in his concept of the *anthrogeographic* landscape, set forth in his book *Il territorio di Architettura* (The Terrirory of Architecture) in 1966. One of the antecedents of this approach was Friedrich Ratzel's turn-of-the-century concept of *anthrogeographic* form. Ratzel was the first to fully recognize that the romantic notion of a pristine and untouched nature had long since ceased to exist and, that instead, what we inherit today is an artificial nature that is just as man-made as the built form by which it is marked, except perhaps for the vast untamed domain of the ocean.

Gregotti's strategic concept of an earthbound architectural territoriality led him to posit a panoramic topographic megaform in the proposal for the University of Cosenza in 1978-80. This admittedly rather utopian proposal envisaged five comprehensive faculty megastructures set against a north-south administrative spine incorporating public transit and other amenities; the horizontal emphasis was composed of long perimeter blocks of low-rise terrace houses. This layered low-rise megaform is a landscape in itself, in categorical opposition to the proliferation of ill-related objects by which it is surrounded.

One may also cite other instances in which pragmatically hybrid megaforms have either been applied to or projected for the existing urban fabric. These range from the 1978 proposal for the main rail terminus in Zürich, to the designs of Mario Botta and Luigi Snozzi, where the covered platforms of the existing terminals are curtailed by a bridge building over the tracks, running along the line of the buried Sihl River. A comparable megaform for a new mixed-use administrative and cultural center was projected by Botta and Snozzi for Perugia in 1974.

Fig. 5: Aerial View & Longitudinal Elevation, University of Cosenza, Cosenza, Italy, Vittorio Gregotti, 1980.

Fig. 6: Aerial Perspective, Rail Terminal Extension, Zürich, Switzerland, Mario Botta and Luigi Snozzi, 1978.

The Canadian architect Arthur Erikson was also committed to the idea of the megaform as a catalytic intervention when applied to the existing urban fabric. This is evident in the case of his 1983 Robson Square development inserted in the deteriorating downtown of Vancouver, British Columbia, and in the compact university campuses that he designed and realized for the universities of Simon Frazer and Lethbridge respectively over the years of 1979 to 1982.

Fig. 7: Transverse Section, Robson Square, Vancouver, Canada, Arthur Erickson, 1983.

Stephen Holl has repeatedly touched on similar preoccupations, first in the megaforms that he projected at the scale of the American continent, and then more practically, in his residential work in the Far East, including the various integrated residential enclaves that he designed for Fukuoka, Japan in 1992. More recently, Holl realized the Vanke Center in Shenzen, China which he calls a horizontally laid skyscraper, in effect a hybrid building wherein different kinds of uses are accommodated within a single structure comprising a hotel, offices, condominiums, rental offices, recreation spaces and a cafeteria. This rectilinear megaform is raised above the ground as a gently undulating cantilevered suspension structure. Its status as a landmark is only too evident when viewed against the backdrop of the mountains to the rear of the city. Although the elevation of the building makes it appear unduly brutal as megaform, its spread form provides space for a park and for civic amenities of various genres.

Fig. 8: Solar & Site Diagrams, Horizontal Slyscraper, Vanke Center, Shenzen, China, Steven Holl, 2009.

Megaforms may also be conceived of as cities-in-miniature in order to emphasize the structure of the existing topography and to establish identifiable places. The Mexican architect Ricardo Legorreta demonstrated this approach on a number of occasions, from the stepped formation of his Camino Real Hotel overlooking the beach in Ixtapa in 1981, to the Renault assembly plant that he realized as an ochre-colored, virtually windowless horizontal form in the arid landscape of Gomez Palacio, Durango in 1985. Similar large-scale megaforms set against dramatic topographies can be found in a great deal of Latin American work, from Lina Bo Bardi's bridge-like Museum of Modern Art completed for the center of Sao Paulo in 1968, to the even more dramatic 108-room linear dormitory block for the European astronomical research center designed by the German architects Fritz Auer and Carlo Weber, completed in 2002. The latter, cutting across the remote wastes of the Atacama Desert in Cerro Paranal, Chile, constitutes a testament to Gregotti's thesis that architecture begins with the marking of ground as a primordial means of establishing order.

Given our entropic motopian culture on one hand, and the imperative to inlay the building form with the constituents of a given site – and especially with the ground – on the other, the potential of using the megaform as a sustainable strategy of remedial urban densification is compelling. As architects, we hardly need to indulge in the further proliferation of freestanding objects that are disconnected from the environment as well as from their neighbors for the sake of presumably autonomous aesthetic merit, or to indulge in the further manufacturing of images that are compelled by the standing regime of economy and aesthetics. We must see the crucial role of the site as an environmental context, most notably its topography, as a primary defining marker of a place in all its aspects. This view is further pronounced if we fully utilize the capacity of technology to simulate, synthesize and model the immediate surroundings of a given building. By such an agency we may come to fully integrate, in a more effective and symbiotic way, the variables that define the inherent aesthetics of the site-building relationship, including the ecology, geology and hydrology of the given environmental context in order to minimize, as far as possible, the potentially destructive impacts of building on the environment.

As for the individual aggregate of architecture, the concept of megaform returns us to the passive hybrid approach that is found in a great deal of building traditions. One can easily recall the time-honored orientational preferences in certain regions, the habitual provision of overhangs or even the implementation of stable thermal mass through the manipulation of vents, shutters and sliding screens so that one is able to maintain optimal conditions inside the building, irrespective of the season. These methods rely on large, double-glazed, insulating openings that are fully exposed to low-angle sun in the winter, while being shaded by adjustable canopies or exterior blinds from the impact of radiant solar heat in summer. Plan configurations that adopt shallow floor depth reduce the need for artificial light, and under temperate conditions, allow one to adjust the interior climate through manually operated windows. The latter provision is even mandated by law in certain European countries. Here, the potential of the passive hybrid approach is clear, especially with regard to the so-called hi-tech and generative architectures where various combinations of sensors, actuators and rather simple control algorithms may be employed to compensate for the fluctuating discrepancies between the internal and external conditions not only to achieve thermal comfort, but to identify aesthetics sensibilities as a fundamental condition of our relationship to the place we inhabit.

In regard to what Catherine Siessor has characterized as *eco-tech* structures,[11] they tend to ignore, almost by definition, two time-honored attributes. First is the issue of embodied energy, all but spontaneously incorporated into vernacular building, the second is the virtually unquantifiable precept of “long life, loose fit”[12] which is to attain in contemporary building practice. This precept was naturally integral to the load-bearing masonry structures of the past, bequeathing us a legacy of eminently adaptable buildings mostly dating from the 18th and 19th centuries, many of which we have been able to put to new uses. Such residual value is more difficult to achieve today on account of our minimal space standards and commitment to the paradoxically inflexible lightweight building techniques. Sustainable buildings should be generically adaptable rather than utilitarian or encumbered with gratuitous formal gestures that soon become dated. Above all, they should be made of low-energy materials that weather and age, rather than high-energy synthetic substances that are often unable to withstand long-term exposure to natural conditions without continual maintenance. Sustainable architecture is impossible without a close integration with its environmental context. Therefore, sustainable architecture must address such factors as micro-climate, topography and vegetation, as well as the more familiar functional and formal concerns addressed in standard practice.

Notwithstanding the contributions of individual buildings, it is the application of sustainable paradigms at the urban scale is destined to be the critical fulcrum over the long haul. The urban scale obviously contains, structures and facilitates two of the most energy consuming aspects of our life: the built environment and the use of automobiles. Understandably, one may remain skeptical of energy-efficient structures when we are faced with our failure to reduce commutation by car that continues to prevail throughout the megalopolis. With all the highly politicized debates on the deleterious environmental consequences of the automobile-based lifestyle, we begin to see a gradual shift to various forms of non-polluting propulsion systems.

There is no manifest reason why environmentally responsive and sustainable design should not be culturally stimulating and aesthetically expressive. Sustainability and its implicit aesthetics ought to be rightly regarded as a prime inspiration to enrich and deepen our emergent culture of architecture, rather than as some kind of restriction upon, or separate from, the fullness of its aesthetic and poetic potential.

Image Credits:

Fig. 1: Zaha Hadid Architects

Fig. 2: Foreign Office Architects

Fig. 3: Henri Ciriani

Fig. 4: Rafael Moneo & Manuel de Sola Morales

Fig. 5: Vittorio Gregotti

Fig. 6: Mario Botta & Luigi Snozzi

Fig. 7: Arthur Erickson

Fig. 8: Steven Holl

NOTES

This article was drawn from the authors' previous writings on the subject matter and reedited for the book.

1 Daniel D. Chiras, *Environmental Science: Creating a Sustainable Future* (London: Jones and Bartlett Publishers, 2001), 167.

2 Ibid. p. 336.

3 Ibid. p. 304.

4 J. Cullen Howe and Michael B. Gerrard, ed., *The Law of Green Buildings: Regulatory and Legal Issues in Design, Construction, Operations, and Financing* (Chicago: American Bar Association, 2010), 11.

5 Peter Buchanan, *Ten Shades of Green* (New York: Architectural League of New York, 2005), 13.

6 Susannah Hagan, "Five Reasons to Adopt Environmental Design," in *Landscape and Building for Sustainability: A Harvard Design Magazine Reader*, ed. William S. Saunders (Minneapolis: University of Minnesota Press, 2008), 103.

7 Michael Backman, *Asia Future Shock: Business Crisis and Opportunity in the Coming Years* (New York: Palgrave MacMillan, 2008), 4.

8 Robert Somol, "12 Reasons to Get Back into Shape," in *Content*, ed. Rem Koolhaas (New York: Taschen, 2004), 86-87.

9 In his 1889 book, *City Planning According to Artistic Principles*, Camillo Sitte refers to the *Ringstraße* in Vienna as the "space-endlessness" where the main monuments of the Ring had been built as free-standing objects rather than as part of a built fabric or bounded form, similar to those that had once existed in the medieval city.

10 Françoise Choay, "Urbanism and Semiology," in *Meaning in Architecture*, ed. Charles Jencks and George Baird (London: Barrie & Jenkins, 1969), 31.

11 Catherine Siessor, *Eco-Tech: Sustainable Architecture and High Technology* (London: Thames & Hudson, 1997).

12 The term was coined by Alex Gordon, former president of the Royal Institute of British Architects. For more on this see: Alex Gordon, "Architects and Resource Conservation," *RIBA Journal* January (1974).

Landscape Aesthetics for Sustainable Architecture

Daniel Jauslin

No, No and No. Three times *No* is the answer to the question: is there currently such a thing as aesthetics in sustainable architecture? This answer is drawn from the discussions of three architects who are acclaimed practitioners and thinkers in the field. If we assume that aesthetics is something that all architects pursue in one form or another, it would appear that, currently, sustainability is not an integral part of it. One of the acclaimed architects considered in this chapter is Rem Koolhaas, a Pritzker laureate and one of the founders of OMA, a highly regarded practice in Rotterdam, the Netherlands. He opened his keynote lecture at a Harvard University conference on sustainability in 2009 with the following statement:

> *I did not assume that anyone in the academic world would ask a practicing architect in the 21st century, given the architecture that we collectively produce, to participate in a conference on ecological urbanism.*[1]

During his lecture, Koolhaas showed a photomontage of a massive wall of skyscrapers set in the desert, including some of OMA's own designs. (Fig. 1) If we asked Koolhaas the hypothetical question: "Does the aesthetics of architecture contribute to a sustainable world and its ecology?" He might answer: "No. Architecture is rarely sustainable as a human activity."

Fig. 1: Collage for the lecture by R. Koolhaas, *Sustainability: Advancement vs. Apocalypse*, OMA 2009.

The second acclaimed architect considered in this chapter is Peter Eisenman. During the Eisenman + Wigley IV lecture at Columbia University in 2009, he made the following statement regarding the US Green Building Council's rating system[2] while discussing the meaning of architectural practice in the context of the current financial crisis:

> *Some of the worst buildings I have seen have Gold, Silver or Platinum LEED Certificates ... and they are awful, architecturally. They are depressing ... They may optimize ecological constraints today but they don't do anything for the culture in terms of the excess required for architecture ... Architecture has always been about an environmentally possible way of being. Hence the buildings that last throughout the history of architecture.*[3]

Although Eisenman might agree that great pieces of architecture – the kind that last for centuries – possess certain aesthetic qualities, if we asked him the hypothetical question: "Does sustainable architecture possess durable aesthetics?" Eisenman might answer: "No. Sustainable buildings do not possess lasting aesthetics."

The third acclaimed architect considered here is Wolf Prix, co-founder of the Coop Himmelb(l)au in Vienna. (Fig. 2) He presented a striking statement during the opening lecture for the 2009 Münchner Opernfestspiele (Munich Opera Festival):

> *Sustainability belies signification – and it is therefore not possible to generate "aesthetics" from the term sustainability. There is no such living aesthetics of sustainability as that of modernist architecture.*[4,5]

This statement led to a major uproar among German Architects and a policy debate or *die* G*rundsatzdebatt*e in the prominent German newspaper, *Die Süddeutsche Zeitung*.[6] If we asked Prix the hypothetical question: "Is there such thing as aesthetics in sustainable architecture?" He might answer: "No. By definition, there cannot be."

Fig. 2: Wolf D. Prix of Coop Himmelb(l)au

To summarize current debates on the aesthetic possibilities of sustainability in architecture, we may conclude that today, there is no consensus as to what these possibilities are or whether they exist at all. At least this is the conclusion that may be drawn from the *unauthorized* summaries of three of the most prominent architects in the field. Their remarks are quite recent – made within the past few years – and quite behind schedule if we consider that sustainability has grown to become a firmly established and often compelling issue in the fields of science and politics over the past two decades.

On a wider scale, the United Nations committed itself to the goal of sustainable development and environmental protection on a global scale when it passed Resolution 38/161 in 1987. In the process, the UN established its own definition for sustainable development:

> *Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*[7]

One decade later, the Kyoto Protocols[8] established energy efficiency as an important policy agenda of many of the UN member states. While definitions of sustainable development and energy efficiency were established at the level of international policy making more than 20 years ago, it seems that on the whole, the profession of architecture still disregards the impact of sustainable development, while failing to connect the notion of sustainability to the notion of aesthetics.

As a practicing architect, it is clear that these problems may stem from fact that environmental destruction does not appear to be a matter that can be ameliorated or resolved through architectural aesthetics. And in fact, that addressing environmental destruction would curtail aesthetic possibilities. For many architects, sustainable design has become an issue not because it is integral their own desires for aesthetic experimentation or development, but because of the new legalities imposed by building regulations and the economic ramifications of the real estate market. As of 2011, we could say that current architecture is not willing to meet the challenges of sustainable development, environmental protection and energy efficiency in a proactive manner, given the widespread assumption of the substantial aesthetic compromises that would be required to do so.

However, it is important to step back from the profession of architecture and look at the scope of the problem, in totality. The human species can be considered an *exploded* ape, the only primate capable of leaving its natural habitat and spreading throughout the globe, even to the most remote and hostile regions in terms of elevation, temperature, precipitation and isolation. Since World War II, the world's population has grown by 4.5 billion, reaching 7 billion today.[9] Needless to say, the impact of providing architecture and infrastructure to these 7 billion people has had a profound – and almost geologic-scale – impact on the natural environment. Concomitant with the rise in population, the dominance of the urban lifestyle has spread. The size of world's urban population has grown five-fold since 1945, surpassing the world's rural population for the first time in history during the first decade of the 21st century.[10] Humans are now a predominantly urban-dwelling species.

The biologist Jelle Reumer introduced the term *exploded ape* to compare humans to an invasive species in fauna, or what we call *allochthonous* species in flora.[11] Invasive species become rampant in a habitat when there are no natural predators or when such predators have become extinct. Except in very rare situations, Reumer concludes that the human species is out-of-place, invasive and virulent in an inappropriate habitat. By profoundly altering the habitat in order to satisfy the trends of population growth and urbanization, we invade and ruin the habitat for other species, leading many to extinction.

In some cases, architectural theory reads like the testament to the exceptional behavior of our species, focusing on the virtues of global proliferation and control over the natural environment. In nearly every classical and modern treatise, architecture is understood as counterpoint – if not an opposition – to nature. Architecture has been conceived *ex negativo* from the *Wild* ever since Vitruvius wrote:

> *The men of old were born like the wild beasts, in woods, caves, and groves, and lived on savage fare ... they began ... to construct shelters ... and so passed from a rude and barbarous mode of life to civilization and refinement.*[12]

The major problem of environmental consciousness in architecture is that it lacks awareness of our modes of sustenance extending beyond their immediate necessities. Often, we refer to the polarity of nature versus culture, and architecture is firmly in the camp of culture, by definition. Architects tend to view aesthetics as their professional entitlement, and therefore as a matter of authorship that carries a certain freedom of interpretation and expression. Architecture ends up being a matter of subjective preference disconnected from the *context* of the natural condition. The matters of subjectivity and preference, and the resulting lack of perception focused on the natural condition, have everything to do with the aesthetics of architecture.

In order to advance the cause of environmental consciousness in architecture, what appears necessary is neither an exclusive commitment to sustainability nor a commitment to another avant-garde aesthetic. However, playing up the polemics of opposition between sustainability and the avant-garde will not lead to a resolution. Rather, a renewed environmental consciousness may be triggered with an aesthetic sensitivity toward the natural environment that provides the context for each piece of architecture, developed in tandem with a wider understanding of the human dimensions and aesthetics qualities implemented in the built environment.

A very different way of dealing with the polarity of nature and culture can be seen in the perspective of landscape. German art theorist and activist Bazon Brock defines landscape as the aesthetic human appropriation of nature.[13] The role of aesthetics in landscape is not to separate natural forms from the cultural realm, but to reconnect them. Drawing inspiration from the inherent terms of aesthetics in landscape, the architectural discipline could develop a real alternative to the invasive practice of architecture where the dichotomy of nature and culture is profound. With inspiration from the landscape perspective, it may be possible to shift the position and approach of architecture toward nature, moving from an approach of opposition to one of integration. Such a renewal is clearly outside the scope and potential of avant-garde aesthetics alone.

A common recognition of where our efforts should lead in terms of environmental consciousness seems to be absent from the education, socialization and profession of architecture. In fact, the question of how a building, city or landscape will be perceived by its users and inhabitants is the key question that underlies most of our design work. Designs that please human perception tend to trump the consideration of the natural environment. However, no matter which side of the discourse they fall on, most architects agree that architecture should contain certain aesthetics, and most decision makers agree that finding a sense of sustainability is a prerequisite of any planning or architectural activity. But the relation between these two priorities – aesthetics and sustainability – changes according to the theoretical and practical views of different actors in the process of building.

Achieving sustainability in the architectural and building fields appears to be inevitable as a matter of governing policy, regardless of the preference of individual architects. In 2010, the European Union adopted a new energy directive with a relatively short-term goal: “by ... 2020, all new buildings shall be nearly zero-energy consumption buildings.”[14] This policy results from the political commitments made during the Copenhagen summit in 2009, based on the European Union’s affirmation of the Kyoto Protocols. Here, “*nearly* zero-energy” implies that the impact of architecture on climate and the environment could be reduced to negligible levels if the policy’s directives were formally legislated and enforced. More likely than not, legislation along these lines will bring the discipline of architecture to a crossroads. Most practitioners and students of architecture today will probably not be able to meet the specific challenges of this legislation with the means provided to them at the present time. The kind of buildings envisioned in the European Union policy may not be the kind of buildings that are designed by architects: they may be designed and built by highly specialized engineers and contractors, assembled with an incompatible mix and match of specialized mechanical components. In this future, terms such as architectonic and aesthetics may be nothing more than the quaint adages of an anachronistic practice.

Although the debate on sustainability is complex, it is possible to define its boundaries and focus the inquiry on the most relevant aspects. Substantively, we should not focus the debate on whether, as a discipline, to give in to political pressure or change the priorities of architecture; we should not endeavor to find an ultimate priority between aesthetics and sustainability; we should not wish for the recent legislation imposed on architecture, such as the European Union's 2010 energy directive, to disappear; and finally, we should not work to make the components of sustainability invisible, as some German architects suggested in the policy debate in reaction to Wolf Prix. Instead, the most relevant and obvious challenge is the integration of both aesthetics and sustainability at the core of each architectural project, and throughout the philosophy of the discipline.

Again, the landscape perspective may be able to unite the seeming dichotomies of nature versus culture, aesthetics versus sustainability, showing that these dichotomies do not have to reside at the core of the discipline. Already, some practitioners of contemporary architecture have been strongly influenced by the concept of landscape. In 1966, Vittorio Gregotti postulated that architects should focus on territories rather than architectural space.[15] And since the late 1980's, architects have developed a wide range of process-oriented approaches to architectural design that include cartographic methods such as mapping, and surface-oriented methods such as folding. These methods expanded beyond the academic circles and into professional practice during the 1990's. Although most of these methods took compositional and philosophical detours and do not implement a purely territorial approach, they are fundamental to a consciousness that is changing the discipline in significant ways: a consciousness that views the organization and composition of architectural space as landscape.

Concomitant with this rise in landscape-oriented consciousness is a research framework that can be characterized as the "architecture of landscape methods,"[16] developed to investigate and understand architecture that has been designed as landscape. Within this research framework, the interior volume of a building and the exterior landscape surface surrounding a building do not merely interact. Instead, the building is designed as an artificial landscape, as a continuation and augmentation of the natural one. This idea of landscape defines the exterior surfaces as well as the interior surfaces, and through these methods, the relation of landscape to architecture is in fact turned inside out.

A specific focus of landscape architecture is placed on understanding the formative elements and qualities implicit in the landscape, and on developing architectural design methods and strategies in consideration of them. With the implementation of this approach, landscape architecture consists of a range of natural, cultural, urban and architectonic constituents.[17] There is an obvious correlation between content and form: the location where the content resides is what connects the landscape to the architectonic in terms of material, topographic, technical, cultural and economic substance. Form involves the way in which the elements are assembled into a composition, based on the development of a variable but intimate relationship between object and context.[18,19,20] In this way, the modalities of landscape architecture are employed in the design of architectonic constructs, in order to formulate a set of design tools that are appropriate to the challenges of designing the built environment in relation to the natural one. The idea of landscape in fact defines an aesthetic mediation between the natural and artificial worlds.

The design methods of landscape architecture are particularly useful; they can be contrasted to architecture in terms of how they strategically approach spatial design. While most pieces of architecture carry a distinct building program forward from the outset of the design work, landscape approaches start from the topography of the site. We can distinguish four distinct *attitudes* toward composition, all of which relate to the site. These attitudes summarize the basic concepts of the landscape approach in terms of four categories borrowed from the work of Sébastien Marot.[21]

1. *Anamnesis* integrates the history that led to the present state of a landscape, as traces of history are visible and legible in most landscapes. We could consider the different stages of time[22] and focus on the process of moving from an untouched natural wilderness, to agrarian cultivation and then to gardening, taken along with the kinds of higher spiritual senses and symbols that accompany the process. The idea of nature with constantly changing means of representation and interpretation is a central theme throughout the history of garden design and landscape architecture. We could see the landscape as a palimpsest[23] of different layers[24] in various models, as illustrated by the stratification of various natural, cultural, infrastructural and built layers.[25]

2. *Process* focuses on the natural and induced dynamics of landscape transformation. The effects of nature and time, but also the effects of design strategies, influence how to approach a site and induce it to grow in a certain direction. Working from this perspective includes the observation, preservation and manipulation of the social and ecological systems present in the landscape. The resulting work of landscape architecture is expected to structure potentials, and should express the incompleteness of design rather than being presented as a final, fixed state.

3. *Spatial sequencing* provides an intrinsic narrative of landscape where the physical design is often connected to certain spiritual storytelling or ritual processions that have evolved through history. In recent times, the dynamics of mechanization, speed and communication have changed our perception of narrative and sequencing, and as such, have changed our approach to sequencing the landscape.[26,27] More historic

qualities such as topography, circulation, the horizon and the picturesque continue to relate to spatial sequencing as well.

4. *Context* refers to the dense functional, visual and spatial relations and points of reference that are connected to a landscape. In landscape architecture, relational structuring means the rearrangement of spatial references or the interweaving and joining of disparate elements. A designed landscape is supposed to create a context rather than simply reacting to one. The important peculiarity of landscape architecture is its potential to derive programs from the relations of various elements in a place, a way of place-making based the form and context of the landscape, rather than on form following function.[28]

While there are four distinct attitudes toward composition in landscape architecture – as described in the work of Sébastien Marot – currently, no such overarching attitudes can be described in the discipline of architecture. The approach taken to design in landscape architecture and architecture diverged, especially as *landscape* has occupied a theoretical blind spot in the architectural discourse since the end of the 1970's. However, we could refer to four comparable *modalities* displayed the work of key architectural theorists of the post-World War II period. Anamnesis was certainly important to Aldo Rossi[29] in his preoccupation with history as well as in his self-reflective approach to architecture and the city. Process was a key element in the theories and designs of Peter Eisenman.[30,31] Bernard Tschumi's influential work on the architecture of events in his Manhattan Transcripts[32] essentially refers to spatial sequencing. And Colin Rowe's Collage City is a critique of the state of placelessness in the modernist city, representing a call for context.[33]

The significance of Marot's landscape method for the disciple of architecture lies not only in its holistic, topographer's perspective, but also in the potential to become an antidote for the disorder of modalities in the production of architecture. In this regard, it is important to note the specific order that Marot has laid out: from drawing on anamnesis to consciously setting up the process, he then involves the spatial sequence and finally culminates in the context. The four modalities result in a program that is connected to building an aesthetic understanding of the given landscape intervention. Such an approach includes building an awareness of the necessary scale and the sustainable impact that the landscape intervention will have on neighboring systems.

One could easily attribute the aesthetic shortcomings – if not altogether failures – of sustainable architecture to the problems of integrating the divergent modalities of a project into a set of closely linked relations. The current demand for sustainable development compels architecture to be inclusive of various modalities – including the highly technical, aesthetic, cultural and environmental – that have the *potential* to coalesce into a holistic system for architectural work. The landscape perspective could provide an important line of thought for the development of architectural theory, a line of thought that has been largely missing in the modernist discourse. Certainly over the past three decades, we have witnessed various architects' experiments and trials along the trajectories of the four landscape modalities, arriving at individual and often intuitive interpretations of the architecture-landscape relationship. However, the landscape perspective could summarize a whole range of apparently disparate approaches toward architecture, advancing the field of architectural theory in relation to aesthetics and sustainability.

The division between the disciplines of landscape architecture, architecture and urban design has been questioned on many fronts. Certain architects have designed parks with the concepts of anamnesis, process and context, such as the two different proposals for Parc de La Villette in Paris by Bernard Tschumi and OMA, as discussed by the architects and the critics alike.[34,35] While at the same time, landscape architects have started to create a new breed of constructed landscapes that are in fact urban places, such as the Schouwburgplein in Rotterdam[36] or the Lijdsche Rijn Park in Utrecht, both designed by West 8. As seen in these examples, blurred boundaries are evident between the disciplines of landscape architecture, architecture and urban design.[37]

For example, Rem Koolhaas describes the OMA's design for the libraries at Jussieu, Paris in 1992 as "a vertical, intensified landscape, urbanized almost like a city,"[38] presenting a new approach for the relation of architecture and landscape. (Fig. 3) In the simplified version of MVRDV's Villa VPRO in Hilversum – where "the landscape is the building"[39] – this new relationship is even clearer. (Fig. 4) With the Rolex Learning Center in Lausanne by the Japanese firm SANAA of Kazuyo Sejima and Ryue Nishizawa,[40,41] the building's provision of a landscape for people[42] is not a goal in itself, but a means to an end: to create a human environment in relation to nature. And in the Yokohama Ferry Terminal designed by the Foreign Office Architects FOA, there is a strong link between the formal and the geographical.[43] (Fig. 5) In fact, this building presents a crucial indicator in the development of aesthetic approaches to sustainable architecture. The design of the Yokohama Ferry Terminal develops a human envelope of transitory space into a completely new type of public building. It has a very clear tectonic language, grounded in the reading of context and integration of the building program with a spatial process of formation. The building mediates between the realms of landscape, urban fabric and architecture, effectively mending the division of context and object.

Fig. 3: Two libraries in Jussieu by OMA, competition entry, 1992.

Fig. 4: Villa VPRO by MVRDV in Hilversum, 1993-1998.

Fig. 5: Yokohama Ferry Terminal by FOA, 1995-2002.

If we turn to Japan, it is possible to illustrate a different conception of space that has been cultivated in traditional temples, gardens and shrines and which continues to influence Japanese architecture to the present day. The designs of many modern architects such as Taut, Tange, Isozaki, Ito, Ando, Kuma, Maki and Hasegawa[44] bring the building and site together within an inclusive configuration of the landscape.[45] (Figs. 6, 7 & 8) Their designs display a completely different relationship in this regard compared to the contemporary work of Western architects. In Japan, the basic conception of space is defined by its openness to the landscape. This conception is striking and immediately apparent in the design of traditional Shinto shrines: in their most reduced form, the *torii* is simply a frame in the landscape, inviting spirits to enter a sacred area marked by a piece of architecture that is, in essence, an opening. This approach stands in stark contrast to Western temples, where sacred space tends to be found in enclosed, restricted chambers. The different approaches to space in the Japanese and Western building traditions may have something to do with the absence in Japan of such spatial definitions as the *cella*, a cannon of Western architecture.

Fig. 6: The Naoshima Museum by Tadao Ando, 1990-2010, located to the left inside the hill, and view on the Japanese inland sea.

Fig. 7: Grin Grin Park with Visitor's Center by Toyo Ito in Fukuoka, 2002-2005.

Fig. 8: Forest and Sea Sliding Walls in The Water Glass House by Kengo Kuma in Atami, 1995, with a view on the Villa Hyuga, interior by Bruno Taut, 1936.

According to architecture historian Kenneth Frampton, one concept for topographical and topological urban interventions is the *megaform,* as introduced by the Japanese architect Fumihiko Maki.[46,47] The *megaform* foresees an architectural intervention as a strategic device for re-structuring areas of high-density urban fabric, referred to as urban acupuncture by Manuel de Sola-Morales. These interventions are configured as surface, epidermis or skin.[48] Frampton points out an essential link from *megaform* to sustainability that has yet to be worked out in its entirety. The link lies in developing the strategic character of the design, situated in the landscape in such a way as to bridge aesthetics and sustainable development with a holistic measure of environmental considerations as context.

In a nascent step toward establishing a method that bridges architecture and landscape, it may be helpful to redraw the maps in order to plot our paths. This approach is exemplified in the recent work that AMO has done in concert with the World Wildlife fund.[49] (Fig. 9) But going beyond this, we ultimately need new geographies, not of boundaries and borders that demarcate but new geographies of topological space, geographies of landscape.

Fig. 9: Detail of the World Energy Map drafted by AMO for WWF, 2011.

Developing the aesthetics of sustainable architecture is necessary. It is probably the only path left in the future of architecture – aside from complete the absence thereof – that can begin to address the impacts of providing architecture and infrastructure to the world's population of 7 billion. Designing for sustainability is a unique opportunity. It does not indicate the end of architecture as an aesthetic system, nor does it indicate an imposition on architecture's creative enterprise. In fact, designing for sustainability is an aesthetic project at its heart, where aesthetic systems can be used to form a symbiotic relationship between the city and its surroundings. If we understand architecture as part of the topological space of landscape, we will also be able to understand our place within the relational system between the natural and built environments. This new approach cultivates an understanding of landscape as a human interface with nature, presenting a means by which to design architecture in a sustainable manner, along with a renewed context of sustainable aesthetics. If we cultivate our spatial relationship to the environment as both a design method and a context, we will be able to gain a much wider understanding of architecture in terms of its range and scale, thereby reclaiming the responsibility for its programmatic and contextual correlations as a discipline.

In a sense, architecture practiced as a landscape method will be closer to an art form more than to a technological accomplishment, and indeed, *Yes* will be the certain answer to the question: is there such a thing as aesthetics of sustainable architecture?

NOTES

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FIGURE CREDITS

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Fig. 4, 5, 6, 7 & 8: Daniel Jauslin

Fig. 9: AMO

7.181 words

Building Envelope as Surface

Sang Lee and Stefanie Holzheu

The building envelope occupies a special position within the strategies of sustainable design. It is not only the primary building element that is exposed directly to weathering, but also a crucial part of architectural design that determines the formal qualities of the building. In the Vitruvian triptych, the building envelope contributes more to the *venustas* or to the delight in the building's beauty than others. The building envelope is also expected to help regulate the climatic, thermal fluctuations of the building. Therefore, the development of building envelopes has focused on the combination of both the climatic appropriateness and the affectation of a given building. The building envelope is expected to shelter and preserve the interior conditions and to express an aesthetic intent at the same time.

This chapter, presented in three parts, will establish a conceptual framework for the design of building envelopes in the context of thoughts on sustainable design. First, we will trace key historical ideas and developments in order to clearly establish what a building envelope is, and how it has been conceived. Within these discussions, we will summarize three main aspects that the building envelope is designed to address: functional, technical and energetic. We will conclude the first part by discussing the pronounced features of three exemplary architectural models as they relate to building envelopes, namely, the modernist, Venturian and biomimetic models.

In the second part of this chapter, we will explore the notion of *surface*. We will speculate on what could be derived from this notion in relation to building envelopes, and in relation to sustainable thinking at large. This discussion will include the notions of surface proposed by Avrum Stroll and James J. Gibson, and drawing from their theories, we will formulate the idea of the building envelope as surface.

In the third part, we will explore *mimesis* – as applied for example to the term *biomimetics* – as one of the key propositions in today's environmental awareness, that is, how we learn from the dynamic conditions of the natural environment and other living organisms. Here, the primary intent is to reevaluate and critique the current practice of biomimetic approaches in architecture. We will attempt to construct, by drawing from the theories of Jacque Derrida and Hans-Georg Gadamer, a perspective of mimesis pertaining to architecture as a kind of relationship to nature.

In consideration of the discussions made throughout this chapter, the conclusion will offer a view to a particular conceptual framework, one that contributes to the design of building envelopes in the context of sustainable design. The intent is to move away from a mechanistic view of sustainable design, and to approach it in a manner where sustainability emerges as a condition rather than as an object. We believe that today, the prevailing view of sustainable design consists of various prescriptive components without offering a comprehensive discourse. Such a discourse should include the very basic, underlying composition of our relationship to the natural and living environments. The building envelope as surface provides a key component of that relationship.

Part I: Making Enclosure – Historical Ideas and Developments

In architecture we can observe two paradigmatic modes of providing shelter. The first one is the condition of a *void* where shelter is found in a cavity, being formed by erosion, excavation and subtraction, be it natural or man-made. Here the enclosure is defined by the hollowed out space in a solid. The second is the so-called *primitive hut*. It is an *assembly* that consists of a distinctive frame structure, reminiscent of vertical tree trunks and an overhead cover of the tree's crown.[1] These two archetypes provide the principles of enclosure: a solid, load-bearing construction analogous to cutting out a cavity in a solid material – the subtractive – and the frame structure analogous to constructing a skeleton of vertical and horizontal members on which covering elements are added in order to provide a protected interior – the additive.

The spread of one model or the other depended on the social and cultural aspects of the local environmental contingencies such as the climate, the available sources for energy and food and the need for protection from natural forces and other animal species. More importantly, the two models can be considered in terms of the nature of each respective enclosure. The cave model is one-sided and reflexive. An example of the reflexive surface can be traced to the murals of the Lascaux cave dating back more than 17,000 years, where the dwellers chronicled their relationship with the outside world. The primitive hut model can be characterized as projective in that the *membrane* consists of two sides, the interior and the exterior. In this case, the membrane stretching over the skeleton is that of duality by which one can conceive of the hut from the outside and suppose its interiority; at the same time, the interior surface informs its dwellers of the conditions outside.

What is important to note here is that, in either model, the notion of enclosure imagines, inscribes and produces habitable solids and voids that are simultaneously cerebral and emotional of one's own necessities and desires in order to *dwell* inside. In these two models, our modes of dwelling have long been those of the *surficial*. The idea of dwelling as surficial is not an idea of demarcation – marking out and occupying geographical territories – but of constructing at once intellectual and emotional relations with one’s own environment.

Today, the concept of sustainability underlies an approach to the development of buildings, cities and the broader built environment in a way that can ensure the long-term viability of resources including food, energy, materials and water, now, in the near future and hopefully, for indefinite posterity. The building envelope is closely associated with energy savings in individual buildings: it is the first plane of contact to the outside world where most heat losses or gains occur, and therefore, the building envelope is a predominant factor in the control of energy consumption throughout the entire life cycle of a building. At the same time, the building envelope has been thought to provide the separation between the conditioned interior and the uncontrollable exterior climate. In both aspects, highly functioning building envelopes are crucial for the building's overall performance and for contributing to sustainability.

Building envelopes can be characterized in terms of three major aspects of design concerns: the functional, the technical and the energetic. In combination, these aspects determine what an observer sees and recognizes as the aesthetics of a building. They form a crucial concern in the design process, if not entirely an overriding one. Also, these aspects of building envelopes are closely related to the local conditions of a site in terms of geographical location, prevailing climate, material availability as well as the kind of intangible, contextual issues that exist such as the tendencies of ideology, politics, economics and thus, the social and cultural practices of the population.

The functional aspects elaborate on the building envelope as a shield, with a primary role of protecting the interior from the detrimental effects of the exterior: they include keeping the interior habitable from the extremes of heat gain and loss by conduction and radiation, keeping water out and controlling airflow. In addition, the overall appearance of the building can be regarded as one of the functional aspects of the building envelope, as historically the appearance and function were intimately linked. On one hand, this stems from the prevailing materials and techniques of the locale, and on the other, from what the dwellers inscribe on the surface in order to express their belief systems, narratives of their life, or simply what they consider beautiful and sublime in and around them. The function of the building envelope as a substrate for expression can be said to be the most primordial and yet also the most analytical of architecture.

The technical aspects arise from the construction point of view, as the building envelope must be assembled with appropriate materials and techniques so that it complies with the functional aspects while maintaining its structural integrity relative to gravity and lateral forces. The technical aspects therefore impart the material and structural qualities in the way the functional aspects are handled. With regard to the measures of durability and sustainability, the technical aspects imply what has been accumulated up to the point of use for the materials that are assembled in the building envelope, including how the material is produced, handled and put in place, whether or not it is safe to use and the extent and severity of the adverse side effects in its production and subsequent use. In addition, the technical aspects indicate how adaptable and accommodating the building envelope is to different uses by incorporating operable openings, devices such as blinds or foils that block or filter sunlight and air, and the degree of material resistance to weathering, wear and tear.

Directly pertaining to energy, the building envelope is expected to perform a key role in regulating the transmission, absorption and containment of energy in a building. Today, the energetic aspects of the building envelope form a key factor of sustainable design: it is through the building's outermost enclosure that significant energy losses, gains and savings could occur. Therefore, energetic performance often provides a crucial design criterion for a building envelope and in one manner or another, all envelopes and enclosures have evolved to deal with energy flow. For example, in a hot and humid climate, screens and louvers are used in combination with a lightweight timber frame construction that is raised above the ground to facilitate ventilation. In a cold climate, the building volume is enclosed in massive, insulating walls with limited openings in order to contain the heat inside.

The building envelope, as seen through the divisions of its functional, technical and energetic aspects, forms the fulcrum of sustainable thinking and aesthetic considerations. Today, technologically speaking, the building envelope also represents the highest concentration of advanced and so-called high-performance materials and assemblies that function in the consideration of energy production, conservation and efficiency. The building envelope is the most up-to-date part of architecture where the constant pursuit of *doing more with less* defines the architectural cutting-edge. This points directly to the two core strategies of sustainable thinking, conservation and efficiency.

Building envelopes seen in these terms fulfill a role that mediates between the interior and the exterior of the building. In this instance, the primary purpose is for regulating the enclosed space in terms of the thermal range: in summer, in conjunction with the outside geography and vegetation, the envelope should let in cooler air while in winter, relative to the sun, the envelope should contain heat from solar infrared radiation. Instead of isolating the interior from the outside conditions, the building envelope should facilitate and take advantage of the exterior variations in temperature, humidity and airflows. And from the interior, the building envelope is expected to provide a pathway for relating to the outside world in terms of *vista*, for example, or the visual presentation for approach and entry. The provision of a view and a relation to the outside world – through the medium of the building envelope – has prompted as much impetus in locating a building with respect to a given site as the issues of geography, solar orientation and vegetation.

a. The Modernist Model

Given these considerations in relation to the building envelope, it would be worthwhile first to set the discussion within the context of modernist architecture that has predominantly shaped the face of our buildings and cities over the last century. Since the advent of modernist architecture to the present day, the one persistent dictum by Louis Sullivan has become the defining marker of modernist thinking: the harmony of form and function. According to this dictum, the building's external form is supposed to reflect its internal structural logic. The aim here is to achieve a union, or at least an agreement, between the interior spatiality and the exterior enclosure; the elevation is seen as the representative of the *venustas* that also expresses the building's *utilitas* and *firmitas*. However, the development of modern steel frame construction has resulted in the separation of façades from their role in carrying the building's weight, as seen with modern curtain walls. The primary purpose of modernist building envelopes has become increasingly directed at implementing an impervious plane designed to maintain a clear separation of the building's interior from the exterior climate. This stems from the idea that the unpredictable and therefore undesirable conditions of the natural climate must be kept outside, and that the interior must be kept constant in order to achieve comfort.

Irrespective of the kind of architecture they may be present in, all non-load bearing building envelopes have had the same objective with little variation: to provide a barrier that seals the building volume from outside wind and water while providing a medium of exterior visual expression that is freed from the impositions of the structural loads. In stark contrast, the architecture for sustainability, as practical requirements and ideological propositions, calls for the kind of building envelopes that are breathable and permeable. These requirements and propositions of sustainability contrast with the vision of Le Corbusier that the outside is volatile and unclean, and that we should seal ourselves from it inside the building where everything is clean and conditioned in response.[2]

Under the modernist model, the building envelope is essentially a mechanical device that can be operated in order to regulate and control exchanges between the interior and the exterior environments. The windows are opened or closed depending on exterior conditions or the building can be sealed from the exterior if needed. By means of thermal breaks and insulating layers, one could minimize the thermal exchanges that take place between the interior and the exterior. As it is hung like a *curtain*, the modernist building envelope is thought of as a membrane-barrier rather than as having the solidity and thickness that a wall may indicate. Yet, through the use of large glass panes that have become available with the advent of modern float glass production, the building envelope can be made visually transparent, letting in unobstructed natural light and outside views. In this sense, the modernist model of the building envelope – with its non-load bearing curtain walls – can be characterized as both mechanical and optical; as a plane that separates the interior from the exterior while simultaneously connecting the two in terms of the visual and tactile experience; as a model that allows a very limited form of exposure to the outside world.

The other crucial, conceptual and obvious development of the modernist model is that the building envelope is no longer intrinsic to the logic of the structure, but made to exhibit its own autonomous logic and aesthetics. Even though the building envelope may inform certain clues to the building's structure and programmatic organization, it is no longer directly reflexive of them. Therefore, the role that the building envelope plays in the appearance and expression of a building becomes independent of the structural composition for building design.

Hence, the modernist building envelope becomes a crucial component that is at once a separative device and a connective, optical device, driven to maximize its transparency and minimize its physical presence. Satisfying these conditions is regarded as the essential design objective for the modernist building envelope. And also, in this view, the history of modern architecture can be seen as a history of shedding material heft by making it lighter, stronger, more insulating and more transparent. While the combination of reduced materiality and heightened performance is by and large consistent with the principles of industrialization – in that one should produce the maximum function-performance assemblies with the minimum expenditure of materials and labor – the design of building envelopes also presents the building's environmental and aesthetic positions in the most direct manner. This is true in terms of how it responds to climatic variations, and in terms of how it expresses form as an aesthetic configuration.

b. The Venturian Model

Subsequent to the modernist curtain-wall, in Robert Venturi's theory, we find a conceptual construct in which the building envelope provides an *agent* that is expected to represent and transmit *messages* by means of flat and thin façades. Throughout the history of architecture, Venturi argues, building façades have been made to communicate ideas and stories by means of material and tectonic making, such as stone carvings, mosaics and fresco murals.[3] This development points to a conceptual articulation of building façades where the substantive separation of the medium and the content takes place. Here the medium is the actual, physical and material presence of the façades themselves, while the content consists of visual effects, messages, signs and other elements that are superficial to the façades.

What the Venturian model offers for the building envelope, primarily in terms of façades, is the notion that it is a communicative device that is expected to signify, symbolize and convey certain narratives, messages and information. In Las Vegas, for instance, Venturi finds that building façades are designed for visual effects that promote fantasy and desire; they are conceived as media that contain information or stories about what the building does, what the building means or what it appears to be.

c. The Biomimetic Model

Today, active research and experiment toward the architecture of sustainability is grounded in the realms of the *virtual* and the *bionic*. With regard to building design in general and to building envelopes in particular, the virtual provides a convincing means of testing and simulating designs, while the bionic provides the basis on which the algorithms for sustainability, for *doing more with less*, may be modeled. With the rapid development in these two areas of engineering, shorter product life cycles, shorter development times and higher resource efficiency are just a few keywords that appear in the context of sustainable design that is focused on biological models.

Within the discussions of sustainability, the primary purpose of the virtual is to measure, compare and simulate the environmental conditions to which a piece of architecture will be subjected, which in essence codifies many of the important variables of architecture. Virtual software applications with a wide range of possibilities for simulation and analysis are used to optimize the performance of buildings. These allow for a building's design-performance relationship to be simulated, visualized and analyzed in the framework of the building environment as a part of the design process. For example, the software application for energy analysis can quantify the energy consumption of various cycles of a building along with the resulting CO_2 emissions. The application can also measure and simulate the degree of thermal insulation and heating and cooling loads.

The bionic is characterized by the use of material, functional and structural configurations that are based on the organic solutions found in nature. The features that distinguish bionic architecture can be characterized in three main categories: material creativity, optimized production and adaptability. As a general condition, the work of nature is held to be *beautiful* because each entity, both living and non-living, is thought to be formed in its appropriate place according to the immutable laws of nature. In our view, the rationale behind bionic architecture concurs with this awareness; it regards nature an appropriate template for architecture. Nature provides a key for achieving architectural materials that are beautiful, durable and strong, highly efficient and yet environmentally appropriate, and can be used in a wide range of flexible, adaptable applications. Thus, considering these two threads in combination, the virtual and the bionic are regarded to offer the possibility for building envelopes to achieve a new intensity in technological and morpho-tectonic sophistication, and above all, a coherent ideological construct.

Currently, the virtual and the bionic are drawn together strongly within the biomimetic model of architecture, which is based on the processes of natural selection, evolution, adaptation and optimization. The biomimetic model attempts to abstract the principles that lie behind a species' capability to sustain itself by adapting and evolving its physiological composition in relation to the habitat over time. This model proposes that building envelopes are increasingly analogous to biological organs, for example biological skins that respond to environmental conditions and function in specific ways. In this instance, the building façade may be conceived as an assembly of dermal layers, each one corresponding to a particular performance criterion, and each one optimized through a virtual process that is analogous to natural evolution.

The biomimetic model propagates that the process of natural evolution has been refined over millions of years and provides a highly refined approach for the design and engineering of the built environment. Common examples include the physical and behavioral features of various animals and insects that are specific to their particular environments. The primary strategy of this model is to devise a certain degree of sensitivity and automaticity in the operation of the building envelope in regard to the various so-called *parameters* that contribute to the relationship between a building and its environment, both natural and artificial. At the same time, the notion of emergent and generative systems, often codified as virtual models and simulations, points to the kind of self-stabilizing and self-regulating configuration of building envelopes that are supposed to embody the notions of material and structural efficiency, formal expressiveness and environmental adaptability in one seamless entity.

Part II: Building Envelope As Surface

The three models of building envelopes presented so far can be summarized as: the modernist envelope that informs the logic of the building's program, space and structure, i.e. "Form *follows* function;"[4] the Venturian façades that signify and communicate, i.e. "Form *accommodates* function;"[5] and the biomimetic, emergent and/or generative systems that respond and adapt to environmental or parametric conditions, i.e. Form *is* function.

At this point, the three models of building envelopes can be hypothesized in terms of *surface*. The first conception that is relevant to the discussion, what the analytical philosopher Avrum Stroll describes as the "Leonardo surface"[6] termed after Leonard Da Vinci's description of surface in his notebooks, posits that a surface is not a material presence but an abstraction. It not only separates but also binds two different entities or states, such as air and water. Surface as an abstraction is also an *interface*. It is a shared boundary with no "divisible bulk" that marks the theoretical differentiation between two substances.[7] At the same time the surface expresses the manner in which the substances fluctuate relative to certain influences or forces, as observed in the way the surface of a lake may ripple from the wind, for example.

The building envelope can be thought of along this conceptual line as a surface that belongs to both the interior and the exterior of a building, and therefore, as a surface that demarcates a separation, while at the same time joining the building and its exterior environment together in a manner that is *inseparable*. In addition, similar to the example of a lake surface exposed to wind, the building envelope is a dynamic and indexical condition where the interaction of the building and its environment is manifest in the resolution of the surface. In this sense, we can conceive of a building envelope that not only possesses certain materiality but also, and more importantly, embodies the dynamic exchanges that occur between the interior and the exterior.

Based on the conception of the Leonardo surface, we can discuss the environmental as well as the tectonic dimensions of the building envelope and its façade as *mediation*. One historical mediative function is to be reflective of the kind of building and the kind of occupants that reside therein, by means of decorating and inscribing the façade. With images and patterns the façade can become expressive of the underlying narratives or conventions – ideological, political, social or cultural – of a given building, its occupants and its context. Apparent to this mediative function is also the environmental dimension, in terms of the materiality and construction methods that are characterized by the kind of available resources and their extraction and consumption. In this way, the dynamic conditions that surround a building become embodied in the mediated building envelope. Conceived as a surface, the building envelope not only reflects the external variations through its materiality and use of local resources – again retuning to the idea of ripples on a lake – but also projects its internal conditions through the use of images and patterns; we can conceive of an envelope that in essence promotes a certain kind of equilibrium through mediation and interface.

In parallel to Stroll's conception of the Leonardo surface, according to the psychologist James J. Gibson, we perceive objects directly (or simply *pick them up*) by means of surface. Gibson's view contrasts with an alternate view that problematizes the integrity of visual perception with the idea that we perceive things in steps from retinal, to neural and then to mental.[8] While it is demonstrable that the appearance of a given object's surface does not always coincide with the actuality of the object – for example, that foreshortening from oblique views may radically alter the appearance of the actual geometry – Gibson posits that what we see when we encounter an object is an material surface. In essence, that our visual perception of an object is direct and achieved through surface. Despite the fact that this view has been disputed as empirically unprovable, various surface conditions do contribute crucially to our understanding of the world in an *ecological* manner.[9] In this sense, we can formulate a position applicable to architecture, one that conceives of the building envelope as surface, or more specifically using Gibson's terminology, one that conceives of the building envelope in relation to *media* and *substance*.[10]

With Stroll's theory of the Leonardo surface taken in combination with Gibson's theory of surface and visual perception, we can imagine the kind of building envelope that is:

a. Immaterial or of minimum material presence that belongs to *both* the interior *and* the exterior;
b. An interface that mediates between the interior and the exterior, reflecting the relations and flows between the two;
c. A membrane that at once separates and connects media and substance, ephemeral and permanent, dynamic and static;
d. A primary means of understanding the ecological and the built environments, to locate ourselves within the web of relations of which we are a part.

In addition, the French philosopher Gilles Deleuze's notion of *fold* may provide a useful construct that describes the relation between the interior and the exterior, describing the façade as an active agent. Not unlike the Leonardo conception of surface, the fold offers a connection and an interface between matter and affectation. The fold articulates the connective tissue of two states – interior-exterior, object-environment, media-substance – as a process of folding and unfolding. Conceived in this sense, the building envelope is simultaneously connecting and separating, permeable and impervious, constant and fluctuating. A building envelope conceived as a *surface-fold* can be viewed as a condition where two states co-exist in a smooth and continuous relation, where the transition between the two is indivisible. What is crucial here is to establish the physical manifestation of the building envelope as surface, working from the conception of materiality in an *ecological* sense.

Here we can speculate on what such an ecology may mean in relation to the building envelope as surface. If we extrapolate from Gibson's theory of visual perception, an ecology is characterized by the way we perceive (or simply *pick up*) the composition of the world around us. This world would be composed of surfaces that divide and join the media and the substance, surfaces that allow us to find location and meaning through *invariants* and *affordances*. We can conceive of an ecology as being comprised of invariants that constantly locate our place in the physical environment such as the light and heat of the sun, the direction of the wind and the precipitation of rain and snow. At the same time, we can conceive of an ecology as being comprised of affordances that allow us to identify and connect to the more intangible senses of meaning and purpose.

Part III: Surface Aesthetics and Mimesis

At this point, drawing from the discussions of the so-called model of biomimetics or biomimicry in architecture, it would be appropriate to consider *mimesis* in greater depth. One of the fundamental problems inherent in the current use of the term *mimetic* is that it often refers to literally mimicking, imitating and emulating certain natural organisms and/or conditions. When applied to the discussions on architectural sustainability, this position, that we can imitate and replicate biological organisms in nature in order to satisfy our needs and solve our problems, misleads and distorts the fundamental issues in sustainability. By focusing on what the product *does* or how it *performs*, the biomimetic, in its prevailing form, ignores *what* and *how* such performance has come to be in relation to our needs. The approach focuses on solving or correcting the problems we have, as well as on providing synaptic excesses by means of developing so-called systems of *interactivity*. However, in the end, there is a lack of critical discourse, resulting from focusing only on how *useful* such biomimetic inventions could be for meeting our needs and solving our problems in pursuit of a more sustainable built environment.

On all three fronts, the biomimetic view appears to argue for producing additional tools and implements without attempting to fundamentally tackle the root cause of the unsustainable conditions inherent in our current patterns of development, transportation, energy use and economics. An apt analogy may be that, instead of trying to find the underlying cause of symptoms, the failing organs of the body are replaced and propped up by mechanical devices that perform each discrete function. To truly address the issue of sustainability, what matters is our relationship to natural organisms and environments, not the usefulness, performance or affectations of such contrived mechanical organs installed in order to satisfy our excessive needs and to reinforce our dysfunctional so-called lifestyle. This is not unlike what Slavoj Žižek describes as "The ultimate *perverse* vision" of the human body as a collection of organs "as in those unique utopian moments of hard-core pornography" in which the (woman's) body is "thus transformed into a multitude of 'organs without a body,' machines of *jouissance*..."[11]

While it is one thing to learn from what a natural organism does in order to adapt and survive in an environment, it is something entirely different to recognize *if* and *how* such replication is indeed pertinent to deal with our atrophic relationship to nature. In a sense, the foundation of biomimetics should be the question of how we relate ourselves and our built environment to the network of natural relations – including those of plants, animals, hydrology, geology and the prevailing patterns of wind and weather, for example. However, the current motivation behind biomimetics seems to be the question of how to fix our problems or how to make our lives more convenient and entertaining, i.e. that of *jouissance*. This kind of biomimetics, stemming from the lack of our meaningful relationship to nature, will only reinforce how biological organisms can serve us to maintain and continue the patterns of excess and waste that we currently enjoy. In a sense, many of the so-called biomimetic designs result in nothing but a teleological exercise that ultimately does not contribute to a sustainable condition.

We can turn to the work of Jacque Derrida in his article *Economimesis*[12] (although the following speculation may be far removed from the original intent of the text) to provide a meaningful view of mimesis that is relevant to the discussion of surface and building envelope. In the text – originally written in part as an analysis of Kant's distinction of nature and arts – Derrida posits, speaking of freedom and necessity as Kant's primary distinction between *free* art (die *freie* Kunst) and *salary* art (die *Lohnkunst*), "Mimesis here is not the representation of one thing by another, the relation of resemblance or of identification between two beings, the reproduction of a product of nature by a product of art."[13] Derrida continues, "The artist does not imitate things in nature, or, if you will, in *natura naturata* but the acts of *natura naturans,* the operations of *physis*."[14] Besides the distinction between liberal or free arts (freedom, no exchange value) and applied or paid arts (necessity, exchanged for money) that Derrida mentions in the text, the question is what it means to participate in "the operations of physis." If we were to consider Derrida's proposition in the context of our discussion, it appears that the work of mimicking is in essence the work of forming an intrinsic relationship with the way that natural phenomena unfold.

In addition to Derrida's physis, in *Truth and Method,* Hans-Georg Gadamer provides yet another clue as to how we can approach mimesis. According to Gadamer, mimesis is in fact a *play*,[15] an enactment or performing of an act that is embedded in the experience of the world. And the enactment manifests itself in the *praxis* that consists of participation: an attempt to render the world meaningful in some way.[16] What Derrida mentions as the operations of physis, Gadamer characterizes as a *Festspiel* that is an enactment and a participation in the emergent patterns of nature. The notion of the dynamic and emergent *Fest* and *Spiel* is crucial in the relationship between art and nature: first, because it posits that the so-called conditions of reality are inevitably interactive; second, that it is an event of becoming by means of performance; and third, that it always includes the consideration for others besides oneself. This is to say that the world and the works of art in it are characterized by the understanding that we inevitably participate in the unfolding of events in which we are transformed in relation to the dynamics of our environment.

In consideration of Gadamer and Derrida, we can project what mimesis in architecture may be. The theories of the two philosophers provide a specific and concise view of surface as the mediator of the unfolding of nature, *physis*, and at the same time of enactment in the play between an entity and its environment, *Festspiel*. In this line of thought, it appears that being biomimetic is not about imitating and replicating what a biological organism does in order to adapt to an environment and its changing conditions. Neither is it about imitating the ways of natural organisms in an attempt to cover up the problems that are symptomatic of our conflict with nature. Instead, it is about how we situate ourselves and establish an intimate relationship with the biological environment. Removed from this end, biomimetics will be nothing but a perpetual reiteration and versioning of copies' copies.

Common in the aesthetic evaluation of architecture is the assessment of geometrical harmony, proportion, symmetry and order with respect to the prevailing worldview. Composition based on such an aesthetic order has been applied and practiced for a long time in order to impart properties such as beauty, grandeur and power in everyday objects, buildings and cities, in other words, in built ecologies. The primary component of sustainable design is the building envelope, the surface through which the building is interfaced with the natural environment. In addition, the building envelope is also an agent by which we situate and establish our relationship, mimicking and enacting our presence in relation to the currents of nature. But how important are the aesthetic qualities in the design of building envelopes and in regard to the issues of sustainability? For that matter, in this line of thought, can we really discuss aesthetics as such? In this case, is aesthetics simply a network of relations and of finding the appropriate position for our built environment within such a network?

Conclusion

Persistent demands for efficient and flexible building envelopes will continue to encourage the use of new materials and technologies in order to minimize consumption and to conserve energy. In this process, efforts to maximize the performance of building envelopes will continue along with efforts to reduce their material presence, and at the same time, building envelopes will be expected to express the aesthetic intent of buildings. Indeed, central to building envelope design is the question: how do we conceive of the envelope in relation to both our necessity to create interiority and the ecologies in which such interiority is situated?

In contrast to the conception that the building envelope is primarily a barrier, the concept presented here is based on the perspective that the building envelope is inherently *both* the interior *and* the exterior. Therefore, it is not only indexical of the building's form and contents but also dynamic and active in the fluctuating relationship between the building and its environment. However, the prevailing notion of responsive, adaptive or mimetic building design appears to simulate the *translated* conditions of the natural world more than the mediative qualities found in the relations between the human elements and the environment. In other words, the building envelope seen as a kind of mimesis should be more reflexive and diagrammatic than representational and mimicking.

If one looks to the natural environment and its organisms without being exclusively formal, it is possible to find unique approaches that deal with similar problems that are currently facing architects in their consideration of designing for sustainability. The current approach, centered on emulating natural conditions in terms of mechanistic affectation, seems to fall short of the potentials of surface to both mediate and embody. The concept of the building envelope as surface, as seen in both an abstract and physical sense, indicates that it can act both as an agent of equilibrium between the interior and the exterior, and as an apparatus within which certain mediative relations are imbedded.

In most cases, we encounter and approach a building in relation to the façades, in relation to the surfaces of architecture. And in our everyday lives, we are surrounded by architectural surfaces that function in seemingly contradictory manners. They compel us to pay attention and admire their visual qualities, and yet at other times, they emphasize the manufacture of economic value engineering. In this relationship, we can criticize the apparent *superficialization* of the building envelope, purely in terms of the visual and the optical, in other words, for the purpose of producing a (green) skin without the body that is both apathetic and euphemistic. We can also criticize the fetishization of so-called interactive or adaptive building envelopes. In this instance, the building envelope serves as an extension of an architecture that is driven by the novelty of effects that soon exhaust their purpose.

Both of these tendencies in the design of building envelopes today are missing the essential point: the superficialization of building envelopes fulfills the function of a mantle that simply covers up an increasingly excessive, obese body, while the mechanization of buildings and building envelopes fetishizes “the desubjectivized multitude of partial objects”[17] in the form of misdirected mimesis and interactivity. However, if we return to the construct of surface as mediation between matter and affectation, the building envelope can be seen, in essence, as the unfolding of various relations and forces between the building and its environment. This unfolding provides not only the aesthetic qualities of the building but also an approach to the environmental conditions that ultimately dictate the terms of human habitation. This vantage point suggests the kinds of tapestries that display narrative, structural, material and environmental expressions, while serving the purpose of architectural enclosure as the surfaces of mediation, indivisible in their composition. From this conceptual standpoint, buildings are *enveloped* in surfaces – not by skins – that should accommodate and interface the interior and the exterior.

The conception of surface in this sense presents the structure, the building envelope and the façades that are interwoven together, and thus, the role of the building envelope is no longer arbitrary. With this conception, the weaving and pleating that takes place in order to *envelope* is done in the context of a certain technical maturity, where the environmental variables of a given site are addressed, and where the aesthetic qualities are inherently imbedded. From this point of view, the kind of performance and expression that is achieved is not simply superficial and passive. The design of surface is blended with the very essence of architecture in a way that radically departs from the position where the building envelope is seen as an additive, redundant drapery.

Sustainable architecture points to the articulation of surface as a means of sublating the disparate views of the interior-exterior relationship with the one that helps weave, pleat and mediate a series of environmental forces and phenomena. With today's digital technology and its *virtual* capability, and with new construction techniques and new materials, it is possible for the construct of surface to become synonymous with the building design process itself. The surface, as seen in this light, not only provides the membrane of communication and exchange but also embodies the quintessential qualities of human space that exist in intimate relation to the natural environment.

7.181 words

NOTES

1 Marc-Antoine Laugier, *An Essay on Architecture* (1753), trans. Wolfgang and Anni Hermann (Los Angeles: Henessey & Ingalls, 1977), 12. Also, see Christian Norberg-Schulz, *Intentions In Architecture* (Cambridge: MIT Press, 1997 & 1965), 109-111.

2 Le Corbusier, *Precisions On The Present State Of Architecture And City Planning* (Cambridge: MIT Press, 1991), 66.

3 Robert Venturi and Denise Scott Brown, *Architecture as Signs and Systems For a Mannerist Time* (Cambridge: Harvard University Press, 2004), 24-25.

4 Louis H. Sullivan, "The Tall Office Building Artistically Considered," *Lippincott's Magazine* no. 57 (March 1896): 403-409.

5 Robert Venturi and Denise Scott Brown, *Architecture as Signs and Systems For a Mannerist Time* (Cambridge: Harvard University Press, 2004), 153.

6 Avrum Stroll, *Surfaces* (Minneapolis: University of Minnesota Press, 1988), 40-46.

7 Ibid.

8 This theory is also termed *Naïve Realism.* Gibson's theory of *ecological* perception was criticized as an indemonstrable and therefore unprovable proposition.

9 Gibson's *ecology* consists of *invariants,* those that provide constant reference such as the horizon or the regularity of the paving pattern of a sidewalk, and *affordances*, our understanding and recognition as to what we can do with objects in situations around us.

Furthermore, Gibson's theory rejects the discrepancy between appearance and actuality where the sense of space is derived from the configuration of surfaces.

10 Gibson defines *media* as the kind of materials such as air or water that we can be immersed in and move through, while *substance* is any solid matter that we cannot, such as a rock or a concrete wall.

11 Salvoj Žižek, *Organs without Bodies: Deleuze and Consequences* (London: Routledge, 2004), 172-173.

12 *Diacritics* vol. 11 (June 1981): 3-25.

13 Ibid. p. 9.

14 Ibid.

15 Gadamer's actual term *Festspiel* is often translated into English to mean a festival. Here we have emphasized *Spiel* (play, game, performing, etc.) rather than *Fest* (party, celebration, festival, etc.).

16 Hans-Georg Gadamer, *Truth and Method* (1974), trans. Joel Weinsheimer and Donald G. Marshall (London: Contiuum, 2006), 112-116.

17 Salvoj Žižek, *Organs without Bodies: Deleuze and Consequences* (London: Routledge, 2004), 173.

8.434 words

The Sustainable Indigenous Vernacular: Interrogating a Myth

Nezar AlSayyad and Gabriel Arboleda

It has become commonplace in architectural and urban literature to characterize indigenous vernacular [1] dwellings and settlements as *sustainable* (Fig. 1). Yet, what are the actual limits of this conception when some of the world's most serious environmental, social, economic and political problems center today on traditional settlements?

Fig. 1: The stereotypical image of the sustainable indigenous vernacular: Mud construction in Sudan, in the early 1900s.

From Vitruvius to present-day writers, authors have repeatedly invoked four of what we now call *sustainability principles* in indigenous vernacular traditions: *material and site appropriateness*, the notion of the use of materials in a way that secures their constant renewal and supply, while appropriately fitting in and relating to the surrounding environment; *climate responsiveness*, the idea that indigenous vernacular dwellings and settlements are, by virtue of their forms and materials, responsive to changing climate conditions; *socio-economic advantages*, the notion that traditional community building processes foster social bonds and lower building costs; and *adaptability*, the idea that these dwellings are flexible, expandable and portable.

Case examples abound, and some of them have become true classics, often reinvoked in literature: the environmental appropriateness of Amazonian *malocas*, or longhouses; the climate responsiveness of the Cameroonian Mousgoum house; the socioeconomic advantages of community building in the Palauan club house, or the adaptability of the Baluch nomadic structures in Iran.

In this chapter, we examine how the relationship between the concepts of sustainability and the indigenous vernacular has developed throughout the history of architectural and urban ideas. By doing that, we propose a model for analysis that incorporates the variable of time into the discussions that link both concepts. Are the environmental advantages of the indigenous vernacular attributable to a mythical, ageless era as many authors propose? Or instead, do these environmental advantages apply to present-day indigenous vernacular traditions?

To address the later question, which is the main focus of our inquiry, we will compare the above cited four sustainability principles – which we identify as commonly proposed by authors throughout history, against current issues affecting indigenous vernacular dwellings and settlements around the world. With this analysis in mind, we reflect on whether the historical consensus regarding the environmental advantages (or "sustainability" as theory now terms it) of the indigenous vernacular holds applicable today when traditional communities faced with the current global pressures of social, economic, environmental and political change. We end by reflecting on the lessons that may be learned from this examination with regard to current discussions on sustainability and the indigenous vernacular in architectural and urban theory.

Genesis of an Idea: The Indigenous Vernacular is Sustainable

In the 1656 *Glossographia Anglicana Nova* – which features one of the earliest appearances of the term "vernacular" in relation to "dwelling and settlement" in an English dictionary, Thomas Blount equates vernacular not only to national, but also to *natural*, [2] therefore hinting that the concept of sustainability (as in "natural") is *by definition* implicit in the notion of vernacular dwellings and settlements.

However, it is critical to introduce another aspect to this definition, time. *When* is the indigenous vernacular sustainable? Through the centuries of architectural and urban writing – up until the late 1970s, the connection between these concepts excludes the notion of time. Authors propose a *timeless* connection in the context of mythical legends about early man and the origins of architecture. However, in a second moment in architectural and urban theory by the early 1800s, it becomes common among authors to propose that the environmental benefits of the indigenous vernacular are a fact of the present era. The relation between the two concepts thus becomes *temporal*. In a third moment, one of theoretical eclecticism from the early 1980s to the present day, authors invoke both notions of timelessness and temporality.

Timelessness

In the first historical moment – timelessness, the connection that theorists make between indigenous vernacular dwellings and settlements and the characteristics that we now term "sustainable practices" excludes the variable of time. This moment extends from the first century BCE to about 1979 (or between the works of Vitruvius and Christopher Alexander). For many theorists in this time period, the sustainable practices of the indigenous vernacular are tied to the ageless; it is not a historical event but a myth of origins, following an ahistorical and a-temporal narrative.

The notion that the indigenous vernacular is sustainable might have its roots in the writings of Marcus Vitruvius Pollio (ca. 80-70 BCE to ca. 20-15 BCE), first architectural writer to connect the indigenous vernacular to the notion of environmental advantage. In the second of his *Ten Books*, Vitruvius writes about the buildings by "foreign tribes," carefully describing the Anatolia Phrygians' earth building technology (Fig. 2) and concluding that the use of this technology "makes their winters very warm and their summers very cool" ([ca. 46-30 BCE] 1914, 40).

Fig. 2: An 1816 illustration based on Vitruvius' description of the building by the Colchians in present-day Georgia (B), and the Phrygians in Anatolia, Turkey (C)

However, there is an element of a-temporality in Vitruvius' observation. The Roman author assumes that the architecture of vernacular-speaking peoples of Asia Minor and Europe provides a true representation of the way that houses were built at the beginning of time (39). [3] Thus, time does not pass for the vernacular in Vitruvius' appreciation. This makes Vitruvius a pioneer in assigning the notion of a-temporality to the indigenous vernacular and its environmental advantage – an idea that would reach one of its most sophisticated realizations with Christopher Alexander's 1979 book, *Timeless Way of Building*.

Between Vitruvius and Alexander, one can trace the transmission of a-temporal notions through twenty centuries of architectural and urban theory, with nascent connections between indigenous vernacular traditions and their local environments, climates and materials. For instance, in the first of his *Ten Books* in 1452, Leon Battista Alberti argues that men first thought about roofs as protection from the sun and rain, and about walls as added protection from "piercing colds, and stormy winds." ([1755] 1966, 2) The first house, Alberti later adds, was built in materials that today we typically associate with sustainable and indigenous vernacular buildings (mud, reeds, bulrushes and timber) (26). The Renaissance author also speaks about how "the ancients" gave utmost importance to "the climate or air" of a given region before settlement and about the sun and wind as the main factors behind the climate differences in places such as Egypt, Libya, Ethiopia and Arabia (3, 8). In the *Second Book*, while invoking the advantage of natural materials, Alberti praises the durability of wooden building and cites examples of very long lasting woods and vines in the building traditions of India and Tunisia. He adds that "good authors . . . say that the

Vine exceeds even the Eternity of Time itself," (31, capitalization in original) thus going back to the theoretical invocation of a-temporality in connection to indigenous traditions.

We can also find similar lines of thought in the centuries to come, with the writings of Filarete ([1461-1464] 1965, 1:10, 2:fol. 4v), Francesco Milizia ([1768] 1826, xiii), Joseph Gwilt (1842, 1), Eugene Viollet-le-Duc (1876, 381-82, 393-94), Camillo Sitte ([1889] 1965, 167), Banister Fletcher (1901, 7; 1924, 1), and Lewis Mumford (1922, 36).

In 1964, opening his influential *Architecture Without Architects*, Bernard Rudofsky rejects time as a variable in the indigenous vernacular, which is for him "nearly immutable" (1964, 2). The environment is one of the main features of Rudofsky's classic book. He praises the climatic advantages of underground houses in Tungkwan in China; the cool narrow alleys in Zanzibar; the interior courts in Marrakesh; coolness and warmth in the covered streets of Benabarre, Spain, Gubbio, Italy, and the Kharga oasis in the Libyan desert. Rudofsky also cites other numerous examples. However, while explaining the connection between environmental sensitivity and indigenous vernacular traditions, the author ratifies his belief in their timelessness, declaring that "as a rule, the origin of indigenous building forms and construction methods is lost in the distant past" (2).

The link between indigenous vernacular traditions, sustainability and timelessness reaches its most theoretically elaborate point with the work of Christopher Alexander. For Alexander, timelessness is in fact the distinctive element that characterizes environmental aspects of indigenous vernacular dwellings and settlements (1979). He confers so much importance on the notion of timelessness that he elevates it into a design method known as "the timeless way of building" (1979, xv, 519). Alexander argues that traditional builders were able to understand the importance of nature, constructing their dwellings and settlements following a creative process similar to that of nature, a "pattern" that not only avoided damage, but instead improved the natural landscape (1979, xi, 174, also 167; 1977, 511). The main premise of Alexander's method is that when designers follow the appropriate logic – the "the timeless way" (1979, 519), the resulting dwellings or settlements "could be Roman, Persian, from Mohenjo Daro, from medieval Russia, Iceland, Africa," thus embodying a "timeless character" (517). The connection that Alexander makes between sustainability (as in natural and regenerative patterns), the indigenous vernacular, and timelessness is thus explicit, and with his work the idea of timelessness reaches the apex of a historical trajectory that began with Vitruvius.

Temporality

In the second moment of historical thinking, a time variable is firmly introduced into the discussions of the indigenous vernacular. The narrative of traditional peoples settling according to natural principles and the characteristics of their environment, climate and materials continues, but the discussions are grounded in the writers' present time. Discussions no longer focus on "men at the dawn of time" but on specific contemporary communities engaged in sustainable dwelling and settlement practices around the world.

For example, praising the advantages of earth building techniques in 1802, French architect Jean-Baptiste Rondelet reports to have seen in the French Alps "very old houses built of adobe, which had never been plastered on the outside and yet resisted the bad weather" (Rondelet [1802] 1812, 237; our translation). [4] The description is of Rondelet's present time. Another author, American architectural critic and writer Barr Ferree, asserts in 1890 that climate is indeed what determines the shape of dwellings, social factors being secondary. Ferree argues that this fact applies to both developed and primitive peoples of the nineteenth century (1890, 147), hence temporalizing his hypothesis. Not only does Ferree geographically localize his examples in a very precise way (i.e., Central Asia's Tartars, Peru's Conibos, Vanuatu's Tannese, Argentina's Abipones), he also gives them a temporal quality: these building practices happen in his day and not in a remote and undefined era.

This now-temporalized narrative is fully mature in *Revolution of Environment*, the 1946 work by Erwin Anton Gutkind. For the German architect, planner and theorist, the industrial revolution forced humanity to focus on the quantitative aspects of life (mass production) and to forget about the qualitative side (1946, 5). There is a present necessity, Gutkind argues, to look back at the sense of humanness that traditional peoples developed through their "organic attachment to Nature" in their methods of building and settlement (10, capitalization in original). For instance, Gutkind explains that in African villages "life is rooted in Nature in a direct and concrete way" and "Man can animate Nature; he cannot dominate and change it" (9). Gutkind's proposal argues that these practices are in the present time and not in an ageless, undefined era. The organic, natural and harmonious way of settlement organization in the African villages of the Baluba or the Baholoholo that Gutkind mentions is of the present (12-13).

This temporal narrative becomes highly developed in the late 1960s with the work of two classic authors of indigenous vernacular architectural studies, Amos Rapoport and Paul Oliver. Rapoport's seminal *House Form and Culture* (1969) is a complex reflection on the present condition of indigenous vernacular building. Rapoport concerns himself with present people who dwell in places like Africa or Oceania, and how they come to decide whether their houses are to be square or circular; their roofs flat or sloped. In connecting such concern with the environmentally appropriate methods of building seen in traditional societies, Rapoport brings some of the assumptions that authors like Sitte, the early Mumford or Alexander make about an ageless era to the present. He argues, for example, that "the effects of primitive man on landscape are minimal" and that among traditional peoples "there is no sharp distinction between man and nature. The primary world view is of harmony with nature rather than of conflict or conquest" (75). But he supports these ideas by providing a wealth of contemporary examples, like those of the Pueblo, the Maya, the Matmata, the Ashanti, and the Yokut, among others (1969, 76, 91-92).

The present is so central a concern for British vernacular architectural theorist Paul Oliver that in his celebrated *Encyclopedia* he only includes entries about "vernacular architecture which has been in use in the 20th century" (1997, 1:xxvii). From his early work on architectural theory Oliver made a case on the necessity to look at indigenous vernacular dwellings differently, not as a-temporal masterpieces as Rudofsky does, but as a response to specific community needs, among which those conditioned by the environment and climate (1969, 28). The idea of present *needs* is a constant in Oliver's research on indigenous vernacular dwellings and settlements. But he reflects on these needs not only as preconditions for vernacular architectural forms but also for professional architects to study vernacular building. Oliver develops this idea in detail in *Built to Meet Needs* (2006), where he advocates for "appropriately supporting vernacular traditions to ensure sustainable solutions" to the vast demands in the present day (2006, xxiii). He adds: "much can be learned from the most sustained of all forms of architecture: the vernacular traditions" (42). Oliver reaffirms his ideas under the "vernacular architecture" entry of the *Oxford Companion to Architecture,* where he asserts that indigenous vernacular traditions "have proved themselves to be sustainable, with their use of natural and renewable resources, their climatic and environmental sustainability, and their capacity to adapt to change" (Paul Oliver, in Goode 2009, 2:994).

The Sustainability of the Indigenous Vernacular: Four Main Principles

The discourse of timelessness and temporality regarding sustainability and the indigenous vernacular is still patent in literature recently produced. In fact, since the 1980s architectural and urban literature has eclectically combined the aforementioned theoretical traditions of timelessness and temporality, with many authors and practitioners championing some of the main historical ideas previously described. Furthermore, the amount of recent literature defending the general notion that the indigenous vernacular is sustainable is so vast it would be impossible to make a detailed survey here, but the most notable defenses of the notion appear to hinge on the following points:

1. Indigenous dwellings and settlements are adaptive to their natural environment, making use of natural, raw materials (e.g. Moshe Safdie 1982, 22-33; Richard Register 2002, 64; Allen Noble 2007, 84, 153; and 7group [Boecker et al.] 2009, 3, 5, 49)
2. Their construction is responsive to local weather and climate conditions (e.g. Glenn Murcutt in Fromonot 2003, 39; Dominique Gauzin-Müller 2006, 8; and Ralph Knowles 2006, 4)
3. Traditional societies have been able to successfully keep the equilibrium between population, resources and environment (e.g. James Steele 1996, 19; and Richard Rogers 1998, 1)
4. Indigenous dwellings can be easily transformed in response to changing conditions (e.g. John Taylor 1983, 63, 125, 155)

Those common traits in the discourse thus constitute the four agreed-upon sustainability principles of indigenous vernacular dwellings and settlements: material and site appropriateness, climate responsiveness, socio-economic advantages, and adaptability. The principles can be roughly summed up in one statement: Indigenous vernacular dwellings and settlements are sustainable because they make appropriate use of local resources to ensure climate comfort at low cost, through the production of structures that are easily adaptable to changing conditions in a socially cohesive way.

It is important to examine the limits of this notion when some of the world's most serious environmental, social, economic and political problems currently center on traditional settlements. In order to explore the present-day relevance of the notion, we will analyze each of the four sustainability principles in a number of vernacular dwellings and settlements long proposed as best examples of sustainability in the indigenous vernacular.

Principle One: Material and Site Appropriateness

The first principle with respect to the sustainability of indigenous vernacular buildings and settlements concerns the use of natural, local building materials and the close connection between building and place. This involves two claims: first, that the surrounding environment provides the materials that are used in ways that allow for their renewal and constant supply; and second, that they are site-specific, perfectly situated within the surrounding environment and in harmony with it.

The first hypothesis is that traditional societies make the best use of their available natural resources, balancing resource consumption and production. Natural building materials, the argument goes, are more appropriate because they are not harmful or wasteful. They are renewable, recyclable or naturally decomposing, returning to nature at the end of a structure's useful life. Therefore, architectural and urban theorists conclude that the use of natural materials is restorative and regenerative, reducing contamination and environmental degradation and taking place in the context of a cyclical ecological process. They also conclude that traditional societies manage these materials in a way that allows for regeneration and therefore does not exhaust the natural resources.

An often-cited example concerns the dwellings in the Amazon River basin, especially those of the semi-migrant Eastern Tukano Ufaina people in Colombia. A group of Ufaina traditionally lives in a *maloca*, monumental thatched structures which in the early 1900s were reported to house more than two hundred people under a single roof (Hildebrand 1983, 12) (Fig. 3).

Fig. 3: A *maloca* or longhouse, as photographed in the early 1900s in southern Colombia's Huitoto territory. The large number of dwellers standing in front provides an idea of the monumental scale of this palm-thatched structure.

According to anthropological literature, a maloca-unit group traditionally stays in a given place for about ten to fifteen years. Then, as local resources become scarce, the group will move to a place with fresh supplies (fish and game especially) about one day's walk from the previous site, where it will build a new maloca (12-14). It is to be expected that Ufainas will only return to the site of a previous maloca after many years, when that place has fully recovered from the impact of their presence and when natural resources have been replenished.

Contrasting with this description, today's Eastern Tukano (as is the case with other indigenous peoples of the Colombian Amazon) remain deeply affected by a decades-old armed conflict now expanding internationally toward Venezuela and Ecuador – a conflict that involves the American and Colombian governments, leftist FARC guerrillas and right-wing AUC paramilitary groups. The Eastern Tukano migration territory – part of a dense forest that is rich in water, oil and medicinal resources, is one of the areas where this conflict has been most intense in recent years. The impact of this decades-old armed conflict on the Tukano and other Amazonian indigenous groups is indescribable: massacres, forceful enrollment of indigenous children in the militias, forced displacement, and with all that a general disruption of the traditional patterns of life, this including the building of the malocas. Hence, given today's geopolitical situation, Colombian Amazon's indigenous peoples seldom have the luxury of developing the kind of natural relationship to their surroundings, let alone developing and maintaining the kind of material culture that is in tune with their environment.

The literature on indigenous dwellings and settlements has idealized similar situations of migration in relation to a careful balance between consumption and production cycles in other places around the world. One such case involves Botswana's nomadic Central Kalahari San, or Basarwa. Given that the Basarwa have no permanent access to water, at the end of the rainy season they move to an area rich in melons, a fruit that provides them with a water substitute during the early dry season. Then, during the late dry season, they scatter throughout an area that provides them with plants to survive on until the next rainy season (Susan Kent, in Oliver 1997, 3:2140-42).

Yet again, the reality of the Basarwa today is rather different. Starting in 1997 the Botswana government started to remove Basarwa peoples from their own territory, claiming that they had shifted from traditional hunting and gathering practices, and that their newly adopted agricultural activities negatively affect the environment of the Central Kalahari, a natural reserve since 1961. However, Basarwa supporters counter that the removal is really an attempt by the government to protect the interests of tourism and mining industries in the reserve. Even though in 2006, Botswana's

High Court ruled that removal of the Basarwa from their land was illegal, as of 2010 the government still has not allowed the majority of the resettled Basarwa to return to the Central Kalahari reserve. Thus, the Basarwa idealized cycle of resource use and migration so often cited in the literature has been severely disrupted.

The two examples above highlight current shortfalls in the notion that indigenous vernacular dwellings and settlements are adapted to their environments. Today many traditional communities cannot settle in locations that provide the best relation to place and resources; instead, they settle wherever they end up after displacement by armed conflict, industrial pollution or hostile government policies. Their capacity to migrate and conform to the natural cycle of use and regeneration of local materials has been disrupted and diminished in dramatic ways.

The second component of the principle involves the idea that indigenous vernacular dwellings and settlements are site-specific, perfectly situated within and in harmony with the surrounding environment. However, one can find ample evidence to counter this notion, and thus refute the generalization that they are site-specific. Already by the 1960s anthropologists John W. M. Whiting and Barbara Ayres were arguing that most of the world's indigenous vernacular dwellings did not appear to be well adapted to their surroundings. Likely, this was a result of forced changes to settlement patterns, as mentioned above. In cross-cultural survey work, Whiting and Ayres studied a statistically representative number of cultures among the 700 listed in the *Ethnographic Atlas* and concluded that an absolute correlation between house form and the surrounding environment did not exist. On the whole, Whiting and Ayres observed, house form depended less on the local environment and more on social aspects such as whether the family organization was nuclear or extended, the group nomadic or sedentary and the pattern of marriage polygynous or monogamous (1966, 12-13). Thus, a more correct generalization for contemporary indigenous communities would be that house form responds to social organization, not to the environmental imperatives of the site.

Similar findings are seen in the work of anthropologists Bronislaw Malinowski (1922), Reo Franklin Fortune (1932), Margaret Mead (1935) and Gregory Bateson (1936), who worked with traditional groups in the mountainous and coastal regions of Papua New Guinea. The building and settlement descriptions provided by these anthropologists show that among the traditional societies of Papua New Guinea, building form was not a necessary, direct or invariable consequence of the surrounding environment. Elements such as social conventions, gender roles and the economic function of the building were what predominantly shaped the area's vernacular buildings and settlements. These examples make it difficult to uphold today's generalization that the indigenous vernacular is primarily designed to sit harmoniously within the surrounding environment.

Evidence thus exists that due to today's geopolitical influences there is no longer a close connection to natural resource use and management in the indigenous vernacular.

Evidence thus exists that there is no longer a close connection between building and natural resource management in indigenous vernacular building, and that today there does not exist, as a general rule, a close connection between building and site. First, issues of resource depletion due to geopolitical conflict and corporate interest (and the combination of the two) are restricting the ability of indigenous communities to exploit their environments in ways that guarantee both resource renewal and the continuation of patterns of subsistence, building and settlement that are in harmony with nature. Second, and partly as a consequence of the previous condition, today's indigenous vernacular dwellings and settlements do not primarily respond to the environmental characteristics of the site. As seen in anthropological studies from the past few decades, traditional communities are not basing their formal decisions on environmental appropriateness, but on social considerations.

Principle Two: Climate Responsiveness

As for the second principle, current theorists agree that indigenous vernacular dwellings and settlements are efficient climate regulators because indigenous technologies such as mud and thatch are more responsive to drastic temperature shifts. Buildings employing these technologies, they argue, remain cool inside when it becomes too hot outside, and warm inside when it is too cold outside. Authors add that this also applies at the urban scale, where dwellings with massive walls and light colors set in narrow alleys provide successful examples of passive thermal control, particularly in desert habitats.

A major problem with this notion is that it ignores the impact of global climate change in two major ways. First, it ignores how the politics of climate change have deeply disturbed indigenous patterns of settlement. And second, it assumes that the climate pattern remains stable in a given traditional settlement, as it used to be until a few decades ago.

One example of the politics of climate change and its impact on indigenous traditions is seen in contemporary water wars – geopolitical conflicts about the access to dwindling water sources. These conflicts have changed people's lives in two societies that are often cited as classic examples of shelter adaptation to climate and environmental constraints: the east African Samburu and the central African Rizeigat, or Rizekat. The classic architectural description of the nomadic Samburu of Kenya is that they move with their houses (main poles and furniture objects) every month or two in search of water and fresh pasture for their cattle and goats (Patrick Dujarric, in Oliver 1997, 3:1988-89). Today, however, the situation the Samburu face is far more complicated. Their area of migration originally comprised parts of three countries – Kenya, Somalia and Ethiopia. In addition to political, economic and environmental problems that have deeply affected this group, severe drought has led to vicious intragroup conflict among Samburu families over water access, and traffic in small arms from Somali militias has allowed it to escalate to fatal levels. Intending to end the conflict, the government carried out violent "pacification" attacks; during the course of these attacks, in 2009 and 2010 members of the military and the police tortured, raped and killed unarmed Samburus in such a systematic and widespread way that, in the opinion of Human Rights Watch, these attacks "could rise to the level of crimes against humanity" (Rawlence 2009, 5).

A second paradigmatic example of climate adaptation concerns the Rizekat, or Rizeigat, of Chad and Darfur. These groups have been described as migrating with oval tents every two to three months in search of pasture as well as water for themselves and their camels and cattle during the dry season. During the rainy season, they move up to the surrounding hills to avoid floods. In the course of their migration, they sell animal produce and buy other products, and at the end of each migration cycle they are careful not to camp at the same location as they did the previous year, so as to avoid the insects flying around old trash (Natalie Tobert, in Oliver 1997, 3:2095-96). Yet, the current reality of the Rizeigat is far more complicated. Already by the 1980s their area of migration had become restricted and their periods of stay in each place shorter, because drought and desertification as a consequence of climate change limited the availability of pasture for their animals (Tobert 1985a, 216; 1985b, 279).

But the real turning point in Rizeigat life – as in the lives of other traditional groups in this area has been the Darfur conflict, in which access to resources, including water, was a triggering factor. Today some of the stops in the Rizeigat seasonal migration are epicenters of this conflict. For example, the Rizeigat trading post of Kebkabiya is now a refuge for internally displaced people, and as of 2004 the population of displaced people there was three times greater than the resident population (UN RC 2004). Fighting on the side of the government-backed Janjawiid, Rizeigat groups have been responsible for brutal crimes against humanity perpetrated on the Fur, Zaghawa, Masalit and other ethnic groups in the area.

The second problem with the notion of climate responsiveness is that it assumes the climate is stable in indigenous settlements today, as it was in past decades. It assumes that a given environment is dry or wet during a given part of the year, and that drought or rain occurs at consistent, predictable time periods. Today, this is not the case in many traditional settlements once praised in architectural and urban theory for their climate responsiveness, for example the settlements of the Philippines Ifugao (affected between 2009 and 2010 by increased rainfalls that caused constant and deadly landslides), the Niger Fulani (harshly hit in 2010 by a severe drought that caused an unexpected famine), or the Malaysia and Indonesia Dayak (recently affected by unpredictable weather changes, including both decreased annual precipitation and flash floods).

It is difficult today for traditional builders to tell when the rainy or dry season will start, and floods or droughts do not have the predictable patterns they once did. It is difficult to adapt to such conditions but furthermore, indigenous vernacular dwellings designed for a stable climate are far more vulnerable to unpredictable climate fluctuations. Such vulnerability becomes critically manifest in aspects such as the structural resistance of buildings. Regardless of how thermally efficient it may be, mud construction easily collapses when exposed to more rain than usual (Fig. 4).

Fig. 4: Two sides of the narrative of climate responsiveness: On the left, the much celebrated mud structures of Taos Pueblo, in New Mexico. On the right, some 200 feet west of the previous structure, a collapsed wall due to excess rain in 2005.]

In fact, the collapse of indigenous vernacular mud buildings has been constantly reported since the early 2000s in central Ghana and Zambia, and in Sri Lanka, in 2003 the flood levels as high as twelve feet destroyed centuries-old traditional buildings, as the international NGO Mercy Malaysia reported.

Such conditions are partly the reason why many traditional settlements in mud have been replaced, their residents preferring to build in industrial materials such as corrugated metal roofing and concrete blocks. Although the design of structures in modern materials usually makes them very hot or cold for their environments, in situations of building collapse, climate comfort stops being a top priority. In fact, perhaps given that human climate perception and tolerance is partly an idiosyncratic factor, [5] traditional communities around the world seem to have become more tolerant of poor climate-conditioning in their dwellings in recent years, as they move toward the use of modern and industrial materials due to a concern for the durability and safety of traditional structures in mud and other natural materials. Take, for example, the case of Salvadorian rural communities living nowadays in tiny metallic shelters that feel so hot inside they have been popularly dubbed “microwaves” (Fig. 5).

Fig. 5: A so-called "microwave," a low-income housing structure with roof and walls constructed from corrugated metal sheets. El Salvador, 2004.

The paradigm of the climate responsiveness of the indigenous vernacular has been deeply disturbed, first by geopolitical situations related to access to natural resources, including water, and second, by changing climate patterns, which make traditional building materials and dwellings inefficient to cope with the current realities of excess rain or drought.

Principle Three: Socio-economic Advantages

The third principle that contemporary authors associate with the indigenous vernacular and the notion of sustainability is that vernacular buildings and settlements offer great socio-economic advantages. There are two main reasons. First, indigenous dwellings are low cost because they are generally self- or community built, and that translates into immediate savings in labor. In addition, the natural building materials (mud or grass, for instance) may even be free if they are obtained from the user's own land. Second, the construction process of indigenous vernacular structures has great social significance since communal work both demands and stimulates bonds among the community members involved.

Indigenous building practice based on community labor traditionally took the form of tax (mandatory labor contributions from each household to the community), exchange (members of the community mutually involved in building each other's dwellings) or ritual (traditional celebrations that involve building). However, given that most traditional societies have either adopted or been integrated to a market-driven economic system (particularly after the 1944 Bretton Woods conference [6]), these forms of "free" community labor are not as central as they used to be. Consequently, the initially invisible economic cost of traditional self-help labor has now become evident. [7] Generally speaking, indigenous vernacular building is so labor intensive that the time investment in construction surpasses any savings that can accrue in the cost of materials. [8] The extensive time investment comes from the fact that most indigenous vernacular structures are *complex*. Consider the intricate roof structures of the traditional Timor Ema house, the highly decorated clan house walls of the Lake Toba Batak in Sulawesi (Indonesia) or the complex carpentry of the Palauan clubhouse in Micronesia. Structures like these are very elaborate, ornamented, and/or use technologies that demand the slow drying, curing and hardening of materials. But in addition, these structures demand constant maintenance, repairs and even full rebuilding after a short time span.

Because of the shift toward a market economy, in traditional communities the sophisticated task of building or repairing indigenous vernacular structures now increasingly relies on individual owners, as opposed to being a community enterprise as it was in the past. Individuals must take time aside from paid labor to engage in this demanding work, which without the communal support becomes prohibitive financially. Thus, because this restricts sometimes for weeks the ability to work on cash-procuring activities, more and more traditional builders are shifting to faster industrial techniques and materials. For example, the Cameroonian and Equatorial Guinean Fang people have been progressively abandoning their rather sophisticated and slow to build rammed-earth wall-building systems. Instead, they are now building using sawn wood boards, prefabricated concrete blocks or corrugated sheets, all of which involve construction processes that take very short time and cost a lot less to complete.

Given that the time and the quality of the work required to build indigenous vernacular structures immediately translates into substantial economic burden, traditional building techniques today often turn out to be unaffordable by the very communities that developed them. It is indeed paradoxical that the indigenous vernacular aesthetics as such has instead become a marker and preference of wealthy urban elites, private companies and governmental institutions in many places around the world. Just to provide a few examples, in Ecuador, large-scale Amazonian structures in traditional palm thatch are nowadays only affordable to eco-hotel operators, oil companies, banks or the government. In a similar case in Guyana, enormous traditional community houses, *benabs*, are now less common in indigenous villages than in urban settings, where they are used as conference and meeting centers. In Colombia, the high levels of labor specialization in bamboo-building have made the work of *bambuseros*, or bamboo builders, equivalent to that of artists, and high-quality bamboo housing is now so expensive that it is normally reserved for the very wealthy. And in Thailand, not only the cost of labor but that of materials has made old, rural houses a precious commodity, and as a result many of these houses – built using now-hard-to-find woods, have been bought and reassembled in urban centers to accommodate wealthy foreigners or upscale stores, or simply placed as display objects in open-air museums (Fig. 6).

Fig. 6: A very elaborate traditional central Thai house, on display at the Arts and Crafts Village, Bangsai Arts and Crafts Centre (2009).

In sum, building an indigenous vernacular structure today is a highly expensive endeavor, because of the generalized shift to a market economy among the world's traditional communities. The sophisticated craftsmanship as well as the indispensably constant maintenance, repairs and rebuilding, vis-à-vis the fact that this type of work can no longer be self- or community-based, have made the indigenous vernacular unaffordable to its originators. These issues challenge the widely acknowledged notion in architectural and urban theory that indigenous vernacular dwellings and settlements are socio-economically sustainable.

Principle Four: Adaptability

The fourth principle, adaptability, is referred to in terms of three separate qualities: the indigenous vernacular may be *flexible*, in that it allows internal space redistribution; *expandable*, in that it can accommodate new uses or users through easy extensions; and/or *portable*, in that a main structure and its covering surface may be disassembled and transported.

In exploring these assertions, it is necessary to consider two critical issues affecting indigenous vernacular settlements today. First is a common trend for rapid population growth mirroring that of the world population, but in some cases at an even faster rate. Second, a generalized pattern of social change in traditional societies, with a critical shift from big, extended families to individual, hearth-based ones. The later may include the breakup of an extended family unit with 150 members living in a single longhouse (such as among the Malaysia Iban or the Colombian and Ecuadorian Tukano) into individual families numbering only about ten members each, where each family demands a separate dwelling.

Both growing population and social change challenge the theoretical adaptability of indigenous vernacular building. How, for instance, can an extended family house be transformed to house individual, nuclear families? And how can it be further expanded when these families grow? If we accept the theoretical notion that the indigenous vernacular is adaptable, the immediate assumption is that the building allows for such changes. Yet, in fact, only the simplest indigenous vernacular dwellings are adaptable enough to allow for that type of change – structures like the seasonal shelters of the Nunggubuyu in northern Australia, or tent-like structures of the nomadic Tuvinian in Siberia, the Nogay in southern Russia, or the Baluch in Iran, Afghanistan, Pakistan and Oman.

The adaptability problem thus extends to buildings that are circular or that have hipped or polygonal-form roofs. In all those cases, it is difficult to transform a structure without major rebuilding. And even in the case of rectangular buildings, transformation is simple only when the form can be modified by a simple addition along the longitudinal axis; transverse additions present complexity because of the need to disassemble the roof and reassemble it later. This situation is particularly critical in the case of thatched roofs, where even simple transformations are difficult without complete rebuilding, otherwise the new roof will be prone to leaking. Likewise, structures in mud or stone demand significant structural transformation to avoid the potential for collapse once the adaptation or expansion is complete.

The community houses of the Kejia people in China's Fujian province are for example difficult to change because of their form (a closed circular courtyard) and their rammed earth technology. The same follows for the Tui'que Huë'e, the Secoya house in the Aguarico River in Ecuador, a rectangular house with semi-octagonal endings. Expanding it would require completely disassembling one of its intricate polar-geometry endings, extending the rectangular portion, and then rebuilding the ending.

Clearly, trying to adapt these houses is more difficult than simply building a second house from scratch – the reason why many traditional communities today avoid radically altering their dwellings, and instead opting to build completely new and separate structures whenever the need for more space arises. One such case is the Ecuadorian Cotopaxi Quichua's woven-grass house. When more space is needed, this Quichua group builds a completely new structure around the existing one, as opposed to modifying it. A Cotopaxi Quichua expanded house is thus a cluster of separate houses, but often, the new structures added are modern ones built in concrete bricks (Fig. 7).

Fig. 7: A modern concrete brick structure in the middle of a traditional homestead of grass-woven and thatched roof houses. Cotopaxi, Ecuador, 2008.

This points to another critical issue regarding the difficulty of adapting indigenous vernacular types. In a good number of cases, the only way for a community to new and changing life conditions is to abandon their traditional house type altogether and adopt a modern one that is more easily adaptable (Fig. 8).

Fig. 8: Traditional structures such as the one at the center of this image are giving way to modern ones in this indigenous Ecuadorian Andes settlement, 2009.

That is the case with the above-mentioned Secoya in Ecuador, an indigenous community that in only a couple of years changed essentially all of its traditional housing stock to the corrugated metal cladding common among urban migrants. The case is dramatic because the Secoya took in a single, massive move once they managed to obtain enough funding and materials to engage in it. [9]

Another obstacle to adaptability appears when the indigenous vernacular house is inextricably linked to traditional social, cultural or ritual aspects, and that link is manifest through the symbolism of the building structure and its spatial distribution. Once the society's culture and the associated rituals change, it is difficult to adapt the house to new uses and traditions. When the logic of its structure and spatial distribution loses its original cultural and ritualistic meaning, the house itself no longer makes sense, in such a case as the Wanukakan big houses in Sumba, eastern Indonesia. These houses are not supposed to be changed because each structural column serves a ritual purpose. The house columns (as well as other structural elements) are thus supposed to remain fixed in location and number with no additions or changes allowed. A related condition pertains with the ancestral house of the Wewewa (also in the Sumba Island), where the original house form is connected to family lineage. In order to preserve the continuity of family links – in particular the connection of distant relatives to the family heart, the Wewewa house must either stay unchanged or a completely new option must be found; the traditional cultural and ritualistic patterns allowing no in-between adaptations.

As the examples above show, indigenous vernacular buildings are not easily adaptable in the face of generalized population growth and social change among traditional communities. Physical restrictions in the modification of indigenous vernacular structures, not to mention social ones, make it difficult to adapt traditional buildings to changing needs. Because of that, modifications are not happening as frequently as architectural and urban theorists have traditionally proposed. It is not uncommon for traditional communities to adopt modern building types, forms and materials when facing new conditions.

The Myth of Sustainability in the Contemporary Indigenous Vernacular

We have set out to explore whether the connection between *indigenous vernacular* and *sustainable* presently holds true, and with that aim we analyzed four principles of sustainability frequently invoked in both historical and current architectural and urban theory: material and site appropriateness, climate responsiveness, socio-economic advantages and adaptability. We found evidence that the notion of sustainability formulated around the indigenous vernacular does not hold true as a general norm today. Circumstances in traditional communities have radically changed – politically, economically and environmentally, especially since the 1944 Bretton Woods conference that promulgated an idea of development centered on modernization and economic growth.

From the analysis of the four principles above it further becomes evident that recent architectural and urban literature has been inadvertently echoing old theories that celebrate the environmental qualities (or the "sustainability," as preferred nowadays) of the indigenous vernacular under the assumption that these theories remain valid. In other words, literature has continued to celebrate the notion that the indigenous vernacular is sustainable, in terms of its relationship to natural environment, socio-economic context, and function, while in good faith overlooking the environmental, geopolitical, cultural and social transmutation of communities it uses as examples.

By overlooking these changing conditions, the discussion on sustainability and the indigenous vernacular has limited itself to purely formal attributes, hence becoming for the most part a discussion on aesthetics. Thus, when the environmental, economic, political and social issues are incorporated into this discussion the limitations of the form-centered approach become evident. The so described pristine harmony between the aesthetics of human settlements and the forces of natural environment belongs to another era, and represents neither the prevailing condition nor a meaningful applicability. As the evidence seems to demonstrate, the theoretical sustainability principles of the indigenous vernacular are frequently inapplicable in today's context, and therefore the generalization that the indigenous vernacular is sustainable is no longer valid. With this into consideration, the inherent aesthetic qualities of the indigenous vernacular appear rather superficial, disconnected from a myth of origins that is no longer valid, when it is not altogether manipulative in the intent behind the promotion of such qualities as a hallmark of sustainable living.

By defending and proliferating this generalization, even unknowingly and unintentionally, some architectural and urban theories that pertain to sustainability might be engaging in the fabrication and diffusion of the sustainable indigenous vernacular myth. To truly reevaluate this myth, it will be necessary for current scholarship to revisit the time variable and consider the changing socio- and geopolitical context of the debate. The discussions connecting the indigenous vernacular and sustainability should move beyond the practice of blindly praising sustainability of traditional environments as an attribute that is also applicable today. Efforts must be made to reassess the numerous case studies that theory still invokes as paradigms of sustainability – to check the examples against the current situations on the ground in those formerly exemplary communities.

In many cases, building and settlement practices that may have been sustainable in the past are no longer so because the built environment in many (if not most) traditional communities has been profoundly affected by diverse factors – ranging from global climate changes, irreversible destruction from industrial development, urbanization and modernization of traditional environments, to the fundamental transformation of commerce and finances by market economy, to name just a few – that have by and large ended the sustainable prospects of their indigenous practices. That considered, architectural and urban theories need to integrate a deeper reflection about present-day environmental, economic, political and social issues into current discussions of sustainability and the indigenous vernacular.

NOTES:

[1] In this chapter, we use the term "indigenous vernacular" (in preference to simply "vernacular") to refer to a dwelling and settlement form in which "architectural production was largely determined by local forces" (AlSayyad 2004, 10). In the developing world, this building and urban form historically emerged during precolonial times (1995, 13). The concept of indigenous vernacular combines two separate ideas. If we understand indigenous as "locally developed" (by its Latin roots *endo-genus*), and vernacular as it was understood in the 1800s to mean "national architecture" (Mozley 1839, 464; Scott 1857, 1; Petit 1861, 195), the combined *indigenous vernacular* refers to a type of dwelling and settlement that is substantially developed within a specific territory through either locally originated (aboriginal) or imported and readapted practices (or both combined), and which is claimed in nationalist political discourse to be part of the architectural or urban stock of a given nation-state, as in "the building of our ancestors." Defined this way, indigenous vernacular architecture is what architectural and urban theory indistinctly, and to some extents imprecisely, calls primitive, indigenous, or vernacular architecture. On occasion we also use "traditional," a more open category, to broadly designate the same condition.

[2] "Proper and peculiar to the House or Country one lives in; natural" (Blount [1656] 1707, s.v. vernacular; capitalization in original).

[3] "That houses originated as I have written above, we can see for ourselves from the buildings that are to this day constructed of like materials by foreign tribes" (Vitruvius [ca. 46-30 BC] 1914, 39). Vitruvius looks in detail at several specific examples of indigenous architecture in order to reaffirm such a conclusion, finding those buildings to be similar to the buildings of antiquity (40). The author also adds

that, although mud and thatch architecture exist in his present, it is a thing of the past, a “reminder of the fashions of old times” (40).

[4] “J'ai vu, dans le département de l'Isère, des maisons fort anciennes, construites en pisé, qui n'avaient jamais été enduites à l'extérieur, et qui cependant avaient résisté à toutes les intempéries de l'air” (Rondelet [1802] 1812, 237).

[5] An environment that a rainforest dweller, such as a Mbote from the Democratic Republic of the Congo, finds cool might be unbearably hot for an Alaskan Inuit, for example. Besides, the coolness of a dwelling is not very relevant when Mbote families spend most of their time outside the house — in fact, using the outdoors as an extension of the house, hanging some of their belongings from tree branches, for example (Allen F. Roberts, in Oliver 1997, 3:2008). In cases like this, temperature inside is not a critical issue given that the house is simply not used that much. But the issue goes beyond being culturally conditioned, to becoming personal: some people have more tolerance to certain temperatures than others because of health issues, body mass, or simply individual preference.

[6] A world conference held in 1944 in order to establish a standardized monetary management structure. It also established the IMF and the international currency exchange system that is pegged to the US Dollar.

[7] See the work by Hans Harms and Rod Burgess. When doing that evaluation in the case of self-help building, an urban form of community building that originated from these traditional practices, Harms finds that it is actually not cheaper (Harms 1982, 20, 30, 34, 47, 50-51). Burgess concurs in this affirmation (1982, 61).

[8] Indeed, the time spent to construct many traditional structures exceeds by a multiple factor that needed to build contemporary structures of similar shape and size.

[9] Their funding came from a negotiation over oil-exploration rights with an international oil corporation.

Image Credits

Fig. 1 Photographs in Marcellin Boule and René Verneau, eds., L'Anthropologie Paraissant Tous les Deux Mois. Vol. 17. Paris: Masson et Cie., 1906. p. 140

Fig. 2 Illustration in Marcus Vitruvius Pollio. De Bioul. trans. L'Architecture de Vitruve. Brussels: Chez Adolphe Stapleaux, 1816. p. 494

Fig. 3 Photograph in Thomas Whiffen. The North-West Amazons: Notes Of Some Months Spent Among Cannibal Tribes. London: Constable and company, 1915. p. 120

Fig. 4-8 Gabriel Arboleda

7.299 words

The *Qanat*: The Dilemmas of Sustainability & Strategic Conservation in Yazd, Iran

Vinayak Bharne

Introduction

There have been times when the design of hydro-infrastructure has been inseparable from the cultural identity of a place. The conscious *aestheticizing* of the modes of their services has not only domesticated their technical and utilitarian dimensions but also formed proprietary territories and communities with profound social dimensions. One thinks of the aqueducts and fountains of Rome, the mosaic-clad water tanks of Khiva, the *acequias* (water channels) of New Mexico, and the *tirthas* (sacred reservoirs) and *vapis* (sacred wells) of Benaras. These infrastructures did not just supply water; they also created compelling urban artifacts whose image was indelibly linked to the social, political and cultural pride of their respective habitats.

In a period of hydrologic uncertainty, do such archeological and vernacular infrastructural systems offer alternative strategies for contemporary city design? Is the global *urban water crisis* a profound opportunity not only for excavating the deeper functional workings of such vernacular systems, but also their relationship with regionally authentic cultural identities? To what degree have these systems and their communities been designed to adapt in the face of massive urban growth and disruption? Can historic infrastructures – in places, developing and industrialized – be re-purposed for contemporary sustainable design? Can visionary design approaches towards their reuse in turn yield practical policy approaches towards their implementation?

The city of Yazd, situated 1,215 meters above sea level, at the confluence of the Dasht-e-Kavir and the Dasht-e-Lut deserts in Iran is the setting for this exploration.[1] Despite its notorious historic cityscape of lanes, domes, terraces and wind-towers, the ingenuity of its urban workings remains relatively less-known. Beneath and around this desert habitat lays an ancient network of subterranean water channels stretching some 10 miles from the urban core. They are visible only as linear man-made earth-scapes of sequential of intermittent wells. They tap water from the distant mountain aquifers and guide it into the peripheral fields, the subterranean domed reservoirs within the fabric, and eventually the individual wells and tanks within the monuments and dwellings. If Rome had its aqueducts and Spain its acequias, then Yazd has its *qanats,* an antediluvian network of dendritic hydro-infrastructure that explains its seemingly counterintuitive origins and sustenance away from a river, lake or stream.[2] (Figs. 1, 2 & 3)

Fig. 1: Historic cityscape of Yazd with the Zagros Mountains in the backdrop.

Fig. 2: Historic cityscape of Yazd with mosques and monuments rising above the horizontal mud habitat.

Fig. 3: Possible morphology of Yazd in the pre-Islamic era. The settlement is shown in black surrounded by agricultural fields and the qanat network.

While the reasons behind Yazd's isolation remain dubious, its historic origins date back to the time of Alexander the Great, a millennium before the emergence of Islam. It was conquered by the Arabs in 642 AD, and subsequently became an important station on the caravan routes to Central Asia and India. Spared destruction by Chengiz Khan and Tamerlane, who expanded its military walls, it flourished in the 14th and 15th centuries, though its commercial success and stability were never translated into any significant political status. With its seclusion and harsh climate sparing it of recurrent foreign invasion, it also became the adopted artistic and intellectual enclave of the Zoroastrians. Eventually, like other towns of Iran, it gradually fell into decline as a provincial outpost up until the extension of the railway line under Iran's last Shah.

Today Yazd is a sprawling urban landscape some thirty times its historic core. Its qanats, once the only water source of a compact agrarian desert habitat, remain alive largely on its outskirts, serving its exurban agricultural fields. Within the historic core, most lay abandoned and buried with rock, earth and dirt affirming their losing battle to modern infrastructure. Incapable of supplying the vast quantities of water supply for the growing city, their constant maintenance has made them not only unreliable, but undesirable compared to the convenience of modern plumbing. Surviving through the indigenous skills of *muqannis* (qanat-makers) who continue to maintain them on a requested basis, Yazd's qanats stand at the critical juncture of the city's past and future. Studying their potential is therefore not just about contemplating Yazd's future, but also about the dilemmas of social, economic and environmental sustainability versus cultural desire, characteristic of so many cities across the world.

The Qanat In Retrospect

While the qanats' origins remain shrouded, they are speculated to have existed in Iran as early as the first millennium BC, evolving over the centuries with the overarching goal of transferring water from source to destination while minimizing evaporation and retaining potability. This is a significant challenge in Yazd's hot, dry climate, where its distance from the Oman Sea and Persian Gulf results in minimal rain and high evaporation. Diurnal temperatures fluctuate from 50^0 to -20^0 Celsius within 24 hours, and seasons vary from a long hot summer (mid-March to mid-September) to a cold winter (October to February). In 2009 it rained from January to September, recording a minimum of 2 mm in June to a maximum of 59 mm in September, with an annual total of approximately 125 mm.[3] The average annual rainfall in the whole of Iran is approximately 242 mm which is less than one third of the global average annual rainfall (approximately 860 mm), and even this minimal precipitation is not consistent throughout the country.

The Zagros Mountains crossing the Yazd province gather snow in the winters and trap water in their crevices forming a subterranean aquifer, and this is where the qanat takes its birth. Experts surveyed the mountain vegetation and soil deposits mapping a potential source-well. Vertical shafts of successively increasing depths were dug at 50-meter intervals and horizontally connected by subterranean tunnels approximately 1-meter wide and 2-meters high, gently sloped to ease flow. (Fig. 4) Water was directed first into the surrounding agricultural fields and the remainder was directed towards the city.[4] (Fig. 5)

Fig. 4: Traditional process of qanat construction.

Fig. 5: Anatomy of the qanat system – beginning with the mountain aquifer to the left and ending in the dwelling to the right.

Historically, the first contact of qanat and city happened at *ab anbars*, subterranean cylindrical reservoirs designed to stabilize low water temperature, withstand water pressure and resist earthquakes. Typically, a linear stairway descended from the *sardar* (entry) to the *pasheer* (platform) at the foot of the faucet used to retrieve the water. The specific faucet depth determined the water temperature, with some ab anbars accommodating multiple faucets at various intervals along the stairway. A semi-circular brick-lined dome with central escape vents helped cool the water through convection while protecting it from dust and pollution.[5] And *badgirs* (wind catchers) helped maintain fresh air circulation and prevent water deterioration. No one was given direct access to the water; it was always drawn beneath the ground level using the pasheer, thereby minimizing water contamination. (Figs. 6 & 7)

Fig. 6: Section through ab anbar.

Fig. 7: Rostam Giv Ab Anbar, one of the largest and most well-preserved ab anbars in Yazd today.

These ab anbars played a pivotal role in the urban structure of Yazd. Distant qanats split into a distribution network of smaller canals called *karez* bringing water to a hierarchy of city-center and neighborhood-specific ab anbars. Their specific locations within this hierarchy determined both their size and character: smaller neighborhood reservoirs were usually endowed with fewer badgirs; larger city-center reservoirs often served by six or more. Each ab anbar provided water to a limited number of streets and houses, defining a distinct community shed around it.[6] While there are no verifying records, it is apparent that the formal complexity of Yazd's historic communities was in fact ordered around existing qanats and ab anbars. Each dwelling was located within easy reach of their only water source, the community incrementally evolving around this infrastructural armature. As evident from the extant examples within the historic core ab anbars thus configured the formal structure Yazd's historic neighborhoods in as much as its numerous mosques and *madrassas*.

As the qanat's eventual destinations, Yazd's traditional dwellings each had their own domestic ab anbars located within enclosed courtyards. They held around 50 cubic meters of water. They would be filled once every two weeks, and cleaned of sediments once a year. When a domestic ab anbar needed filling, the *mirab* (local water manager) would record the formalities and open up the specific qanat or karez from the reservoir leading to the dwelling.[7] The water would first fill the pool within the courtyard, and then the storage tanks located in the basement.

The spatial organization of the dwelling was a climatic diagram of summer and winter spaces centered on this domestic water source. In the hot, dry summers, inhabitants spent the day in the cooler basements connected to the badgirs (wind towers), or in the vaulted summer rooms around the courtyard oriented north to keep the sun away. At night they would sleep on the roof under warm quilts while the cool night winds would circulate through the open doors and wind catchers, drawing the heat from within the house. In winter, the wind catchers were closed off to prevent heat loss. The activity shifted to the south-facing winter rooms around the courts. Their glass doors captured the low winter sun storing heat within their thick walls helping to maintain a warmer temperature during the cold nights.[8] In buildings with wealthy owners, the badgir and water storage systems were combined to create the effect of a water cooler. The air draft created by the badgir was circulated over a small pool or reservoir in the basement, now converted into a gathering room. With the temperature of the flowing water in a karez generally lower than that of a standing pond the temperature drop could be as much as 20^0 Celsius. (Figs. 8 & 9)

Fig. 8: Section of traditional Yazd dwelling.

Fig. 9: Badgir.

The ownership of the numerous karez varied from private to communal ownership. In the case of a long karez, the land above could have several owners with some landlords endowing the karez routes partially or wholly to the served community. Wealthy families who could afford to have land holdings at the head of the karez distribution system took the best water supply not just for agricultural purposes but also for the maintenance of ornamental gardens. The poorer citizens had land further down the route, with the poorest subsisting on trickles of muddy water. The ownership and distribution rights of these networks have developed over hundreds of years, and survive to this day, with water distribution determined by a salaried official who is elected by the users or appointed by the government.

As a macro infrastructural form that unified the region and dwelling, qanats and ab anbars transformed the arduous processes of obtaining, storing and distributing water within a desert to a publicly visible civic art. On the social side, while the qanat's complex ownership became the contested territory of political power and social hierarchy, its public punctuation as dramatic ab anbars became the centers and local monuments of the various urban communities. There was a lot more to Yazd's historic hydro-infrastructure in its complex intersection with architecture, urbanism, administration and public life.

The Qanat's Decline

Over the past six decades, the role of qanats in securing and supplying water has been diminishing across Iran, even as motorized wells and dams have gained dominance. Qanat use has decreased "from 70% prior to 1950, to 50% around 1950 and to 10% in the year 2000."[9] Today, Yazd's principal water supply comes from the Zayandeh River in the city of Isfahan some 200 km away. A number of modern tunnels redirect water from the Karun River (Iran's largest river that also starts in the Zagros Mountains) to the Zayandeh, facilitating water supply for the growing populations in both the Isfahan and Yazd provinces. No new qanats have been built using traditional methods since 1963.[10] This is also apparent in the shrinking numbers of ab anbars relative to the spread of urbanized land. Of the 3,300 qanats within the Yazd Province, around 3,000 are increasingly polluted from industrial discharge, and less than 500 badgirs don the city's historic roofscape.[11]

One obvious reason for the qanat's decline was Yazd's rapid urbanization. Until circa 1925, Yazd had grown at a steady pace. The historic core had expanded southward avoiding the northern desert and dissolving into the outer agrarian villages. Further growth continued due south-west and by 1979 (towards the end of the White Revolution in Iran) it had enclosed the historic core to the east and west. But subsequently, in as less as three decades, rapid urbanization transformed Yazd into a sprawling modern city occupying an area of 16,000 kilometers, accessible by road, rail and regular flights from Tehran and major towns, with a population of over 423,006 (per the 2006 census).[12] Modern urbanity's shifting desires coupled with the qanats' inability to supply the vast quantities of water for the growing city left it undesirable. (Figs. 10 & 11)

Fig. 10: Growth of Yazd. The black dots are the principal ab anbars. Note the shrinking numbers of ab anbars relative to urbanized land.

Fig. 11: Growth of Yazd, showing the shrinking qanat network and agricultural fields ca. 1979, top and ca. 2011, bottom. The primary qanats are shown as white dots. The grey patches are the fields.

The qanat's erosion was also in part a political phenomenon. With the advent of the White Revolution and its Land Reform Program against feudalism in 1963, the government began purchasing agricultural land from feudal owners and selling it back to the peasants at a much lower price. The Shah changed the system of land ownership, breaking up large traditional holdings, leading to confusion about the ownership rights and maintenance responsibility of the karez beneath the land. Water distribution and ownership traditionally controlled by a select few now came under a much larger purview, and subsequent government intervention had to be geared towards giving this larger demographic their fair share. With simultaneously increased agricultural production necessitating the drilling of source aquifers, many qanats began to dry out or became seasonal, even as the drilling industry attracted more people into the city.

Over the past decades, hundreds of motor-equipped wells have been excavated as replacements for qanats. Worst of all, they have been randomly drilled without consideration for the original location of qanats. In Iran, in 2000, of the 70 billion cubic meters of provisioned groundwater, merely 12% (8.6 billion cubic meters) was allotted to qanats, with most given to wells.[13] Ironically, wells have a shorter life span (a maximum of 50 years) when compared to qanats, and their excessive excavation has led to the drying up of both wells and qanats, contributing to drought and increasing water shortages. And while wells have been mostly constructed by the private sector, the Iranian government has been responsible for the construction of dams as the other qanat counterpart.[14]

Consequently, the skilled labor for the construction and maintenance of qanats has severely declined due to extremely low wages, poor insurance benefits as well as a general dissatisfaction with their social ranking. Many have left for the larger cities as construction workers, digging deep wells for black-water absorption in new development sites, and as a result the agricultural and participatory qanat-based patterns of life have been gradually disappearing.

Today, houses in Yazd are no longer organized around a courtyard, but a central covered hall with a separate entrance from the front garden to ensure privacy for women. This hall often has a higher ceiling to buffer the dwelling from the sun, with operable clerestory windows to expel hot rising air. The traditional north facing *aivan* (the raised veranda for enjoying morning and evening breezes) though present is often air-conditioned, making it in effect, a year round living room for the family. With emerging development increasingly oblivious to anything indigenous, the culture of the qanat despite all conservation efforts is dying, of not almost dead.

Saving The Qanat – Scenarios & Challenges

What is the place of qanats and ab anbars as alternative models of development in Yazd today? What is their promise as sustainable infrastructure for the long-term future of the city? In a post-industrial milieu, are there significant reasons for keeping alive this ancient system?

Is qanat-conservation a romantic whim or practical wisdom? The following scenarios attempt to examine these questions from multiple visions and strategic viewpoints, each gauged through the filters of cultural and technical feasibility.

i. Incentives For Preservation Within The Historic Core

A few areas of Yazd's historic core continue to be served by qanats today. But going by the track record of the past few decades, it is only a matter of time before these systems will be abandoned. The overarching question in the core therefore centers on whether or not qanat preservation and maintenance can be successfully incentivized.

Qanats are fragile subterranean systems, and unless maintained, do not lend themselves to easy retrofit or reuse once abandoned. While it is possible to enhance active or recently dormant qanats by updating the substructure with steel or concrete piping and monitoring mechanisms to gauge their water levels, such steps require highly specialized labor and significant cost. The unpredictable water supply from a typical source-aquifer dependent qanat does not justify such specialized preservation.

However, with the historic core having undergone a significant transformation over the last few decades, the qanat's preservation needs to be re-assessed in this light. In his 1973 study of Yazd's old town, architect Mehdi Kowsar had observed that its dominant low-income demographic suffered from the increasing departure of the wealthy middle class and the municipality's subsequent disincentive towards maintaining the old town's infrastructure and facilities.[15] Today, the dominant demographic within the core is still low-income, but with the restoration of the historic quarter of Sahlebne-Ali (that has consequently attracted the schools of art, architecture and urban studies of the University of Yazd), and the transformation of the Malek-o-Tajjar house into a hotel in 2000, the value of Yazd's historic monuments has increased tenfold.[16] (Fig. 12)

Fig. 12: Panorama of the historic core showing the principal avenues that connect the old town to the surrounding modern city.

Amidst this renewed historical consciousness, opportunities for civic engagement and participatory governance can hopefully help enhance qanat awareness and preservation. Select neighborhoods in New Mexico for instance are mandatorily served by traditional acequias offering citizens an alternative lifestyle by choice. They are owned and managed by public and private organizations, and maintained through regulated community participation.[17] Such choices within Yazd's historic core can generate a deeper appreciation of qanats and offer residents the choice of paying their rents partially or fully through contributions towards their upkeep. Policies that incentivize the qanat's use through subsidized housing alternatives (such as the 1975 master plan's unimplemented recommendation for subsidizing property taxes by 20% for 10 years for residents who contribute to the restored fabric) remain far more important to the qanat's continuing sustenance.

ii. As Gray Water Recycling Networks

Recent concerns over dwindling groundwater reserves and costly sewage treatment options have generated increasing global interest in the reuse or recycling of grey water, for domestic use and commercial irrigation. Grey water is the wastewater generated from domestic activities such as dish washing, laundry and bathing, and is significantly less contaminated than black water that contains fecal matter and urine. In Yazd, such grey water could come from a number of sources. Besides dwellings, rain water collection, however little, from roofs particularly in Yazd's modern concrete developments is something that would not have been possible in its historic adobe habitats. Ablution water from numerous mosques also offers a unique opportunity to integrate sustainability with cultural practices.

Abandoned qanat networks already in place could be reactivated, saving significant expenditure on what would otherwise be an infrastructural installation from scratch. They could carry grey water for adequate processing. Others could bring back this processed gray water to ab anbars for storage. Others could return the water to tanks below homes and buildings to be used for flushing toilets, watering gardens or direct it to larger destinations such as urban parks. The idea of qanats an ab anbars as grey water infrastructure could retain the original workings of the system for a contemporary cause, empowering their reuse, rebuilding and maintenance. New qanats and ab anbars could be built to localize water collection on a neighborhood basis, with their capacities and performance monitored with modern technology. They could significantly reduce the load on Yazd's current water supply through large-scale waste water management, merging a desert culture's reverence for water with a contemporary sustainable distribution system nurturing a variety of functions. (Fig. 13)

Fig. 13: Diagram showing qanats as a parallel grey water infrastructure. The horizontal lines at the base indicate the qanat; the dotted line indicates the modern water supply.

There are significant challenges to this proposition. As a gravity dependent system, qanats are always sloped towards the destination such as an ab anbar or a dwelling. Thus within an existing qanat network, grey water recycling from dwellings to ab anbars would require a reverse water flow against gravity, thereby needing electrical pumps. The cost and un-tested performance of such hybrid systems weighed against the convenience of durable modern installations remains a significant question.

Also, gray water recycling through passive means is most efficient when done on a lot scale, that is, when the water is treated within or near the site where it is returned. Thus while qanats and ab anbars as grey water systems are justifiable on a lot or even a block scale, their large scale application as a city-wide system remains untested and therefore technically dubious.

iii. As Storm Water Collectors

Compared to the complexity of grey water distribution, qanats and ab anbars are much more applicable as storm water collectors. Storm water is the water that hits the ground during rainfall. In Iran up to 70% of the total rainfall per annum evaporates, amounting to a loss of around 300 billion cubic meters of water. Around a third of this is lost as surface water. The remainder of the total volume of the annual rainfall (60-75 billion cubic meters) penetrates the ground. In short, a third of the country's annual rainwater is wasted, even as the volume of water demand in Iran has shown an incremental increase from 40 billion cubic meters in 1960 to 75 billion cubic meters in 2000.[18] Thus, the most vital resource for securing water in the growing cities of Iran is groundwater.

Traditionally, qanats have always collected wastewater penetrating into the soil thereby saving more water on an annual basis. If modern piping could direct storm water to ab anbars for storage, connecting qanats or karez could direct the water via gravity flow to various destinations, from necessary treatment facilities, to dwellings to parks, re-using their exact traditional workings for new purposes. But in an industrialized landscape, one obvious challenge is that of water contamination. Surface water with industrial pollutants could land up being absorbed into the substrata eventually impacting the aquifer. Further, abandoned, dormant or ill-maintained qanats filled with filth for years are dangerous conduits for storm water. They will require scrupulous cleaning and testing to meet the required hygienic standards, raising the costs of such efforts.

Further, such an operation whether on a small or large scale, would require substantial documentation and mapping of the precise location and condition of the existing qanat network. Unlike modern infrastructures, which are clearly delineated within the public or private parcels of the city, qanats criss-cross the sprawling street pattern as well as the private properties of the growing city. With several buried under recent buildings, such efforts would have serious impacts on existing development, re-surfacing the same complex traditional questions about the private versus public rights of owning, operating and maintaining specific portions of these underground conduits from the land above them.

iv. As Cultural Memory

Beyond its old town, Yazd's sprawling landscape struggles for an identity with neither citizens nor public officials seemingly willing to mandate strategies and visions for alternative growth models. Apart from standard planning documents and policies, there is no larger framework for aesthetic or physical urban design, let alone any deeper idea about how and why one builds in the desert.

One noteworthy strategy in this regard is the enrichment exercise proposed by American architects William Morrish and Catherine Brown for another sprawling desert city, Phoenix, Arizona.[19] They conceived of a strategic fusion of public infrastructure and public art into a new cognitive mapping system to ameliorate the vast distances of disoriented sprawl. It thus co-opted the very transportation and irrigation networks that had enabled sprawl by giving them a cultural legibility. Seven years since, the city dump has become an "instructive sculptural presence in the form of a new reclamation and recycling building," the Squaw Peak Parkway now serves as an armature for major art installations and various sprawl neighborhood streetscapes are now playful abstractions of the place's history.[20]

Perhaps like Phoenix then, it should be the Yazd Arts Commission that inherits the leading role as the aesthetic urban designer for the city. The Commission can implement a new vision for the city's sprawl through public art projects that pull together public agencies, citizens and designers. It can be sponsored by a budget allocated specifically for public art in qanat-related projects paid for by public funds. This emphasis on indigenous infrastructure can create an unparalleled opportunity with simultaneous aesthetic and conservation dimensions.

If reactivating qanats and ab anbars as infrastructural systems seems dubious, can they at least contribute to Yazd's image and identity as iconic cultural landmarks? Qanats are visible above ground only through their sequential intermittent wells, creating a unique land pattern at various scales. (Fig. 14) Communal gardens and open spaces, if incorporated around these existing patterns, can both increase their awareness and celebrate qanats as local and regional civic art. The dramatic formalism of existing and newly built ab anbars can likewise lend itself to generating a parallel cognitive system throughout the city accommodating a number of communal uses from internet cafes to restaurants. While some may criticize such approaches as overly nostalgic or kitschy, such incentives can help expand the current preservation rubric to not simply restore but reactivate these infrastructures as civic artifacts, and thereby celebrate their history in participatory and open ended ways.

Fig. 14: Qanat landscape of sequential intermittent wells.

v. As New Development

Parallel to Yazd's numerous mosques, ab anbars historically added a formal layer of order to the city, with various communities organized around their local water source. Could new ab anbars help establish a similar spatial order in new exurban development? Their locations could help establish walkable neighborhood sheds akin to Clarence Perry's ¼ mile radius "Neighborhood Unit."[21] (Fig. 15) The extant qanats at the city's fringe could become parts of parks, creating formal armatures for new development. They could be expanded into a new karez network using traditional construction techniques, with new ab anbars strategically introduced within the new development to store the water for irrigating its open spaces. In exurban low-income schemes, a "sites and services"[22] approach could regulate the layout and funding of the qanat and ab anbar apparatus through a public agency, with incremental habitats built through *self-help-self-build* processes. The same extant ex-urban infrastructure that could be engulfed in sprawl could now become the framework for sustainable urban growth.

Fig. 15: Diagrams showing the growth of potential exurban neighborhoods, each within a one quarter mile pedestrian sheds around new ab anbars.

The idea of qanat-builders as intrinsic participants in urban development is in fact an echo of their ancient tradition. (Fig. 16) They could be involved in the early planning phases as experts on the location and viability of old or new qanats and ab anbars. Such trends could generate a significant employment base within Yazd's real estate market allowing the amalgamation of traditional building techniques with modern methods. The challenge, of course, is that such ideas will need significant political and administrative incentives to get them off the ground. Effective branding among other things will constitute a key part of this effort, with new developments involving qanats and qanat-builders needing to find ways to inspire citizens to want to live in them. It may seem like a distant possibility today, but no planning effort can anticipate the vagaries of public sentiment. If qanats and their builders can remain marginalized on the one hand, they can also become the force behind a renewed public environmental consciousness.

Fig. 16: Qanat-builders at work today.

vi. As Agrarian Systems

Qanats remain alive in Yazd's exurban agricultural fields. With their proximity to the mountains and to the source aquifer, the existing qanat network is economically and environmentally far more efficient than wells. Though the cost of excavating a qanat proves to be more than double that of a deep well with pumps, qanats, if regularly dredged and repaired have proven to have an almost unlimited life span, compared to the typical 20 year life span of a well.[23] Conserving qanats as agrarian and rural infrastructure is therefore an absolute necessity, and ongoing efforts such as the UNESCO-organized "International Training Course on *Qanats"* held in July 2007 to create awareness on their cultural and technical aspects represents a positive step in this direction.

There are socio-cultural challenges to qanat conservation in rural areas. The long-term sustenance of a qanat is only possible thorough communal willingness and participation, a challenge hardly limited to Yazd. In the 2000 pilot program for qanat renovation in the Syrian village of Shalalah Saghirah, east of Aleppo, inter-clan disputes and ambiguous ownership patterns deterred initial communal consensus on the qanat's restoration. It was only after much discussion and field work that the *haqoun* ("holders of the right") were persuaded to settle their differences.[24] The qanat was cleaned, with its technical impact measured by a flow meter, and sixteen young community members trained for its upkeep. But when the project team returned in the summer of 2002, though the qanat was providing a substantial amount of water, the community was again divided with social tensions, and the qanat's future remained dubious. Qanat conservation, especially in agrarian and rural areas, must therefore be done on a case by case basis after analyzing the social pulse of the community.

Agriculture and agricultural land has diminished significantly with the city's dramatic growth, and several qanats have died as a result. Ongoing efforts such as combining qanats with modern irrigation techniques like drip irrigation to enable high value crops and increase farmer incomes are important in this regard. But from a qanat conservation standpoint, the bigger question is: what decisions does Yazd need to make to conserve its remaining agricultural lands?

For municipalities and regional jurisdictions across the world, the gradual erosion of agrarian land by sprawl has been one of the greatest environmental challenges. Greenbelts and Urban Growth Boundaries (UGB), despite their varied degrees of success, have persistently separated agriculture and urbanism as two disparate worlds. More recent practices have challenged these notions. The rhetoric of "Agrarian Urbanism" for instance has sought, among other things, to empower new exurban development towards the sustainable production of food.[25] It has called for cohesive forms of development along the urban fringe, liberating land for agricultural use and merging the house, farm and field as integrated prototypes for different conditions along the urban edge.

Any attempt to merge agriculture and development in Yazd, no matter how theoretically sustainable, would open up a plethora of challenges. Integrating farming into development would not only need significant political retooling, but more importantly a cultural acceptance of changing lifestyles and co-existence with the low-income agricultural labor demographic. Further, it would need additional means of gathering, supplying and reusing water to fulfill the needs of both living and farming, thereby threatening the current singularity of the qanat within the agricultural hinterlands. Stringent agricultural easements and locally administered policies aimed at discouraging piecemeal and isolated exurban sprawl may be Yazd's best bet towards this goal.

vii. As Drought Water Systems

According to Mohammad Reza Haeri, if Iran enters a period of a lasting drought, with the majority of the country's rivers being seasonal, Yazd's river-dependent water supply will have an extremely poor stand. Iran's rivers and surface springs will dry up rather quickly, and since motor-equipped wells evacuate aquifers rapidly, they too will be threatened and eventually dry up. Iran's dams, though more drought-resistant, will rely on their geographical characteristics and maintenance consistency for long-term sustainability, especially with soil erosion being a serious problem. Dams constructed in the 1960's today retain a much lower water reservoir, and even dams engineered with the utmost precision are apt to suffer damages caused by drought.[26]

In a drought, qanats are bound to be far more resilient. They do not dry up rapidly, as they evacuate the aquifers at a gradual pace. When every drop of water is critical, qanats return water to the aquifers, while dams evaporated it. Qanats are far more energy efficient since there is virtually no need for electric power or pumps. Qanats do not impair the quality or quantity of the groundwater since they are utilized gradually and assist in keeping the balance of ground water in the various layers of the earth. Moreover, qanats bring freshwater from the mountain plateau to the lower-lying plains with saltier desert soil. The salinity of the soil is thereby naturally controlled, helping to mitigate desertification. Qanats may be the final frontier for a city like Yazd in case of a serious hydrological crisis. It may be the qanat's future that determines Yazd's eventual destiny, and not the other way around.

Conclusion

The future of vernacular hydro-infrastructure remains a complex subject across the world. The case of qanats, within or beyond Yazd, is particularly complicated since they are fragile, subterranean systems that are far more difficult to construct and upkeep compared to other indigenous forms of hydro-infrastructure such as acequias or aqueducts. The scenarios discussed above affirm the complex rhetoric and uphill climb surrounding the qanats' future. But as aesthetic artifacts from a bygone era, contemporary tandem water systems, exclusive agrarian infrastructures or emergency water systems, this discussion affirms that the long term promise of the qanats makes them deserving of more than a marginal life. Their future does not rest within an exclusive cocoon of preservation, but at the complex intersection of history, sustainability, strategic conservation and public life.

However, the sustainability of the qanats' future must be assessed holistically from an environmental, social and economic standpoint. From an economic standpoint, qanat conservation is an expensive proposition compared to its low performance efficiency, given Yazd's recent scale and pace of urban growth and development. But conversely, its low expenditure in comparison to the high maintenance charges of wells and motor pumps provides a definite advantage in rural areas, making the qanat a safer long-term water source for the city's agricultural lands.

From a social standpoint, qanats remind us that the *urban water crisis* will demand significant shifts in our perception of water, its use and its related infrastructure. Qanats remind us that the attitude towards obtaining, distributing and using water, the very lifeblood of any community, is a thing to be celebrated and not hidden, and that the mainstream expression of urban infrastructure as utilitarian footnotes needs to be transformed, so that they become visible armatures for the cultural and spiritual enrichment of people. From an environmental standpoint, two aspects transport the qanat to the top of the sustainability chart: first, their long term dependability and viability as drought-resilient systems; second, their ability to conserve the optimum amount of water from a limited source through minimal evaporation. These qualities are worthy enough to justify their strategic conservation in a time of climatic and hydrological uncertainty.

There is no doubt that qanats will die in many cities. The question is: will they survive in others? As indigenous artifacts set on the seeming path to extinction, perhaps in their eventual death, their value will finally be realized giving them a chance for new life. Whatever the case, their destiny is intrinsically tied to a city's decisions and directions regarding future growth patterns, and the extent to which these places will succeed in transforming their petrified bureaucracies towards socio-cultural appropriations for a time of unparalleled environmental and economic crisis. The task at hand is to mediate the ongoing dialogue between tradition and modernity, and unapologetically choose between the volatile whims of mainstream urbanity and the deeper wisdom of sustainable policies, patient capital and long-term investment. The qanat's eventual destiny – whether as an active agent in the future of sustainable city-making or as a long-forgotten anachronism – will emerge from this choice.

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NOTES

1 Yazd was called Ke-Se and Issa'ees during the ancient period of Iranian history. It was renamed to Farafiz and Yazdan Gerd during the reign of the Sassanian king Yadgerd I (399-421 AD). The name Yazd comes from *Yazdan* and *Izad* denoting "holiness" and "blessedness."

2 The *Qanat* is a provincial name specific to Yazd. Various places have their own nomenclatures: *Karez* (Afghanistan), *Khotara* (Morocco), *Foggara* (North Africa), *Auyoun* (Egypt) and *Manbo* (Japan).

3 World Weather and Climate Information, http://www.weather-and-climate.com/average-monthly-precipitation-Rainfall,Yazd,Iran (accessed January 2011).

4 For more on *qanat* construction see: A.A. Semsar Yazdi, *Qanat from Practitioners' Point of View* (Tehran: Mohandesin Moshaver Setiran, 2005). Also see: A.A. Semsar Yazdi, *Proceedings of International Symposium on Qanat, Volume Two* (Yazd: Sherkat Sahami Ab Mantaqe, 2001).

5 Builders are known to have first constructed the storage space, then filled it up with hay and straw to where they could start constructing the dome. After the dome's completion, the straw would be set on fire, clearing the interior.

6 As is often true with secular public use structures, one cannot trace the precise origin or patron of most ab anbar reservoirs in Yazd. Though the earliest urban water supply

constructions in Yazd are believed to date from the Sassanid period, and many others have been continually repaired and used, most extant ab anbars can be traced to the late Safavid and Qajar periods. The Shesh Badgiri anbar or "Six wind catcher" reservoir was constructed in the Qajar period, while the Khan Bazaar anbar can be more accurately dated to Qajar ruler Nasr al-Din's reign. There are approximately 75-90 surviving ab anbars in Yazd today. Some of the important ones are the Seyed Va Sahra, Masoudi, Hadji Ali Akbari, Khajeh, Golshan, Rostam Geev, Kolah Doozha, Malekotojar and Mirza Shafi reservoirs.

7 For more on this see: Javad Safi-Nejad, *Qanat-Selected Scientific Articles* (Yazd: Sherkat Sahami Ab Mantaqe, 2001).

8 Typically the *badgir* was high enough to trap the breeze and direct it through a chimney downward to the building's lowest level. The badgir openings opposite the wind create a suction effect, sucking the air out of the building. When there is no wind, the south face of the badgir tower heats up and the air rises, sucking the air down from the north-facing cooler section. At night, the tower cools down first, and the cold heavier air settles down through the chimney into the building, pushing out the warm air through the windows.

9 Mohammad Reza Haeri, "Kariz (Qanat); An Eternal Friendly System For Harvesting Groundwater" (paper presented at the In Adaptation Workshop, New Delhi, November 12-13, 2003), available at http://unfccc.int/files/meetings /workshops/other_meetings/application /pdf/121103_iran.pdf (accessed January 2011).

10 Hossein Kalantari and Hossein Hatami Nejad, *Renovation Planning of Historical Area of Yazd* (Tehran: Faragostar Publishing, 2007), 200.

11 Abouei Raza, "Conservation of Badgirs and Qanats in Yazd, Central Iran," (paper included in The 23rd Conference on Passive and Low Energy Architecture Proceedings, Geneva, Switzerland, 2006).

12 According to the administrative division rules, the Yazd province is divided into 10 districts; each includes at least one town and a number of villages. These districts are Abarkuh, Ardakan, Bafq, Khatam, Maybod, Mehriz, Tabas, Sadough, Taft and Yazd. For more see: World Gazetteer, http://www.world-gazetteer.com/wg.php?x=1152404802& men=gcis&lng=en& dat=32&geo=-106&srt=npan&col=aohdq&geo=-1929 (accessed January 2011).

13 Mohammad Reza Haeri, "Kariz (Qanat); An Eternal Friendly System For Harvesting Groundwater" (paper presented at the In Adaptation Workshop, New Delhi, November 12-13, 2003), available at http://unfccc.int/files/meetings /workshops/other_meetings/application /pdf/121103_iran.pdf (accessed January 2011).

14 For instance, the Kardeh Dam in Iran's Khorasan province has an elevation of 67 meters from its foundation, and it is engineered to provide 31 million cubic meters of water per annum.

15 Mehdi Kowsar, "A Master Plan for Yazd," *Environmental Design: Journal of the Islamic Environmental Design Research Centre* 1-2 (1989): 80-85.

16 Abouei Raza, "Conservation of Badgirs and Qanats in Yazd, Central Iran" (paper included in The 23rd Conference on Passive and Low Energy Architecture Proceedings, Geneva Switzerland, 2006).

17 For more on this see: The Middle Rio Grande Conservancy District, http://www.mrgcd.com (accessed January 2011).

18 Mohammad Reza Haeri, "Kariz (Qanat); An Eternal Friendly System For Harvesting Groundwater" (paper presented at the In Adaptation Workshop, New Delhi, November 12-13, 2003), available at http://unfccc.int/files/meetings /workshops/other_meetings/application /pdf/121103_iran.pdf (accessed January 2011).

19 Catherine Brown and William Morrish, "Western Civic Art: Works in Progress," *Places* vol. 5, no. 4 (1989): 64-77.

20 Ibid.

21 The Neighborhood Unit was conceived in 1929 by American planner Clarence Perry. It represents a fundamental human habitat within a ¼ mile pedestrian-shed. In its ideal form, it is a compact urban pattern with a balanced range of living, working, shopping, recreational and educational accommodation. For more on the Neighborhood Unit and its derivatives, see: Andres Duany, Elizabeth Plater-Zyberk and Robert Alminana, *The New Civic Art: Elements of Town Planning* (New York: Rizzoli, 2003), 84-90.

22 Sites and services approaches have been successfully implemented in several parts of Asia. Perhaps the most published project of this nature is Indian architect Balkrishna Doshi's "Aranya" Low-Cost Housing in Indore (1983-1986). Commissioned by the Indore Development Authority, the project comprises about 6,500 housing units built primarily for the poor, but it also includes other income groups and has been planned to house a population of 40,000. For more see: James Steele, *The Complete Architecture of Balkrishna Doshi* (London: Thames & Hudson Ltd., 1998), 114-129.

23 Mohammad Reza Haeri, "Kariz (Qanat); An Eternal Friendly System For Harvesting Groundwater" (paper presented at the In Adaptation Workshop, New Delhi, November 12-

13, 2003), available at http://unfccc.int/files/meetings /workshops/other_meetings/application /pdf/121103_iran.pdf (accessed January 2011).

24 Joshka Wessels and R.J.A. Hoogeveen, *Renovation of Qanats in Syria*, available at www.inweh.unu.edu/drylands/docs/Publications/Wessels.pdf (accessed January 2011).

25 For more on Agrarian Urbanism see: Philip Langdon, "Newest Eco-development Model: Agricultural Urbanism," *New Urban Network* (2008), available at http://newurbannetwork.com /article/newest-eco-development-model-%E2%80%98agricultural-urbanism%E2%80%99 (accessed December 2011). Also see: Charles Waldheim, "Notes Towards a History of Agrarian Urbanism," *Places* (2010), available at http://places.designobserver.com/entry.html?entry=15518 (accessed December 2011).

26 Mohammad Reza Haeri, "Kariz (Qanat); An Eternal Friendly System For Harvesting Groundwater" (paper presented at the In Adaptation Workshop, New Delhi, November 12-13, 2003), available at http://unfccc.int/files/meetings /workshops/other_meetings/application /pdf/121103_iran.pdf (accessed January 2011).

FIGURE CREDITS

Fig. 1, 2 & 7: Brian McMorrow

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The Vernacular, the Iconic and the Fake

Harald N. Røstvik

Romance of the Vernacular

Once upon a time, all architecture was seemingly *sustainable*. Overcrowding was not a challenge and waste was absorbed naturally. If we were to imagine the world of the vernacular, we often imagine that it was better, more balanced and free of environmental aggravations. But this is simply a fantasy. It is true that prehistoric men and women used what they found in their surroundings to survive and to shelter themselves from the natural elements. Their structures consisted of local materials that blended well with the landscape. For millennia, mankind gathered together in structures built from naturally occurring materials including sundried earth, stone, wood, woven mats and skins. Some of these traditions persist to the present day, as over one-third of the world's population continues to live in earthen buildings.[1]

If we reflect on them in terms of so-called aesthetics, these structures are characterized by considerable restraint with regard to building techniques and the use of available materials, having a sensitive dialog with the land. These characteristics underlie the notion that traditional and vernacular forms of building are also sustainable. In addition, it appears that the everyday architectural expressions that emerged throughout history were mostly logical: while building their homes and settlements, people used materials that were available in the region, and the region was determined by the means of transportation. Over time, the means of transportation and trade networks evolved, increasing the range of building materials available for use. An aesthetics of sophistication emerged, drawing from the use of new materials such as brick, mortar and glass. These processes have continued into the present.

Today's industrial, financial and economic systems offer architects access to an almost limitless range of building materials that are produced globally, many of which have to be transported around the globe to reach the construction site.

However, is it possible or even meaningful to ask the question: was vernacular architecture really sustainable? Locally harvested materials certainly were, but it is important to consider the full picture in any appraisal of sustainability. For example, many vernacular heating and cooking methods degraded interior air quality, and would have proved fatal after long-term exposure. Water-born diseases were rampant and territorial violence was common. And the labor-intensive building methods of stacking bricks or ramming mud required a great number of men and a large quantity of supplies in order to fuel such manpower.

Our respect for the vernacular is based not only on an idealized perception of prehistoric settlements, but also an idealized perception of 19th century pastoral landscapes, characterized by modest houses and well kept gardens for the newly affluent middle class in the green suburbs. Pictures from this period are indeed lovely and charming, given the landscape and garden, the harmonious scale of the buildings, the solid natural materials and the richness they expressed. Now, such buildings remain in rural areas that are not heavily developed, far from the city's skyscrapers. However, in the counterpart to this pastoral setting – the 19th century quarters of the working class vernacular – the widespread living conditions that arose as the industrial revolution took its toll are clear. (Fig. 1) The real face of the period was in fact neither pretty nor admirable; the quality of human life in the majority of houses and settlements was appalling. The romance of the vernacular – be it for early, prehistoric settlements or for 19th century pastoral landscapes – has always been a detached one, seen from a comfortable distance away from the stench and the soot.

Fig. 1: Working class housing from ca. 1880, Moss Side, Manchester, UK.

Mass Consumption of the Iconic

With the advance of materials, design tools and construction techniques, as well as the advance of global communication, industry and transport, architecture took on new forms and overcame the vernacular. Architecture is no longer tied to a specific culture, place or palette of locally available materials and rituals. The process of globalization has produced new architectural forms, as well as a new class of professionals often called *starchitects* [2] who have created some of the most recognizable buildings of our time. However, in regard to the starchitects' buildings, the only issue that seems to matter is the production of architecture that is spectacular (aka the *wow-factor*), no matter what the local situation may be in regard to the culture and natural climate. It is again all about romance, conceived from a comfortable distance. We see the outcome of this *romantic-global* ideal in many of the recent iconic buildings, most notably in Frank Gehry's Guggenheim Museum in Bilbao, Spain, which spurred the expression *The Bilbao Effect.* Several of his other titanium-clad variations followed, such as the Hotel Marques de Riscal in La Rioja, Spain and the Disney Concert Hall in Los Angeles, California. These buildings would not have been possible without the use of advanced design technology and highly sophisticated systems for construction and management. However, given the level of technology invested, it is surprising that they express little interest in environmental variables. It is important to ask: is the creation of a sustainable relationship between a building and the natural environment best left to the engineer to sort out as an afterthought? If advanced technology was invested not only to create spectacular designs but also to ensure the sensitivity of those designs in relation the natural environment, we would be able to admire the starchitects' designs as examples of a seamless symbiosis of form, materials, techniques and the forces of the environment.

In the vernacular, we see the development of certain types of structures and settlements that are replicated in great numbers by the builders of the time. Most of them have their roots solidly planted on the ground, thus *marking* a certain era in a certain location and leading to an archetype that is bound by the clear limitations of the local culture, climate, environment and available materials. The traditional vernacular stands in strong contrast to the tremendously accelerated expansion in the range of possibilities available to architects and builders in the present day. However, it is interesting to think of what is *vernacular* or archetypical about architecture in our own time, and it may be that a surprising number of designs are environmentally damaging and ultimately unsustainable.

These characteristics seem to mark current architecture on a global scale. As a result, when it comes to balancing the need for sustainable thinking with a license for aesthetic autonomy in architecture, it is timely to ask if architects actually impede sustainable innovations rather than advancing them. Here, the notion of innovation indicates not only the self-referential and intensive kind but also the kind that is related to the external forces that problematize the internal logic of the so-called aesthetic system. In many ways, there is perhaps little change from project to project that results in the transgression of the disciplinary borders of architecture, and thereby, little expansion of the field toward new and innovative solutions to environmental problems.

Despite the marvels of advanced design tools, their coding systems often reinforce and maximize self-referential repetitions and replications; this self-referentiality leads to archetypes that limit innovation. The puzzling outcome of such practices is that the resulting buildings do not show much consideration for their surroundings. They are similar to aliens that have landed in the middle of an open field, engaged strongly in theories and aesthetics but not in the environment they landed in. Yet in an apparent contradiction, when these buildings capture something of the iconic, sublime or spectacular, they do seem to *elevate* their surroundings, making their neighborhoods richer by drawing people in to see and experience them.

Again focusing the discussion on Frank Gehry's titanium-clad designs, while the alien shape may create the contrast necessary to achieve a sublime effect, one must wonder why the potential for using the mirror-like metal cladding as a giant photovoltaic skin was not developed, given the powerful technology at hand. It is striking that however advanced the design technology and however wide the range of design variables and materials may be, architecture is still about the architect's personal preferences, whims and aesthetic regimes. One would have thought that the knowledge and the experience now available would have resulted in a completely different perspective. The current stream of technology-driven aesthetics in architecture appears to stifle innovation – that is, of course, except for innovation in the area of form-making – contrary to the tremendously rich array of materials and techniques that could enable us to venture beyond the limited, self-referential aesthetic regimes developed by individual personalities.

It is striking to argue that the disciplinary tradition of architecture – in terms of its forms, programs, materials and techniques – is now stunted by the degree of its own success. In this sense, current architecture may be compared to automobile design where a particular model's formula for success is repeated over and over with only minor variations through time. But, however much we demonize the automobile industry for the environmental problems it creates, we know that the industry is as design intensive as architecture, and has been able to adapt to the changing environmental, natural, social and economic forces that effect it in more innovative ways than architecture has. What limits the search for workable and sustainable designs in architecture is not the *capacity* to understand the surrounding environment that a given piece of architecture is supposed to respond and fit in to, but the *kind* of practice driven by individual personalities and their implementation of self-referential aesthetics.

The personalities of architecture are nothing but a straitjacket that immobilizes the free relation of ideas and innovations that could bring us closer to achieving a kind of widespread and environmentally relevant aesthetics. While at the same time, is obvious that architecture should adapt to the conditions that frame its existence. Here I am drawing two threads of the argument together: first, that personality-driven practices tend to develop regimes of aesthetic integrity that trump other variables, requiring strict servitude; and second, that the aesthetic limitations of architecture are imposed, rather too conveniently, on a design process that is supposed to be transformative and which could ultimately be sustainable.

Today, sustainable architecture does not explore the full range of potentials that are available, be they in the areas of form-making, engineering or design. We are still eager to hide the materials and products that make buildings sustainable and in tune with the environment. This tendency attests to the suspicion that the high tower of architectural aesthetics does not hold the notion of sustainability as part of its oeuvre, and that sustainable design does not have a place in architecture as a form of aesthetic praxis. We talk of buildings with integrated solar systems in their exterior envelopes – be they thermal collectors or photovoltaics – but these components are often deployed as if they were roof shingles or ceramic tiles. There is an urge to oppress new possibilities when it comes to sustainable design while fitting them into the conventional aesthetic vocabulary that has, paradoxically, become irrelevant given the very existence of these new possibilities.

The Tight Box

Houses that were sheltered in earth, naturally ventilated, with roofs covered in grass and with small greenhouses on the side emerged as symbols for the *new aesthetics* of living. This represented one direction in the search for architecture that was environmentally conscious. The other direction was more technologically driven, represented by high-tech labels and materials. Environmental control components were directly integrated into building façades offering new opportunities for formal expression, and buildings appeared that combined highly insulated, airtight enclosures with air recirculation systems. Under this direction, it was considered wise not to heat or cool the interior air, while relying on mechanical systems to recycle heat; these measures formed the basis of the tight box concept.

Certainly these measures reduced energy bills, but seeing as they caused buildings to stop *breathing*, can they really be considered sustainable? With the proliferation of tight box enclosures, architecture faced a new set of challenges and health hazards stemming from poor indoor air quality, humidity, condensation, insufficient air circulation and filtration and airborne fungi. While the tight box is a valuable concept for reducing the energy needed to heat and cool buildings, it is not an approach that can stand on its own. Implementing it in a way that is disconnected from the consideration of other environmental variables does not lead to sustainable designs. This brings us to the following question: is the tight box only appropriate for use in climates with harsh winters, and ultimately, is it an inadaptable, dead end?

Benchmarks and Efficiency

Furthermore, the downside of the tight box concept can be underscored in terms of the calculation methods used to determine a given building's energy performance.[3] Obviously, a tight box building would score quite well based on the projected energy consumption per unit area or volume per year. This is ensured by good insulation, reasonable window size and thermal recovery rates that can reach 70% to 80%. But more often than not, we are blinded by the numbers and do not investigate the other ramifications that surround the particular benchmark data. For example, we may focus on thermal recovery in our energy calculations while ignoring the large floor area of a building, along with the concomitant need for energy expenditure in the production, transport and construction of building materials.

This is significant given the fact that floor area has risen dramatically over time. In Norway in 1967, the average residential floor area per person was 29 m^2. Only three decades later, in

2000, it reached 51 m^2 per person.[4] These increases can be seen as parallel to the proliferation of automobiles. Although individually, automobiles have become far more energy efficient, the number of automobiles in the world is growing exponentially, mainly in developing nations and in emerging markets such as China and India. As such, the individual gains in efficiency per automobile are lost manifold. And while individual buildings may be more energy efficient per unit area or volume, the sheer amount of square footage built every year ensures that worldwide energy use related to architecture is on the rise.

Although there are parallel problems between architecture and automobile design, we can look to the automobile industry for potential solutions as well. New electric vehicles are smaller and lighter than their petroleum-based, internal combustion counterparts making them much more energy efficient as summarized by the US Department of Energy.[5] Although electric vehicles have shorter life spans, they can be scrapped and recycled more efficiently than their internal combustion counterparts because of their simpler design. In the same manner of thinking, creating buildings that are smaller, lighter and highly recyclable is in everyone's interest. Those in the construction industry will gain high profit margins; architects will find new challenges and opportunities in terms of the relationship between aesthetics, techniques and materials; and developers and owners will save on construction and operation costs. These prospects should be strong enough to forge a new mode of collaboration while pushing architectural design toward a more sustainable model.

And in addition, a new aesthetics might emerge through this process: an aesthetics of efficiency not only in terms of energy consumption, but also in terms of how architectural space is conceived, designed, constructed, destructed and recycled. Architects have an obvious responsibility to push their work toward a more holistic direction, and away from conventional practice that is limited by their aesthetic regimes and methods for calculation and evaluation. In order to engage in this new process, the discipline of architecture must shed two of its current molds: that of a service industry, and that of a creator of lifestyles and images. As far as the indications go, the lifestyles and images created thus far are not sustainable, as illustrated when architects with a *strong focus* on sustainability end up designing mansions with only a thin veneer of so-called sustainable materials to be occupied by a handful of people and their luxury cars. The term *sustainable* has become another designer label and lifestyle cliché, and in the end, it falls very short of the promise envisioned by the first environmental pioneers.

The Sustainable Glass Box?

With the advent of modern technology, architects have come to struggle with a different kind of challenge: the glass box. Apart from the pros and cons of using glass as the primary component of a building envelope, the glass box is a building type whose feasibility is intimately connected to the harnessing of cheap energy. The effect of the glass box has been powerful, elegant and smart. It was quickly established as the de facto indicator of modernist design in architecture, providing a living and working environment that was full of light and a sense of liberation. The most substantial benefit was *free* passive solar energy and huge thermal mass; in some cases, the glass façade area would exceed the building's floor area.

This aesthetic archetype of modernism, whether a glass box or a glass tower, is quite logical in its rationale of structure, materials and effect. Contemporary iterations include Foster and Partners' Swiss Re headquarters, the so-called *Gherkin* in London, and the Torre Agbar by Jean Nouvel in Barcelona. (Fig. 2) While their creators claim that these buildings are designed to be energy efficient by incorporating natural ventilation and lighting, it appears that the underlying logic and rational are not as strong. One could argue that the main point of investing powerful technology and great cost in these buildings was not to accomplish sustainable designs, but to accomplish interesting aesthetic features, while the quintessential qualities of a glass skyscraper remained unchanged. Again, the central importance of creating the iconic seems to take priority in the design process. It is important to ask: how do we reconcile the apparent contradiction of creating excessive problems – including the problem of re-inventing the glass box – in order to solve them again with powerful technology and at great cost?

Fig. 2: Jean Nouvel's Torre Agbar in Barcelona, Spain; the tower employs an intricate system of operable translucent louvers that regulate the natural ventilation of the façade.

In frigid Norway, glass boxes have been a problematic due to their heat loss in winter. But even during the relatively cool, temperate seasons throughout the year they can create heat problems as well. The Nordic sun is of a low altitude; it hits the glass box almost horizontally, causing the cooling capacity to skyrocket to unnecessary and excessive levels. For example, at the Oslo Opera House, the glass façades were so oversized in the name of *sustainable* natural light and openness that they caused excessive solar thermal gain. In a rather farcical way, the oversized glass façades that are normally seen in glass buildings prompted the use of external louvers or internal curtains, which in turn forced the use of electrical lighting for the interior. Moving away from the sustainable goals of the building, the glass-skinned Oslo Opera House relies on electrical lighting even during beautiful, sunny days in spring. (Fig. 3)

Fig. 3: Oslo Opera House by Snøhetta]

At the moment, there is a tremendous drive for development in the solar energy industry. While pioneering architects have struggled with the design of well integrated, glass covered solar systems for decades, a new solution has emerged quite silently and steadily: the evacuated tube solar collector system. While most architects equate *integration* to the hiding and masking of technology, the evacuated tube system represents a highly efficient and promising aesthetic element for architectural design. The system is not flat like standard photovoltaic panels; it contains round glass tubes of approximately 100 mm in diameter, each with its own heat collector. Many of the tubes arranged next to each other form a kind of louver-like appearance. Even though from a conventional design standpoint the system is harder to incorporate, adopting an experimental approach to design that takes advantage of new technologies, their forms and their aesthetic potentials will be rewarding work. The two types of solar energy collectors available today, the thermal and the photovoltaic, are now offered in a wide range of shapes, sizes and colors. In essence, the aesthetics of sustainability in our age points to more intelligent designs that incorporate not only the full range of environmental variables, but also the aesthetic capabilities of technological elements to their fullest extent. This may be the appropriate starting point for starting to re-envision the quintessential qualities of the glass box.

The Nordic Timber Tradition

If we consider the Nordic timber tradition as a kind of vernacular-iconic architecture, how do we approach its materials and techniques in today's context? Timber construction is about to have a renaissance in Nordic countries, fueled by arguments of its sustainability. Certainly, timber construction in the region possesses a distinctive, vernacular aesthetic that has been developed for centuries in relation to the particular environment and climate of the far north. Timber construction in this part of the world is nothing new: it was the building material of the stave churches in the Nordic tradition from 1100 AD on, and the fact that 28 of the 750 churches that were estimated to have been built are still standing is a testament to their structural and cultural durability. Some Norwegian examples were even carefully disassembled and exported to Iceland for reconstruction. (Fig. 4)

Fig. 4: Garmo Stave church from 1100 AD in Sandvigske Samlinger, Lillehammer.

Today, timber construction is *faked* as something new: a new kind of sustainable architecture with renewed aesthetics. Yet compared to the profound examples of timber construction in history, the quality of what is delivered today is highly questionable, to put it mildly. One popular argument in support of renewing the timber tradition is that much of the wood used in Norway is cultivated, harvested and supplied locally, therefore removing the need for a long transport process and the concomitant use of fuels and energy. However, the claim of environmentally sound and sustainable forestry practices in Norway is highly dubious, casting a shadow of doubt on the sustainability of today's timber buildings.

First, forestry involves a set of complicated processes that often seem contradictory when viewed in terms of sustainability. For the most part, timber used for construction purposes comes from healthy trees that would have continued to absorb CO_2 naturally if they were left to grow in the forest. Harvesting trees for construction purposes means that the forest needs to be replanted and renewed. However, while the timber from old forests is of excellent quality for use in construction, it could take up to half a century for the newly replanted trees become mature enough for this use. And in the waiting period, there is reduced forest area available to absorb CO_2, although preserving this function of forests is critical to addressing worldwide environmental problems. The bottom line is that the pace of replenishing a cleared forest cannot keep up with the demand. From this point of view, timber construction in most cases is hardly sustainable.

Second, the use of timber construction in many Norwegian buildings is by and large cosmetic; they are developed in the same manner as standard commercial buildings without a clear focus on sustainability, and then outfitted with a veneer of timber. The resulting effect – that of an attractive timber building – appeals to many, given the allusion to vernacular Nordic aesthetics. Some even make their way to the cover of glossy lifestyle magazines as fine and tasteful examples of sustainable architecture. In this regard, we have already reached a point where image making – the making of a sustainable illusion – is more important than the actual substance of the architecture itself. The fact of the matter is that these buildings are no more sustainable than the average concrete building around the corner, and should not be pitched as such; branding them as something they are not actually stifles real progress in the field of architecture. While it is widely believed that timber is a sustainable building material in Norway, it is hard to find numeric indications, measures and statistics to support this belief. What we do find in Norway is that many of the high-profile, so-called sustainable timber buildings of recent years have turned out to be hollow, when viewed against their initial claims of environmental sensitivity.

Third, timber buildings constructed in Norway today are, by and large, not durable. In order to promote the use of timber in architecture, the campaign Norwegian Wood[6] was launched with the goal of promoting exemplary timber buildings, both large and small. One scheme consisted of developing a large number of affordable, energy efficient row houses that boasted the typical hallmarks of sustainable design such as low energy and high efficiency. However, as seen from the outside, their appearance does not indicate a distinction from other standard housing projects. And when the houses became occupied, it was apparent that one fundamental concept of sustainability was ignored: that of universal design. The wisdom of universal design, exemplified by the loose-fit, foresees a building's use and re-use for generations, and hence, its structural and cultural durability. As today's timber buildings are built to tight commercial specification, just as any other kind of building, they will not hold up in terms of value or usability, lacking one of the essential qualities of sustainable architecture: durability.

Closing

This essay points out some of the contradictions in the field of architecture regarding those concepts that are widely held to be sustainable, including the vernacular and the iconic, and those of various aesthetic traditions including the tight box, the glass box and the use of timber. It goes on to discuss the profession that, in large part, is dedicated to aesthetic expression yet reluctant to engage with sustainability on an integral level. In this regard, we hope that a change in course will take place sooner than later, one where sustainable thinking becomes a crucial part of architecture's comprehensive aesthetic system. In the development of this system, sustainability will present rich potentials for innovative designs that incorporate not only the fundamental principles of architecture – including form and space – but also sustainable materials and techniques as intrinsic prerequisites for the discipline. Overall, the practice of architecture must recognize and take advantage of the opportunities that sustainable thinking presents, through a regime of aggressive and proactive experimentation. We all know that sustainable design is about much more than adobe bricks, planted roofs, timber cladding and the romantic-iconic of the vernacular.

NOTES

1 Jean Dethier, *Down to Earth* (London: Thames and Hudson, 1983).

2 The term *starchitect* is a neologism used to describe famous architects who have been widely publicized for their iconic buildings. In use since around 2001, the terms *starchitect* indicates the kind of wide media exposure certain architects receive.

3 A calculation method that considers the area or volume per person figure underscores that some buildings are more compact and contain more people per area or volume than others. Hence, they are more energy efficient per person.

4 According to the Norwegian architect Gaia Frederica Miller in her article in Arkitektur N (March 2010), the methods of calculation and comparison should be based on energy needs *per person* using the building, instead of being based on the building size (m^2 or m^3).

5 For example, see the US Department of Energy's guidelines for Energy Efficiency and Renewable Energy, available at http://www.fueleconomy.gov/feg/evtech.shtml (accessed April 2011).

6 Norwegian Wood was a part of the Stavanger 2008 festival, a European Cultural Capital 2008 project, aimed at promoting the innovative use of timber in Norway. Based on this initiative, 20 projects were planned to be built.

IMAGE CREDITS

All images by Harald N. Røstvik

2.664 words

Natural Architecture

Kengo Kuma

Does Natural Architecture Mean Sustainable?

Whenever I have the opportunity to work on projects outside of Japan, I am always surprised by the keen interest in Japanese architecture and architects that I encounter. While trying to find the underlying reason for this interest, I started to understand that it is based not only on the austere aesthetics of Japanese architecture, but also on the aspects of sustainability and the deep respect for nature that are inherent in Japanese architecture. In my work outside of Japan, I have encountered an interest in simple design as well as an evaluation and expectation that Japanese architecture will deal with natural elements from a position of respect. Japanese architecture is viewed as a response – or even an antidote – to the deep and longstanding criticisms of Western-centric architecture.

Indeed, we could say that these powerful tides in architectural history – stretching from the ancient Greek and Roman times, to twentieth century Modernism and to the present day – have contributed to the environmental degradation and urban malaise that we now face on a worldwide scale. I believe that traditional Japanese architecture can be thought of as an antithesis to the Western-centric model, regardless of whether or not there is scientific proof to underlie the belief. I would not be surprised if the methods and techniques of traditional Japanese architecture are indeed scientifically proven to help alleviate the environmental challenges that we now face on a worldwide scale. In the context of these challenges, it is not meaningful to argue between *nature* and *architecture* in terms of vague aesthetic theories. The scientific aspects of architecture are more crucial and relevant than the kinds of aesthetic theories we use in our designs; aesthetic theories alone are no longer sufficient in relation to the widespread, severe environmental problems that architecture must respond to today.

Environmental Issues and Architecture

Following my lectures, I am often asked about my designs in relation to certain scientific aspects of sustainability. A typical question may be: “Timber architecture is nice, but doesn’t it contribute to deforestation?” In response, I argue that forests and timber production can be truly sustainable if we harvest and replant trees both systematically and locally. If we do not follow sustainable methods of timber production, we will not be able to sustain the health and longevity of our forests. This is true even if we cease building architecture with timber due to the wide demand for a variety of wooden products, as well as current patterns of deforestation associated with urban and rural development. Another process is at work as well. In order to avoid the cost of harvesting local trees in places like Japan, Europe and North America, the demand for cheap, imported timber from the rainforests of South Asia and South America has increased ever higher. Ancient rainforests are depleted in unsustainable ways in order to meet the world’s constantly increasing demands for timber, and unnecessary greenhouse gas emissions are accumulated during timber production and the long transport process from the rainforests to construction sites. We are all familiar with the fact that the ancient rainforests of South Asia and the Amazons help to reduce global warming by absorbing CO_2. Meanwhile, the forests in Japan – which may provide a sustainable and local source of well-managed timber – are neglected and overgrown. After my lectures, I try to respond to questions regarding my designs and their relation to sustainability as courteously as I can. However, it is important to note that our forests will remain in jeopardy, regardless of whether we continue to build structures in timber or not.

Washi Architecture and Environmental Load

Another recurring question focuses a building that I designed in Takayanagi, Niigata prefecture using traditional Japanese paper, *washi*. (Fig. 1, 2 & 3) It is common for people to ask: "Certainly washi lends an ephemeral quality to the building. But isn't it a waste of energy for heating and cooling when we use such a material for the building envelope, given its lack of thermal performance?" From the standpoint of Western architecture, a building envelope made of thin washi seems to be extremely unreasonable and impractical. Many of my Western colleagues are shocked to learn that the building is located in an area that is very cold in winter, with heavy snowfall.

Fig. 1: Takayanagi Community Center.

Fig. 2: Interior View of the Washi Screen.

Fig. 3: Light Effect of the Washi Screen.

I address this question with the statement that I am often skeptical of engineering calculations. I have experienced that projections of environmental loads based on engineering calculations vary a great deal – sometimes they are not even comparable to one another – depending on how we set the relevant parameters, assumptions, variables and their ranges of acceptability. Building materials that may be considered undesirable according to the outcome of *environmental number crunching* in one time and place may, in fact, be considered good in another. Calculations pertaining to environmental conditions could be interpreted as either positive or negative, depending on the built-in assumptions that lie behind the calculations themselves. I believe that the reality of environmental issues today depends strongly on how we set up and evaluate our data and statistics. The parameters and assumptions that underlie the evaluation of the washi building in Takayanagi vary greatly from those that are commonly used to evaluate Western buildings. The widespread suspicion of reliable materials like washi – those that lie outside of the standard Western building palette – casts an unfavorable shadow on both architectural practice and architectural research, especially when these suspicions are based on engineering calculations. I see these problems and constraints clearly as I serve as a professor at a university of technology.

Elements of Technology and Culture

Sometimes, I explain environmental issues in terms of cultural differences. In reality, the definition of human comfort varies from one culture to another, and this can be seen between Western and Japanese cultures. In the West, the thermal comfort of a building is understood in terms of the average temperature of the interior air mass at different times of day, and throughout the different seasons. When a room feels cold, the entire air mass is heated. However, if this Western method was used to heat a traditional Japanese building made with washi paper screens, it would certainly lead to a waste of energy. In the Japanese context, there are many different ways to create physical warmth inside a building that are inherently cultural – and therefore, inherently linked to architectural aesthetics – that do not involve heating the entire volume of the interior air mass. We can take for example the *kotatsu*, which is essentially a table with a thick blanket skirt that touches the floor, with a radiator or a heater mounted underneath the tabletop. When you sit at a kotatsu, you feel very warm and comfortable even when the ambient room temperature is quite low; the kotatsu provides the sensation that your lower body is warm, while your head remains cool and clear. This is the kind of wisdom that is offered by traditional Japanese architecture that I try to rediscover and reintroduce in terms of today's architectural and environmental contexts.

Although washi architecture might be branded as an energy wasting building form from a Western point of view – which emphasizes a building's mean ambient temperature and heating the entire air mass – the same material is efficient and comfortable from a traditional Japanese perspective. Through these discussions, it becomes clear that it is problematic to standardize the world according to unified, Western-based performance criteria, denying the unique technologies that each culture employs in its architectural forms and materials.

Is Plastic Necessarily a Bad Material?

The third question centers on the use of building materials that are supposedly *natural*. Few complain about the architectural works that I have made of such materials as timber, stone or washi, as these are generally regarded as natural materials. However, sometimes I design with plastics. I have been interrogated as to my motives for using plastics – a supposedly *bad* or *artificial* material – in my designs rather than something more desirable such as marble or fine timber. However, it is important to ask if the division between natural and artificial materials – and the subsequent implication of good and bad materials – is so clear? Plastics are primarily derived from petroleum, a naturally occurring substance formed from ancient microbes and the remains of other beings that lived millions of years ago. When we say that the plastics derived from petroleum are bad, this characterization does not address the inherent material qualities of the plastics themselves – including their durability, lightness and appropriateness for use in certain kinds of design. Rather, it addresses the environmental side effects of their production and later discard. I feel that the characterization of plastics as a bad material is due to a dichotomous viewpoint that is very common in Western ways of thinking, where it is convenient to draw a clear line between the good and the bad. I believe that in order to solve architectural problems, it is crucial to be able to overcome and design beyond this dichotomous viewpoint. This will allow us to explore the use of many types of materials, based on an evaluation of their inherent qualities.

For example, when I was commissioned to design a teahouse in the garden of Museum für Angewandte Kunst in Frankfurt*,* I chose to use a new type of polyester called *Tenara*. (Fig. 4) At first, I wondered if I could use clay, washi or bamboo, but the curator of the museum, Mr. Schneider, told me that Germany was not like Japan. He insisted that if such soft materials were used the teahouse would be destroyed overnight by vandals and other potential abuses. To solve this problem, I felt that I should perhaps offer him a teahouse in concrete! Instead, I proposed a design using Tenara, a polyester material that is inflatable and deflatable depending on the needs of the building. Using Tenara, the teahouse could be stored when not in use, addressing the curator's concern for damage, while still being able to render the light atmosphere of a teahouse. (Fig. 5) Tenara was the most suitable material for this design. Indeed, it is a petroleum product – usually considered to be bad or artificial – but it allowed the form to expand and fold with flexible movements. This material helped me solve the problem of vandalism, while at the same time, making the teahouse's form more similar to an animate being than to traditional, hard and stiff forms of architecture.

Fig. 4: Inflatable *Tenara* Teahouse, Museum für Angewandte Kunst, Frankfurt.

Fig. 5: Interior View, Inflatable *Tenara* Teahouse.

Fig. 6: View of Ceiling, Inflatable *Tenara* Teahouse.

Once, Frank Lloyd Wright proposed a vision of *organic architecture,* which consisted of fluid surfaces and vague boundaries between the inside and the outside of forms. Without materials such as Tenara, it would be impossible to explore the design potentials of organic architecture, and it would be impossible to express the kind of lively, breathable, membranous ambience achieved in the teahouse. Those who are having tea inside of the membrane feel at ease, as if they are being swallowed by a benevolent living being, or that they are sitting inside an organ. While the teahouse illustrates the use of plastics in design – challenging the dichotomous viewpoint of good and bad materials – we also face negative connotations in the use of shape-memory alloy and other metals in architecture. During the same period when we developed the teahouse, we developed architectural forms that change shape according to the temperature. While these trials have real consequences for developing architecture that responds to temperature in environmentally appropriate ways, metals can be considered bad and unsuitable materials for architecture under a dichotomous, Western perspective.

Water Bricks

I have also received quite a few questions about the Water Brick project, commissioned by the MoMA in New York, where I employed plastic water containers. (Fig. 6) I have had the idea of using water bricks for architecture in mind for quite some time, initially being inspired by the adobe bricks used in *Anyo-ji* in Shimonoseki. Traditional masonry and adobe brick structures can be easily erected without using cumbersome construction machinery, and can even be done as a DIY project without specialized expertise or professional help for construction. However, in reality, masonry bricks are too heavy to be assembled into a building by one person, and the lack of structural performance during earthquakes is a problem as well. While trying to reconcile these problems in my search for lighter and more manageable building blocks, I came across some strangely shaped plastic tanks at a road construction site. These plastic tanks contained water, and they were placed to prevent people and cars from entering the construction site. When empty, they are light and easy to transport to the construction site; when they are filled with water, they make a heavy barrier; and when the construction work is complete, they are drained of water, moved to a different site and reused. I decided to use water containers as a simple and flexible construction system in architecture, and started designing prototype water bricks similar to LEGO™ blocks. The water bricks developed through these trials can be assembled to build high walls, and when they are filled with water, they become heavy and structurally stable. I also came up with a water circulation system that runs through the water bricks for heating and cooling. As a strong and stable architectural material, they can be applied to different parts of a building including the walls and the foundation. In this sense, they are quite different from conventional architectural components that are usually defined for specific applications. Yet at the same time, I cannot be fully confident that water bricks are suitable for widespread use in architecture, as they are indeed made from petroleum-based plastics. I feel uncomfortable when I think of the possibility that they will become as commonly used as ordinary bricks, given the environmental side effects of their manufacture, use and eventual discard on a large scale.

Fig. 7: Plastic Water Brick Installation, The Museum of Modern Arts, New York.

Fig. 8: Detail, Plastic Water Brick Installation.

The question is, would it be possible to make architecture that is 100% natural and sustainable? Given the nature of our industrial production system, all the materials we employ in architecture affect the natural environment in adverse ways and varying degrees during the processes of extraction, production, transportation, construction and use. I find it difficult to trust the claim that certain materials are 100% natural and therefore environmental friendly and sustainable.

Instead of striving for architecture that is 100% natural and sustainable, I believe that we have to try, do and experiment with a variety of materials and forms in our designs, knowing that the results will never be perfect. I also believe that we should formulate practical solutions that offer a certain balance in the way we produce and use our materials and resources. Achieving this balance includes acknowledging and practicing the kinds of ideas that may be unpopular – including opening the door for timber, thin materials in building envelopes, culturally-specific methods for heating and comfort, and the use of plastics and other *artificial* materials – otherwise there is no hope for architecture, and no hope for the experimentation necessary to arrive at practical solutions to the environmental problems we now face. This is a humbling thought when we consider *natural architecture* in the truest sense of the term.

Translated from Japanese by Chihiro Iishi and Gaku Takahashi

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5.605 words

The Concept and Aesthetics of Sustainable Building in Japan

Minna Sunikka-Blank

Introduction

Today, there is widespread debate about what constitutes ecological design.[1,2] The aesthetics of sustainable architecture have been associated with green roofs and earthy materials, but also with high-tech eco-gadgetry and installations such as solar collectors, building automation systems and double-skin façades. Given the amount of diversity it is important to ask: what environmental measures really have an impact on architectural aesthetics? Innovative energy strategies can be highly visible or hidden in architectural design, or, they may be more related to land use than to buildings.[3] For example, highly efficient heat exchange systems can work on the land use level, where waste heat is exchanged in a micro-grid between different building typologies. These systems do not have a visual impact. In Helsinki, an innovative project uses the waste heat generated by computers in an IT center as a district-wide heating source for up to 500 households. What do these kinds of technically successful and sustainable projects have to do with aesthetics?

On the other side of the globe in Japan, architecture is often associated with the use of natural materials to the fullest effect – such as exposed and untreated wood – the ability to use limited space as a quality rather than a constraint and with sensuous relations to nature. And despite the lack of insulation, an average Japanese household consumes around a third of the energy for heating and cooling compared to its counterparts in Germany or the UK.[4] When modernism was still more of a method than a style, Japanese aesthetics (*japonaiserie*) played an important role in the context of both American and European post-war modernism by providing a theme to fill the absence of a dominant stylistic principle.[5] Today, could Japanese aesthetics – supported by current trends in technological innovation – offer something to be learned in the field of sustainable architecture?

This article analyzes the aesthetics of material use and passive energy strategies in Japanese architecture. The research is based on case studies selected from a number of projects visited during a research period in Japan in 2009. Interviews with policy-makers and academics at the Japanese Ministry of Economy, Trade and Industry (METI), the Institute of Industrial Science at the University of Tokyo and practitioners helped to identify the key policy documents and concepts of sustainable architecture in Japan.

The Architectural Institute of Japan (AIJ) defines a sustainable building as one that is designed:

> *to save energy and resources, recycle materials and minimize the emission of toxic substances throughout its life cycle, to harmonize with the local climate, traditions, culture and the surrounding environment, and to be able to sustain and improve the quality of human life while maintaining the capacity of the ecosystem at the local and global levels.*[6]

With this definition, sustainability is implicit in the environmental sense through the goals of minimizing energy demand, the use of natural resources and the production of waste, and in supplying energy from renewable sources. Furthermore, the emphasis on harmonizing buildings with the local climate, tradition and culture of the surrounding environment highlights a consideration that is often made in the context of *good design* rather than in the context of sustainable building per se. This article will follow the lead of the AIJ, where a *softer* approach to sustainability is adopted, above and beyond technical measures. It should be considered that the policy development described in this article is based on the situation in Japan in 2009 and 2010.

In the section *Material as the Concept*, the aesthetics of sustainable material use in Japanese architecture is addressed in relation to timber, structure and adaptability. Energy strategies, namely passive solar measures and patterns of energy use and behavior, are described in the subsequent section *Energy Strategies*. It is clear that the culture, social conventions and values of Japanese households are distinct, impacting the overarching trends of material and energy use in buildings. In the *Discussion* section, the aim is not to advocate transferring any measures as such, but to comprehend one alternative approach for the aesthetics of sustainable building. This is followed by the *Conclusions*.

Material as the Concept

Indigenous Japanese architecture is characterized by the use of materials that are natural, weak and sensitive with low embodied energy such as local timber (including Japanese cedar), bamboo, paper (*washi*), rope, woven straw or willow. These materials are often left untreated and exposed. From an environmental perspective, the low embodied energy of these building materials is important due to the fact that the average life span of a Japanese home is 26 years, compared to 44 years for a home in the US, and 75 years for a home in the UK.[7] Although still valued as an aesthetic ideal, the use of indigenous and natural materials like timber is hardly visible in the development of Japanese cities today, and it can be said that the "Japanese house is dead."[8] Although many local governments support the use of local materials with subsidies, it is estimated that no more than 50% of new homes in Japan are constructed of timber. Even when they are, the timber used is largely imported and not necessarily aesthetically pleasing or sustainable.

However, there are examples of contemporary architecture where the design concept is based heavily on material. In the Hiroshige Ando Museum (2000) by Kengo Kuma, local wood is used in an unconventional manner. The building achieves contemporary lightness and the compositional clarity of traditional Japanese architecture both in plan and in elevations. The character of the minimalist building relates to its enclosure, a brise-soleil built of Japanese cedar. (Fig. 1) The wooden lattice consists of untreated timber battens of 30 mm x 60 mm, spaced at 120 mm. The lattice acts as a filter for light making the timber, which usually appears as a massive and heavy material in sustainable architecture, nearly translucent. (Fig. 2) Due to the carefully considered proportions of each component in combination with large transparent surfaces, the visual effect is minimalist, light and sharp instead of earthy and organic. The use of wood in a building as large as the Hiroshige Ando Museum was not without problems, however, as a new technique for heating Japanese cedar to a point where fire retardant products would penetrate had to be developed, patented and approved.

Fig. 1: Exterior View, Hiroshige Ando Museum.

Fig. 2: Interior Hall, Hiroshige Ando Museum.

In the Hiroshige Ando Museum, the filigree construction is supported by a steel structure. This is in line with indigenous Japanese architecture, where the secondary and primary members of the lattice structure are often exposed; the aesthetics and spatial order often relate to a structural system that can dominate the composition. In the Hiroshige Ando Museum, structural steel and timber members are readable though the lattice, giving scale and proportion to the space. (Fig. 3)

The result is a layered, filigreed structure with large openings in the timber lattices responsive to natural light and to the surrounding landscape.

Fig. 3: Exterior Space, Hiroshige Ando Museum.

The strong presence of materials in Kuma's work results from a solid knowledge of material properties and dimensions. He suggests that "we are separated from construction and separated from nature" while in the studio, and he tries to remedy this with a unique approach to materialization. The size of building components – which Kuma talks about as *particles* – is an essential part of materialization which can make a building merge with its environment, as seen in the size of the filigree lattice at the Hiroshige Ando Museum. The aim of *particalization* is not to make the boundaries transparent, but to relativize the appearance of architecture so that the experience becomes relative and capable of change, depending both on the light and the subject. Breaking a surface into particles and *erasing* architecture is one of the main themes of Kuma's thesis of "anti-object" architecture, in opposition to "photography architecture" which is determined by its communication to the media.[9] Both Tadao Ando and Kengo Kuma – in the Kiro observatory and a competition entry for the Jewish museum in Warsaw – have explored the theme of "erasing architecture" by minimizing the impact of buildings on vulnerable sites by hiding or sinking their structures.[10]

Moving back from the work of contemporary Japanese architects to examine the underlying vernacular tradition, it is important to note that Japanese carpentry developed to an exceptionally sophisticated level; until the adoption of Western construction methods in the 19th century, no buildings were made of stone.[11] Habitually, indigenous Japanese buildings had a platform timber frame and a post-and-beam (*hashira*) structure rather than a heavy log construction. Even in temples, wood was cut into rectangular units whereas in China, square-sectioned timbers were considered wasteful. Indigenous Japanese woodwork is rooted in the *kiwari-jutsu* proportional systems established by medieval carpenters: the column spacing was set to 197 cm (*cities*), and the cross section of the column was set to 1/10 of the column spacing. The foundations of a post-and-beam structure were light, and if a building was demolished, its footprint was very small. The kiwari system was tuned to the measurements of the *tatami* flooring mats made of compressed straw, and these measurements continue to affect the size of Japanese rooms. The Yoshijima house in Takayama is an example of a traditional timber frame town house (*machiya*) that was re-built by Nishida Isaburo in 1907 with dynamic flying beams, center pillars, posts, and primary and secondary structures that are visibly exposed in the void space of what used to be a shop area. In this traditional house, natural light is received from the upper windows. (Fig. 4)

Fig. 4: Shop Area, Yoshijima House.

In the Yoshijima house, one of the main columns (*daikokubashira*) at the center of the building supports most of the weight of the roof and, in the case of an earthquake, balances the load. Inside the house, some columns are free of the load bearing function and have no more than a furnishing or decorative purpose, as in the alcove pillar (*takobashira*). While Le Corbusier saw the history of Western architecture as the struggle against the window, Ueda sees the history of Japanese architecture as the struggle against the pillar – and the pillar as the last vestige of ancient tree worship. However gradually, and partly due to current fire regulations, pillars are disappearing from view and moving inside of walls, radically changing the aesthetics of Japanese architecture.

Incidentally, the exposed structure in the Yoshijima house is not dissimilar to the Yusuhara Town Hall by Kengo Kuma (2006), where a lattice structure of glulam beams with a span of 18 meters strongly characterizes the interior architectural space. (Fig. 5) Due to the use of local timber and the characteristics derived from indigenous architecture such as exposed primary and secondary members, (Fig. 6) passive solar strategies, the use of PV's and natural ventilation in the summer, the Yusuhara Town Hall achieves the highest environmental assessment rating for building environmental efficiency with CASBEE (Comprehensive Assessment System for Built Environment Efficiency), an environmental assessment system that has become the definition of sustainable building and quality assurance in Japan.[12] A life-cycle assessment (LCA) and field survey conducted in three stages (production, construction and maintenance and operation) demonstrates that, compared to a usual city hall, the building achieves a 54% reduction in life-cycle costs – yet the building has a strong visual identity emanating from its sustainable materiality.[13]

Fig. 5: Interior View, Yusuhara Town Hall.

Fig. 6: Detail of Structure, Yusuhara Town Hall.

In traditional Japanese post-and-beam architecture, as seen in Yoshijima house, there is a strong element of modular thinking connected to aesthetic proportions. Technically, the modular platform structure allows the plan to grow intuitively, according to the needs of the occupants. Traditional Japanese buildings seem to be designed from the inside out: the continuous matrix-like rooms are connected directly to each other, separated by movable screens and added according to functional need. Consequently, the form of a building seems to develop from functional need first, rather than from an underlying formative style. The clear division between load bearing and space dividing elements makes a building easy to dismantle and adjust, clearly serving the goals of adaptability.

In fact, a traditional Japanese home is practically a one-room structure that can be partitioned by *shoji* opaque sliding screens (*fusuma*) or further divided with small wooden fencelike partitions (*kekkai*). Tatami rooms, typically living and guest spaces, do not have a specific function that is determined by the objects placed within them; they are named after the floor surfaces (*wooden room, tatami room* or *earth room*) and the space itself is multifunctional. The Yoshijima House, for example, is divided into five areas: business spaces with an earth floor; a tea room and four guest rooms upstairs that could be combined to one large hall; spaces used by the servants and employees; buildings where sake was brewed; and seven tatami rooms that were used as multifunctional living spaces. Different surfaces are used for dividing the space –including the floors, sliding screens, solid walls with sand or lime plaster and the ceilings – which are emphasized and linearly articulated with columns, beams, cross beams, window frames and handrails. In Japanese architecture, depth is traditionally expressed by means of layered planes and a flat composition of sliding screens. (Fig. 7) Horizontal layers tend to have more visual emphasis than vertical walls.

Fig. 7: Layers of Interior Screens Walls, Yoshijima House.

Energy Strategies

Japanese houses are notoriously uncomfortable in winter, and even new buildings like the Hiroshige Ando Museum become very cold in winter according to the staff. There were no thermal regulations for buildings in Japan before 1980, and a large number of buildings are still exempted.[14,15] Regulations have caught up to the need somewhat – thermal requirements have been sharpened by 50% over the last two decades. In the Tokyo region, for example, the heat loss factor was halved from 5.2 W(m^2/K) in 1980 to 2.7 W(m^2/K) in 1999. However, since 2009, thermal regulations have been limited to large developments (buildings over 300 square meters) and exclude most of the residential sector. The interviews conducted at the Ministry of Economy, Trade and Industry (METI) as part of this study indicate a reluctance to impose thermal regulations on private households or to disadvantage the construction industry with additional regulations. In addition, the maximum floor area allowed under the current regulations is measured from the center of the wall, so insulation thickness reduces the usable living area; this is a major barrier to providing insulation in high-density areas. Yet despite these conditions, household energy consumption in Japan is very low compared to that in Western countries.

In Europe, energy concepts are often described in relation to reducing the temperature difference between the inside and the outside of buildings, increasing the tightness of building seals and the effectiveness of heating systems. While in Japanese, energy concepts give way to design principles that are traditionally based on avoiding overheating in the summer months. Japanese energy concepts have been characterized by an old saying by Yoshida Kenko (1283-1350): it is important to make it a principle to consider the summer season as the main factor in building a house – in winter it is possible to live in most buildings anyway. In fact the whole concept of a wall in Japan is more of an opening than an enclosure. (Fig. 8) A wall is seen as a lattice fence whose lightness serves ventilation in hot and humid summer months – there is an ideal of *wall-less* houses where a whole façade of shojis, fusumas or shitomidos can be opened for ventilation. (Fig. 9) In the Yusuhara Town Hall, the concept of *wall-lessness* is evident in large openings that are based on traditional upward swinging shutters (shitomido) that allow for cross-ventilation during the summer.

Fig. 8: Exterior Layers of Enclosure, Yoshijima House.

Fig. 9: Opening of Screen Walls from the Interior, Katsura Villa.

Passive energy strategies that make allowances for the local climate have an important role in reducing the problem of overheating in the traditional Japanese home, and consequently, in its aesthetics. As seen in examples of indigenous architecture like the Yoshijima house, long eaves, an elevated ground floor, shades made of bamboo curtains, wooden latticework to protect the bay windows (*demado*) and plants all have important roles in the reduction of thermal load, while at the same time, giving visual depth and subtle variation to the façade. The space under the eaves (*entgawa*) surrounding an inner garden balances the transition between artificial and natural, blurring the visual boundaries between inside and outside, and providing an intimate feeling of nature even in an urban environment and a protected outdoor circulation route. In new projects like the Hiroshige Ando Museum, Nezu Museum and One Omotesando in Tokyo, passive solar strategies continue to be integral to the buildings' aesthetics. (Fig. 10) However, the long eaves that used to have an indispensable role in Japanese towns providing passageways (*inubashiri*) and sheltered semi-public spaces are shrinking (typically from 90 cm to 40 cm) or are disappearing altogether.

Fig. 10: Roof Overhang, Hiroshige Ando Museum.

With indigenous Japanese architecture, like the Yoshijima house, the inner gardens are used to provide light and ventilation; the deep plan gardens are habitually considered one of the finest features of a Japanese house, and despite their particularly small size (a traditional *tsubo* garden is not more than 3.3 m^2) they provide visual enjoyment, contentment and unity with nature when viewed from inside the house. (Fig. 11) Unlike a baroque garden that imposes its geometry on a site, a Japanese garden borrows and builds on the characteristics of the surroundings. Consecutively, architecture plays an imperative role in garden design; the most aesthetic and picturesque elevation of a building often opens up toward the garden.

Fig. 11: View of the Inner Garden, Yoshijima House.

In the Katsura Imperial Palace, for example, the exterior resembles the formation of *flying geese*, where all the rooms face the pond at a uniform angle set back to the left and right, with an emphasis on light and ventilation rather than a clearly defined or a dominant form on the outside. In sustainable architecture, gardens can provide daylight and self-controlled natural ventilation, but just as importantly, they can provide associations to the environment, the climate and the changing seasons for users that spend more and more time indoors.

These days, however, it would be difficult to eliminate the need for artificial cooling in hot and humid climates, one reason why the Passivhaus concept has not gained ground in Japan. Air-conditioners are installed in 87% of Japanese houses, and the average household owns 2.3 air-conditioning units – although their energy use is limited by disciplined behavioral patterns.[16] Housewives, for example, who are at home alone in the daytime do not use the air-conditioning for themselves, but only put it on in the evening when the whole family is at home. If air-conditioning cannot be avoided, it should use renewable energy sources. So far, one of the most successful applications of renewable energy has been in the form of ground source heat pumps, supported by nighttime electricity tariffs and government subsidies.

Disciplined energy use behavior seems to be the main reason behind the low household energy consumption in Japan, where greater fluctuations in comfort levels are accepted. Indoor room temperatures are kept between 18 and 20 °C, and nighttime room temperatures can be as low as

10 °C, although in colder climates like Hokkaido, higher average temperatures are common. Lowering the indoor temperature does have a great impact on energy consumption. In Britain, for example, for every degree that the thermostat is turned down, heat loss decreases by about 10%, and turning the thermostat down from 20 °C to 15 °C would nearly cut heat loss in half.

Traditionally, the Japanese prefer to heat one room rather than a whole house. Heating the whole house is considered a wasteful behavior – and due to the low or nonexistent insulation levels found in most houses, it is. The difference in energy use patterns between Japan and Europe can be described in the different concepts of personal heating versus spatial heating, respectively. The Japanese prefer to heat one room or to use appliances like convectors or the traditional *kotatsu* heating, a low table with an electric heater under the table covered with a kilt; the overwhelming majority of Japanese households use the kotatsu that can be easily bought at a household appliance store. (Fig. 12)

Fig. 12: *Kotatsu* Table.

In Japan, there is a strong culture of turning off heating and cooling systems, as well as lights, when their use is not necessary. This has been supported by a traditionally communal way of living, but the lifestyle in Japan is in flux, and has become more individual over time. In general, the Japanese seem to have a good grasp of energy consumption compared to the residents of European countries, such as Norway.[17] This may be pragmatically due to a monthly billing system that provides a better grasp of the actual energy consumption. However, it can be said that due to patterns of culture and behavior, the transparent, ephemeral structures that work in Japan should, in fact, be applied with great care in Europe where occupants are used to higher insulation levels.

Discussion

The aim of the article is not to suggest the Japanese house as a model for sustainable architecture. Climatic and cultural differences such as disciplined energy use would make such a suggestion absurd. First we need to ask: are there lessons to be learned from indigenous architecture that are even feasible inside Japan? The Kobunaki Ecovillage in Omihachiman City, Shiga Prefecture, gives an example of Japanese sustainable housing in current practice. Most of the homes in Kobunaki have walls with around 160 mm of insulation, passive solar strategies, natural ventilation, individual heat pumps, high efficiency appliances, rainwater tanks and structures that are earthquake-safe – but the architecture of the buildings is rigid, providing little room for modular growth. (Fig. 13)

Fig. 13: A House in The Kobunaki Ecovillage.

The interviews conducted in Kobunaki indicate a number of barriers to sustainable building in Japan. Three levels of management bureaucracy – at the government, prefecture and city levels – presented major barriers to the project, and forced changes to the master plan during the development process. Also, land prices in Japan are very high, leaving little room in the budget for anything that can be considered additional such as environmental measures. In Kobunaki, government subsidies were limited to information dissemination, with some support for the use of local wood and solar panels. All green areas and vegetable gardens in the development are privately maintained, since the local government cannot afford the cost of their maintenance. Public transport to Kobunaki has been introduced. However, it is poorly managed, leading households to be dependent on private cars. The use of sustainable materials seems to be limited by the liability issues of the construction industry as well – if local materials and craftsmanship are used there is a risk of complaint, which is why contractors prefer to use more standardized products. Due to these circumstances, the eco-housing area of Kobunaki contains few references to the sustainable characteristics of Japanese indigenous architecture.

Large contractors that dominate the mostly prefabricated housing market in Japan seem to be interested in the market potential of sustainability, although it is too early to speak of any large-scale implementation. Examples of sustainable homes launched to the market include the Carbon Neutral House by Sekisui House, and a large housing development by Toyota. The sustainable buildings often make use PV's, passive solar strategies, natural ventilation and intelligent home energy management systems. According to the interviews conducted at the Ministry, large architectural offices such as ARUP understand sustainability as a business opportunity, but this knowledge is more limited in smaller design practices.

Furthermore, by tradition, the maintenance and renovation of houses has not been strong in the Japanese ownership culture. The market for used houses is limited; only 12% of annual real estate transactions involve existing houses, compared to 81% in the US.[18] In fact, over the past 24 years the resale value of a Japanese house decline to almost zero, which means that in reality, investment in most environmental measures exceeds the lifecycle of a building.[19] Consequently, the renovation rate remains low: the ratio of house renovation to housing investment is 11% in Japan, compared to 65% in the UK and 41% in the US.[20] This is true despite the fact that according to the Housing Demand Survey, half of Japanese families are not satisfied with their house, and a majority are not satisfied with energy efficiency and sound proofing in particular.[21] The rebuilding and relocation culture in Japan is seen to follow the natural model of regeneration associated with traditional wooden structures. However, the lack of incentives to renovate creates an actual threat to sustainable building, not only in terms of the environmental consequences of waste and the use of new resources, but in terms of economic sustainability, where a long PPT commonly exceeds the life cycle expectancy of a building.

Overall, it must be recognized that the examples provided in this article are selective. While the architecture of Kuma can offer lessons translated from the indigenous tradition into contemporary minimalist architecture, it must be emphasized that the reality in Japanese cities and rural areas is different, and much of the sensitivity and sustainability of indigenous architecture has been lost. (Fig. 14)

Fig. 14: A typical row of houses in rural Japan.

Japanese architecture has usually been evaluated in relation to two polar approaches, and it must be remembered that minimalist aesthetics are fairly typical for upper-class architecture. The dualist division of tastes can still be seen in Japan: in the authentic, minimalist and tranquil *honmono* that is light and transparent – as seen in the *Yayoiesque* Katsura Imperial Palace and the Yoshijima house – and the more vulgar, populist and kitschy *ikamono* (*Jōmonesque* naïvism), later expressed in modernist brutalism.[22] Modernist photographs and writings of the Katsura Imperial Palace that drew attention to Mondrianesque patterns and surfaces chose to ignore less minimalist and kitschy curved roof planes, detailed decorations and picturesque trees. The presentation of Japanese aesthetics continues to be selective: in photographs, Hiroshige Ando is often portrayed as unattached, but in reality it is located in the center of a rather mundane village and, aside from the main façade, enclosed by a parking lot.

Yet, despite the reservations mentioned above, the sensitive use of sustainable materials with low embodied energy and a certain logic of minimization drawn from the Japanese indigenous could offer new and contrasting ways to approach the aesthetics of environmental architecture. Today, there is a risk that visually enclosed envelopes are becoming our legitimized form of sustainable building. From an architect's point of view, it may seem unfair to draw smaller windows while TV screens are getting bigger and the number of electronic appliances is increasing. While Japan may urgently need thermal regulations itself, its example of passive solar measures, natural ventilation and person-specific heating concepts could offer alternatives for Western policies that are currently moving in a different direction: focusing on high insulation thickness, small openings, sealed envelopes and mechanical ventilation.

Consequently, a methodological question remains in how to include the unquantifiable *softer* aspects of sustainability in environmental performance assessments that are currently used – in the absence of better methods – to legitimize what is considered sustainable. In the Japanese building assessment tool CASBEE, environmental performance is not only measured in terms of load but also quality. Environmental quality consists of the indoor environment (including acoustics, lighting, thermal comfort and air quality), service quality (including adaptability, flexibility and durability not present in Western tools like BREEAM or LEED) and the quality of the outdoor environment. Environmental load refers to energy, materials and the off-site environment. Compared to BREEAM (UK) or LEED (US), there is a fundamental difference in terms of the absence of biotopes in the assessment: no compensation for green space is encouraged, and an urban environment is presumed, including a reduction for the heat island effect.[23] It is possible that by relating design and environmental quality to environmental load in the assessment of building performance, themes like aesthetics and user perception could be established more firmly in the field of sustainable architecture, inspiring designers think beyond technical measures for achieving sustainable goals.

Conclusions

Despite the lack of insulation, an average Japanese household consumes around a third of the energy for heating and cooling compared to a German or UK household. Recognizing the limitations of any kind of cultural transformation, this paper suggests characteristics from contemporary Japanese architecture (as seen in the Hiroshige Ando Museum by Kuma) and the Japanese indigenous (as seen in the Yoshijima house) as one alternative approach to the aesthetics of sustainable architecture. Kuma's buildings demonstrate the intent of minimization – as opposed to minimalism's simplification of form – that aims at criticizing and minimizing matter, a concept not alien to the basis of Japanese aesthetics, described by Bruno Taut as simplicity "almost to the point of poverty."[24] Material-based *environmental minimization* could underlie a change of paradigm, contrasting with our usual methods of energy-focused sustainable building which seem to strive toward excessive insulation and mechanical ventilation. In an approach characterized by *material as the concept*, the use of natural and contextual materials – for example, timber with low embodied energy – would drive the sustainable design concept, rather than it being driven by technical measures added later in the project. This would be an approach to sustainable design led by architects, instead of by engineers. Mechanical and technical aspects of sustainable building comprise just one part of the complex issue of design that depends on and draws from the cultural perspective.

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FIGURE CREDITS

Fig. 1 to 14: Minna Sunikka-Blank

8.271 words

Durability in Housing – The Aesthetics of the Ordinary

Marie Antoinette Glaser

Introduction

When it comes to cultural practices of the everyday, such as housing, it is not possible to regard aesthetics without regarding the perspective of use. In contrast to design, use is a physical situation of being attached to a specific place and identity. Houses that have existed for a long period of time necessarily go through many transformations, with successive generations changing the ways they are occupied and used. Generally, what guarantees a building's longevity is its dynamics and ability to change – the possibility for it to have more than one kind of use. Specifically in relation to housing, diverse exchange processes take place between a house and its users: the residents enter into a relationship with the living space, possibly identify with it or change aspects of it, and end the relationship at a later point in time. Simultaneously, some constants may remain over the course of time including the physical building elements and spatial structures. People leave traces of use in the houses they occupy, and these traces can provide important information about the prerequisites and conditions that underlie the longevity of housing in general.

In his *Kunstwerk* essay, Walter Benjamin considers the double reception of buildings as highly significant:

> *Buildings are received in a twofold manner: by use and by perception. Or better: tactilely and optically ...On the tactile side, there is no counterpart to what is contemplation on the optical side. Tactile perception comes about not so much by way of attention as by way of habit. As far as architecture is concerned, The latter largely*

determines even the optical reception of architecture, which spontaneously takes the form of casual noticing, rather than attentive observation.[1]

As discussed by Benjamin, contemplation and habitual use form our primary modes of reception for architecture. As part of the aesthetic whole, visual perception traditionally dominates over tactile perception, however, Benjamin's radical proposal is that the latter actually determines the former. Architecture consists of phenomena that we perceive consciously and unconsciously through habitual use over time. From this results an aesthetic position that defines the notion of beauty as a process of long-term habituation and use. Durability signifies a specific kind of beauty in architecture that stems from the intimate traces of long-term use: un-perturbed, un-exceptional and un-faddish.

Durability and Sustainability: Theoretical Issues

Vitruvian categories of beauty (*venustas*), appropriateness (*untilitas*) and solidity (*firmitas*) in architecture were still present in the 19th century – consequent to the long, slow process of the development, use and removal of buildings – creating a long-term demand for the viability of artifacts that we now term sustainability. With the progress of time in the 20th century, these long-term ideals were replaced with the ideal of timeless aesthetics as part of the Modernist view to reform all facets of life through good design. The Modernist ideal of a car-friendly, relaxed town with a separation of functions – built from industrialized construction products – proliferated in the post-war period. However, one possibility was thoroughly excluded from this conception: that of eternity. Some objects, which nevertheless outlived the others, became monuments having a new function, that of a "fixed point of memory in the sea of the transient." For the architect Aldo Rossi, the community at large finds its:

... permanent expression in a town's monuments. As primary elements of municipal architecture, they are signs of collective will and represent as such fixed points in urbanistic dynamics.[2]

Rossi ascertains that a town's dynamics have:

> *... a greater tendency to further development than to preservation; that monuments during the course of this development ... remain preserved and even have a stimulating influence on development.*[3]

Rossi develops a theory of permanence through these ideas, the theme of which is that a monument such as the Palazzo della Ragione in Padua, one that has retained "a visible shape from the past" but changed its function over time has "in doing so, remained alive." Furthermore the quality of permanence defines a monument's survival "which is based on its urbanistic reminder-value from a historical perspective of art and architecture." Rossi describes permanence – a lasting form of the past – in a positive sense because it makes the past relevant to us today, while he makes a distinction between monuments and other forms of buildings that remain, yet are "the isolated and the displaced." Rossi describes residential buildings as constantly changing signs of everyday life and the expression of urban dynamics. However, he excludes residential building from his "theory of permanence" and asserts that the conservation of residential areas contradicts a town's dynamic development process.

Nevertheless, some of Rossi's thoughts on the viability of monuments are topical. First, the idea that urban phenomena are based on the characteristics of individuality, location, design and memory. And second, an interest in the qualities that have been retained since the time of construction: the remaining desiderata point to the attention made to the perspective use.[4]

A broad new discussion about the qualities of the sustainable started in the 1970's when criticism of the ecologically destructive patterns of mass consumption in the post-war period became apparent. Against this backdrop, discussions began in architecture in the 1980's regarding the longevity of buildings and their impact on sustainability. In the periodical *The Architect*,[5] arguments were made that people within the dominant "mass consumer society" should think about sustainability and erect more durable buildings "contrary to the transient spirit of the time." In his essay *Modernity of the Durable*, Vittorio Lampugnani advises people to analyze existing traditions and building practices in order to create lasting solutions for housing construction: "It is only from tradition that objects, buildings and towns that possess the quality of sustainability can develop."[6]

While Lampugnani emphasizes simplicity and comprehensibility as timeless qualities in architecture, his notion of "simplicity" does not refer to the reductive formalism of the "radical modernists" who turn towns into geometric schemes, to the avant-gardes' focus on abstraction or to the anonymous simplicity of vernacular architecture in the sense of Rudofsky. Instead, Lampugnani's traditional sense of simplicity is based on the use, not on the building form. He condenses the answers to countless requirements and desires[7] that are still being developed in architecture. For a building to be sustainable its form can hardly be fashionable or avant-garde, because "Things are permanent when they are neutral and simple enough to leave space for our changing, multi-faceted lives."[8] Over time, what remains are those buildings that proved themselves to be of lasting value, and not those that stand out as experiment. The kind of unperturbed, inconspicuous houses that possess the qualities of simplicity and comprehensibility of structure that Lampugnani discusses are "the result of careful reclaiming and utilization of tradition – not as a stylistic category, but rather as an handed down, tried and tested method of converting requirements into designs."[9]

Instead of a catalog of prescribed answers, Lampugnani demands "uniqueness" instead of "universality" in building, moving toward the "exemplary and general" instead of the "tailor-made."[10] For these reasons, he is criticized as dealing only with the "aesthetic of sustainability" in architecture, simply on the "surface," and for dealing too little with the qualities of "building itself," including engineering, construction and how material is used.[11]

Against the backdrop of sustainable thinking since the 1970's and 1980's, the sense of urgency regarding global climate change has been widely addressed by the media in recent years. And discussions regarding the careful use of resources and the principles of durability have come to demand attention in consumer products, architecture and construction. This is especially true with such technologies as the BIM for managing finances over the duration of construction and the patterns of material flow. In general, the challenge of achieving durability has become less centered on new construction, and more on finding intelligent ways of updating existing buildings. While questions regarding the careful use of resources in construction are common, they are limited to saving energy by structural and mechanical means: environmental analyses of existing engineering practices are not common and the possibility of engineering structures for smart, long-term use is rarely considered. However, it is precisely these kinds of perspectives that bring to planners and investors the long-term prospects of sustainability and durability. If a building is cherished, it will house many meaningful uses over the span of generations.

Based on the combined ideas of Rossi and Lampugnani, the notion of sustainability includes the physical, cultural and social qualities of a building – and the underlying qualities of durability. For architects, what stands out in these considerations is the investigation of constructive conditions to question a building's context – in terms of its culture, ideals and concepts – and how a building will used by the residents, owners and the public at large. From this perspective, a new and comprehensive view of sustainability emerges: the central issue is neither purely technical nor bound to aesthetics. In order to make use of the term durability, I will propose and refer to a basic model of five levels, particularly in regard to social and cultural dimensions.[12] In addition, the terms *durable* and *sustainable* will be used synonymously to mean those that last: things that are continued and maintained over a long period of time, ideally spanning generations. Here the term sustainability possesses an additional cultural dimension, referring to social values, norms and ideas.[13] A house is sustainable when it is appreciated and loved for a long period of time by successive residents, or when it is handed down to posterity until it enters the cultural memory of a society. A house is durable if it supports existing values and ideals, while at the same time, being integrated into those of subsequent generations.

This article contains two basic premises. First, in Switzerland and other West European countries, one of the key issues of the 21st century will be how to define the strategies for dealing with the existing building stock. The majority of this building stock is residential and rented, as is traditionally the case in Switzerland. In Zürich, almost 60% of the residential buildings were built in the period of the "construction boom" from the 1950's until the end of the 1980's. The major part of Zürich's building stock is older than thirty years, and only 20% of all apartments were built after 1970.[14] Zürich was chosen as exemplary city for this article because of its high percentage of cooperative and communal housing.[15] Such co-ops and communities build and invest with a strong interest in a long-term perspective and quality housing. In this article, the notion of durability over the whole lifecycle of a building is focused on developing an integral and critical understanding of enduring residential buildings and their strategies for maintenance, while rethinking the factors of building appraisal and enriching future strategies for action.

Second, there is little knowledge about how the residents use and assess housing during the course of its lifecycle, or how the owners deal with properties over the long term; this is important, as the way buildings are maintained contributes decisively to their longevity. There are, however, no well-grounded studies on the way that buildings are dealt with both socially and individually. Which criteria are responsible for residential buildings standing the test of time over a long period? Which criteria make a building suitable for daily use? Overall, these questions are difficult for architects to visualize in the projects they design.[16] Architects generally leave the completed, still unused building before the residents move into it, and usually, they do not return. In order to gain knowledge on whether or not residential buildings function in a lasting way, a building would have to be studied on location, without applying any preconceived architectural or historical opinions. One would have to interview the residents, as they are the ones who use the house and know whether it is suitable for living. Likewise, the maintenance personnel of a building can provide their expertise on maintenance and care over time; their responsibilities are enfolded in the building itself, inscribed in its history of qualities.[17]

This article is based on research conducted at middleclass, multifamily housing estates located in Zürich with regard to their history of use, meaning and value over time.[18] Specifically, the article discusses a highly valued residential settlement owned by the municipality of Zürich, the Zurlinden Estate of 1919, concentrating on the notions of quality in both the social and cultural dimensions. It begins with a discussion of the theoretical background and the principle elements of the study's multidimensional approach. A particular house-biography compiled at the estate illustrates the application. The article concludes with exemplary principles of enduring quality in housing drawn from the study of the estate.

Roderick Lawrence states that, in general, the interrelations between the architectural, cultural and social dimensions of housing have been overlooked in architectural research.[19] Comprehensive research in residential buildings requires an integrative approach to bring the interrelations between human ideas and values, and the design and use of residential buildings, to light. One example of the integrative approach, house-biographies, employs a method of "thick description,"[20] evaluating residential buildings through the lens of their inhabitants and owners, combined with an assessment of public perception over time. The history of the building's maintenance and repair is connected with that of appraisal and economic validation. The narrative of acceptance is not always steady, consistent or enduring, but of fluctuations of highs and lows over the course of time. The purpose of the investigation is neither to write a "pure construction history" or a socio-critical study. Rather, it is to demonstrate what happens in between, among the structures and the people who are involved with them over time, in the most diverse ways.

As far as residential buildings are concerned, it makes sense to talk concretely of the "house" as a relational and processual space. The existing research on "house" and "home" has developed into a vast field of literature.[21] In the context of house-biographies, the term "house" – following the work of the cultural historian Karl Schlögel – defines the "small unit ... in the middle between the large space: street, neighborhood, town, countryside and the smaller unit: flat, room, interior."[22] "House" refers not only to the "built space" consisting of materials and construction, but also to the cultural and historical dimension of the "lived space." The latter includes the way that people treat the built space, including the use, appropriation, relocation, modification, tactile and visual perception, appreciation, emotion and conceptual and planning-related discussions. The spatial term "house" does not only comprise the instances within the property lines where the building was erected. It also includes the infrastructural, social and spatial aspects that provide a context where the building and the residents form their relationship. The longevity of residential buildings therefore means the lived and built spaces of houses, and emphasizes those aspects that both change and remain constant over time.[23]

As a consequence, recent research on housing integrates the "living" house into its scope. The seminal study – the first in construction research[24] of the house-biography – focused on the "Berliner Mietshaus" rental housing in Berlin in the 19th and 20th centuries; it was conducted by the architect Johann Friedrich Geist and deals with the residents in relation to the history of the building and the context of the city's cultural history. Where Geist remains historically oriented due to a lack of people to discuss the Berliner Mietshaus with, the opportunity arises in the current study to establish contact with long-term residents, and to explore their use and experience of the house, the apartment building and its surroundings in a "living" way.[25] A particular house-biography of the Zurlinden Estate illustrates the application of these theories and methods, leading to the principles of quality and durability in housing drawn from this example.

Zurlinden Communal Housing Estate, Zürich

The Zurlinden Estate was the first urban apartment building in Zürich that was built following a design competition; its type and style make it an exemplary character of housing construction. The estate has maintained a sense of consistency despite the changes in social living in the surrounding neighborhood, and has produced a concentrated strategy of consistent maintenance based on the simple standard of durability and attention to detail. On one hand this strategy has made low rent prices possible in that the maintenance strategy prevented the need for major repairs. On the other hand it also guarantees the kind of living space and neighborhood that tenants identify with and stand up for, including decisions concerning overall renewal. The owner's maintenance strategy, along with the involved tenants who identify with the neighborhood, all make their mark on Zurlinden in terms of its built and lived space. They contribute decisively to the way the estate is appreciated, and therefore to its durability and longevity.

Fig. 1: The site plan of the Zurlinden Housing Estate in Zürich in the context of 1900's urban block perimeter.

From 1914 onwards, the municipality of Zürich found itself confronted with an increasing lack of affordable rental housing, as private construction activity had come to a standstill. The construction of communal residential buildings was still in its early stages. Common initiatives in housing construction – such as the establishment of building cooperatives to create less expensive apartments – were just starting to form.[26] In the middle of the 1920's, Zürich attempted in vain to stimulate private residential construction activity. In the case of the Zurlinden estate, there was strong pressure for the local authorities to act by alleviating the housing shortage. The task was so pressing that the municipal council decided to organize an architectural competition in order to obtain the best possible solutions. Bischoff und Weideli[27] won the competition with their design related to the monumental axis of Sihlfeld cemetery's gate and adopted a perimeter block structure, which was, and still is, typical of the neighborhood. The present municipal housing administrator still sees the character of Zurlinden today: "If one enters [the estate] from the outside, it is clearly evident that it possesses its own identity through its size alone."[28]

Fig. 2: The floor plan types of 1917 provide apartments with a living room and two bedrooms.

Solid Basic Material With a Straightforward Building Standard

The housing development was constructed for working families, and constructed to inexpensive, simple standards.[29] There was a shared bath, laundry and drying room in the basement of each building, a drying room in the attic and wooden compartments, common in the region, that resemble poultry coops.[30] The choice of materials for the interior was typical of the period such as wooden slat or parquet flooring in the rooms, ceramic tiles in the kitchens and simple wooden wainscots along the walls. As early as 2006, the architects who were commissioned to update the buildings commented on their existing and original interiors, stating that "The apartments displayed a simple but very meticulous design."[31] Considering the fact that the specifications of most houses built in the early 20th century do not meet today's Swiss standards of floor area, domestic equipment, amenities and insulation,[32] the upgrading of the Zurlinden estate was exemplary because of the "soft" way it was handled. Substandard conditions were upgraded, but this was done on a moderate level.

Extended Cycles of Renewal

The Zurlinden estate experienced a few interventions to update the buildings in the 1960's before the first major maintenance work was carried out. From today's point of view, the earlier interventions were "rather more reserved with maintenance. Maintenance was oriented more to individual components or individual measures rather than to the whole package."[33] The materials, which were initially chosen for construction, proved to be durable and robust.[34] After forty years, between the years of 1959 and 1962, the first extensive maintenance of the façade was carried out due to "normal signs of wear and tear" while "Further major expenditure" was expected and planned for subsequent years.[35] This work included modernizing the kitchens, which had remained in the original simple configuration, but with outdated, inefficient appliances and fixtures. At this time, installing new baths and fireplaces had become unavoidable, since the communal baths had become culturally obsolete and therefore in a poor condition. As a result of the estate's careful design and consistent maintenance strategy, between 1960 and 2006, it was possible to reduce the regular upkeep cycle for Zurlinden[36] without incurring any serious consequences to the buildings, while keeping the rental costs unchanged and low. This was possible because of the regular and economic approach to maintenance and repairs.

In 1986, the building was added to the official registry of culturally significant objects in Zürich to be protected for their communal importance. An approach characterized by "gentle renewal with regular maintenance work" emerged as a strategy for the years to come.[37] A survey of Zurlinden conducted in 1996 after 80 years of habitation confirmed "very durable basic materials, well-preserved roofs but in need of update. The plumbing pipe work in need of update."[38] This demonstrates an aim to optimize the life-cycles of various components together, in order to determine the ideal timing for repair, and therefore to prevent high costs in the maintenance process. The Housing Administration of the Municipality of Zürich works on the basis of long-term planning. Their plan for Zurlinden included structural upgrading in

2006 to 2007; installation of central heating in all apartments; renewal of the entire plumbing and piping system; combining smaller units to create four-room and five-and-a-half-room apartments; and reserving fifteen apartments close to an elevator for the disabled. Maintaining the basic but durable materials and the straightforward design of Zurlinden – directed at keeping the rental prices affordable while preserving the integrity of the buildings – remains a high priority for the coming decades.[39]

Fig. 3: A typical street façade with one entrance door after the renovation in 2006

Public Participation in Housing Renewal and Upgrading

In addition to the design, construction and administration, one crucial factor must be emphasized when assessing the durability and longevity of the Zurlinden housing estate: the way the tenants' interests are reflected in the process.[40] The local administration integrates the involvement of Zurlinden's tenants in important decisions as an additional means to maintain to the quality of the housing.[41] They are given the opportunity to become actively involved in the design of their own living space, along with the option to carry out their own adaptations. This increases the tenant's ties to an apartment, creating a sense of identification and the apartments tend to be treated with care.[42] The old building standards and low rental prices have served to compensate many tenants for the investments they have made in updating their apartments.

The tenants' interest in maintaining the buildings was so high that a comprehensive and expensive plan to combine more apartments into larger units was rejected due to the tenants' fear that it would lead to higher rental costs. Even in the early stages of the renewal project, active tenants took on the initiative to communicate between the administration and the rest of the tenants about the planned measures so that it would be possible for the tenants to carry out some of the alterations themselves and guarantee the costs. These arrangements occurred when converting the rooms in the corner flats and equipping the apartments with new kitchen furniture – a measure that surely satisfied both parties, both the tenants and the administration alike, over the long term.[43] Interestingly, through this dialog, the tenants rejected the new kitchens that were proposed by the administration for cost reasons, and also because the appearance of the new kitchens did not appeal to them.[44] The administration concluded that the tenants identified strongly with the "old" house, agreeing to their rejection of this particular aspect of the renewal.[45]

Maintaining the original material had to be accounted for during the last major renewal work at Zurlinden, conducted in 2006.[46] The architects who won the commission to plan the work intended to improve the floor plan in a way that was easy to implement, and to accommodate all of the plumbing and electrical work between the kitchens and the bathrooms in an efficient way. The new plan has brought the ninety-year-old housing development up to modern technical standards. However, the building material was hardly changed; many of the original building elements such the interior doors, wood wall paneling and certain parquet and stone flooring materials were maintained. Original details such as the small windows-within-a-window[47] in the kitchen and the two-tone paint on the kitchen walls were reconstructed.[48] However, signs of wear and tear on the floors had to be deliberately tolerated by the residents as they were not addressed in the upgrade.

Fig. 4: The original doors from the kitchen to the balcony with a view to the street.

Renting Affordable Apartments for Different Social Groups

Over time, a change took place in the social status of the tenants living at Zurlinden, from the original group of worker families to the present group, which consists of freelance craftsmen, employees, students and workers. The proportion of families has remained constantly high over the years. Interest in the apartments and in the estate as a whole has remained, even increasing with the development of the surrounding area into an urban lifestyle neighborhood for young families:

> *People have always been interested in these apartments. They are affordable. The rooms are well planned, the position is good, the apartments are family-friendly; they are surrounded by a park.*[49]

Due to the fact that the landlord is the city, Zurlinden's administration acts in accordance with the costs-rent model currently in effect, and the rental prices remain comparatively inexpensive.[50] In the highly competitive Zürich housing market,[51] the local authority plays an important balancing role by providing affordable options for living space in the city. Property is rented out in accordance with guidelines, which demand a mixture of tenants from different social groups to create a sense of social "coherence."[52]

In municipally administrated housing estates throughout Zürich, the principles of mixing and social "coherence" have changed the tenant make-up of the estates, from the original majority of Swiss families through the 1960's, to an increased proportion of non-Swiss residents.[53] At Zurlinden, these trends were in line with general changes in the neighborhood, where an increasing number of immigrant families were settling. A new group of tenants moved in during the 1990's after a period of high fluctuation, possibly caused by the simple standards and the fact that the buildings were in need of renewal and repair. This group consisted of young, single, well-educated, childless freelance people and artists who became interested in the traditional worker and family neighborhood. The administration ascertained a further stage in the development of tenants during the complete renewal in 2006, when predominantly young Swiss and foreign families moved in. Over the years, housing conditions at Zurlinden have remained fundamentally unchanged, and these are viewed as an expression of appreciation by the tenants.[54] During the analysis, it became noticeable there were some very long tenancies, some of which endured for 50 years or longer.

Adaptation Strategies: Consideration, Community, Creativity and Flexibility

As the original flooring, wall surfaces and doors were deliberately kept in the apartments, and the original paint was maintained in the kitchens, the character of the old building remains constantly present. However, the opinions of the tenants differ with regard to the present materialization. The simplicity, high degree of sturdiness and durability of the materials were predominant in the administration's selection of the materials to be preserved. However, the age of the building materials in general calls for tenants to exercise a degree of creativity and tolerance when adapting to their apartments. Materialization has an influence on patterns of living: wall coverings influence the way that individual rooms are furnished, and also make certain styles of furnishing or patterns of use in certain rooms impossible. All of the tenants questioned in the study report defects in their apartments that need to be tolerated, including cracks in the flooring and noise from other apartments. For example, the transmission of sound through the flooring is still a problem, even after the renewal work, which calls for the tenants to take appropriate measures with their living arrangements and their use of space. If the social network functions well, it is possible to develop bottom-up adaptation strategies within the community of tenants for living with certain material defects in the building.

The Kitchen – Simple but Spacious Heart of the Apartment

When the long-term tenants of Zurlinden were questioned about their use of space, the spacious kitchen-cum-living room was frequently mentioned as a feature of living quality, both in the past and in the present.[55] With an area of 11 m^2, the kitchen can be used in a variety of ways: as a place for work, retreat and gathering around the kitchen table. The spatial structure of the kitchen allows the tenants to furnish it in a variety of ways, and it receives ample light from the window and the balcony door facing the street. In the 1960's, the kitchens were brought up to date from their original, simple standards, but continued to remain simple in comparison to the kitchens in most private or cooperative housing developments in Zürich at the time. Since the 1960's, the kitchens have been fitted with an old cooker, sink, draining board and cupboard, and between 1962 and 1996, the only upgrades that have been carried out are those by individual tenants.[56] Originally, the kitchen stove was the primary heating source for the apartment which compromised the quality of living; this poor heating source was compensated with additional heaters at the tenants' expense. After the renovation in 2006, this problem ceased to exist, much to the tenants' satisfaction.

Fig. 5: The original kitchen and wood-burning oven in the 1960's.

Flexibility of Use and Personalization of Spaces

In the context renovating old housing stock, the sustained potential of the Zurlinden apartments is grounded in their inherent adaptability[57] facilitated by the arrangement of the rooms and the floor plan.[58] The dimension and arrangement of the rooms allows the tenants to use them in different ways: the living space can be used very flexibly because the living room and bedroom have the same approximate area of 16 m^2, and both look over the quiet inner courtyard. What was originally a child's bedroom, for example, can become a spare room after the child moves out, then a storage room at a later point in time.[59] The bedroom and living room can be swapped around, and the additional surfaces in the rooms, such as the large wooden windowsills, provide spaces where private objects can be placed; these spaces for personalization are another important feature of quality, often mentioned by Zurlinden's tenants.[60]

Fig. 6: The inner courtyard.

The generous room dimensions and well-conceived floor plans at Zurlinden continue to provide a high standard of living to the tenants today. One aspect of quality is the size of the rooms – 14 to 16 m^2 – which allows them to be used flexibly and freely. Originally, the most common type of apartments had three rooms. One room was equipped with a built-in cupboard, which was often removed by the tenants to create additional room for a child's bed.

The original four-room apartments had a permanent built-in cupboard in the hallway, and families residing in these units particularly appreciated the additional storage space.

The Socio-spatial Relations - the Block, the Surroundings and the Green Spaces

At first sight, the Zurlinden estate gives the impression that it merges with the surrounding urban block structure. This interlocking of neighborhood and building can also be analyzed as the residents of the surrounding neighborhood use the hidden inner courtyard of the housing estate as a green space, spending time there along with the residents of Zurlinden. However, this is not always without conflicts, as semi-public space and public space are limited. The intrinsic perception of the housing estate focuses on the division of social space into parts; as such, the estate is not experienced as one integral unit, but rather as a perimeter block settlement with different entrances, or even as a row of streets.

The perception of spatial structure in the Zurlinden housing development and the surrounding areas is differentiated by axes, as seen in the rows of streets, and by areas, as seen in the public Fritschiwiese and the inner courtyards. According to their proximity to these axes and areas, different qualities are perceived by the tenants living in different blocks at Zurlinden.

The central courtyards form the housing estate's semi-private exterior spaces, which are accessible to the local public, since the entrance gates are not locked during the day. These courtyards add to the high quality of life in the development and "have the character of an oasis" in the city.[61] A nursery school and a crèche use the large children's playground in the courtyard. Residents in the adjacent block use the large courtyard in their leisure time, above all in the evenings and the summer months.[62] The public park of Fritschiwiese used to provide an important place for outdoor relaxation to substitute for the absence of outdoor space in the apartments, but recently, the park has become a meeting place for many other residents in the neighborhood. The interviewees at Zurlinden feel the loss of the private intimacy of this space. Many of the elderly residents now consider the Fritschiwiese to be an "area for foreigners" and avoid it completely, in contrast to former times. One reason for these new cross-cultural encounters is the way that the social structure and demographics have changed in the housing developments surrounding Zurlinden since the 1990's.[63]

Although some residents feel a strong sense of identification with the housing estate as soon as they glimpse the façade from the street, other residents whose apartments face the noisy street tend to disassociate themselves from the street and the exterior façade in order to feel at home in their flats.[64] Although Zurlinden is located in the city, the residents describe the surrounding area as *rural*: "This is a proper residential neighborhood. And the people in the street say 'Hello' to each other like in the country side."

Conclusion

As this study of the Zurlinden estate shows, the key concepts – focused on the construction, management and social aspects of multifamily housing – support the appraisal of a building's durability. The key concepts are crucial for maintaining the quality and durability of investment prospects and use for decision-makers, investors and residents alike. Non-profit investors such as local authorities, housing cooperatives or even for-profit investors such as pension funds or real estate holding companies may consider these findings when deciding whether to demolish or to renew a building. The perspectives of the residents and users are often overlooked in the decision-making process, despite the fact that their perspectives could provide a clear picture of the social value of the building under consideration. This is apparent in the case of the neighborhood networks and their efforts to support and maintain the Zurlinden housing estate, an estate that is old-fashioned yet socially rich and economically viable.

The perspectives presented in this study of the Zurlinden housing estate underlie the key concepts of durability and sustainability for multifamily housing, focused on three different areas: construction, management and social.

(a) Construction

An architectural concept that is sensitive to the urban location; the choice of durable materials of high quality, built to simple but exact standards; a spatial organization of apartments that allows for flexibility in their use through the concept of adaptability;[65] an apartment size that is defined by sufficient space for flexible use, and not by sheer floor area; a kitchen-cum-living room at the heart of the apartment; adequate storage and space for personal effects; the provision of multiple options for connectivity with doors and passageways inside the apartment; construction and floor plans sensitive to visual and aural privacy; and access to clearly defined private, semi-public and public spaces in the immediate outdoor environment that are available for multiple uses.

(b) Management

A rental practice that is differentiated according to the qualities of the apartments; a diversity of tenants from various social groups including those of different age, health, employment, income, family size and nationality; long-term planning strategies for repair and renovation that include the residents as key partners; and client-oriented communications with the residents, with personal contact to resolve immediate problems which may take the form of an on-site superintendent.

(c) Social

Ensuring the participation of tenants in the process of housing renewal; giving tenants the possibility to personalize their home interiors when doing personal upgrading work; enhancing social adaptation strategies to overcome the defects of older buildings by encouraging communication among neighbors and creativity, flexibility and negotiation in the use of living space.

These concepts provide not only the effective basis for designing and managing housing estates but also the fundamental premise, in parallel to the design practice, necessary to achieve durable and sustainable living conditions that are also beautiful and healthy. Everyday residential buildings – those built in the past with different funds for different social groups – can shed new light on the questions of sustainability, quality and durability of architecture. Everyday architecture is marked by the demands of usability over the course of many years, along the lines of what the Swiss architect Michael Alder mentions about the qualities of architecture in general:

> *If someone builds a house, the contractor is the first inhabitant; after maybe 20 years other people will live in it. If I design a house, I start from the premise of rooms, which I do not determine more exactly; they can be used in different ways and what they are is decided by what the inhabitants do with them.*[66]

At the beginning of the new century, we require new strategies for dealing with the buildings of the last hundred years. Those erected during the post-war period are now being renewed, requiring up-to-date measures. The problem cannot be solved by a policy of replacing older buildings with new ones, even if ecological construction methods are used in the process.

The strategies for sustainability must include the long-term use or reuse of existing buildings over the course of their life-cycles. Discovering and promoting everyday residential buildings that continue to adapt and provide a good quality of life for their residents is crucial. House-biographies provide new insights into the qualities that constitute long-lasting buildings, addressing the important question: what has stood the test of time? Neither uncritical maintenance nor uncritical destruction should be allowed to determine today's planning practice, and it is important to note that longevity can also become an obstacle to urban development and densification. Studying durability therefore means reviewing things in the present without remaining anchored in the past.

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Figs. 3 & 6: Marie Antoinette Glaser

Fig. 4: Annelies Adam

NOTES

1 Walter Benjamin, "The Work of Art in the Age of its Technological Reproducibility," in *The Work of Art in the Age of its Technological Reproducibility, and Other Writings on Media*, ed. Michael W. Jennings, Brigid Doherty and Thomas Levin (Cambridge: Belknap Press of Harvard University Press, 2008), 40.

2 Aldo Rossi, *L'Architettura della Città* (Torino: CittàStudi, 2006), 497.

3 Ibid. p. 509.

4 Ibid. p. 498.

5 *The Architect* 5 (1988).

6 Vittorio Magnago Lampugnani, Die Modernität des Dauerhaften: Essays zu Stadt, Architektur und Design (Berlin: Wagenbach, 1995), 33.

7 Ibid. p. 37.

8 Thomas Herzog, "Einfachheit und Dauerhaftigkeit. Ein Versuch," *Der Architekt* 3 (1988): 196-197.

9 Vittorio Magnago Lampugnani, Die Modernität des Dauerhaften: Essays zu Stadt, Architektur und Design (Berlin: Wagenbach, 1995), 34.

10 Ibid. p. 73.

11 Uta Hassler, "Das Dauerhafte und das Flüchtige. Planungsleitbilder und die Zukunft des Bestehenden," in *Nachhaltigkeit und Denkmalpflege. Beiträge zu einer Kultur der Umsicht*, ed. Marion Wohlleben and H.R. Meier (2003), 43-53 & 49.

12 Margrit Hugentobler, A. Henz and S. Gysi, Nachhaltige Stadtentwicklung: Ein Evaluations- und Handlungsforschungsprojekt in der Stadt Zürich. Synthesebericht (1997), 22.

13 Margrit Hugentobler and S. Gysi, "Sustainable Urban Development in Zürich. Learning from Successful Projects," in *City and Culture. Cultural Processes and Urban Sustainability*, ed. Louise Nyström (Kalmar, 1999), 306-320.

14 See "Facts on Living in Zürich," in *Wohnen in Zürich. Programme, Reflexionen, Beispiele*, ed. by the City of Zürich (Sulgen: Niggli, 2006), 187.

15 The share of non-profit housing (communal housing and cooperatives) in the city of Zürich is high, almost 25%. For more information see Statistics Zürich: http://www.stadt-zuerich.ch/prd/de/index/statistik/bauen_und_wohnen/gebaeude_und_wohnungen.html (accessed April 2011).

16 Margrit Hugentobler, A. Henz and S. Gysi, Nachhaltige Stadtentwicklung: Ein Evaluations- und Handlungsforschungsprojekt in der Stadt Zürich. Synthesebericht (1997).

17 Gilles Deleuze, tran. Tom Conley, *The Fold: Leibniz and the Baroque* (London: Continuum, 2006), 144.

18 The interdisciplinary SNF funded project "On the Career of Durability. The Biographies of Appreciated Apartment Houses from 1900 up to the Present" was carried out by Marie Glaser (project leader), Anna Joss, Annelies Adam and Sabine Herzog from 2007 to 2010 at the ETH Wohnforum–ETH CASE, Department of Architecture ETH Zürich. The findings (with English subtitles) are at: www.hausbiografien.arch.ethz.ch (accessed April 2011).

19 Roderick Lawrence, "Integrating Architectural, Social and Housing History," *Urban History* Vol. 19, no.1 (1992): 39-63.

20 Clifford Geertz, "Thick Description: Toward an Interpretive Theory of Culture," in *The Interpretation of Cultures*, ed. Clifford Geertz (New York: Basic Books, 1973), 3-30.

21 In recent years there has been a proliferation of writing on the meaning of the house and the home as a multidimensional concept. Environmental, social, ethnographical, psychological, philosophical as well as geographical studies have dealt with the concepts. Referring to all of them is not possible. A helpful discussion is provided by C. Despres, "The Meaning of Home: Literature Review and Directions for Future Research and Theoretical Development," *Journal of Architectural and Planning Research,* Vol. 8, no. 2 (1991): 96–115.

22 In this work, Schlögel's goal is to break down the conventional chronological approach to history and to add the perspectives of place and synchrony to it. It is not, after all, only chronicles and books that serve as sources of history, but also timetables, address books, maps or buildings. They bear witness to civilization and make history tangible in the truest sense of the word, becoming in themselves a part of historiography. Karl Schlögel, *Leggere il Tempo Nello Spazio* (Milano: Mondadori Schlögel, 2009), 314. The German title: *Im Raume Lesen wir die Zeit: Über Zivilisationsgeschichte und Geopolitik* (2003).

23 Roderick Lawrence, "Integrating Architectural, Social and Housing History," *Urban History* Vol. 19, no.1 (1992): 39-63.

24 Johann Friedrich Geist and K. Kürvers, *Das Berliner Mietshaus 1862-1945* (München: Prestel, 1984).

25 Marie A. Glaser, A. Joss, A. Adam and S. Herzog, Zur Karriere des Dauerhaften, *Hausbiografien wertgeschätzter Wohnungsbauten aus den Jahren 1900 bis zur Gegenwart* Final Report (Zürich: ETH, 2010).

26 Quartierspiegel Sihlfeld (2006), 25.

27 Robert Bischoff (1876-1920) and Hermann Weideli (1877-1964) owned a well-known office, and were responsible for building the Café Odeon at Bellevue, among other things.

28 Transcript of the interview at the Housing Administration City of Zürich (2008), 2.

29 Setting up common baths was a normal practice in housing construction at the time, (housing was kept as low-priced as possible) according to the original construction standard of the settlement industry I (BEP) as well as the Limmat I municipal housing development.

30 Housing Politics of the City of Zürich (1957), 53.

31 Stücheli Architects, *Documentation, Zurlinden Residential Development* (Bauherrschaft City of Zürich LV: Construction project file LV, May 17, 2006), 6.

32 Roderick Lawrence, Housing, Dwellings and Home: Design Theory, Research and Practice (Chichester UK: John Wiley, 1987).

33 "The reserves have not been as rosy ... as it actually could have been because of the housing development's age. The reason for this is that maintenance work or repair work used to only be carried out on an individual measure." Transcript of the interview conducted at the Housing Administration City of Zürich (April 8, 2009), 6.

34 AStRP (1004) Housing Colony Zurlinden, Housing Renovation, City Council Resolutions LV (May 16, 1952).

35 AStRP (1317) Housing Colony Zurlinden, Façade Renovation Block III, City Council Resolutions LV (May 19, 1961); (2931) Façade Renovation of Blocks II […] City Council Resolutions LV (November 5, 1965).

36 Replacement of windows (without those in the stairwells) occurred 1977/1979.

37 Transcript of the interview conducted at the Housing Administration City of Zürich (April 8, 2009), 5.

38 Residential Development Zurlindenstrasse, Description of Housing Development LV, (January 10, 1996).

39 Transcript of the interview conducted at the Housing Administration City of Zürich (April 8, 2009), 5-6. The cost of a three-room apartment with approximately 70 square meters of living space was on average 600 Swiss Francs before the renewal and 940 Swiss Francs after. This is still well below the average monthly rent in Zürich, which was 1,236 Swiss Francs in 2006.

40 This cooperation started with the initiative of the tenants who began to communicate actively with the Housing Administration City of Zürich in an early stage, after receiving the first official information. This action was seized by the administration and the communication process was structured in a participatory manner: negotiations were possible regarding the joining of apartments and the new kitchen furnishings.

41 "We are a fairer landlord, as a local authority. For example, it takes a lot for a tenant to be evicted. More than with a private landlord." Transcript of the interview conducted at the Housing Administration City of Zürich (April 8, 2009), 12.

42 Roderick Lawrence showed there are factors that impinge upon the daily life of residents, like the layout of rooms and the materials of furnishing, which can easily be overlooked by architects, planners and housing managers. The involvement of the tenants in housing upgrade and renewal projects supports the long-term acceptance and appraisal of residential buildings. See Roderick Lawrence, *Housing, Dwellings and Home: Design Theory, Research and Practice* (Chichester UK: John Wiley, 1987), Chapter 8. Also, for further information see the well-known German handbook on participation in housing: K. Freisitzer, R.Koch and O. Uhl, *Mitbestimmung im Wohnbau: ein Handbuch* (Wien: Picus, 1987). Also, see M. Hugentobler and M. Brändle-Ströh, "Sustainable Urban Development: A Conceptual Framework and its Application," *Journal of Urban Technology* Vol. 4, no. 2 (1997): 85-99. This article discusses concepts of public participation in sustainable housing development and renovation that count the participation of residents as a factor of successful action on the social level. And finally, see M. Hugentobler and S. Gysi, "Sustainable Urban Development – Learning from Successful Projects" in *City and Culture, Cultural Processes and Urban Sustainability*, ed. Luise Nyström (The Swedish Urban Environment Council, 1999).

43 Transcript of the interview conducted at the Housing Administration City of Zürich (April 2009), 7.

44 Ibid. p. 4.

45 Dazu Ansätze der nachhaltigen Quartierentwicklung, die Partizipation und Mitwirken als einen Faktor für den Erfolg auf sozialer Ebene fassen. See M. Hugentobler and M. Brändle-Ströh, "Sustainable Urban Development: A Conceptual Framework and its Application," *Journal of Urban Technology* Vol. 4, no. 2 (1997): 85-99. Also, see M. Hugentobler and S. Gysi, "Sustainable Urban Development – Learning from Successful Projects" in *City and Culture, Cultural Processes and Urban Sustainability*, ed. Luise Nyström (The Swedish Urban Environment Council, 1999).

46 In order to adhere to the characteristics of listed properties, no wooden court balconies were erected. Cf Mehr als Wohnen (2007), 52.

47 Läufterli, Swiss German for a “small window in a window.”

48 Stücheli Architects, *Documentation, Zurlinden Residential Development* (Bauherrschaft City of Zürich LV: Construction project file LV, May 17, 2006).

49 Transcript of the interview conducted at the Housing Administration City of Zürich (April 8, 2009), 1.

50 Ibid. p. 9.

51 The Zürich apartment vacancy rate was 0.07% in 2010.

52 Transcript of the interview conducted at the Housing Administration City of Zürich (April 8, 2009), 10.

53 Ibid. p. 10.

54 Transcript of the interview conducted at the Housing Administration City of Zürich (April 8, 2009), 11.

55 Interview II (2008), 00:06:49.02.

56 Transcript of the interview conducted at the Housing Administration City of Zürich (April 8, 2009), 3; and Interview I (2008), 00:00:51.00.

57 See Roderick Lawrence, *Housing, Dwellings and Home: Design Theory, Research and Practice* (Chichester UK: John Wiley, 1987). Also, see S. Pikusa, “Adaptability: Designing for Functional Adaptability: a Lesson from History,” *Architecture Australia* Vol. 72, no. 1 (1983): 62-67.

58 Old buildings from before the 1960’s often possess inherent adaptability. The apartment contains rooms, halls and passageways that can accommodate multipurpose

domestic activities. Changes in use are possible within the space. As Pikusa states, "the inherent adaptability is built into the initial design, giving the occupant the choice through intentional ambiguity, within fixed physical constraints of a given plan ... The plan characteristics make a wide range of interpretations possible and there is a minimum of design features that would inhibit particular choices of use." See S. Pikusa, "Adaptability: Designing for Functional Adaptability: a Lesson from History," *Architecture Australia* Vol. 72, no. 1 (1983): 62-67.

59 Tour of apartment I (2008), 00:07:41.01.

60 A high volume of research has been carried out on the process of "home-making." For important literature see Clare Cooper Marcus, *House as a Mirror of Self: Exploring the Deeper Meaning of Home* (Berkeley: Conari Press, 1995).

61 Documentation of the municipal Zurlinden housing development, hg.v. LV der City of Zürich (2008).

62 Interview II (2009), 00:13:26.02.

63 "There are a great deal of unsavory characters in Fritschistrasse, groups of youths and the likes. It has been bad in the last ten years." Interview II (2009), 00:06:00.03.

64 Interview II (2009), 00:26:11.03.

65 Also, see design details in Lawrence (1987); Hertzberger (1977); Henz (1995); and Beisi (1994).

66 Michael Alder Interview in *Archithese* 1 (1984): 8.

6.385 words

Environmental Issues as Context

Elisabetta Pero

<u>*Sustainable Living: the City, Density and Forms*</u>

In Milan, the websites and papers for homebuyers are full of real estate listings such as this one:

> *Property for Sale in Trezzo sull'Adda, Milan*
>
> *A highly desirable area with tree-lined avenues, bicycle lanes, quiet streets with easy parking; great attention to detail with superior materials and finishes; the property also features independent access through a private garden, a large living room, a spacious kitchen, two bedrooms with full size bathrooms, a wine cellar and a garage in the basement. The windows are impact resistant and perimeter and indoor burglar alarms are also available.*

These listings describe for many what is probably their dream home, but above all, they represent the kind of residential planning and development schemes that are widely endorsed by Italian municipalities. Due to the fact that available land for real estate development has become limited in cities, and therefore excessively high in cost, many people have left the cities to find new homes in the suburbs. However, once outside the city, people often realize they have moved to places that are too isolated to attract and sustain the quality of life they expect, and often, that the suburbs are unsafe. Throughout Italy, daily commutes from the suburbs to the cities are congested and arduous.

These trends of suburbanization coexist with a general increase in ecological awareness and tighter environmental regulations. In response, some experimental areas of urban residential development have adopted the use of recycled materials, along with mechanical systems for solar energy and water recycling. Even though the two trends coexist – one characterized by traditional suburbanization and the development of single-family homes; the other characterized by experimental development in the urban areas – suburbanization is clearly a stronger and farther-reaching force at the present time.

Experimental urban development has grown from the critical reflections that some architects have made, regarding the contemporary urban context as an appropriate structure for sustainable development. This trend is based on the observation that the number of homes using active and passive energy systems should increase, while the design of individual homes and their surrounding areas should be reconsidered. However, it remains difficult to consider which forms, densities, designs, technologies and materials these revisioned habitats should take. Already, a wide range of solar energy products exist that are integrated into the construction of traditional homes, however, the design of these energy-saving systems is primarily aimed at reducing their impact on the aesthetic elements of traditional homes. In considering experimental urban development, different possibilities exist in regard to reconciling architectural features with the inclusion of energy-saving systems and sustainable or recycled materials. In addition, designing low-energy buildings does not simply mean applying technologies to a design in retrospect, at the end of a project. It also means devising kits of modular elements that can be assembled from the ground up into various configurations, according to individual tastes.[1] Along these lines, Roberta Morelli argues:

> *Some experiments effectively present excessive processes of simplification with respect to the complexity of the aspects involved, suggesting where the architectonic choices are reduced to identification with the accessories of a construction that loses an identity of its own, because it is completely estranged from where it stands.*[2]

Two aspects are important to the exploration of aesthetics in sustainable architecture: the city and its density on one hand, and the form of individual buildings on the other. These two aspects must be considered both discretely and jointly, as they lie at the center of far-reaching ramifications that underscore current debates on sustainability. Namely, can the city be regarded an adequate form of contemporary living on which to develop the principles of sustainability? And through this process, should the identity of the city be preserved, and on what criteria should these decisions be based?

The City as a Form of Sustainable Living

Oriol Bohigas defends the city as an appropriate structure for sustainable development. In an article entitled *Ricostruiamo le Mura* (Let's Reconstruct the Wall) he maintains:

> *… the expansion of cities cannot take place without rules. On the contrary, they can expand on three fundamental conditions: multi-functionality, i.e. spaces, neighborhoods, squares, streets and so on cannot be classified only according to their presumed purposes of use; compactness, i.e. there must be no physical or practical separation; legibility, i.e. each place must be immediately comprehensible for those who live there.*[3]

According to Bohigas, it is important to preserve and develop a traditional understanding of the city. He characterizes as the standard bearer of urban design a type of development that gives collective space the leading role, and consequently, "any action of redeveloping an existing city or building new neighborhoods must start from the reconsideration of collective space, the form of which is determined by various factors but in particular by the transformations of the context."[4]

He goes on to specify that the Modern Movement has not been conditioned by this context, instead, devising and giving rise to autonomous architectonic forms:

> *Almost all the new typologies have been developed as modules of blocks or towers in a non-urbanized territory, in the abstraction of a landscape which is neither properly urban nor suitable for the formal tradition of the existing one ... This is why another line of research would seem advisable for residential typologies ... that start from the conditions of the identity of places and urban recognizability.*[5]

If some consider cities to be autonomous bodies with lives of their own, inevitably destined to expand to the extent that it becomes preferable not to speak of individual cities at all but of regions and the *infinite city*, others like Bohigas would take a different view. They maintain: a city that survives through history is one that lays down rules to regulate the extent of its development.[6] Milan, which stands for a highly built-up region stretching from Turin in the west to Venice in the east, was chosen to host the 2015 Expo, *Feed the Planet, Energy for Life*. Following the debates and reflections arising from the Expo, Milan began, for the fist time, to discuss the need to increase the density of its existing territories, while structuring a more innovative and appropriate relationship between its urban and rural contexts. Milan's Territorial Governing Plan (*Piano di Governo del Territorio*, or PGT), slated for approval, discusses the need to activate processes of urban regeneration to increase the city's current density. The intent is to launch a process that is no longer based on the idea of concentric urban development, but on a territorial vision of the habitat. Within this the new territorial vision, interstitial voids are highlighted as strategic places to increase the density of residential and public functions.

Façades and Energy Efficiency

Reflections on the potential forms that sustainable architecture could take, and in particular, on the potential forms of sustainable homes in an urban context must be placed within wider and more critical debates on the notions of contemporaneity. The dynamic and volatile global economy has impacted contemporary architecture in many important ways: among them, by fostering a certain approach to architecture as *spectacle*, and the tendency to place scientific discoveries and engineering innovations at the forefront, promoting the *technocraticization* of architecture. Laura Thermes maintains that:

> *... in contemporary architecture, living in a cultural condition in which there is no common conception of beauty, the architect who wants to show his achievement cannot concentrate his energy on form, unless this means making it a talking point. To attest to having produced something more innovative, he can only act on a technical level, the only one which according to a generally held opinion allows agreeing on meanings which can gain a widespread consensus.*[7]

The identity of a city is not only rooted in the meaning and image of its public buildings and monuments, but also in the mundane and everyday fabric of its residential areas. Contemporary architecture of the home is concerned with the production of designs that are domestically recognizable, given the incorporation of new technology and energy-saving concepts. A resident needs to be able to recognize his own home in ways that are both literal and figurative. Along these lines, Paul Ricoeur suggests a transformation of the verb *recognize* into its passive voice *to be recognized*: “I actively recognize things, persons, myself; I ask, even demand, to be recognized by others.”[8] In this sense, the façade of a building plays an important role in its ability *to be recognized*, both by its inhabitants and in the context of the city. The concept of recognizability could serve to redefine Vitruvius’ concept of *venustas*, by opening up the idea of beauty in ways that are not only based on material interiority, but also on the relationship between the home those who inhabit it.

According to Nicola Emery, this dualism, between the autonomy of a project and its responsibility for relationship defines the idea of "difficult architecture" in that it "has to be able to harmonize two laws which are almost opposite to one another and this is why good architecture is always threatened by a sort of paradox, or by an antinomy that makes it essentially difficult."[9]

Raffaele Pugliese summarizes the continuous and conflicting process of city building in two different positions put forward by the Abbé Laugier in 1755. The first position is that:

> *If we want a city to be well built we must not abandon the façades of homes to the whims of private individuals. Everything that looks on to the street must be defined and subject to the design laid down for the whole street by the public authorities. Not only must it be laid down where building is allowed, but also how building is to be done.*[10]

The second position is that "everyone is entitled to have their say on what is built in public." Considering these two divergent positions, Pugliese states that:

> *Between these two different points of view, discussion can be opened on the inevitable need that building a city, in particular its public space, has to be the result of unitary and collective decisions, which in the case of Laugier are restricted to the established authority, as the interpreter of the social will, and in the case of the popular saying, are the result of a shared process of progressive refining of common taste.*[11]

Overall, façades play a fundamental role in building the identity of a city. The potential to respect urban areas while renewing them requires a profound understanding of which characteristics of façades have contributed to the construction of dense and compact habitats. It includes the establishment of a recognizable *image* for the city's public spaces and private houses, representing the civic – in the sense of belong to the city – value of each within the collective habitat. Understanding these characteristics is a way of keeping the city alive, preserving it from the centrifugal forces that scatter homes over the territory.

Today, the design of façades is enriched by the potentials offered by new materials and techniques. As Christian Schittich points out, "the façade materials range from traditional bricks and timber to new forms of glass construction and iridescent metal skins, and in many cases, a specific texture is involved."[12]

The rang of materials has generated work on façades that led Oliver Domeisen to wonder, "How does one define the term *ornament* and where is the dividing line between ornament and mere texture?"[13] Given these trends, recent transformations in architectural design have been triggered by the need to save energy, and their visible components – new materials, techniques and systems –are concentrated on building façades. These transformations are valuable in creating a recognizable *image* for the homes in a given city with an effective formal synthesis of civic values, technical qualities, aesthetic qualities and a high degree of efficiency, all drawn together in the façade itself.

Environmental Questions and Context

Context can provide a valid foundation for the above-mentioned formal synthesis. This is based on the idea that sustainable forms consist of technological elements, along with the establishment of an appropriate relationship between the building and its environment and the intelligent and critical application of a given building tradition. The notion of sustainability points to the creation of buildings that meet contemporary demands for programmatic flexibility, while at the same time, staying durable and resistant within a given cultural and environmental context.

Context has profoundly influenced architectural discourse and production since the end of the Second World War. Through his investigations of how different cities destroyed during the war were to be rebuilt, William Curtis reconstructs the debate on the subject of context, highlighting the nuances proper to individual European countries from Germany, France, the Netherlands and Italy.[14] In the rebuilding of Italy, Ernesto Nathan Rogers coins the term *environmental pre-existence*:

> *… we can accuse criticism of formalism when, in appreciating with a hindsight the meaning of a Brazilian building, it does not take into due account the fact that the building is in Brazil; reciprocally, we must accuse the architect of formalism when he does not absorb a priori in his work the particular and characteristic contents the environment suggests to him.*[15]

By environment, Rogers refers to a set of cultural values in which new forms are historically situated.

Today, the growing awareness that energy resources are limited has forced us to concentrate not only on the anthropic traces of our territories and their cultural implications, but also on their natural and geographical implications. Provocatively, we could announce the end of the anthropocentric habitat, which places human needs at the center of design. The anthropocentric habitat was strongly envisioned by Le Corbusier in his design for the Tsentrosoyuz in Moscow in 1928, and through his idea that buildings in Russia, Paris, Suez and Buenos Aires, along with boats that cross the Equator, should be hermetically sealed: heated in the winter and cooled in the summer so that pure air at 18° Centigrade circulates through them at all times. The end of the anthropocentric habitat would foster an architecture that does not aim to resist nature, but to enter into dialogue with it through the production of buildings that are decidedly *not* hermetically sealed.

Early industrialization started a revolution in the building industry that was interpreted by architecture's Modern Movement with the fervent enthusiasm of the Enlightenment. For the first time in history, architects had the chance to build homes for all, quickly, at all latitudes and with higher standards. This new architecture had to express new spiritual attitudes:

> *This architecture cannot be subject to any law of historical continuity. It has to be new just as our state of mind is new ... Architecture is being detached from tradition. We have to start all over again.*[16]

After the Second World War, the prevailing architecture concentrated on rules rather than individual vision for the basic reasons of shelter and survival. Construction was standardized based on relatively neutral modernist building configurations. These provided a solution for the problems of shelter, hygiene and function, but Curtis notes that they:

> *... often lacked humanity and urban sensibility. The new order seemed destined, with or without architects, to create objects that were scattered and isolated, hostile to the models of the traditional European city and in general void of any sense of identity. The problem was no so much a lack of talent but the absence of an acceptable set of rules to organize the city ... The void was not filled by the diagrammatic versions of pre-war urban visions built in the 1950s, indifferent to the variations in climate, culture and topography.*[17]

In Italy in 1950's, as in other European countries, a critical position re-emerged that called for the needs of particular situations and places to be considered in architectural design, and according to this, the modernist legacy was to be revised. Writing in 1955, Nathan Rogers states in *Casabella* that:

> *The notion of the 'maison de l'homme' ... evolves beyond the abstract and indiscriminate pattern of the ideal man: it becomes richer by acquiring the sense of human history in its dramatic events of the past, and spreads to recognize the distinctive individualities of modern society (and, therefore of the popular classes) which only now find the strength to emerge. These contents cannot be inserted without any effect on appearances, as forms are modeled, immediately, on them, in the physical representation.*[18]

According to Rogers, the assumptions of the Modern Movement were inherently sound, but they had to be recognized as activating an evolution. Without falling into any contradiction with the original approach, he proposes:

> *... carrying on those same principles to further consequences: this method helps us to broaden the horizons of research and to include new and coherent results. The functional relationship between utility and beauty ... expands, influencing larger areas, where cultural exchange becomes more intense, more sensitive and more dramatic: in essence, more human.*[19]

Given this history of thought, it is important to ask whether sustainability – understood as an environmental issue strictly connected with the concept of context – can continue within the reflections of the Modern Movement, and the reactions to it after the Second World War. One appealing hypothesis places sustainability in continuity with Rogers' arguments. It maintains that just as modernist architects gave shape to new construction in concrete, steel and glass from heavy industry, contemporary and sustainable architects can give shape to intelligent buildings based on electronics and information technology. These intelligent buildings would accommodate the goal of living in greater symbiosis and harmony with nature, instead of the modernist notion of being sheltered from it. In part, this goal has already been accomplished by the transition from industrial standardization to digital customization that allows the design of more flexible and adaptable buildings.

Energy and the Revision of Environmental Pre-existence

Rogers also suggests that "The Step to Make"[20] is not exiling technique as something exterior to the project. But rather, taking control of technique fully, to the extent that it can be transformed on contact with culture. "Adaptation must be possible despite these conditions imposed by modern life and it is here that technical considerations must find the appropriate language to guarantee that a building stands there, in exactly that spot, and not anywhere else."[21]

These ideas provide the possibility to update Rogers' concept of *environmental pre-existence* through reflections on the identity of home and reflections on today's environmental and ecological issues. Could these reflections update certain paradigms of the architectonic? The question of identity is closely connected to Rogers' theory of *environmental pre-existence*, and it provides a compelling agenda for architecture in the context of today's globalized world. In addition, the question of urban civic identity can also find new opportunities in the context of today's environmental and ecological issues, with respect to orienting the scattered city.

Façades of Milan between Efficiency and Conservation

Current technological abilities to measure the characteristics of a city – including its cultural and environmental characteristics – taken along with the knowledge of building techniques that confer both a lasting and durable nature to homes, may provide the orientation necessary to develop new forms of sustainable building. These advances may be based on studies of the use of new facing materials and the types of construction details necessary for buildings to function, integrated with reflections on the recognizability of the home. These studies can contribute to defining new forms of sustainable homes, while providing guidelines for preserving and updating the energy efficiency of existing homes within the context of individual cities.

In particular, the firms of Cino Zucchi Associati and Consalez Rossi Architetti Associati have recently worked in this direction in Milan. Their designs are decidedly aligned with the reflections of the large number of architects who rebuilt Milan after the bombings of the Second World War, and with the city's later expansion. Among the most important architects of the post-war period, Gio Ponti laid down his program of architecture in *Domus*, the magazine he founded in 1928, by stating a philosophy of living aimed at reformulating the idea of the modern home:

> *The Italian home is not the cozy and protected shelter of dwellers against the harshness of the climate ... Its design does depend solely on the material needs of living, it is not only a 'machine à habiter.' The so-called comfort is not in the Italian home only in the things that meet the needs and comfort of our lives and the organization of services. Its comfort is something superior, it gives us back the measure of our own thoughts; it encourages healthy habits through its simplicity.*[22]

In this regard there is a larger moral ramification that confronts architects: the home is not only a problem of art or technique; it is a problem of civilization. In Ponti's words, visionary, poetic and interesting tensions can be perceived when architects work from an *anti-dogmatic* and *a-specialist* approach. His reflections are aimed at redeeming architecture from the formal abstraction of a certain rationalist culture. In a sense, redeeming architecture from "an impatient search for a technical civilization capable of expressing the intrepid taste for the new to which he attributed value, characterizing the myth of a culture ready to continually be reborn from the ashes of its past."[23]

An exemplification of Ponti's ideas can be seen in his use of the light façade. Ponti believed that civilization in general – and therefore architecture as well – proceeded from a heavy period to a lighter one. The ideas underlying his beliefs remain under debate, unsettled to the present day:

> *... it would suffice to think of two very immediate examples such as Mario Botta and Herzog & De Meuron ... who propose two different hypotheses on the role of technology as a motor of different hypotheses linked to form: on the one hand the idea of monumentality linked to the concentration of matter, on the other an idea of de-materialization linked with the autonomy of the skeleton of the façade.*[24]

With the Palazzo Montecatini, built between 1935 and 1938, Ponti's façade aims to exalt the regularity of the openings through the use of:

> *... horizontal and vertical alignments of the windows and openings ... well represented by the abacus of the stones. The two materials produced by Montecatini, slabs of marble and aluminum, become the protagonists of the entire building, being translated into an interesting means of communication and icon of the group ... all the window frames are exactly flush with the marble slabs of the façade, in order to eliminate the window as a hole, as a contour of smashed-in wall.*[25]

With the design of the Palazzo Montecatini, the aim was to remove all impressions of heaviness, taking architectural lightness to a new level synonymous with the progressive lightness of civilization. In addition to looking for an image of architecture appropriate to his time and place, Ponti was also looking for an *incorruptible* form of architecture, unlike the simply plastered images of modernity that tended to deteriorate quickly – both physically and culturally. As such, Ponti's consideration of the heavy/light can be associated with the consideration of the lasting/ephemeral. Today, the globalized economy impacts architecture by demanding schematic solutions to the factors such as speed, industrialization, repetition of elements and ease of transport; these pressures act in concert so that the entire building process has been transformed by them.

Moving back to the consideration of deterioration, the heavy/light and the lasting/ephemeral, the overall impression today is that buildings are not designed to last as long as they used to in the pre-modern period. Their deterioration is not just due to the lack of material solidity, but due to the fact that architecture seems ready to become an ephemeral art, or in a more sinister light, one of the society's *consumables*. According to Raphael Moneo, "This is one of the reasons ... why architecture today often has recourse to a superficial image of its past: contemporary society does not believe that its creations can last. What counts is the first impact of a building and not how long it will last."[26]

Another topical and interesting theme developed by Ponti, which remains relevant to the present day, is the value of light moving from the interior of the building to the façade. He believed that the façade should be designed taking into consideration how it would look during the day and the night. The window was seen as a standard hole in the wall, but also, as a passage for the nocturnal projection of light streaming from inside the building and through the decorated window. In terms of window design, Ponti envisioned a frame with movable and fixed parts, with a very thin cross-section of aluminum or wood containing shelves for objects, small collections of ceramics, vases or books so that the light streaming from the house reflected the culture of those living in it. In the apartment building on via Dezza (1956-57) he concretized the idea of the *expressive home* by rejecting the uniform repetition of standard plans. (Fig. 1) In some way, another contemporary theme appears here as well: that of the expressive flexibility of use. The balconies at via Dezza create the fixed point on which to play with the variations of the openings, corresponding to the variable size and flexibility of the apartments.

Fig. 1: Gio Ponti, House in Via Dezza, Milano, 1951.

The research conducted by two other Milanese architects, Mario Asnago and Claudio Vender, is strongly linked to the work of Gio Ponti and his theoretical positions. The long-standing collaboration of Asnago and Vender, from 1923 to 1970, left its mark on the city of Milan, as they designed a considerable number of buildings in the center and in the area of the first residential expansion. Their production concentrated on light façades in particular. At first sight, their façades may seem ordinary, but after careful observation, there emerge gaps, imperceptible shifts and different dimensions. Fulvio Irace criticized the illogicality of these differences in a letter to the Building Commission by stating, “Asnago and Vender explained how their poetics consisted precisely of working on these imperceptible differences of axiality, with the introduction now and again of a slight variant in the constructive logic of the whole.”[27]

According to Cino Zucchi, while the invention of gaps and shifts seems to be markedly Mannerist in nature, they are underlain by a great comprehension of place and made in the attempt to create continuity between the building and its environment.[28] For example, the counterpoint between the form of the roof and the position of the building often appears like a comment on the building’s position within the city or, in other situations, the building bends to follow the exposure of the sun, to open views or to create spaces of great environmental quality. In the residential building on via Faruffini (1953) the façade is characterized by openings of different shapes and dimensions, in part recessed with respect to the façade and in part flush with it. (Fig. 2) The window frames are made of wood, iron and anodized aluminum, while the overall building is faced with white ceramic tiles. Replying to the technical commission that opposed these variations, the architects used expressions in such a way as to "destroy an excess of verticality ... not to increase the repetition of windows ... animate the architecture which otherwise would be arid and inexpressive."[29]

Fig. 2: Figini & Pollini, District Ina-Casa in Via Dessié, Milano, 1951.

Consalez Rossi Architects, in their social housing project on Via Civitavecchia in Milan, completed in 2010, consider the urban role of the home comprehensively in their design of the building plan and the façade (Fig. 3). The plan and the façade were designed in parallel, being adjusted and tweaked gradually and incrementally. Another design produced by Consalez Rossi Architects, the International Social Housing Competition in the Via Cenni area, (Fig. 4) is attentive to the relationship between the building and its context, and through this relationship, the building explicitly opens up to the issues of energy efficiency. The project statement expresses the wish to build places that can represent new identities for the urban home, both socially and environmentally, through:

> *... a better quality of life and relations and that represent, even symbolically, a way of life that is more attentive to the needs of the environment. The first, founding thought, concerns the composition between the reasons of the urban design and the rules of orientation of the bioclimatic design. From this point of view, the desire to create sequences of fluid and enjoyable spaces, which design without enclosing them, the private and the public parts of the neighborhood, had to confront a main exposure (south ~30°) which was binding for the correct bioclimatic functioning of the homes.*[30]

However, the provision of bioclimatic elements does not prevail over the reasons for the urban design deemed fundamental for the correct functioning of this new portion of the city:

> *The design consequence is the identification of a prevalence of exposure, which defines the fronts useful for bioclimatic functioning. In this way, 60% of the surface of the buildings is optimal, whilst the remaining 40%, although with a good exposure, does not reach the necessary angle, both for reasons of exposure and for the projection of shadows at the most unfavorable times.*[31]

The complex thus identifies parts of the building that adopt a regenerative approach, with greenhouses that accumulate heat and mediate thermal exchange with the exterior, and parts that pursue a conservative objective, limiting thermal exchanges with the exterior.

Fig. 3: Consalez Rossi Architects, Social housing in Via Civitavecchia, Milan, 2000-05; Façade studies.

Fig. 4: Consalez Rossi Architects, International Social Housing Competition in Via Cenni, Milan, 2009; Street façade showing bioclimatic greenhouses.

Since the 1990's, the work of the Studio Albori has pursued a great interest in developing both identity and environmental context in the design of the home. This interest is exemplified in one of their buildings on Via Altaguardia, designed for a housing cooperative. (Fig. 5) Using a traditional building process, the Studio Albori articulated the block with different figures and materials, excavating it to localize and characterize each individual residential unit in opposition to the idea of a *standard*. With this design, the relationship between the street and the courtyard was challenged, effectively domesticating the exterior of the building facing the street, while evoking a collective dimension of views to the courtyard. In addition, many elements of the building are borrowed from the economically-built homes of the 1920's and 1930's. The building's internal façade enters into a dialog with the façades of the individual homes through the use of open walkways, evoking the sense of a running balcony with elements that are actually verandas. The architects associate the Paulonia tree that was maintained along the street frontage with the pre-existing local and historical environment. This provides the character of a garden to the entrance of the building, anticipating a new attitude toward housing design that is further developed in some of their more recent work.

Fig. 5: Studio Albori, Residential building in Via Altaguardia, Milan, 1993-99]

However, there are detractors to the Studio Albori's project. Giacomo Borella defines the building at Via Altaguardia as the offspring of an approach that is "rationalist and abstract" which he considers unsustainable, revealing an *extraterrestrial* approach to building that is profoundly far from what would be necessary to achieve harmony with the earth. According to Borella, architecture's inclination to devolve toward abstraction and stylization has adversely influenced the theme of ecological sustainability.[32] As such, ecological sustainability has been reduced to yet another technocratic scheme neutralizing the potentials of regeneration, which if fully developed, would have introduced an opening in the collective imagination of the discipline and moved it toward a more sustainable ground.

Despite the theoretical criticism, the Studio Albori's work on sustainability is animated by a renewed approach to contemporary design. In opposition to dematerialization, Borella uses the term "architecture as maintenance" in reference to the various projects by the Studio that have inserted new bodies into existing buildings. The dimension of architectural maintenance in a city frames two major questions: first, how to limit the seemingly deleterious and infinite process of urban expansion; and second, how to undertake ecological conversions of the existing building stock. Answering these questions is crucial in the wealthy, overdeveloped and energy-devouring parts of the planet that were built up in the second half of the last century. They outline a picture where the re-elaboration and re-articulation of the existing the city – focused on architecture of widely differing scales – plays a decisive role in achieving a measure of sustainability. The Studio Albori's definition of architecture as something that finds its path *time by time* is an expression that echoes the *case by case* of Rogers. The architects experiment with seemingly mundane architectural features such as the downpipe on an architectural scale, *time by time*, for innovative designs with sustainable elements.

Usually invisible in contemporary architecture, the Studio Albori transforms the downpipe into an element that can characterize the building façade, highlighting its role in recovering rainwater. Research along these lines can be seen in the conversion of a small farm building located on Mount Ispra into a holiday home. (Fig. 6) The massive vertical stone structure of the original building is maintained and consolidated. And the missing façade has been reconstructed with a new, stratified façade. The renovation includes a large wooden frame that casts shade in the upper part of the building, while stacks of firewood collected from the surrounding forest provide the lower portion of the façade. The base of the building is made of Poroton® brick, with large doorframes surmounting it. A wood-burning stove in combination with a solar collector heats the house, while the frame structure serves an additional insulating function. The prominent downpipes on the façade characterize the front of the holiday home and the collected rainwater is fed to a swimming pool for the owner's children.

Fig. 6: Studio Albori, Farm building renovation, Ispra, 2010]

The Studio Albori's experimentation with building façades has continued with the Nursery School and Creche in Rome in progress since 2005 (Fig. 7) and with the Solar House in Vens in Val D'Aosta in 2010 (Fig. 8). The position and prominence of the Studio may entail them being called to work on projects outside of the city, while at the same time, tackling complex architectural issues within the constraints of contemporary urbanity.

Fig. 7: Studio Albori, School campus with a rainwater recovery pool, Rome, 2005]

Fig. 8: Studio Albori, Solar House in Vens, Val D'Aosta, 2010]

Since the end of World War Two, a prominent group of Milanese architects has contributed to the construction of the city with great professional commitment and technical expertise. The reflections by Asnago and Vender on the identity of the city, that architecture should be produced in close connection with the technical innovations of the period and synthesize both civic and technical competence, have yet to find their heirs. Connecting this history to the issues of environmental sustainability may engender a new, experimental direction for the building of homes in Milan today. As Rogers would say, it is an experience that has gone on in continuity with the Modern Movement, and with regard to the productive situation of the period, based on a regard for the dignity of the habitat and on building a sense of sensitivity within it.

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Fig. 1 & 2: Elisabetta Pero

Fig. 3 & 4: Gonsalez Rossi Associati

Fig. 5: Gianni Berengo Gardin

Fig. 6~8: Studio Albori

8.022 words

Magic, Inc. – Reframing the City

Matthew Skjonsberg

Aesthetic Perception as an Interpretive Act

The ideal backbone of architecture is the creation of functional habitats for *Homo Sapiens*: giving form to a society where the polarities of entropy and complexity are acknowledged, in which evolution and succession can take place. The physical artifacts of the discipline invoke a long tradition of references – employing illusions, allegories and poetic heritages – while evolving a legacy of building form, public space, infrastructure and access to nature. Is the tradition of *reframing* still useful for architecture in today's society, where every imaginable reference has been commodified as cliché and entertainment? And what is the relevance of architectural aesthetics in an era of social and environmental crisis?

In recent times, the common use of the term aesthetics has come to carry the connotation of being *superficial* or *for appearances only*. The Greek root of the term, *aisthesis*, means the cumulative effects of sensory perception and intuition, along with the intellectual or logical cognition gained from that which is sensed. Aisthesis deals not only with the anatomic composition of our five sensory organs, but also with our cognitive *sensibilities*, which are of great significance in the evolution of our social structures, built environments and artifacts. In short, sensibilities inform our *ethics*: our expectations of propriety, integrity, wellbeing and justice. While they are shaped partly by external factors, over time, they accumulate and come to define our very attitudes toward life. Working from the etymological origin of the term aesthetics, aisthesis, we can say that ethics are intrinsic in any form of aesthetic expression, either consciously or unconsciously.

Magic, Miracles and Medicine

In 1940, the science fiction author Robert A. Heinlein published the novella *Magic, Inc.*[1] (Fig. 1) This is an allegorical work, a social critique couched in humor. It highlights the antagonistic relationship between populist labor unions and secretive military industrial interests, illustrating insightfully how both, when narrowly pursued, can disrupt society and act against the common good. Heinlein begins by writing how magic, a kind of organic technology so to speak, is a commonplace skill openly practiced by various disciplines. Several powerful industrialists collude and found Magic, Inc., a profit-driven racket disguised as a non-profit organization based on exploiting popular support for the unions. Initially recruiting, then finally coercing specialist magicians to participate, they drive up prices and extort *insurance* payments from their bewildered clientele.

Fig. 1: *Magic Inc.*, originally published under the title, *The Devil Makes the Law* in the September 1940 issue of *Unknown*.

Through various machinations, legislation is enacted giving them a monopoly on magic, effectively putting all honest magicians out of business. The unlikely hero – a building contractor turned shopkeeper – enlists the help of a *white witch* to break the monopoly of Magic, Inc. The allegory emphasizes that magic, as much as current technological or medical knowledge, deals with forces that are beyond our understanding. While the complex and interrelated nature of reality commonly defies our fragmented attempts at comprehension, we can recognize the corrosive effect of unscrupulous power on those who wield it over others.

This reference to a science fiction novella from 1940 is not gratuitous. Architecture and science fiction are two disciplines perhaps uniquely dedicated to the future. They are disciplines that implicitly speculate, assume and even structure a certain kind of reality in the future. Although architects are not generally considered political activists, when they yield to unscrupulous economic interests as opposed to standing for genuinely sustainable objectives they become, however unwittingly, the *technical enablers* of a biased and unjust environment.

Power manifests itself in many ways, drawing from the mysteries inherent in the complex nature of our reality, including the mysteries surrounding health and sickness. These mysteries were commonly addressed through a belief in magic in former times. As society evolved a faith in religious miracles, magic was largely displaced by religious policies enforced by the church, and the church itself became a distinctly powerful and political institution.[2] Likewise, the belief in miracles[3] has largely been displaced by current beliefs in medicine and technology. Early medical practitioners were effectively scientific alchemists who were implicitly at odds with the authority of the church. It seems their adoption of Aaron's rod as the symbol of medicine was a clever way of shielding their evidence-based discipline from the faith-based authority of the church and its political regimes. Today, the uneasy relationship between science and religion is still a source of political division in society. However, riding the wave of current medical beliefs, profiteering pharmaceutical and insurance industries have grown to politicize and control the institution of medicine – of which we, as laypersons, have little knowledge or control.

Aside from the genuine differences between magic, miracles and medicine, there is a notable similarity in peoples' attitudes toward each: many people wish for effects that satisfy their subjective desires and preferences while remaining ignorant, often willfully so, of the underlying causes and the wider effects to impact on both other people and the world in general. Interestingly, a similar disconnect can be seen in the field of architecture. Can architects afford to operate with such indifference, with a lack of sincere interest in the relationship between their work and its consequences, between cause and effect?

Certain implications for architecture's evolving scientific paradigm can be drawn from the field of medicine. Both fields require clarity of intent and an awareness of why the work is being done; both benefit from imagination and faith while at the same time benefitting from a commitment to scientific methods. Bringing all of these aspects together scientifically and artistically is necessary in order to establish the new.aesthetics of sustainability. On a cautionary level, architects can learn from the deeply compromising economic collusion between the pharmaceutical, insurance and medical industries. And on a more instructive level, architects can learn from how the rigorous educational methods and licensing requirements of medicine exemplify the rigor of medicine's ethics. With the current demand for demonstrable sustainability in architecture, architects may develop a similar rigor of evidence-based practice – a correlation between its ethical framework, a knowledge-based method of materialization and an assessment methodology capable of scientifically evaluating the results of its performance.

Therefore, it is important to ask: what is a reasonable basis for establishing an ethics of sustainable architecture? Ostensibly, both architecture and medicine hold *the common good* as their main objective, and investigations in both fields might begin with the dictum "First, do no harm." In medicine there exists the explicit holistic ideal of reducing symptoms first in order to provide physical and psychological comfort, followed by invasive care if necessary only after carefully weighing the risk of causing further harm. This means that active treatment is a last resort in medicine – an idea that coincides with Frei Otto's assertion that the most sustainable architecture is no architecture at all.[4] But it is important to consider whet this conservative approach holds true in the face of widespread environmental or social catastrophe. This question may be a good place to start in order to gain a sense of the aesthetic, and therefore ethical, implications of sustainable architecture.

It has truly been said that asking *how* is as important as asking *what* in regards to ends and means, causes and effects. Sincerely pursuing answers to both questions can enable the discipline of architecture to move toward an evidence-based discipline with an acceptable degree of scientific integrity, thus validating the legitimacy of its asserted artistic license. If evidence is the basis used to substantiate belief, then what evidence can be provided to effectively address beliefs – whether social, religious or economic – that persist despite the accumulation of compelling evidence of their irrationality? And with evidence-based inquiry, how can the city be reframed to champion the common good through social and environmental justice?

The Physiology of Perception: To Trust One's Senses

Based on the interaction of sensory organs and genetic predisposition, perception isis inextricably linked to individual interpretation. Both *nature* and *nurture* play a role, and together they constitute a behavioral predisposition – an attitude – informed by experience, intuition and DNA. It appears that the quantum ambiguity that lies between seeing and believing provides evidence of Aristotle's statement that "nature abhors a vacuum." Our brains are expert at finding and attributing meaning, and in the absence of meaning, we are very likely to create it ourselves. While we embody the cumulative tendencies of untold inherited legacies, aesthetic perception is an interpretive process shaped by individual habituation. Both our sense of belonging and our sense of autonomy are valid, and through inference and association we are constantly engaged in the interpretive, aesthetic act of perception.

On a fundamental level, what is the relationship between perception and consciousness, and can we really trust our senses? We know from experience that the flavor of a perfectly formed tomato on the supermarket shelf cannot compare with that of a more wild, asymmetrical and homegrown tomato from the garden; the ambiguity between seeing and reality is directly mediated by a history of conscious experience. Furthermore, color does not exist outside of our ability to perceive it – color is a subjective experience, governed by the context in which it is perceived. There is no *redness* or *blueness* in the natural world. There are only the affinities of light as a form of energy. And we *interpret* those perceptions in order to guide our behavior.

It is generally acknowledged that any one perceptive organ is not entirely independent and autonomous. For example, our sense of taste becomes severely limited if we lose the sense of smell, or the hearing is sharpened with the loss of sight. In other words, the intermodality of the senses indicates that the so-called perception of *sight* is in fact not purely of vision but a combination of other sensorial influences that we may as well consider *illusions.* To be taken in by illusions is not just curious and puzzling; it appears to be key to our success as a species. Far from being a disadvantage, illusions are a powerful and necessary shortcut found at the heart of *Homo sapiens*' most sophisticated perceptual abilities. Implementing illusions in novel scenarios may be the best way to establish a difference between their potentials for appropriate use and manipulative exploitation.

Consciousness itself is an *emergent* phenomenon, resulting from a subtle interplay of patterned electrical impulses between distinct regions of the brain. Empathetic feeling is first enabled by perception, and is therefore pre-conscious. Our subsequent emotional – or ethical – response further enables or obstructs a sense of empathy. As in the study of epigenetics, in which DNA is seen not only to carry inherited characteristics but also to change in response to experience, our brains physically change in response to experience in an ability known as *neuroplasticity*. Most of us are familiar with the idea that the loss of one sense can result in the amplification of others. Likewise, *sensorial plasticity* can occur wherein one sense actually adopts the use of another that is absent. A blind person using echolocation actually takes advantage of the brain's visual cortex in processing the spatial description of location from sounds. And this use is not temporary – it becomes permanent. Neuroplasticity not only impacts those whose senses are impaired; it has the potential to affect all of us.

One remarkable example is the *feelSpace* belt, a research project conducted at Onsabrück University in Germany.[5] (Fig. 2) The feelSpace belt is arrayed with vibrating pads that constantly buzz at one's waist, indicating the direction of north in response to the earth's electromagnetic field. After a short time, the sensation and interpretation of these vibrations becomes second nature, and eventually it is possible for a subject to use the feelSpace belt to navigate complex pathways with remarkable accuracy. The feelSpace belt creates an altogether new and learned sense for the navigation of the physical world.

Fig. 2: Prototype of the feelSpace belt by the Institute of Cognitive Science, Department of Neurobiopsychology, Osnabrück University, Germany.

Studies like this may inform architects the symbiotic or intermodal sensorial dimensions, the ones that may access, stimulate and instill architecture. In addressing this possibility, we do not need to resort to mysticism or pseudo-science; we can look to everyday technologies that have recently opened communications between large segments of society, as illustrated by the ubiquitous '*map of the internet*' (used graphically on the cover of this book). How can architecture be used to foster a greater sense of empathy and social consciousness? And is the evolution of individual consciousness analogous to the evolution of a *collective consciousness*, as such, in society itself?

While we began by questioning how to "reframe" the city in terms of the senses, it is useful to point out, without bringing various modes of subterfuge and secrecy into account, that what we *perceive* does not point directly to what it *is* – as we have noted previously, reality is subject to interpretation. To further complicate matters, in the context of the contemporary city the relationship between sensory perception and the underlying actuality of objects and spaces is often strained; we are unwittingly manipulated by the artificiality of our environment beyond the point of credulity, leading us to situations where to trust our senses can be counterproductive, if not altogether unwise. For example, an otherwise useful sense of caution is aroused unnecessarily by the experience of heights in a glass elevator, or is allayed by the presence of armed security guards and security cameras. In forwarding our objective to reframe the city, what if intentional emphasis were placed on such processes of cause and effect, highlighting the interplay between our senses and the artificial environment of the city in a manner that actually reveals the hidden nature of the city itself? This could become the objective of architectural research and urban design with regard to sustainability. In principle, if we regard the problems of affectation as, at least in part, illusory, a new perspective emerges on how cities can be *reframed* in regard to the principles of sustainability as representation and reality in a dynamic equilibrium. *Signs* and *symbol*s have a role to play, bearing the countenance of principle and creating an architectural vocabulary consisting of elements recognizable in their signification and demonstrably effective in their performance.

Current architectural endeavors should seek a new strategic *alchemy* – clever correlations that yield powerful performance benefits. In the context of architecture, alchemy constitutes a kind of faith in the discipline's ability to work within and simultaneously to subvert the systems of governance, economics and materialization that shape the modern city. Success in this regard can be measured by the demonstrable relationship between design intent and actual performance. By defining aesthetics as an interpretive act that encompasses the totality of human perception and cognitive empowerment – our holistic, internalized 'sense' of the world around us – the relationship between aesthetics and the projective qualities that architecture assumes for the future is transformed. The strategic correlation of actuality and affectation can provide an antidote to a clichéd and commercially exploitative architectural repertoire. Given these views on perception, aesthetics and architecture, what is the concomitant face of sustainability in architecture?

Identity and the City: What is the City and for Whom?

In the evolution of the city – from early agricultural settlements to the contemporary metropolis – there have been occasional intuitive leaps of informed imagination that have contributed to the practice of city-making at a fundamental level. These leaps have drawn from other disciplines and realms of philosophy. Richard Sennett coined the term "domain shifts" in order to describe the transfer of knowledge from one discipline to another.[6] Often, these shifts leave traces in language itself that are surprisingly familiar: *cantus firmus* (of a distinctly geological analogy) in the discipline of counterpoint musical composition, and *urban fabric* (connoting a weave of discrete layers and strands) in relation to urban design.

Innovations in the craft of city-making are also enacted by shifts in scale, although these changes are of a somewhat different nature than "domain shifts." Fundamental to the inherited legacy of city-making is the notion of the city wall – you are either inside the city or outside of it. In retrospect, one can easily imagine the agrarian's stacked stone fence, initially used to keep animals in or out, giving rise to a defensive fortress wall over time. But the difference between a defensive wall and a garden wall is obviously more than a difference in size – it is a difference in intent. Fundamentally, the wall is a control device, consuming one space and producing others. Given the current potentials of the sustainable city, it is important to ask: what are the limits to such notions of control devices, and will they remain a useful part of the identity of sustainable cities? Clearly benefit may still be found in privacy walls as much as in seawalls to protect coastal regions. Yet, because walls are associated with social and political control – from the Great Wall, to the Wailing Wall, to the Berlin Wall and the US-Mexico *Wall of Shame* – it appears that one of the challenges of our generation will be to conceptualize city-making without the use of walls that operate in a social sense.

Arguably, the most effective form of social order is produced voluntarily, through the means of mutual understanding and *common sense*, including self-control, self-preservation and an understanding of the implications of one's actions toward one's neighbors. Such voluntary order can be exemplified by conscientious activities like recycling, shoveling snow from your sidewalk or restraining yourself from behaving in ways that disturb or harm others. Of course, there are many areas of overlap between these voluntary forms of control and forms of control emanating from external sources – namely from law enforcement or the threat of retribution. However, both forms have their limits set by ethics. One noteworthy limit to the ambition for control was established by international law in 1976 when the United Nations passed the *Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques*.[7]

An interesting implication of this resolution for architects and planners is that while they may concern themselves with affecting the environment at the micro scale with an eye on how, over the long run, their choices do have environmental consequences at the macro scale. Regulations such as the UN Convention do not account for the cumulative effects of unregulated, aggregate activities and for the effects of inadvertent environmental modifications over the long run. These are regarded, in the parlance of the insurance and legal industries, as *force majeure* or *acts of God* – faith is, in this way, used as a pretense by which to externalize culpability. While law may establish the limits of a discipline, the effectiveness of any law depends on its enforceability. Activities beyond the law are regarded as the prerogative of those capable of effecting change on the scale of *acts of God*. There are a number of such cases worth considering, including those of *geoengineering*, the questionable science behind the deployment of stratospheric sulfate aerosols, and the practice of establishing such high risk technologies as nuclear facilities in earthquake-prone regions or, arguably, in any region of the earth at all. We see that the high risks involved in these endeavors – risks that reach the scale of *acts of God* – are institutionalized, and disasters linked to them are routinely exploited as economic opportunities by corporate interests.

In this context, we must view the cumulative development activity of architects and planners, that of city-making, as a means to an end: fundamentally, the city is a communal survival strategy for *Homo sapiens*. In today's cities, we expect the advancement of equal opportunity, freedom of movement and more or less universal accessibility for citizens in terms of both physical and social space. Simultaneously, however, citizens have come to accept rather constant levels of surveillance and control. Given this situation, how do we envision the *infrastructure of justice* in a sustainable city? Can a sustainable city safeguard the justice of its citizens with such rudimentary means as transparency, openness and illumination, or is surveillance and control essential? This issue is at the heart of the discipline's debate about *how* and *of what* the city should be conceived.

Those who profess greater openness through an *honor-system* are often characterized as naïve (bleeding-heart communists) or as calculating (cold-hearted capitalists). Those who argue for increased security are often criticized as being intolerant of diversity, such as those belonging to the National Rifle Association, or as power grabbing, such as those advocating blanket security legislation like the USA Patriot Act. We can say that public trust in law enforcement actually acts as a restraint to powers that would otherwise overreach the edifice of justice. But when it comes to the control of resources in the semi-public sphere, we see that the term "semi-public" is actually a euphemism for "private". Control that is based on law fundamentally determines the form and shape of any public space. The means of control and the processes of city-making are often directly analogous. Given these trends in thought, it is also important to ask: how do we determine the social sustainability of cities, and how do we assess their performance?

The Politics of Sustainability: Hybrid Public Space as Catalyst

> *They hang the man and flog the woman*
> *That steal the goose from off the common,*
> *But let the greater villain loose*

> *That steals the common from the goose.*
> – English folk poem, ca. 1764

The earliest use of the term 'commons' in the English language may be found in the *Carta de Foresta* (1217), a supplement to the *Magna Carta* (1215), in which the rights of common access to royal lands were assured. While this remained in effect on paper until 1971, a steady stream of pro-enclosure acts since the 1500's consolidated land for the use of the gentry, exclusively for their benefit. Subsequently, industrial and other economic interests have successfully *enclosed* and privatized not only the physical milieu (land, water and natural resources) but also the social commons (education, housing and health care) and the creative commons (knowledge, patents and copyrights). [14] In modern society, individualized property ownership is mediated through a market exchange; this form of ownership has effectively colonized public infrastructure as well, including the infrastructure for water, energy, transportation, prisons and telecommunications. Boston Review contributor David Bollier wrote in his essay *Reclaiming the Commons*:

> *The commons refers to that vast range of resources that the…people collectively own, but which are rapidly being enclosed: privatized, traded in the market, and consumed. The process of converting the…commons into market resources can accurately be described as enclosure because . . . it involves the private appropriation of collectively owned resources. Such enclosures are troubling because they disproportionately benefit the corporate class and effectively deprive ordinary citizens of access to resources that they legally or morally own. The result is a hypertrophic market that colonizes untouched natural resources and public life while eroding our democratic commonwealth.[15]*

What role does architecture have in evaluating, questioning and implementing its professional prerogatives with regard to the commons: common land, resources, rights and justice? And especially, how should architecture balance the needs of its clients – be they public or private parties – against the needs of society at large?

The beginning of the twentieth century was an era, not unlike our own, when public mistrust of authority ran high. There were several widely publicized events that galvanized public opinion against the oppressive conduct of early industrialists who acted against the common good and in collusion with the state. The Ludlow Massacre in 1914 marked the tragic conclusion to a record-setting fourteen-month miners' strike. The Colorado National Guard was prompted by representatives of Rockefeller's mining interest to break up the camp of over 1,200 striking miners, resulting in destruction and death. (Fig. 3)

Fig. 3: Ruins of the Ludlow Colony near Trinidad, Colorado, following an attack by the Colorado National Guard, 1914.

The Ludlow Massacre created a tremendous wave of notorious publicity for Rockefeller. In response to widespread public hostility Rockefeller hired Ivy Lee,[8] a public relations pioneer who launched a disinformation campaign asserting that an overturned stove had burned the union camp and not the industrialist's hired thugs. Lee described his work as *perception management*, and he was highly successful at it.

Despite, or as a result of, the early power of Rockefeller and other corporate interests, labor unions eventually became an established institution to represent the rights of oppressed and exploited workers, and they have largely succeeded in maintaining those rights to the present day. However, narrowly implemented union interests have also compromised measures to ensure the public good through the practice of *occupational protectionism*. For instance, when in order to save vast amounts of water the State of Minnesota replaced thousands of conventional urinals in public buildings with new waterless models, the plumbing union sued the State, arguing that they held contracts for the right to supply water to the State's urinals. The union prevailed, and their workers were paid to replace the waterless urinals with a conventional watered variety. This action nullified the State's legislative efforts to conserve water in public facilities, which would have clearly benefitted the broader public good, and set a precedent that was successfully used by plumbing unions in other states as well.[9]

To date, much of the pioneering research in the development of effective criteria for sustainability is *proprietary*, such as the fee-based C2C certification process. Their industry and government supported counterparts – such as LEED and BREEAM – perform a delicate balance, advocating rigorous criteria for sustainable development while appeasing established industrial interests. As in any industry, sustainable development is subject to market branding and the manipulation of perception. Given these challenges, it is important to ask whether a singular measure for sustainability is possible. Is it reasonable to attempt to evaluate sustainable development in terms of justice and the public good when corporate and occupational economic interests continue to take control of powers? In addressing these questions, we can turn to Jane Jacobs, who advocated public space interventions as a basis for evidence-based strategies:

> *I stay away from visions of cities of the future. Any city at all that is worth learning from and considering has parts that work. So what should we study? We should study the parts that work! ... And the greatest asset a city can have, or a city neighborhood can have, is something that makes it different from anywhere else. Don't think it can be done with wishful thinking or pretty words*

... Everybody needs networks of other people, and it is impossible to make a community without networks.[10]

Networks are social, and therefore inevitably political in nature – public policy both enables and limits these networks with the provision of physical space and communication infrastructures. It does so both according to the influence of law enforcement and those tasked with private security. Such networks are now part of the highly contested realm of the commons. In his seminal book, The Craftsman, Sennett recounts that the painter Edgar Degas is once supposed to have told Stéphane Mallarmé, “I have a wonderful idea for a poem but I can’t seem to work it out,” whereupon Mallarmé replied, “My dear Edgar, poems are not made with ideas, they are made with words.”[11] Likewise, public space withmay be conceptualized with ideas and words, but it is made with physical space, materials and infrastructural networks.

[12]....[13]While in the US, Britain and elsewhere, populations have grown accustomed to the presence of security in their common public spaces, the means used by authorities to maintain control are sometimes overreaching and surreal. Whether referring to actions taken to maintain control on *Tag der Arbeit* (Labor Day) in Zürich[14] or during the G20 Toronto Summit in 2010,[15] these events show that when broad powers are granted to secure public space, they are often abused at the expense of civil rights. As such, creating an assurance of public trust in the commons is clearly a key metric of performance for public space.

Considering Jane Jacobs’ advocacy of public space, a practical example can be found in a skatepark recently designed by our studio.[16] At the outset, the municipal client required a peripheral fence and security cameras. We suggested a different strategy, and a meeting was convened with the municipal attorneys to discuss the issue. As the conversation progressed, the group assembled came to the conclusion that, indeed, the fence and cameras actually increased the liability of the city as they falsely implied a measure of security by the city authorities. If someone managed to enter the park and subsequently became injured, neither could they get out nor could others reach them to offer assistance. Ultimately, rather than fences and cameras, the provision of more lights and more paths in the park was agreed to be the best solution. While this stark reversal – from a fenced and monitored approach, to security achieved with illumination and accessibility – was rationalized by perceived liability, it fundamentally represented a shift in attitude. This is just one example of the kind of shifts that architects can make within the domain of their practice to ensure that the public trust is maintained. And, undeniably, the results of this approach to architecture look and feel better: more like a commons.

Transparency and the Open Source Ideal: Architecture's Legacy of Truth-in-Expression

> *That ideas should freely spread from one to another over the globe, for the moral and mutual instruction of man, and improvement of his condition, seems to have been peculiarly and benevolently designed by nature, when she made them, like fire, expansible over all space, without lessening their density in any point, and like the air in which we breathe, move, and have our physical being, incapable of confinement or exclusive appropriation.*[17]
>
> – Thomas Jefferson, 1813

The “exclusive appropriation” referred to by Jefferson has been increasingly sought after by corporate interests, often under the guise of “disaster relief.”[18] Making the distinction between “the appearance of truth” and “the truth of appearance,” Neil Levine’s *Modern Architecture: Representation and Reality*[19] powerfully illustrates the legacy of modern architecture as emerging from the iterative relationship between representation and reality. He works chronologically, beginning with the English garden, and drawing a red line through the works of Boullée, Soane, Schinkel, Pugin, Labrouste, Viollet-le-Duc, Semper, Sullivan, Wright, Mies and Kahn. The red line he draws highlights figures who have dealt with the expressive reality of architecture in the context of emergent industrial powers. Each of these architects allied themselves with power, while at the same time advocating the public trust. Each one faced their own struggles within the realm of this particular kind of architectural alchemy. The legacy of these architects continued in groups of architects such as Team 10 and the Texas Rangers, whose influence was widely felt, as they became critical academics and educators at key institutions of architecture. But while Colin Rowe’s ideal of “transparency” led him to seek compositional principles in the *aesthetic* arts, Jane Jacobs’ early work on cities developed an implicit, *ecological* conception of social value – closely connected to economic and political goals while emphasizing the intrinsic good of the community. Her later works developed an explicit set of ethics, arguing that governance and market exchange required two parallel schemes of values and virtues. Jacobs stated the following in a 2003 interview, one of the last before her death in 2006:

> *Toronto City Council adopted a pedestrian charter, which states that walking is the most sustainable method of transportation, and it should be everybody’s right. So everything ... should take into account what it does to*

> *pedestrianization. [So] you don't have to put the children into cars for everything ... It becomes about the freedom that comes with that, for everybody concerned. And when the children themselves latch onto something active and free, like skateboarding, that shouldn't be automatically disapproved ... No, this is a healthy thing ... And that is part of freedom.*[20]

Politics are at the heart of policy - it may be inevitable that in order to advocate for bike lanes in cities, one must confront political resistance from auto clubs and the financial interests they represent. A careful understanding of the objectives of each interest, and their relations to law, politics and economics is necessary to ensure that the rights of each are maintained. Fundamental to this understanding is the difference between corporate proprietary knowledge and the rising power of open source culture. The complex proprietary framework of copyright law, while protecting some rights, poses a challenge to maintaining a vital discourse of ideas and interpretations.

Take, for example, how in 2007 the business model of the music industry was completely rewritten. Radiohead, one of the biggest bands in the world at that time, left their label EMI to release a new record on the Internet, and furthermore, they let their fans decide how much to pay for it in a manner similar to church donations. Within a matter of weeks, DJ Adlive released a remix of Radiohead's material. But when he posted the songs on his website, DJ Adlive got a cease-and-desist letter threatening a lawsuit. Radiohead didn't issue that letter – it was issued by Warner/Chappell Music, Inc., the music publishing company that owns the rights to the material. Radiohead told the company to back off, and then released their raw studio files, both video and audio, to the public for use by anyone to download, remix and distribute freely.[21] At this point, the wall had fallen: the music industry is now driven to evolve with media, by necessity and from within. The discipline of architecture faces similar pressure; the challenge of giving form to social space is embodied by the parallel rights of the individuals and institutions that will ultimately inhabit them.

On the other hand, because of the aggressive attitude of the pharmaceutical industry, hospitals and others in the medical field, certain safeguards for the public's wellbeing have been implemented by law. These include reducing the cost of life-saving treatments, and the implementation of expiry dates on the patents of new drugs. These are beneficial outcomes for the public good. However, they do not negate the fact that medicine is a for-profit industry, relying on a supply of patients and the implementation of proprietary knowledge to cure them. And due to its inherently opportunistic nature – relying on clients instead of patients – architecture also carries the stigma of being a for-profit, technical enabler, providing physical form to established institutions and their proprietary knowledge. Can beneficial outcomes for the public good be gleaned by legislation from architecture that is opportunistic and for-profit, in a similar manner as that seen in some aspects of the medical industry? And how can this type of industry be implemented alongside that of open source culture for the benefit of the common good?

Heinlein's allegory of collusion and exploitation in *Magic, Inc.* can be taken as a symbol of the consumer city, where the resources of rural regions, and of the population in general, are relentlessly exploited for profit by corporate interests. While a drift in the direction of the consumer city is pronounced, some architects have consistently found ways to subvert this trend through a practice for common good – contributing to the evolution of sustainable initiatives for infrastructure, buildings, public space and natural resources. And their ethics are often visible in the aesthetics of their designs. However, it is possible that the trend of selling *sustainable* *development* as a for-profit brand has inadvertently provided the incentive for many architects to gloss over the severity of environmental issues, instead of implementing fundamental changes in their approach to city-making. Through all of this, architecture's saving grace may be its physical presence: when you touch something, it touches you back. This physical, sensual interaction informs our ethics; we *feel* intuitively that to cause pain to others is unjust. Likewise, developing a comprehensive system of sustainable ethics and aesthetics would encompass a deep understanding of how the built environment – over which architects have control – impacts the physical and social lives of others, and would involve informing our senses about our relationship with the natural environment in broad and direct ways.

The power of aesthetic perception lies in its directness. It is one thing to feel the wind, to smell it, to sense the vastness of origin and destination implied by its movement over the surface of the earth; it is another thing altogether to know values for annual wind speed or precipitation. An ethical framework draws from both types of knowledge. It depends on the ability to anticipate cause and effect and to make deliberate choices in relation to this. Perspectiveperspective and counterpoint were two aesthetic breakthroughs in the arts during the Renaissance - what would be the comparable achievements in the discipline of sustainable architecture? These breakthroughs will arise from initiatives that actively forward the cause of justice and equity in city-making. One such initiative is the establishment of an interdisciplinary modeling framework to ensure the quantifiable verification of sustainable performance. A challenge in this regard is how to assess – and therefore how to quantify – violation of the public trust by deception, manipulation, and falsification.

The discipline of architecture is clearly at a crossroads. The current distinction between architects, landscape architects, engineers and urban designers is relatively recent, and it often appears to impede the development of sustainable initiatives. At a recent public debate between advocates of *New Urbanism* and *Landscape Infrastructure* at Harvard's Graduate School of Design, the pretense of these disciplinary distinctions was contentiously debated. After an intensely polemic discussion, the moderator Michael Sorkin concluded the event with the following statement:

> *Let's make humane, equitable, sustainable and beautiful cities … Cities need to supply their own food, energy, water, thermal behavior, air quality, movement systems, building and cultural and economic institutions. This urban self-sufficiency is a means to political autonomy and planetary responsibility. Sustainable, equitable, and beautiful …* [22]

Sorkin put his finger on the need for architecture to transcend disciplinary polemics, successfully emphasizing the need for architects to be *tuned in* to the development of a sustainable urbanism that is capable of championing public interest, public space and engaging the public imagination. However, his urban-centric assertion that cities can be self-sufficient is analogous to the isolated city-state, and as such is obsolete.. Sustainable, contemporary cities will acknowledge their reliance on the environmental health of the overall region. Just as conventional medicine is complemented – not displaced – by chiropractic, acupuncture and homeopathy, the scope of architecture's interest does not end at the city wall; it holistically encompasses the surrounding rural and natural regions as well.

In transcending disciplinary polemics it is important that the distinctions that gave rise to such disciplinary differentiation not be merely ignored, but rather that they be essentially integrated within the architectural discipline. Just as the seed must die that the plant may grow, the 'object' attitude of architecture must die in order that an 'ecology' attitude might take root and grow. For example, when Frederick Law Olmstead and Calvert Vaux coined the term 'landscape architecture', the psychology of perception was at the heart of their disciplinary aspirations. In 1881 Olmstead wrote to Charles Eliot Norton that the few people who were familiar with his views seemed to feel "that I have original and peculiar ideas and am not only what I want to be, the expounder, indicator and applyer of views which are – not views at all but well established science…it is absurdly incomplete to say as I do that the prime object of art is to affect the emotions." In his last year of professional practice he felt isolated and lacking support from scientific writers, and in a report to the city of Hartford he described the unsatisfactory state of the discipline's theoretical science:

> *The objective point of the practice of the art, the commodity which its practitioners undertake to supply is a certain effect or class of effects on the human mind. There must be a psychological science of the subject and you may have reasonably expected me to teach you the outlines of this science. But I have to tell you that after much study and discussion I am satisfied with no presentation of it that has come to me. In the larger part, my practice has been based on the teachings of personal observation and experience that certain conditions being attained certain effects follow. [25]*

We live in an era that has seen the blossoming of both the psychological and physiological sciences, and any aesthetic theory that is relevant to our age will champion the very health of the human organism.

We have seen that justice thrives when the public trust is maintained - equitable and shared public place-making is necessary in the common interest of all. Deep sustainability will be scientifically based on the sense-enhancing, aesthetic empathy of inclusive discretion, rather than sense-deadening exclusion and control.

To paraphrase Heinlein's protagonist in *Magic, Inc.* and use his words in relation to architecture, architects too "are out to make a legitimate profit – that their services are sought shows that they are useful." However, it is up to architects to determine to whom our efforts will be of use to. By engaging the public trust, the profession of architecture ought to thrive in the new scientific paradigm - the ethics and aesthetics of sustainability being nothing less than the ethics and aesthetics of justice, made physical through the art of city-making.

NOTES

1 Robert A. Heinlein, "Magic Inc.," originally published under the title, "The Devil Makes the Law," in *Unknown, September 1940, Vol. 4, no. 1*, ed. John W. Campbell, Jr. (New York: Street & Smith Publications, Inc., 1940). Fittingly, the plot of the story hinges on a bill that is surreptitiously submitted to lawmakers by representatives of the organization by title alone, so that its contents wouldn't be revealed until it was taken up in committee: 'A Bill to Establish Professional Standards for Pharmaturgists, Regulate the Practice of the Pharmaturgic Profession, Provide for the Appointment of a Committee to Examine, License and Administer (Pharmatergists).' Clearly, it isn't really a proper title – rather an omnibus on which can be hung any kind of regulation, including, in this case, abridgement of anti-monopoly regulation. Such political committees as semi-public bodies have ample

precedent (i.e. the Bar Association, the American Medical Association, World's Fair Corporations, etc.), and with a few strategic nominations they can easily turn into a tax-funded oligarchy.

2 See Keith Thomas, *Religion and the Decline of Magic* (London: Penguin, 1991).

3 The Greek words rendered as miracle in English Bibles were semeion "sign," teras "wonder" and dynamis "power," which in Vulgate are translated respectively as signum, prodigium and virtus. For more on this, see the Online Etymology Dictionary, available at http://www.etymonline.com/index.php?term=miracle (accessed April 2011).

4 See Frei Otto, *Frei Schriften und Reden, 1951–1983* (Braunschweig: Vieweg Verlag, 1984).

5 Institute of Cognitive Science, Department of Neurobiopsychology, Universität Osnabrück; the project report is available at http://cogsci.uni-osnabrueck.de/~feelspace/downloads/feelSpace_finalReport.pdf (accessed April 2011).

6 Richard Sennet, *The Craftsman* (New York: Penguin, 2008), 127-128.

7 Adopted by *Resolution 31/72* of the United Nations General Assembly on December 10, 1976. The Convention was opened for signature in Geneva on May 18, 1977.

8 Ivy Lee is also credited with inventing the press release, and had many high profile clients, but lost public credibility himself when it became known that he was a war profiteer who worked for both the US and German governments during the wars.

9 From the author's personal project experience. Also, see the article Plumbers Unions vs. Waterless Urinals by Brian Doherty, available at http://reason.com/blog/2010/06/24/plumbers-unions-vs-waterless-u (accessed April 2011); also see the article Philadelphia Plumbers Union Pipes up About Waterless Urinals, US Water News Online, available at http://www.uswaternews.com/archives/arcconserv/6philplum4.html (accessed April 2011).

10 See the interview of Jane Jacobs: Urban Visionary Speaks Out, on the website Designing Active Communities, Promoting Healthy Lives, available at http://www.activeliving.org/aln/profiles/jacobsfullinterview (accessed April 2011).

11 Richard Sennet, *The Craftsman* (New York: Penguin, 2008), 119.

12 Massimo De Angelis and Stavros Stavrides, "On the Commons," *An Architektur* 01.23 (2010).

13 David Bollier, "Reclaiming the Commons," *Boston Review* Summer (2002).

14 If you visit the district of *Langstrasse* in Zürich on Tag der Arbeit (Labor Day), euphemistically referred to by locals as the *milieu*, hundreds of black-masked protesters pass through the neighborhoods leaving a trail of destruction. As they pass through these neighborhoods certain agents provocateurs smash out the windows and doors of banks, jewelers and tram stops, spray-painting anti-capitalist slogans. All the while accompanied by police escort they are herded through a carefully chosen path, the police stand by and watch bemused so long as they damage only property, and not people. The following day the insurance assessors come and tally the damage; glass installers and graffiti removal services are retained; and within a week the trail of

destruction is meticulously replaced with gleaming new installations better than the last. While this at first appears enlightened tolerance, the policy of law enforcement can be seen as the strategic cultivation of a public justification, by publically discrediting the anarchists, for the need to provide more power to law enforcement.

15 See "Toronto G20 Unrest: Civil Rights Groups Seek Inquiry," BBC News, February 28, 2011. Available at http://www.bbc.co.uk/news/world-us-canada-12599964 (accessed February 29, 2011). As a further and well-publicized instance blurring the lines between law and order, events related to the G20 Toronto Summit in 2010, Ontario's "Public Works Protection Act" which, without being announced to the public, vested police, security guards or peace officers with the authority to "require any person entering or attempting to enter any public work, or to approach thereto to furnish his or her name and address, to identify himself or herself and to state the purpose for which he or she desires to enter the public work, in writing or otherwise." The widely documented reality was that the police proceeded to require identification from any passersby on public property within 5 meters of the fence – arresting them if they refused to provide it or to move on. Even these powers were clearly overreached in at least two instances: one, in a related event elsewhere, three agents provocateurs (later acknowledged by the police to be their own officers – somewhat embarrassingly, after several attempts at denial, and only when it emerged that the readily identifiable boots the three wore were police-issue) attempted to incite a mob and thereby provoke the riot police on the scene by throwing rocks and other aggressive behavior; another, police some 2 kilometers from the aforementioned public works fence patrolled a public park, interrogating and searching anyone they chose.

16 From the author's personal project experience;. Also, see the entry for "Alamosa Skatepark Environment," Wikipedia, the Free Encyclopedia, available at http://en.wikipedia.org/wiki/Alamosa_Skatepark_Environment. (accessed February 27, 2011).

17 Philip B. Kurland and Ralph Lerner, "Article 1, Section 8, Clause 8," in *The Founders' Constitution. Vol. 3* (Chicago: University of Chicago, 1987), 333-335.

18 See Naomi Klein, *The Shock Doctrine: the Rise of Disaster Capitalism* (New York: Metropolitan/Henry Holt, 2007).

19 Neil Levine, *Modern Architecture: Representation and Reality* (New Haven: Yale University Press, 2009), 224. As Levine writes " ... what [Mies] liked to refer to as 'the will of the epoch', and what the US President Dwight D. Eisenhower was to describe in early 1961 was the growing danger of America's 'military-industrial complex.'"

20 See the interview of Jane Jacobs: Urban Visionary Speaks Out, on the website Designing Active Communities, Promoting Healthy Lives, available at http://www.activeliving.org/aln/profiles/jacobsfullinterview (accessed April 2011).

21 See "Rip!: A Remix Manifesto," Brett Gaylor, director, and Girl Talk, performer, May 19, 2009. Available at http://ripremix.com/ (accessed December 11, 2010).

22 Genevieve Sherman, "GSD Throwdown: Battle for the Intellectual Territory of a Sustainable Urbanism," *Urban Omnibus. Architectural League of New York* November 17 (2010). Available at http://urbanomnibus.net/2010/11/gsd-throwdown-

battle-for-the-intellectual-territory-of-a-sustainable-urbanism/ (accessed December 10, 2010).

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Fig. 1: Street & Smith Publications, Inc.

Fig. 2: Institute of Cognitive Science, Department of Neurobiopsychology, Osnabrück University

Fig. 3: Bain News Service, Collection of The George Grantham Bain Collection, the Library of Congress

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Constructing Sensuous Ecologies: Beyond The Energy Efficiency And Zero-Carbon Argument

Giancarlo Mangone and Patrick Teuffel

An Introduction to Sensuous Ecologies

Buildings are generally considered to be static, abiotic components of the constructed or natural ecosystems in which they are situated. They are typically designed as the inert backdrops for the dynamic biotic and abiotic components and processes that inhabit and engage them. This perspective regards building systems and processes in terms of isolated design parameters, ignoring a building's inherent ecological interrelationships and interconnections with the mutable, complex ecosystems that it inhabits. These include local systems of infrastructure, socio-cultural dynamics, natural organisms and natural processes. Resultant design solutions are typically unable to respond to a site's inherently dynamic environmental changes, and tend to develop parasitic relationships between buildings, building systems and their ecosystems; such parasitic relationships generate significant performance losses. These losses affect the local natural environment, community and occupant well-being, and the initial and operational fiscal costs of the building itself.

A more adept perspective is to redefine buildings as constructed *habitats*: as active, interconnected environments that engage the local ecosystem and its dynamic ecological processes. This approach focuses on the interrelationships of the external (and internal) biotic (and abiotic) components that generate such processes, while providing spaces and programs based on the inhabitants' needs. This suggests an innovative design methodology grounded in the context of the natural processes of a given site. The concept of a building is thus reconceived as the ever changing, dynamically responsive confluence of constructed ecologies (interrelationships and processes) that occurs within and around a given ecological area (the building). Typically isolated components such as mechanical, plumbing and electrical systems are reconsidered for the active roles they play in the ecosystem, and for the benefits they can provide beyond the basic provisioning of water or electricity. This perspective shifts the focus of design away from how to design a building as an object toward how to develop and optimize the ecological processes and systems of a constructed habitat. All of these ideas contribute to the notion of sensuous ecologies.

A Focus on Ecological Processes

The construction of sensuous ecologies involves the rigorous integration of inherent site conditions into the design process – including the ecological systems, bioorganic and natural processes and energy flows that occur in and around the site. This process generates innovative and optimally performing design solutions through the development of symbiotic relationships and connections among the variant and seemingly independent processes of the occupants, the built environment and the natural environment. Constructing sensuous ecologies results in the development of multi-sensory and engaging constructed habitats that sustainably evolve the social, economic and natural ecologies of their contextual sites. This design approach inherently encourages exploration of the performance potential of incorporating multivalent behaviors into the design process.

Establishing Performance Design Goals

In order to design optimally performing constructed habitats in a rigorous way, we must establish a robust metric system for performance evaluation at the beginning of the design process. Thus, it is necessary to review the effectiveness of current performance goals in the building industry to determine how they relate to the development of sensuously constructed habitats.

In this endeavor, it is necessary to evaluate current goals for sustainable design and to place current arguments related to energy efficiency and the control of carbon emissions into perspective. In general, these goals are focused on generating *net zero carbon* or a potential energy surplus in the built environment. To this end, one of the most cost-effective measures for reducing global emissions of carbon dioxide is to improve the energy efficiency of buildings. Thermal conditioning systems account for approximately 50% of the energy consumed in buildings, making these systems ideal candidates for improving energy efficiency and reducing the operational cost of buildings.[1,2] The performance of energy efficient technologies such as solar panels, insulation and the heat transmission performance of glazed wall assemblies continues to improve, while the initial cost of these technologies continues to decrease. It is projected that renewable energy technologies powered by wind, water and solar inputs will be able to address the world's total energy demands more reliably than current energy sources. Some models predict a 92% reduction in energy-related CO_2 emissions in the future, compared to the emission levels seen in 2005.[3,4] These factors indicate that current sustainable design goals focused on attaining net zero carbon and energy surplus can be achieved through advances in building technologies, advances in building energy sources or through a combination of the two. However, it is important to note that aspects such as minimizing adverse solar radiation inputs and energy loads, as well as connecting occupants to their contextual environments, are unnecessary to achieving these goals. The approach leads to hermetically sealed building environments that disconnect their occupants from the natural environment.

An evolving disassociation between buildings and their natural site conditions is increasingly evident in current practice. Projects may be hailed as pinnacles of sustainable design, ground breaking and LEED *platinum certified* simply by checking off a list of typical appendages such as solar panels, plantable roofs and rainwater collection schemes. Although meeting current sustainable design goals, these projects fail to resolve the underlying and deeply negative impacts that today's buildings impose on the economic, social, natural and ecological contexts in which they exist.

In order to redefine the performance metrics of sustainable design, it is necessary to look beyond today's energy and carbon-related goals. A design's performance should be evaluated based on its potential to generate measurably positive symbiotic environments, and on its potential to work toward the creation of mutually beneficial relationships among the natural, social and economic ecologies that exist. Attention must be paid to these relationships at the level of the constructed habitat, the local ecosystem and the global environment. But how does one rigorously evaluate a design's effects on these various ecological relationships?

Certain ecological economists, such as Herman Daly and Robert Costanza, have developed a conceptual framework that, when applied to architecture, suggests evaluating design solutions based on three categories of influence: the natural environment, the social parameters and the economic parameters that are involved in a project.[5,6] William McDonough, among others, has found in his work that valuing social and natural parameters as much as economic ones during the initial conceptual design phase yields significant fiscal surpluses while generating innovative design solutions. He notes that companies that typically focus only on the economic bottom line – those that consider natural and social benefits as an afterthought – are detrimental to the performance, quality and cost of the resultant design solution.[7,8] The individual weight and influence given to the three general evaluation categories (environmental, social and economic) and the individual parameters within each category should be identified and determined by the project design team. They are project specific, as the environment of each site is composed of unique conditions and issues. Although these three categories should be considered equally in the design process – and considered as part of the overall project objectives – individual factors within a project will dictate which specific categories and parameters need to be more heavily weighed or given greater attention. This is similar to the performance of an ecosystem, in which key species and processes have greater effects on its performance and integrity than others.

In order to generate a metric system for evaluating and designing constructed habitats, we can turn to the work of ecologists who recognize that natural ecosystems are sustained by their ecological integrity and inherent biodiversity. Ecologists define integrity as an ecosystem's ability to perform *nature's services*, evaluated in terms of biodiversity, stability, resilience, sustainability and naturalness. Among these five criteria, biodiversity is considered to be the most important factor, and thus it is the primary metric for evaluating the integrity of a given natural ecosystem.[9,10] Like ecosystems and other ecological processes, constructed habitats are highly complex, interdependent and constantly in flux, albeit in different ways. All are continuously acting and reacting with a diverse range of individual and systemic components and processes. Ecologists have determined that the integrity of a natural ecosystem is dependent on the degree of dynamic and complex interrelationships therein. This makes it difficult to objectively distinguish parameters and processes that advance, from those that diminish, the quality of an ecosystem. This also makes it difficult to define and evaluate the performance of overall systems and processes.[11] Given the parallels that exist, similar challenges are likely to arise when establishing the metric system for evaluating constructed habitats.

Despite these challenges, ecologists do measure the performance of ecosystems by their ability to "support and maintain a balanced, adaptive community."[12] Transferring this to the built environment indicates that constructed habitats and ecosystems – including the building systems, components and processes that comprise them – should be evaluated based on their flexibility and ability to adapt to current and future changes. At the same time, they should be able to support and maintain the building's necessary programs and functions at a high level of performance.[13] Thus, a building's performance must be evaluated on a wide range of factors and scales: from the level of the microhabitat, or the individual spaces and systemic processes of a building, to the level of the local and the global environment.

In order to approach different metrics and scales in the evaluation of built environments, ecosystems can be classified into two categories: natural and constructed. A natural ecosystem refers to the biological community in a given area, the abiotic components of the environment and the biophysical feedback that is generated through their interactions; taken together, these interactions produce and regulate every life supporting function on the planet. These include climate regulation, water filtration and nutrient and energy cycles. Natural ecosystems such as rainforests, deserts and prairies sustain both human and natural communities without producing negative natural, social or economic effects.[14] Every natural ecosystem is at some risk of modification and degradation by human activities. High-risk ecosystems, the ones in danger of losing their distinct biodiversity and ecological integrity, are becoming increasingly prevalent. They are found primarily in regions with high human population densities or high levels of natural resource exploitation. Currently, direct habitat alteration – including loss, degradation and fragmentation – is the primary cause of damage to the integrity and biodiversity of natural ecosystems. The artificial introduction of alien species is the second most important cause.[15]

Natural Ecology Metrics: Ecosystem Scale

When constructed ecosystems such as buildings, cities and regions are developed, natural ecosystems are actively subjugated in the process. The integrity of natural ecosystems is compromised and their biodiversity is dramatically reduced; they are no longer able to generate and regulate their own biogeochemical cycles, produce raw materials or sustain life for the various species that rely upon them. Furthermore, the potential benefits and values that could be derived from the innate natural processes and components of the contextual site are displaced. This detrimentally impacts not only the natural ecosystem but the performance of the constructed ecosystem as well. To cite one example out of many, natural ecosystems act to reduce solar radiation and replenish local aquifers. When sites are developed, these are typically replaced with stretches of barren, non–porous concrete topography which cause downstream flooding, municipal sewer overflow, topsoil degradation and increases in the urban heat island effect. As constructed ecosystems continue to subjugate natural ecosystems on a worldwide scale, levels of pollution will continue to rise, threatening local and global economies, agricultural supplies and communities, while the problems of climate change and toxicity of the land, air and water will continue to pose very real threats for human survival.[16,17,18,19]

Although it is common practice, this subjugating approach to development is certainly not required. It is possible for constructed ecosystems to be developed in symbiotic ways, when natural ecosystems and processes are understood as valuable design elements. This perspective reconnects natural and human processes and environments, considering them to be interdependent, and in the end, ultimately indistinguishable. The development of symbiotic ecosystems will generate more effective and mutually beneficial interrelationships while promoting a sense of place through the preservation and experience of natural environments.[20] All of these aspects provide direct benefits and values for a building's users.

Detailing Metrics of Importance

Most buildings are posited within pre-existing built environments and their design should be considered based on the scale of the natural and constructed ecosystems that exist within these environments. Scale consists of metrics derived from a given location, providing one way to evaluate a building's performance in regard to the interrelationships of external (and internal) biotic (and abiotic) components and processes. Buildings must be of an appropriate scale for these interrelationships to exist, and as such, scale is integral to grounding a building within the context and processes of a given site.

Next, the social ecology of the built environment provides metrics pertaining to the contextual environment and its inhabitants, highlighting a myriad of potentially symbiotic ecological interrelationships. When constructed habitats are built with these metrics in mind, they can help form a sense of place and community, while improving the quality of life, mental health and physical health of their inhabitants by providing spaces for communal engagement and social services. Sensitively addressing the social metrics of a site will benefit productivity and creativity, among other potential social parameters that may be engaged.[21,22,23]

In regard to the metrics of economic ecology, in order to evaluate a project's economic performance, it is important to note that a building's operational costs significantly outweigh initial construction costs. They account for up to 75% of a building's lifecycle costs.[24] The development of innovative, highly performing constructed habitats, systems and processes can significantly improve a project's economic performance. To this end, current building practices are not always the most efficient or the best performing, especially when the innate natural processes of the contextual site – along with their innate values – are subjugated and displaced. Every non-farming industry in the US has improved productivity since the 1970's except for the construction industry, which has experienced steady productivity declines. The creation of sensuous ecologies may provide one way to reverse this trend.

Design Process for Constructing Sensuous Ecologies

The construction of sensuous ecologies relies upon exploring the performance potential of multivalent ecological systems (environmental, social and economic) and integrating them into the design process. Investigating performance-based strategies during the pre-design process will have the greatest impact in terms of simplifying construction, decreasing the building's initial and operational costs and reducing the build schedule. However, in order to effectively incorporate ecological systems into the performance-based design process, it is essential for the individual project members to be well versed in how these ecological systems function. Ecological components always result in a complex matrix of interdependent processes and components, bridging the environmental, social and economic worlds; this poses a substantial difficulty in identifying the influence of individual components and evaluating their interrelationships. In addition, variations between these components do not occur in a linear fashion, and therefore, making slight and seemingly insignificant changes to one may significantly affect the others.

In relation to the building design process, it is important to understand, represent and evaluate the performance of individual project parameters as interrelated parts of larger systems within the constructed habitat; and to understand that the constructed habitat itself is nested within still larger systems, including the contextual ecosystem and the global environment. In the development of sensuous ecologies, those participating in the design process must rigorously determine the potential beneficial interactions between various parameters that may have been previously considered as unrelated. This process will reveal gaps, disjunctions and conflicts between variant parameters that could negatively impact the performance of the constructed habitat as a whole.

The typical, linear practice of designing a geometrical building form and visual envelope is significantly more inefficient than the design process proposed here; the typical, linear practice attempts to force the building infrastructure and other project parameters to fit within a given site. In contrast, the ecological design process leading to the creation of sensuous ecologies allows for effective performance optimization through the development of symbiotic interrelationships between the building and the site. The resulting design outcome is more malleable and responsive to the performance analyses generated during the conceptual design process. This is because the function and design of individual parameters, as well as the overall design options, can be adjusted without having to fit within predetermined project constraints, such as the visual and geometrical character of already designed spaces and forms. This flexibility is achieved by giving priority to the processes and interrelationships that the building will engage in over the design of individual programmatic and spatial considerations. This approach to the allocation, design and development of space – including the building envelope and its forms and programs – results from investigating the potentials for integration. This leads to a more exploratory and investigative design process, helping to generate innovative design outcomes and interactions between the occupants, the building and the natural ecosystems within a newly constructed habitat.

Why Sensuous?

Ecosystems are intertwined matrices of sensations and perceptions, a collective field of physical experiences lived through many different perspectives.[25] Merleau–Ponty defines an individual's perception as an on-going interchange between one's sensually engaging body and the entities that surround it.[26] As people inhabit their contextual environments, they become attuned to the inherent qualities and characteristics of the perceived objects. Natural ecosystems are inherently sensuous environments that engage the body through the variant sensory perceptions of ecological processes. This engagement is at the basis of developing symbiotic interrelationships and interconnections between humans and the natural environment. The research in *biophilia* and restorative environments, for instance, has shown that human interaction with the inherently dynamic and sensually stimulating natural environment helps to promote people's physical, intellectual and emotional well-being.

This is because the stimuli from variant animate and inanimate natural processes have informed the development and evolution of human beings' physical, emotional, problem solving, critical thinking and constructive abilities; they have been fundamental to human health, maturation and productivity for millennia.[27,28,29] It is only within the last 5000 years that human civilization has progressively severed its connections with the natural environment. The development of technology and constructed, man-made environments has come to isolate, mask and remove the natural environment, replacing it with the principally non–stimulating, sensually bereft one that civilizations have chosen to develop and inhabit. The past two centuries have been exponentially destructive in this regard. Mechanized living dominates people's environmental existence, obviating the potential to sense the natural environment and deterring people from occupying and interacting with the external environment. The widespread adoption of air conditioning, for example, has led to the thermally constant, sealed interiors of buildings and vehicles, all but eliminating the benefits derived from human sensory connections and interactions with the temperature changes of the natural environment.[30,31,32] Humanity's current sensory deprivation has led to the loss of a sense of place.[33,34,35] However, developing habitats that interweave the natural ecosystem with the constructed ecosystem is one approach that has the potential to provide much more intensity and nuance than current static environments allow.[36]

In addition to the approaches drawn from the field of economic ecology discussed above, *attention restoration theory* provides another means to consider the performance of sensuously constructed habitats from the perspective of their human inhabitants. Directed attention is required for critical thinking, problem solving and creativity, but an individual's directed attention progressively diminishes as the mental effort becomes prolonged, leading to a condition called directed attention fatigue (DAF). DAF causes people to become easily distracted, impatient, less willing to help others, hasty, irritable and more impulsive. Human productivity and effectiveness are thus directly linked to one's directed attention, and there are very real economic consequences for DAF. This form of mental fatigue can be addressed with restorative environments.

Four general qualities determine the performance of a restorative environment: being away, fascination, extent and compatibility. Being away is more of an abstract concept than a physical one. It is focused on getting away from unwanted distractions that require sustained, directed attention. If one moves to a different environment but is still focused on old thoughts, then the new environment will not be restorative. However, a familiar environment viewed from a different perspective or frame of mind can be restorative, which can lead to the development of functionally dynamic spaces.[37]

Fascinating stimuli are environmental elements, events or processes that people find engaging and attractive. They inhibit boredom and function as distractions, allowing time away from prolonged, directed attention. There are two types of fascinating stimuli: soft and hard. The soft fascination stimuli are effortless without directed or involuntary attention, thereby allowing one to achieve relief and restoration.[38] Natural phenomena such as waves crashing against a shoreline or the view of a fiery sunrise are the most common examples. The hard fascination stimuli are events and objects that require significant involuntary attention such as a soccer game, movie or immersive virtual game environment; these have been found to be less restorative. Recovering from DAF involves removing so-called cognitive clutter and restoring the capacity for directed attention and reflection in order to refresh one's mind. This process is similar to various meditation processes and may involve reflections on a person's "life, priorities, possibilities, actions, and goals."[39]

Next, the environment must provide a certain extent; it must be coherent and sufficient enough to allow one's senses to engage in stimulating exploration, be it real or imagined. For example, relatively small areas can be designed to provide a sense of extensity, making them seem larger, such as Chinese and Japanese gardens. Compactness, such as when occupying a cave, may even generate a feeling of inhabiting a different world. Extent can also function on a more conceptual level. For example, historical artifacts provide a sense of connection to the past and its people and environments, thus linking the viewer to a larger world of mental engagement.[40]

And in the end, the environment must be compatible with what people want to do, allowing them to perform their desired activities effortlessly. Prompt and useful feedback from the environment is necessary in order to help achieve one's purposes. This is necessary for the design of restorative environments, otherwise, they end up only as momentary diversions or distractions, being irrelevant and inconsequential. Natural environments are perceived as being highly restorative for the myriad of purposes they provide, such as the potentials for observing animals and plants, hiking, camping and meditation.[41]

Highly performing restorative environments can help regenerate direct attention even if the amount of exposure is brief. Research has shown that restoration can take as little as ten minutes, but in general the amount of time it takes to fully restore the level of direct attention varies.[42] When they are well-conceived, restorative environments stimulate the kind of activities that promote mental, social and physical health, which in turn increase efficiency, productivity and economic value.[43,44,45,46] The degree of sensual engagement – or the degree of direct interaction with the environment devoid of distractions – determines the environment's restorative capabilities. Direct interactions are more sensually engaging: they may include the feel of the sun and wind on one's skin while listening to the rustle of leaves, as opposed to looking at a tree from the window of a static office space. Through the design approach and methods propose here, it is possible to construct sensual environments that are hybrids of restorative spaces and socially collaborative spaces, functioning at the level of individual buildings and at the level of the community; current built environments have failed to foster such restorative conditions. The key is to redefine buildings as constructed *habitats*: as active, interconnected environments that engage the local ecosystem and its dynamic ecological processes.

Why Multivalent?

Each building process, component and system is typically designed to perform a single, specific function; once a person's senses become accustomed to these functions, they are no longer sensually stimulating.[47] Infrastructure systems such as those for water circulation are usually designed to be hidden from view, save for their casings. Typically, the architect's aesthetic design focus rests on the visual expression of the building's geometry, leading to design schemes that fail to engage or incorporate the potential of other sensory perceptions. This failure is detrimental to the overall sensual quality of the project. On the other hand, in biological systems, multivalent infrastructure is the norm rather than the exception. Tree branches function as a spatial network of material transport, an integrated component of the tree's solar shading as well as its evapotranspiration thermal conditioning system. These systemic functions inherently facilitate a variety of interactions with the natural site conditions: the branches sway in response to local wind conditions while the leaves harvest solar energy. Dynamic patterns of shadow are cast on the ground below while the leaves release moisture into the atmosphere and cool the surrounding local environment.

Inspiration from such biological systems can be translated to the design process, generating innovative spatial typologies that are more responsive to the potential building programs and the needs of their occupants. In essence, the processes inherent in the building's infrastructure are inherently dynamic; they can be conceived as potential fascination stimuli, being designed to sensually engage the building's occupants.

Why Natural?

In addition to the benefit of preserving natural ecologies for their roles in climate regulation, water filtration, nutrient and energy cycles and various other life sustaining functions, the incorporation of natural site conditions into the built environment can generate a greater understanding of – and a greater connection with – the inherent processes of the local environment. This approach helps define a greater sense of place for a building's inhabitants. Naturally occurring inputs from the site such as vegetation, wind, water and solar energy, among others, can be incorporated into the design process as positive performance inputs that inherently engage the human senses. For example, occupants of naturally ventilated buildings prefer temperatures that are more closely related to the local exterior environment and accept a significantly wider temperature range as thermally comfortable. They inhabit and directly interact with the exterior environment more than the occupants of air-conditioned buildings. Natural ventilation also results in significant building lifecycle cost savings, along with allowing for thermally dynamic interior environments.[48]

With regard to natural thermal control, establishing a shifting porosity in the building envelope is key to establishing a connection between the building's internal and external thermal qualities throughout the year. In winter, the building envelope may be closed to the outdoors for heat retention; in summer, the building may become porous, with a greater amount of external sensory stimuli infiltrating the building and interacting with its occupants. An exterior vegetated courtyard or a micro forest – drawing from and preserving the natural vegetation, soil, hydrology and geology of the site – could be implemented. (Fig. 1) Such a design element could provide a naturally ventilated system for fresh air that connects the occupants to their environment, while providing a seasonally changing source of fascination. Vegetation arranged as a courtyard or micro forest can help filter air pollutants, lessen noise transmission, reduce summer solar heat gain and serve to infiltrate the building with various aromas, all while stimulating the inhabitants through seasonal changes. If the space is enclosed in the winter, it can be utilized in the colder months as an occupiable, passive solar heat gain system. This will reduce the building’s cooling and heating loads throughout the year, reduce the size of the mechanical HVAC system and ducts, and increase the quantity of usable space that mechanical rooms typically occupy. Natural site conditions can thus be utilized as multivalent components of the building's infrastructure, thereby reducing project costs and leading to a more dynamic and sensually stimulating environment.

Fig. 1: Design for a dynamic, vegetated courtyard.

Why Spatial?

In today's architectural projects, natural site conditions are typically incorporated into the design process as additive surfaces, taking the form of components such as green roofs, solar panels and thick thermal walls. However, a different approach emphasizing the incorporation of natural site conditions as sensuous spatial components of the building's infrastructure is significantly more effective. These can be incorporated into a building's spatial organization either indirectly as elements, or they can be incorporated directly as occupiable spaces.

For example, designing a pool that contains a certain quantity of water needed to supply a set of fixtures is an indirect spatial element. Bodies of water naturally generate informal spaces that foster social interactions. As the building occupants observe the pool over time and perceive the water level fluctuating, as well as changes in the quality of the water, they will become directly engaged with their water resource in a spatial way. Alternatively, if the pool collected rainwater from the building's roof, the occupants would become sensually engaged with the natural rainfall fluctuations of the site. The connection between the occupants and the site's periodic precipitation could be further reinforced by distributing water to the pool through a network of channels, designed in a series of fluctuating visual stimuli. If future building codes allowed for exposed water circulation, water could fall at distinct heights and on a variety of materials. This would provide a range of acoustic stimuli as well and a mask for noises, helping to reduce occupant stress and improve overall perforance.[49] As such, the circulation and storage of the building's water resources can be designed as sensuously perceptible elements. (Figs. 2, 3 & 4)

Fig. 2: Sensuous Water Circulation System.

Fig. 3: Water Circulation Typologies.

Fig. 4: Overall Building Water Circulation System.

At the same time, more direct and occupiable infrastructure systems can also function as restorative environments while incorporating the natural ecologies of the site. For example, this could take the form of a spatial, occupiable thermal mass similar to a cave, built with dense materials such as concrete to maintain a steady temperature throughout the year. (Fig. 5) Alternately, this could take the form of a spatial, occupiable micro forest incorporating the site's natural ecologies, as discussed above.

Fig. 5: Cave Infrastructure Spaces.

Why Adaptive and Responsive?

The contextual ecosystems that people inhabit are in a constant state of flux. Climate change is leading to more extreme weather conditions with less frequent but heavier rainfall each time. Seasonal fluctuations of temperature are becoming more intense and more extreme. In such a destabilizing environmental context, when evaluating the potentials of responsive infrastructure, one should consider how biological and natural systems constantly adapt – and thereby optimize – their performance in response to feedback from dynamic environmental stimuli. This should be considered at three temporal levels: in real-time (within seconds), over months or years (in a biological developmental process) and finally over several generations (in species evolution).[50]

At the scale of the constructed habitat, programming spaces to effectively accommodate their occupants' needs is one of the key design drivers for a built environment. Occupant needs change over the course of the day to accommodate different situations for a specific user; these can also change over the course of weeks, due to different functions or events taking place within the building; or they can change over the course of months or years in response to the fluctuating contextual environment and the shifting occupancy of the building.[51] As such, building systems and spaces should have the potential to adapt to varying functions based on the real-time program needs of their occupants. Responsive design solutions mean allowing for creative solutions to a broad range of endemic design problems, such as adapting to unpredictable local climate conditions and occupant needs in the future. This also includes rigorously determining the performance benefits and design potentials of incorporating various ecological processes. And in the end, buildings that are as constructed as *habitats*: active, interconnected environments that engage the local ecosystem and its dynamic ecological and social processes will be more adaptable than buildings produced through the existing, static process of design and construction.

For example, Howler Yoon Architecture designed an acoustically and visually responsive urban pedestrian environment for the Athens 2004 Olympics, called White Noise/White Light. The design team constructed a grid of semi-flexible, vertical fiber-optic strands that individually responded to the movement of pedestrians by emitting white light and white noise when pedestrians passed between them. (Fig. 6) This design solution developed a visually and acoustically engrossing, sensuous, restorative and fluctuating field of bending light and white noise, effectively masking the surrounding urban noise pollution and creatively incorporating human circulation processes as a parameter of the responsive environment. At the building level, such responsive systems would not only generate high fascination stimuli but also contribute to the multivalent utilization of mechanical space as a restorative environment for sensuous experience – drawing patterns of human movement in to interact with patterns from nature.

In all, the examples provided here – the micro forest, the water bodies, the cave-like thermal mass and the pedestrian environment – are all examples of single components that could be incorporated into broader and more inclusive systems in the pursuit of sensuously constructed ecologies. At their basis, these systems would draw on the interrelationships and interconnections that exist between buildings and the mutable, complex ecosystems that they inhabit.

Fig. 6: Pedestrian-activated light field.

Conclusion

Constructing sensuous ecologies redefines what is conventionally perceived as the built environment through an exploratory-experimental design process, producing a systemic network of constructed habitats. These habitats consist of constructed and natural processes, systems and parameters that are innately interdependent; at the same time, they directly contribute to the quality of their occupants' well being, the quality of the global environment and the quality of its myriad of ecosystems. The focus of the sensuous design process is the development and optimization of ecological processes, building systems and system components, highlighting their relationships within an environmental context. This process reevaluates how people interact with and benefit from individual project parameters; it fosters and strengthens connections between the human and natural environments. In order to generate positive, symbiotic built environments it is essential to incorporate the valuable ecological systems, processes and components that exist within a given site. This approach evolves the purpose of design from merely accommodating human processes and needs to one that balances and interrelates various ecologies (environmental, social and economic). Each project parameter or requirement can be seen as a potential asset to the design process, rather than a negative limitation. As the range of parameters grows, the system becomes more effective and resilient as a whole in relation to its contextual ecosystem.[52,53] Therefore, project parameters are innately sensuous, multivalent, natural, spatial and responsive. The approach results in the development of highly performing form-places that blur the boundary between natural and constructed ecologies. The results are more effectively defined as microclimatic boundaries and environmental stimuli, rather than through typical mechanistic boundaries and divisions that result from the current design process.

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Fig. 1~5: Symbiosis Architecture

Fig. 6: Howler+Yoon Architects

5.918 words

Symbiosis and Mimesis in the Built Environment

Luca Finocchiaro and Anne Grete Hestnes

The Scottish biologist D'Arcy Thompson, in his book *On Growth and Form*, argues that the form of any organism can be read as a diagram of forces, "not merely the nature of the motion - according to kinetics - but also the conformation of the organism itself."[1] Any living form bears the physical record of all the different external forces that were exerted on it during its growth and evolution. The balance between the external forces and the internal disposition determines the robustness or the fragility of form in its continuous evolution. D'Arcy Thompson's book gives a clear understanding of the production of form as a meaningful process. Robert Venturi, in his book *Complexity and Contradiction in Architecture*, quotes Thompson and associates architectural design to the growth of a vegetable, influenced by external forces and internal genetic code.[2] Sustainable design presumes the same equilibrium between the external and the internal prerequisites of form. But in the physical dimensions of the environment,[3] external forces become tangible and quantifiable variables that make the production of form dependent on technology. The notion of sustainability stands for the external-internal symbiosis in regard to nature, based on a rational use of available resources and technologies. In sustainable thinking, architecture is bound by the scientific principles of the physical environment; these principles influence the way built forms are produced as well as their aesthetics, the way they *affect*.

Le Corbusier compared the idealized built form to a soap bubble that is "perfect and harmonious if the air is evenly distributed and perfectly ordered from the inside."[4] However, to achieve sustainable design, the built form cannot be determined by conditions of insular interiority. It must be conditioned by the external environment and by the need to engage in bi-directional *breathing* through the medium of its materials. Sustainable design requires:

> *... a change in our approach toward materiality, away from an understanding of material as exclusively physical and tangible, to include both the physical and the non physical – climate, sound or economics as well, as wood, steel or glass ... This expanded notion of materiality liberates built form from a dualist approach that separates ... production from perception.*[5]

While questioning the use of materials, sustainable design also calls into question the use of a unique system of dimensions in the production of form, as dimensions have a direct impact on the ability of a form to engage with its surroundings.

Achieving spatial continuity between the interior and the exterior – and the consequent dematerialization of physical boundaries – is also an objective dimension of sustainable design. Temperature, humidity and air speed values represent the perceptible manifestation of climate outside of form. They also characterize the desired climatic conditions inside of form. The quantitative comparison between the exterior and the interior, considered to be the basis of sustainable design,[6] rests on the analysis of these environmental parameters. Their values also inform the science underlying the production of sustainable form, leading to forms that achieve a balance of forces in ways that are verifiable through calculations and simulations; the goal is to enhance the disposition of all the components within the form and the overall environmental sensitivity of the form itself. Essentially, the qualities of sustainable design lie in achieving the exterior-interior balance.

Le Corbusier was aware that the *way* form follows function affects the *way* that form is perceived. For him, the movement of the human eye inside of form was the basis of its perception, while the relationship of movement and perception was structured by the architectural plan. Le Corbusier defined the plan as "the generator, carrying in itself the promise of sensation. Without plan is disorder, arbitrariness."[7] For Le Corbusier – working from the position of modernist principles – the architectural plan provided a primary tool for experimenting, evolving and elaborating a new aesthetics in architecture.

However, sustainability imposes a new set of principles on the production of architectural form and aesthetics in response to the consideration of environmental variables. Sustainable forms have to enter into a symbiotic relationship with the natural environment and engage in the act of *breathing*. Breathing is achieved by implementing an exterior-interior dialogue through the maximum use of natural light, the movement of air and the flow of energy. These natural phenomena may be controlled with air stratification, stack effect and cross ventilation, conduction and the reflection of light and sound. Ideally, sustainable forms would adapt to the environment in a manner analogous to a living organism, responding to the context and seeking balance with its climate, culture and nature. While Le Corbusier focused on the architectural plan in his explorations of form, today's sustainable architects may focus on the architectural section instead, in order to achieve the objectives of breathing, symbiosis and the effective control of environmental phenomena. In the instance of sustainability, the section reveals the formal characteristics, dimensioning and composition needed for sustainable architecture. (Fig. 1)

Fig. 1: Hall 26 for the Deutsche Messe AG, Hanover (Thomas Herzog). The section is a tool to control and improve the internal environmental conditions.

Early attempts to consider the environment in architectural form can be seen in Candilis, Josic and Woods' 1964 design for the Berlin Free University. The architects stated that their design was "an attempt to discover structuring principles that might be used for the organization of the physical environment."[8] They aimed at inserting environmental concerns into the modernist imperative that form follows function. In the Berlin Free University, the principles adopted in the production of form guarantee the presence of small fragments of natural air and light within the perimeter of the building. This fragmentation provides the form with the ability to breathe, while enabling the creation of a more perfect microclimate within the perimeter of the building that draws from – yet substitutes for – the existing climate on the exterior. The resulting typology was described as a *mat-building* due to its horizontality, and due to its implications of infinite expansion across the landscape. Criticism of the typology centers on the idea that the mat-building is an environmentally deterministic model for architecture. However, in these early explorations at the Berlin Free University, the mat-building "provided a means through which the outside could be controlled, much in the same way as the interior environment was climatically controlled."[9]

The design of Le Corbusier's Venice Hospital was based on the production of form from the interior, and the building is identified as part of the mat-building typology. (Fig. 2) In the Venice Hospital, the form represents the physical expression of the internal functional program, while the circulation system was used to determine the arrangement of the functional units. The form was strategically designed to increase the building's flexibility, but environmental considerations were made as well. In dimensioning the overlapping circulation grids, Julián de La Fuente, a project architect of Le Corbusier at the time, appealed to the study of the climate charts of Venice. The resulting organization was characterized by a remarkable continuity with the Venetian urban fabric, and in that continuity, the building's breathing became implicit with the climatic patterns of Venice. Both the Berlin Free University and the Venice Hospital represent two significant examples of how the development of form is affected when embedded with environmental concerns. In mat-buildings, the external boundary is fragile and less valuable: the form itself loses significance. Environmental sensitivity is instead identified with the circulation grids on which the functional program is organized. The grids, the internal code, guarantee the growth and survival of the form.

Fig. 2: Le Corbusier's Venice Hospital.

The goals of functional and environmental performance suggest the use of different principles in the production of architectural form; this contradiction unavoidably creates tensions in the design process. Venturi asserts that those tensions "help make architecture,"[10] giving the wall an architectural meaning as a spatial record of their resolution. "Since the inside is different from the outside, the wall – the point of change – becomes an architectural event." When those tensions do not find a solution in the wall, the envelope dilates itself until it includes in-between spaces, and those interstices give "the exterior and the interior a different order; an exterior not coinciding with the interior."[11]

According to Venturi, the development of form represents an outside-in process as opposed to a functional program where form grows from the inside-out; this approach tends to dissociate performance and form. A similar approach is true in sustainable design, where forms are tuned more strongly to the characteristics of the external environment than to the building's internal program, contrasting with the modernist dictum that form follows function. In sustainable design, the building form becomes a tool for the environmental control of comfort parameters, to mediate between the external-natural environment and the internal-artificial one. As a consequence, the environmental and functional performances of form may be dissociated within the building and allocated to different architectural components.

In the Akademie Mont-Cenis in Herne, Germany, designed by the Lyonese architects Françoise-Hélène Jourda and Gilles Perraudin, the form is an environmentally performative device that is totally independent of the functional program. The Akademie consists of a timber truss and glass structure that forms a shell, covering nine independent pavilions inside. The structure is almost completely devoid of shading devices, aside from the photovoltaic panels integrated into the roof glazing to limit solar radiation. The external shell is devoted to the creation of a microclimate for the pavilions inside. (Fig. 3)

Fig. 3: Akademie Mont-Cenis, Herne, Germany (Jourda and Perraudin). The form, as an environmental performative device, is independent of the functional program.

While the use of in-between spaces for environmental control in architecture is nothing new, two fundamental ideas distinguish the Akademie from more common type of integrated atria: the indeterminacy of the Akademie's energy strategy, and the total structural separation of its interior and exterior components. First, unlike most energy concepts, the architects do not clearly define a specific energy strategy. The climatic factors are all simultaneously reflected in contradictory conditions in order to underline the possibility of adapting to any external environmental condition. In essence, the possible thermal corrections inside the shell are infinitely variable. The second fundamental characteristic is the total structural independence of the shell from the nine interior pavilions where the different functions are located. On one hand, it can be said that the contents lose significance: the pavilions are fragile in comparison with the container that is designed to survive functional changes. This characteristic is physically expressed in the abstraction of the architectural components that constitute the shell: their homogeneity signifies uncertainty and unpredictability of both the external and internal events. In contrast, the complex volumes of the pavilions located inside the simpler container go against the tenet of an intimate agreement between form and function.

Within current approaches to sustainable design, previously useless components – in terms of their ability to interface with the environment – have become useful for initiating the potential of breathing at all scales of the project. Even in programs driven by the total environmental functionalism of form, new architectural expressions do have the potential to take place, based on the establishment of new forms that are sensitive to the conditions of the surrounding environment. While the goal of sustainability may bring about discrepancies in the production of forms, forms do have the potential to acquire new architectural meanings that go beyond the modernist imperative of form that follows function.

Working from the general objective of sustainable design, the exterior skin will continue to channel and filter natural air and light into the interior, and building components will be conceived as organs for the body, contributing to the growth and the continued viability of the body as a whole. The constituent organs will be proportionate, based on a system of principles to establish a symbiotic relationship between the body and the external environment. The composition of these elements will flow from an understanding of the external environment, defining the strategies for air stratification, heat radiation, conduction, convection, evaporative cooling and the transmission and reflection of daylight.

However, despite these ideal approaches to sustainable design, the physical aspects of the environment are often contradictory; the mechanisms needed to facilitate natural light may be different than those needed to facilitate heat and airflow, often leading to contradictory directions and the application of various complicated details in architectural form. As a consequence, different performance criteria are delegated to specialized equipment forming a patchwork of mechanical elements. (Fig. 4) Such fragmentation is often resolved in the application of multiple skins. This current pattern of fragmentation and specialization is analogous to the gradual dematerialization of the physical boundaries of form made possible hundreds of years ago by the understanding of the dispersal of static loads, as implemented in Gothic cathedral structures.

Fig. 4: SOKA BAU office building, Germany (Thomas Herzog) showing a different patchwork of elements, each one with its own function.

In sustainable design today, such mechanical complexity is usually delegated to various engineers or experts throughout the different stages of the design process in order to perform calculations, simulations and evaluations. Today they rely on specialty software in combination with 3D modelers in order to delve into the kind of complexities that were impossible to deal with only twenty years ago. The numeric parameters that result from these evaluations are fundamental to the development of meaningful and environmentally sensitive architectural forms. Engineers use advanced software to determine the positioning of architectural components within the three dimensions of space, based on a quantitative comparison between the exterior environment and the desired interior conditions, and on the overall thermal performance of the building. In this design process, successive iterations – alternating between cause and effect – are essential to achieving the maximum efficiency of optimized form.

Within this digital approach, architects still maintain the primary role of form-giver and the author of the final product, consistent with their underlying aesthetic philosophies. Along with the use of digital tools in the design process, algorithms and mathematical equations bring their own aesthetic layers to the project regardless of the design intent of the architect. Some “see in the computer a chance to liberate architecture not only from the old formal rules but also from the creator ego.”[12] Current digital trends have inevitably influenced the process of form-making and formal composition. Therefore, in sustainable design, the physical performance of a building should be, in essence, inseparable from its physical shape: architecture, engineering and aesthetics are supposed to be integrated through the use of digital tools, into one. (Fig. 5)

Fig. 5: London City Hall (Foster & Associates). The form was conceived to optimize the thermal performance in relation to the sun.

However, the formal outcomes of these digital processes are still intimately tied to the designer's understanding of environmental behavior and performance, as well as to the designer's aesthetic decisions. In a recent study conducted at the Harvard Graduate School of Design by Lagios, Niemasz and Reinharton,[13] the researchers found an infinite number of different but related shapes that could be generated in parametric space. And out of this infinite number, they were able to isolate a single shape that embodied the optimal criteria to resolve the given architectural prerequisites, relative to the analyzed parameters. However, one shortcoming is that such a solution is only valid within the range of parameters held constant during the analysis. As the authors of the study discussed in their work, there is no "single, ideal performative solution that will reveal itself during the process and which consequentially 'has' to be used by the designers."[14] In addition to this, they also found that it is rather difficult to control a large number of parametric variables simultaneously. While "some designers might be inclined to use" parametric analyses "as a form-giver for their designs," the researchers suggest that "others might use it to understand how a building form reacts" in order to evaluate the impact and robustness of specific parameters. Consequently, the aesthetics of sustainable architecture may not be considered an objective scientific exercise that provides the single most suited version to the given requirements. In this case, the outcome depends on the subjective aesthetic choices, albeit highly informed, of the designer as the author.

In general, the energy efficiency of form is based on two complimentary criteria: the optimization of environmental behavior on one hand, and the maximization of internal thermal performance and its technical apparatus efficiency on the other. The first criterion refers to a morphological approach that relies on passive strategies for environmental behavior, such as cardinal solar orientation, surface geometry and compliments to reduce infrared radiation; these strategies minimize energy consumption through the building envelope by means of composition. The second criterion refers to an engineering approach that defines the technical characteristics of form, maximizing the efficiency of climate control equipment and devices. In recent years, the traditional boundary between the two approaches has become less clear, moving toward a more integrated one and pointing to the kind of architecture that is no longer analogous to a body on life supporting machines. Under the current tenets of sustainable design in combination with digital technology, the form and its technology should be integrated, and together, adapted to environmental variables. The technical equipment is no longer considered to be grafted on at the end of the project; rather, the technology is integral to the formal logic of the building from the beginning. Calculations and simulations for energy efficiency and environmental sensitivity have become the means by which the formal exploration of new architectural scenarios can take place. But, "The point is that the architect thinks more about the technical consequences of the forms he designs and the engineers have to consider more the aesthetic results of their concepts and decisions."[15]

The term *Archi-neering*, (Fig. 6) coined by Helmut Jahn, Werner Sobek and Matthias Schuler, envisions a total integration between the disciplines of architecture and engineering. Implicit in this term is the potential to overcome the traditional boundary between the low-tech and the high-tech as two possible alternatives for sustainability. Archi-neering, as low-tech architecture, is based on maximizing inputs from the environment and its resources and materials, however, the approach also considers the possibility of resorting to technology to reinforce the dialogue between the interior and the exterior.

Fig. 6: The roof structure of the Sony Center, Berlin (Helmut Jahn).

The current potential to integrate architecture and engineering indicates that the disjunction between the internal conditions of a building – its function, structure and services – and the kind of technical equipment needed to sustain them, will disappear. In essence, form and performance will converge and this integration occurs through the permeability of the building envelope and the provision of different devices that respond to natural phenomena, so that the overall form may adapt its breathing to the climatic variations of the given environment. Often, the result of this approach is a building that is simple in shape, yet complex in technological content. One example is the California Academy of Sciences building by Renzo Piano. (Fig. 7) This building responds to environmental variables in such a way that the term high-tech cannot be identified with the kind of environmental controls that are appended to the body as an afterthought. Instead, the building represents a transformative process in which the traditional static envelope is made adaptable through its inherent morphology, engineering and technology.

Fig. 7: California Academy of Science, San Francisco (Renzo Piano Building Workshop).

Within this approach, characterized as the total environmental functionalism of form, the artificial environment becomes more organic, while its aesthetics become closer to the adaptation found in nature. Over the past few decades, the accelerated development of advanced materials and techniques has led to the emergence of sophisticated *artificial codes* for the built environment. Such codes contribute to the design of rigorous, adaptable envelopes, significantly raising the intimacy between form and climate. At the same time, this process makes less clear the once familiar relationship between the climatic context and the construction materials and techniques of vernacular architecture. For example, new airtight and highly insulating envelopes have the potential to replace the vernacular compact shapes in frigid climates, providing a range of new architectural possibilities. In addition, due to the availability of new materials and techniques, the characteristics of a given vernacular may be extrapolated and integrated into new systems in different combinations and contexts. Passive strategies that were once closely connected to specific climates and locales may now expand beyond their applicable geographic boundaries.

The aesthetics of sustainable design is thus an evolving process crucially connected to the technological development of new materials and techniques. However, it is important to return to the more subjective ideas of beauty when considering sustainable design. For Euclid, the aesthetic experience of form, especially the sense of beauty, was most perfect when the geometric properties of form could be described in terms of numbers. From this position, Jürgen Schmidhuber describes and postulates an algorithmic theory of beauty that takes the subjectivity of the observer into account. Schmidhuber states that "among several observations, classified as comparable by a given subjective observer, the aesthetically most pleasing one is the one with the shortest description."[16] This conception of beauty is based in simplicity and inherently linked to the extent of attention by the observer, and to the ability to understand the meaning of form through certain regularities such as repetitions, symmetries and self-similarity.

Sustainable design presumes a rational approach in the production of form. The use of advanced algorithms and digital modeling provides architects with a rational means to implement order and harmonic relations among the various components. Mies van der Rohe classified as *true* those forms that were built according to the logic of their materials; for him, this notion of truth represented a fundamental requirement of beauty. In sustainable design, forms that can be said of as true go beyond material rationality to enter into a sensitive dialog with the environment: truth lies in avoiding the superfluous and the redundant, in accordance with nature, while preserving what is essential. Truth may lie in finding the balance between the external and the internal, without engaging in pointless exercises of self-referential form-making. The affective qualities of sustainable design are not only based on rationality and order, but also on environmental sensitivity and lightness, achieved through the maximization of the interior-exterior dialog. (Fig. 8) In this way, the skin of sustainable forms is often characterized by a pronounced permeability, while the internal space is adaptable and sensitive to the external environment.

Fig. 8: Commerzbank Headquarters, Frankfurt (Foster & Associates).

The recurrent analogy of sustainable architecture to living organisms does not come from a romantic idea of achieving a peaceful reconciliation with nature. Instead, this analogy is based on the view that architecture should be part of nature, brought into symbiosis with environmental forces in order to move the artificial world closer to the organic one. Extending the analogy between architecture and living organisms is the practice of applying the logic and values of systems found in nature to sustainable architecture. In his observation of bees, Colin Maclaurin, a mathematician in the 18th century, states that "the perfection of mathematical beauty is such that whatsoever is most beautiful and regular is also found to be the most useful and excellent." Particles of cells, tissues, shells and bones all "have been moved, molded and conformed in obedience to the laws of physics."[17]

Over the past few decades, the field of biomimetics has drawn, as the term implies, from natural forms and processes in order to deal with artificial human problems. It is based on the Aristotelian assumption that if there is an answer to a problem, it has probably already been found by nature. The biomimetic process of mimicking natural organisms is based on understanding and abstracting the underlying functional principles of biology. The resulting forms are seen as the manifestations of the specific necessity for self-preservation that is thought of as aesthetic. As discussed by Dennis Dollens,[18] Janine Benyus refers to biomimetics as:

> *... the technical term used in biochemistry, biology, pharmaceuticals, and by material scientists in their quest for properties in living organisms and natural systems that can*

> *be extrapolated from observation and scientific analysis, in order to recreate those properties for industrial, medical, and biological products.*[19]

In architecture, this view of biomimetics points to a means of achieving symbiosis, an instrument for the production of sustainable forms. However, architecture represents another reality altogether when compared to the natural world. Architecture is part of the artificial, built environment, a synthetic parallel to the natural world that is conceived, designed and constructed by people in ways that are often unconscious of – and in conflict with – the natural world. In this sense, architecture would require a set of approaches that are different from other disciplines that have more direct connections to biomimetics.

The other component of architecture that is inspired by natural forms is the so-called "digitally grown architecture."[20] This type of architecture is conceived of as *grown*, as opposed to being assembled of standardized parts. Its designers will have to develop and produce each form as a unique whole, specific to a given project and context. For example, Dennis Dollens acknowledges that in order to realize his experimental models inspired by natural forms, it is necessary to develop advanced materials that possess biological properties that do not exist in the present day. He emphasizes that these kinds of forms should not be seen as buildings but as "concepts and experimentations in design research."[21] As such, they cannot be adopted for the built environment as they cannot be supposed to fulfill the kind of *architectural* requirements related to the function and materiality necessary for human habitation. This inevitably results in the production of digital forms that embody only the superficial appearance of nature's phenomena, without being able to function as buildings.

The potential benefit of incorporating biomimetic processes into architecture can be framed as a way of finding "a more efficient use of materials or ... the development of lighter components and structures integrating different performances."[22] For example, living organisms may inspire new architectural models for the optimal response to thermal variations, as a way of finding optimal solutions for responding to the natural heat source of the sun. However, the call for environmental responsiveness in architecture, derived from the adoption of natural forms, can be misleading. Often, natural forms are simplistically translated to the appearance of architecture, and this translation does not add up to any measure of environmental sensitivity or sustainability other than that they *look* organic and natural.

Another compelling argument for taking inspiration from the organic world is that nature integrates and adapts technical, functional and aesthetic values in the most efficient way possible, based on millennia of adaptation and optimization. Architects have attempted to *translate* these properties into sustainable design through methods such as botanical algorithms. However, the growth of forms within these algorithms is continuous, undisturbed and most of all, unnaturally pure. The discrepancies and disturbances that occur in nature are either conveniently excluded or impossible to model due to the infinite variations of complexity. In their homogeneity and perfection, the so-called digitally grown forms do not mimic the natural world or confer any benefits from the natural process of adaptation to architecture. Indeed, the resulting forms are contrary to the actualities of the organic world, where responses and adaptations to natural events, both nominal and catastrophic, often determine the outcome of a species' form and function. Such a simplistic approach results in unbridled randomness, contradicting the fundamental basis of biomimetic processes.

In current practice, architecture as a discipline has accumulated the foundational knowledge necessary to advance the project of sustainable design; the exploration of natural forms has been meaningful in this process. The increasing ubiquity of advanced 3D modeling and simulation software has enabled architects to conceive of highly complex forms, to analyze their structures and to evaluate their behaviors in relation to natural phenomena. The use of software has also altered the creative process through which architecture is conceived, and modified the aesthetics to which a project may be referred. When combined with environmental consciousness, 3D modeling is often directed toward affective form-making, alluding to the goals of sustainable architecture. However, the projects produced in this way often differ in regard to language, concept and design approach. It is therefore necessary to reflect on the position of sustainability in the current technocentric architecture, in a way that goes beyond the etymology of the terms biomimeticism and sustainability. Simplistic approaches to biomimetic form-making, with no regard for environmental factors and scope, are devoid of the process necessary for substantive mimesis. These approaches reduce architecture to bare visual affectation lacking the design's relationship to the natural processes it purports to reflect. In this way, sustainable architecture is hollow and only skin deep.

The recurrent identification of organic forms with the notion of sustainability has generated quite a few misconceptions about the word sustainable. Today it seems:

> *... hardly essential that a sustainable architecture look naturalistic. It seems that a building that looks like a natural organism, or is generally softened in appearance, is apt to be considered more environmentally responsible (or responsive) than a conventional tower or box.*[23]

With the appearance of a certain *organic-looking* vocabulary, the kind of design that *appears* organic is promoted as sustainable. However, such an application of biomimetic processes, resulting in an allusion to sustainable design, is tantamount to 21st century mannerism where a hotchpotch of overestimated techniques are devoted to producing only the appearance of environmental performance. Bio-mannerist design processes will never attain a meaningful basis, as the physical dimensions of the environment are rational and quantifiable. And the inefficiencies of form will be spontaneously exposed when analyzed against the environment. This provides a means of testing and improvement, where an inefficient form can "either change its relative proportions or find new materials"[24] in an effort to move toward a more concrete measure of sustainability, and away from affectation inspired by organic and natural forms.

Artificial forms can be likened to pathogens whose environmental presence needs to be artificially controlled, and this is especially true where architecture and engineering seem to diverge. The formalistic manipulation and misuse of mimetic principles has resulted in the appearance of a new category of professionals. The climate engineer, for instance, is such a new professional, specializing in the improvement of the environmental behavior of architectural form. The role of the climate engineer resembles that of the archaic architect, genuinely devoted to shelters in an antagonistic view of human against nature. Along with the climate engineer, architecture runs the risk of relinquishing another meaningful disciplinary basis, as the responsibility for structure becomes the domain of engineering.

In reconciling with nature, sustainable architecture means an adherence to the physical dimensions of the environment, with a distinctive inherent logic in the production of form. However, this does not imply recourse to a specific formal language of one kind or another. Returning the term sustainability to its original meaning will impose a more specific and more coherent scope on architecture, from which certain projects might inevitably be excluded. In a work of architecture the relation to the actual, physical dimensions of the environment determines the degree of sustainable logic, or the lack thereof. In many ways, sustainability is an exact science that may be critically evaluated and rigorously verified.

The term aesthetics has been characterized as anything that is perceived through the senses and as the recognition of certain beauty. But as a matter of fact, the aesthetics of sustainable design is in many ways an equation of forms and dimensions, relative to the given environmental variables. The construction of a new artificial world on the basis of such equations, in a way that is sensitive to the natural one, carries in itself the notion of beauty. In this equation, mimesis and symbiosis do have a crucial role to play in informing the internal logic of the artificial environment, bringing the artificial environment to a state where it becomes an inherent constituent of the natural one. But in architecture, mimesis does not necessarily imply symbiosis; symbiosis with nature does not necessarily suppose mimesis. Those two concepts, however intimately related in the organic world, are not necessarily connected in the built environment. The internal genetic codes of the natural and the human-made still differ too much. However, the aesthetics of sustainable design is an evolving process that is tightly linked to the development of new architectural components, materials and techniques; when applied to architecture, biomimetics does point to a coherent evolution of both form and function that embodies this process of evolution.

NOTES

1 D'Arcy Thomson, *On Growth and Form* (London: Cambridge University Press, 1917), 11.

2 Robert Venturi, *Complexity And Contradictions In Architecture* (Chicago: The Museum of Modern Art- Papers on Architecture, 1966), 82.

3 In its physical acceptation, the word environment indicates all those energy balances that can be controlled through the use of mathematical equations. The physical dimensions of the environment in regard to comfort are the thermal, the luminous and the acoustic ones.

4 Le Corbusier, *Toward an Architecture*, trans. John Goodman, intro. Jean Louis Cohen (Los Angeles, California: Paul Getty Trust, 2007), 217. Translation of the 1928 *Vers une Architecture*, 2nd ed. (Paris: G. Crès, 1924).

5 Ibid.

6 Steven Szokolay, *Introduction to Architectural Science, The Basis of Sustainable Design* (Oxford: Elsevier, 2008).

7 Le Corbusier, *Toward an Architecture*, trans. John Goodman, intro. Jean Louis Cohen (Los Angeles, California: Paul Getty Trust, 2007), 314. Translation of the 1928 Vers un architecture, 2nd ed. (Paris: G. Crès, 1924).

8 Alison Smithson, "The Work of Team 10," *Architectural Design* 34:8 (1955): 380.

9 Hashim Sarkis, ed., *Le Corbusier's Venice Hospital And The Mat Buildings Revival* (New York: Prestel, 2001). See the essay included from M. Addington, N. Kienzl and S. Intrachooto, p. 66-79.

10 Robert Venturi, *Complexity and Contradictions in Architecture* (Chicago: The Museum of Modern Art- Papers on Architecture, 1966), 86.

11 Ibid.

12 Hugh A. Williams, *Zoomorphic, New Animal Architecture* (London: Laurence King Publishing, 2003), 25.

13 K. Lagios, J. Niemasz and C. F. Reinhart, "Animated Building Performance Simulation (ABPS) - Linking Rhinoceros/Grasshopper with Radiance/Daysim" (paper included in the proceedings of SimBuild 2010, New York City, United States, August 2010).

14 Ibid.

15 Werner Blaser and Helmut Jahn, *Architecture Engineering* (Basel: Birkhäuser, 2002), 13.

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18 Dennis Dollens, "Digital-biomimetic Architecture" (lecture presented at the University of Barcelona, Spain, March 29, 2006).

19 Janine Benyus, *Biomimicry: Innovation Inspired by Nature* (New York: Quill, 1997).

20 Dennis Dollens, "Digital-biomimetic Architecture" (lecture presented at the University of Barcelona, Spain, March 29, 2006).

21 Ibid.

22 Hugh A. Williams, *Zoomorphic, New Animal Architecture* (London: Laurence King Publishing, 2003), 31.

23 Ibid. p. 20.

24 D'Arcy Thomson, *On Growth and Form* (London: Cambridge University Press, 1917), 19. Those words were used in regard to the static dimension of the environment. They are however also true in the other dimensions of the physical environment – acoustic, luminous and thermal.

FIGURE CREDITS

Fig. 1: Dieter Leistner, Thomas Herzog and Partners

Fig. 2, 3 & 8: Luca Finocchiaro & Anne Grete Hestnes

Fig. 4: Thomas Herzog and Partners

Fig. 5: Foster & Associates

Fig. 6: Maurizio Fedullo

Fig. 7: RPBW, Nic Lehoux

7.039 words

Aesthetic Potentials in an Open Network Inventory System

David Briggs AIA LEED AP

Introduction

Since computer aided drafting systems were developed for architects, the design and documentation process has transformed from pencil and ink drawings to sophisticated virtual models. Digital technology has provided a remarkable means for reducing production time, cross-referencing consultants' work, making design changes and constructing virtual models for visualization and presentation. Some professionals believe that the computer is no substitute for design talent, and merely a tool for enhancing and reinforcing the architect's vision. Others suggest that without the easy manipulation of digital forms, the range of aesthetic potentials will be limited. Setting aside the merits of both arguments, a new opportunity has arisen with digital documentation that is currently in the infancy of its development: the opportunity to explore how the aesthetic choices made by architects during the design process can be shaped by materialization processes and by global and local environmental systems.

With regard to so-called sustainable design, there are extensive resources available for selecting the right materials and designing the most efficient energy systems to minimize a building's impact on the environment. Architects such as Walter Stahel and William McDonough[1] have proposed that we go a step further and consider our buildings as part of a complex and closed-loop economic system, moving forward to design the output (waste) of our buildings as the nourishment (food) that ensures the metabolic health of the system. The foundations of this "cradle-to-cradle" approach, described in a 1976 report titled *The Potential for Substituting Manpower for Energy* by Walter Stahel and Genevieve Reday,[2] focus on non-linear industrial processes that support job creation, economic competitiveness, resource protection and waste elimination. The report lays out a broad vision of sustainable development that addresses the issues of ecological, economic and social compatibility. Adopting this vision and implementing it in architectural projects tends to occur only in cases where an enlightened client mandates a fundamental change in the way that architects conduct their practice. However, if architecture is to help mitigate our mounting environmental problems, then architects must aggressively expand their influence on industrial processes and take responsibility for the decisions they make while designing and detailing buildings. For example, the aesthetic choices made in the early design stages should be valued by their direct impact on the environment. By integrating the creative process with an open network that responds to market forces and environmental consequences, the architect can meld creativity with the set of conditions that defines a building's sustainability.

At the global scale, an enormous amount of energy is expended during the processes of manufacturing and construction, and environmental systems are damaged by the consequences of modern industry. International trade agreements and access to cheap labor markets have opened the door for wealthy societies to construct their communities with materials shipped to them from the other side of the planet. With poor oversight of manufacturing processes in developing nations – along with the significant pollution created by antiquated factories and shipping traffic in addition to the catastrophic effects of clear cutting, strip mining and other raw material extraction practices – it is compelling to consider how wealthy nations merge their concern with the upstream effects of resource management with the downstream effects of industry.

And how do developing nations establish an economic value for their resources while maintaining fair trade and labor practices? Though they may be less conscious of the larger implications of their decisions, architects should move to embrace these and other challenges through the design process.

Whether dealing with global or local issues, the odds seem stacked against architects who are trying to address environmental problems by researching the chain of custody for building materials or weighing the costs and benefits of energy systems. Given these challenges, an architect's designs tend to be guided by personal values, independent project objectives and third-party rating systems. The intent of this chapter is to highlight the tools that are currently available and to further develop – both within and beyond the profession of architecture – a broader approach to sustainable design.

Current Technology

Despite the rapid advance of digital technology over the past couple of decades, the existing digitized design process lacks two essential elements. First, it lacks direct means for architects to measure how a project's materials and systems will impact the physical environment, including the effects of harvesting and mining on ecological systems, and the associated impacts to water use, air pollution and waste. Second, it lacks direct means to measure the adverse impacts to local, regional and global milieus that result from the physical alterations to the environment, brought on by the construction of architects' designs.

Building a substantive understanding of a project's environment impacts, though a massive undertaking, can be achieved by looking at other models of production and at technology that is currently available in the architectural profession. Building

Information Modeling (BIM) software has enabled architects and engineers to gather a wide range of data on their projects, including building geometries, spatial relationships, geographic information, projected energy use and the properties of building components. Based on this data, the life-cycle costs of a building can be calculated, and levels of performance can be predicted over the long term.[3] Since it is a dynamic model, BIM has become an extremely powerful tool for use in construction and subsequently facility management. For example, contractors can generate shop drawings for various building systems and create schedules for the ordering, fabrication and delivery of materials and components; building and planning department officials can use the models for compliance review; forensic analyses can be conducted to graphically illustrate potential failures, leaks and emergency plans; and the costs can be precisely estimated, extracted and updated as the model changes. In terms of integrating BIM with other forms of digital technology, building components such as structural steel can include radio frequency identification tags (RFID) that track their delivery and installation on a construction site;[4] construction process data, such as location and sequencing, can be automatically updated when linked to field scanning devices; and there is an initiative, for example, by the BuildingSMART Alliance to integrate BIM with Geographic Information Systems (GIS) in order to place buildings within the context of real world data.[5] A project team – including an architect, contractor and client – that is well versed in BIM has the capability to rigorously analyze design proposals and subject them to simulations. BIM, along with the other technologies mentioned, offers an exciting interface between process and product: it embodies the next stage in the evolution of digital design in architecture leading to improved and innovative contextual solutions.[6] However, one component that is missing from BIM software is how to accurately assess the impacts of the proposed building design and its long-term operation on the environment. For example, how do design decisions impact the availability of building materials, and even further upstream, how do they impact the supply of raw materials and the environment of the producing regions? If the design process was dynamically linked and interfaced with the market network, we would have the basis for creating a feedback loop and a tool for architects to use in the design of truly sustainable buildings. These buildings would not only be outfitted with recycled materials and energy efficient systems, but also, they would be based on explicit choices about how the building's design, construction and use will impact environmental systems worldwide. Paraphrasing Stahel and Reday's proposal made thirty-five years ago, architects must seek to integrate aesthetic objectives into a digital, closed-loop process that supports sustainable systems.

The second objective – raising an understanding of how aesthetic judgments impact local, regional and global societies – is a difficult challenge. Without science to provide the substantiated facts of global warming and the serious predicament associated with our current patterns of resource use, the goal of designing buildings that are less damaging to the environment and to societies cannot be measured in a meaningful way. In this regard, a renewed interest in evaluating our impacts to environmental and social systems in a global context, coupled with the tools provided by modern technology, enable us to better understand the dynamics of both the natural and artificial worlds, and the linkages between them. Given such trends, BIM and other energy modeling software should not only be used to enhance the design process and its productivity, but to better understand how design decisions impact far flung economies, societies, infrastructure, ecosystems and natural resources. By expanding the scope of current modeling software, the architect can choose a solution that better integrates a project's purpose in relation to the broader goals of global sustainability.

The construction industry has been slow to participate in the digital revolution despite recent progress in the digitization of the design and documentation process. Under the traditional model, the contractor receives a set of construction documents that are either plotted on large sheets of paper or uploaded to an FTP site for his use. He will then tabulate the quantity of materials, review the proposed systems and develop a plan for efficiently sequencing the construction and installation processes. Once awarded the construction contract, the laborers, subcontractors and suppliers are hired to execute the project according to the construction drawings and specifications. Here the contractor simply controls the building materials that are delivered to the site in order to achieve the design intent that is outlined in the construction documents, with little regard to the expenditure of resources required prior to their delivery on site.

In order to expand the use of technology for the construction of better buildings, contractors will need to assume an earlier, integrated role in the design process. As information on building systems is provided to the architect, the contractor can begin to identify fabrication processes that represent the most appropriate means to achieve the design intent. As with the architect, the contractor must become aware of how the building's proposed construction methods impact certain externalities such as waste by-products, efficient use of materials, shipping costs and labor challenges. With this information, the architect and contractor can expand their frontline roles in choosing an appropriate design scheme, where aesthetics and sustainability are defined by the information provided by an open network of information.

Open Network

Early in the design process, when an architect begins to consider the formal qualities of a design, many external decisions are made that will affect the finality of the finished product. From the outset, the client would have presented a desired building program and explanations for the intended use. The architect, working with various consultants, will determine what kind of structural and mechanical systems most effectively respond to the client's needs, and will choose materials and assemblies that he finds most desirable. Historically, these decisions have been guided by the architect's interest in achieving a self-defined aesthetic, based on his existing body of work and an evolving sense of issues such as proportion, scale and materiality. If BIM is expanded to access a real time inventory and information system network in order to track the specific attributes of assemblies and materials, the application could also provide feedback on product availability, sourcing, pricing and environmental impact at an early phase in the design process.

Although most models provide cost estimates for assemblies and materials – as well as data on their energy efficiency characteristics – they are also capable of storing information such as the proportion of recycled materials and life-cycle assessments which could be aggregated into a more holistic model. In this way, the BIM can become a repository of data-rich information streaming directly into it from a variety of sources – from manufacturers, institutes, consultants and governments – that provide the architect with a series of choices directly related to the environmental qualifications of a given project. As the collected data is sorted and the project's impacts on environmental systems is assessed (and re-assessed with each design change), the role of the contractor will be to review the lead times, costs and byproducts of construction for each iteration. Under this scenario, the architect and contractor work together from the outset to create viable options to deliver the project while accounting for the external impacts of its development. The role of the client is to evaluate the results of this process, and decide how the project will proceed within a broad framework that more fully represents the true cost of its design, construction and maintenance. Such evaluations will be made in light of the client's desired goals for the project, not only in terms of the immediate and direct costs of construction, but also in terms of the long-term costs related to the operation of the building and its environmental impacts.

Inventory management systems already exist, and they are well used in architecture and construction.[7] These could be expanded to provide feedback when information on a building's material and energy systems are entered into the model, highlighting specific areas of environmental vulnerability. Feedback systems could facilitate the review of quantitative data sets regarding the building materials and their sources, the transportation energy that would be expended to bring materials to the job site as well as Material Safety Data Sheets (MSDS).[8] Overall, the goal would be to highlight and keep track of the upstream and downstream effects of the building design process, which include both environmental and profit-oriented considerations. Using prevailing marketplace conditions a building's expense, based on its environmental impact, could be derived as a direct result of the architect's decisions. Once this information is in hand, the architect faces a choice: whether to set aside the information and justify a design's expense by subscribing to more arbitrary and personal aesthetic preferences, or to adopt a systems-oriented approach that, through the objective collection of data, identifies the causal relationship between the design process, our current industrial systems and their wider environmental consequences.

By understanding this relationship, the architect can establish a new set of aesthetic values, taking into account the systemic environmental impact of the construction materials and systems deployed in his design.

Precedents and Rating Systems

In his book *Ecology of Commerce*, Paul Hawken argues that by eliminating the income tax system and assigning actual costs to supplies and materials based on their environmental, social as well as monetary costs, the free market system would naturally account for the environmental damage caused by the industrial manufacturing process.[9] Although this is a difficult proposition to execute given the complexities of measuring cause and effect, his proposal parallels the ideas behind an interactive BIM modeling process and inventory system. The key difference is found in the role of the architect. In Hawken's scenario, the end user is merely responsible for purchasing the cheapest product once the actual costs of the manufacturing process are factored in. In the BIM scenario, architecture directly influences the industrial process through a design feedback loop, where building components are selected based on the BIM network's impartial evaluation of environmental impacts. Additionally, by closely incorporating the contractor's role into the process, the architect would work upfront with those who would ultimately be responsible for procuring the building materials and executing the design. The architect would expand his critical role in choosing an aesthetically appropriate design scheme with the project team – where aesthetics are defined by the *choices* made during the design process – guided by the aggregated data processed in real time by the internet-based, open source inventory system.

A few applications for tracking the industrial process already exist which can be held as simplified versions of this new design model. Patagonia, the clothing retailer, tracks its manufacturing process from raw material to product delivery in *The Footprint Chronicles* on its website.[10] A consumer can log on and select a product; the impacts of the product's design, manufacturing and delivery system appear along with a comparison between the positive and negative aspects of its overall manufacturing process. A similar system could be created for building materials and systems. For example, when planning to specify a product or a material that has high embodied energy or that is derived from a non-renewable resource, the architect could view the system for an alternative that provides a better set of standards. By entering a series of performative parameters that include the project's location, performance expectation, durability, quantity and finish, the architect would receive immediate feedback on the environmentally relevant aspects of the material, including its indigenous context, method of extraction, the energy consumption to ship it to a manufacturing plant and to the site, the downstream effects of the manufacturing process, the possibilities for reclamation of manufacturing byproducts, the installation methods and the maintenance prospects. At first glance, this appears to be an overwhelming amount of information, however, the information for each material could be evaluated according to a scale that calculates the environmental impact of the building as a whole, based on the architect's choices and updated in real time with the addition of each new material. This could help the architect choose the kind of design alternatives that are more environmentally optimized.

Several rating systems already exist that quantify the impacts of building construction and occupancy on the environment. These include the United States Green Building

Council's (USGBC) LEED Rating system, the non-profit Green Building Initiative's Green Globes, the Building Research Establishment Environmental Assessment Method (BREEAM) from the UK and a myriad of other government agency guidelines. Within each system, credits are given for specifying materials from responsibly managed sources, with lower embodied energy levels and higher recycled contents. Points are also awarded for energy efficient systems and construction projects located within dense urban areas. LEED Online has evolved to support a new certification system with more direct data-flow capabilities, which should eventually establish a direct correlation between BIM models and the LEED Online submission process.[11]

However, as rating systems developed and clients began to realize the profit potentials of marketing *green* buildings, the process has become polarized in the sense that *brand-name* architects are commissioned to design signature buildings which are then subjected to *greening* by third-party consultants in order to meet the selected rating system. By abdicating responsibility, the lead architect is no longer in control of the specific connection between the unique design aesthetics and the sustainability considerations, and can no longer participate in the BIM loop. As a result, the challenge of exploring the potential performative aspects of sustainable design and its inherent aesthetic expressions becomes ignored.

Additionally, the rating systems in essence represent the information provided by the material manufacturers and suppliers, which is certified by their respective testing organizations. There are undoubtedly rigorous protocols in place to ensure that the claims of sustainability are reliable and accurate. However, just as the architect can relinquish the issues of sustainable design to consultants who are peripheral to the essential substance of design, he can also allow third-party rating systems to dictate environmental performance and aesthetics without directly correlating them with the design process.

An application developed for Apple's iPhone called RedLaser offers new insight into the way that architects can interject themselves into the production cycle for construction projects. RedLaser allows the user to scan any bar code to find product information such as allergens, pricing and the location of suppliers that carry the item, giving the user immediate access to information on a product's cost, where it can be purchased and if it is healthy to use.[12] This immediate inventory system could be translated to the specification of any architectural trade. In such a system, when the architect selects a material within the BIM model, the information on price, lead-time, manufacturing origin, shipping cost, the MSDS, recycled content, maintenance requirements and manufacturing by-products would become immediately available. For architects interested in responsible, sustainable design, the information presented confronts them with a set of values that interface with the BIM software and calculate an overall picture of sustainable standards for a building, which the architect can incorporate in real time during the design process. As the primary specifier of the project components along with the consultants, the architect would no longer operate outside of the production system, but would become an integral part of it. The architect could guide the building's development based on a series of decisions that directly impact the cost, embodied energy, recyclability, operations, indoor air quality and durability of the construction based on information that is fed back through the inventory system network. As the project progresses, the architect could frequently update the model, much in the same way that computer software is updated. New information would arrive, and the project would automatically adjust its sustainable performance criteria based on new market conditions.

The advantages of this open network inventory system are obvious. The system offers an efficient and measurable way to understand the environmental benefits of design choices, and architects who subscribe to the system can influence the manufacturing process by favoring products that quantifiably reduce adverse environmental impacts. In turn, as these more beneficial products strengthen themselves through the feedback loop and higher sustainable ratings are achieved, they become more cost effective through the traditional application of free market principles. Over time, the initial challenges of the proposition recede, and the new database of measurable criteria becomes a key intelligence for the evolving aesthetics of sustainable designs.

As the open network inventory system develops over time with an increasing user base, it could be expanded to include acknowledged accreditation services (for example, the Forest Stewardship Council's FSC labeling on wood products[13]) as part of the review of building products, as long as a system of transparency provides checks and balances to the internal workings of the service's review methods. As these accreditation systems come online, architects could make decisions that extend beyond standard *green* goals to review how products were borne out of the manufacturing process. For example, if a boardroom is to be constructed out of an exotic wood species, the architect can verify over the network if the raw lumber was shipped from a clear-cut tract of land, or if it followed the procedures of sustainable forestry supported by a chain-of-custody review. Presently, wood that is responsibly harvested is at a premium, but as direct feedback information becomes available through the inventory system, the incremental cost can be measured against the cost of the project as a whole. As the system fine-tunes itself and architects actively lead the specification of more beneficial materials, the need for responsibly managed materials such as tropical hardwoods will grow. As a result, developing nations with rich resources will be encouraged to support these practices. As more products meeting the criteria for sustainability become more available, their costs will be driven lower.

As the system continues to evolve, there would be a natural shift toward the specification of environmentally responsible materials and energy efficient systems that offer competitive prices. These materials and systems would integrate themselves into the building's creative development at stages during both pre- and post-occupancy as part of the BIM process. As the design industry transitions to BIM and develops a real time inventory system, an aesthetic will emerge that has its foundation in the successful application of the inventory system to the challenges of building design. By creating a baseline and a quantifiable measure of sustainability, the inventory system can guide a project's core design intent, materials and systems toward meeting a series of established guidelines for environmental sustainability. As it becomes easier to meet these guidelines through the free market tendency of the inventory system to become more efficient, the guidelines will respond by providing tighter protocols, more rigorous material sourcing requirements and by actively encouraging methods of construction that reduce the amount of material entering the waste stream.

The obvious challenge in creating such a complex system is the overwhelming amount of data that needs to be stored, sifted through and analyzed for each project. The processing of this data is well suited to take advantage of so-called *cloud* computing, for example, and a data-intensive BIM model could be stored on a social collaboration platform that is accessed on desktop computers by web-based applications.[14] The convenience, scalability and underlying infrastructure of the cloud computing would support an ongoing feedback loop between the BIM model and the inventory system as building designs develop within a parametric model that is embedded with layers of data. As Chris Anderson wrote in *Wired* magazine in 2008, traditional models for organizing our world are disappearing as the amount of available data far exceeds our capacity to visualize it.[15] This is true for architecture: design and construction documents have moved far beyond the amount of information that was stored in two-dimensional pencil and ink drawings. The data that will be processed in the proposed inventory system will become an impartial intelligence that correlates massive amounts of information without rendering an aesthetic judgment on the BIM model; and while the architect cannot visualize all of the information, it will still be up to him to evaluate the data and make decisions based on the environmental impacts of the proposed design.

As the BIM model is created for an individual project, each material or system would be assigned a value, and the values tabulated according to the level of sustainable measures achieved. Points would also be calculated based on the externalities of construction, including distance from the project site, chain of custody, downstream effects of logging and recyclability of the wood, for example. The BIM model provides an overall picture of the given project's measures toward sustainable and durable practice. However, in contrast to the USGBC's LEED certification system, it offers a more dynamic data environment that includes the production and supply chain, as the architect's decisions during the design process would actively impact the manufacturing process. By specifying a material in real time and inserting it into a project, the manufacturing company would receive this information and reallocate inventory based on the architect's design decisions. It is critical that the contractor and the client be included in these early steps of the project, since they represent the parties who ultimately purchase and assemble the materials. By making critical decisions and securing these purchases as a project develops, all three parties become collaborative participants in defining the sustainability and aesthetic achievement of a building design, rather than having the architect simply hand over a set of drawings for a contractor or client to execute.

Urban Impact

The most profound needs for revolutionizing our digital design process exist within the world's cities. Given that construction in urban centers will increase to accommodate the continuing influx of people, our methods for designing and building will need to develop beyond their current conventional methods. The raw materials for construction currently exist outside of cities, and it is likely that manufacturing facilities will be pushed out of the urban areas as land becomes more valuable for housing in growing communities. Transport systems for bringing materials into urban construction sites will be challenged as transportation corridors are expanded to accommodate the growing population. Buildings themselves will require flexibility in their use as the demands of a larger urban society diverge from their rural roots.

Referring back to *The Footprint Chronicles* it is important to ask: what are the regional and global effects of constructing buildings in a city, and how do they dovetail with the global supply chain? In his book *Earth in the Balance*, Al Gore describes three environmental systems that are affected by humankind: local, regional and global.[16] Without a doubt, contemporary design and construction techniques have a tremendous impact on all three. And although it is convenient to think of them as independent systems, it is apparent they are in fact closely linked. Almost any project in an urban area is created with systems and materials that have been sourced from locations a few city blocks away to thousands of miles away. The resources required to create these inputs are global. As the world moves toward urban areas with dwindling manufacturing centers, how does a project stay within its local context, or if it cannot, how does a project interact responsibly with regional and global environmental systems?

One model proposed for handling the demands of growing urban centers is the New York City regional foodshed developed by The Urban Design Lab at Columbia University, which considers the food production capacity of the New York City metropolitan region.[17] Their proposal considers localized land use, soil type, transportation infrastructure and climatic conditions to assess production at several scales, as well as actual food consumption data. Additionally, the initiative allows for the comparison of existing regional production and distribution with potential regional production and distribution to identify concrete possibilities for enhancing the capacity of the foodshed.

Similarly, a regional plan could be developed for the sourcing of construction materials and systems for building projects. Although architects currently have an option to specify materials that are locally sourced – especially if a project is to be certified under the LEED rating system – architects must rely on third-party sources to verify a product's origins. Even though we have bits and pieces of information on production and supply for the architecture and construction industry, collectively, a meaningful *data* system does not exist that describes the total annual consumption of these materials and systems on a regional basis. Many databases listing construction material suppliers exist, but they lack the real-time update capability necessary for architects' use in order to make meaningful decisions during the design process. With the current accepted rating systems, architects rely on paperwork, reports and testing to determine the environmental impacts of products. In spite of a plethora of forward thinking organizations and individuals, along with well established certification processes, the profession has yet to solve the disconnect between a building constructed in mid-town Manhattan and the raw materials shipped to it from another ecosystem thousands of miles away. This disconnect can be bridged within the design process itself by implementing a collective data network infrastructure.

As one can surmise, even if the manufacturing of building materials across the globe begins to meet stricter environmental guidelines, the effects of shipping such materials to urban centers remains a logistical and environmental trial. Consequently, the costs of foreign materials will remain high relative to materials that are locally sourced. This is one of the most important contributions of a digitized inventory system: an urban form would emerge as a result of how buildings are designed, built and used within an open network that can measure the impacts of urban development on environmental systems. Some cities are located near areas of rich natural resources while others are far removed from the raw materials that are required for construction. As the proposed BIM model is implemented, each city would cultivate an aesthetic by accounting for its context and its local materials, as well as by making conscious decisions that reflect the region's environmental composition when designing new buildings and retrofitting old ones. The inventory system would allow the architect, contractor and client to steer a project's development toward a more geographically specific focus.

Conclusion

With the implementation of the proposed open inventory network system, early adopters would select products and materials that benefit their projects. As these projects are built and as the system expands, more projects would come online with complex models that access the data that best suits their contextual constraints. Urban planners would start implementing the system, leading to a more defined and regionally specific character, and to the re-establishment of an urban typology that counters our modern tendency toward broad cultural homogenization and the prevalence of repetitive architectural clichés. The emerging urban fabric would reflect a particular society's place within local, regional and global ecosystems, as well as a more philosophical character that defines the essence of a place and its underlying character.[18] This character is not simply a stylistic one, but is embedded in how the citizens see their culture as a reflection of the profound environmental issues that affect their lives.

The current digital software systems used for creating buildings – coupled with the inventory systems used by many companies – offer new methods for calculating the environmental impacts of architectural projects. By engaging with inventory systems, architects can use the software to guide market-based principles toward sustainable design solutions. As the materials and systems with increased sustainability factors are selected at higher rates, the manufacturing process will respond by making more of those items available to the market, thus reducing their costs. Materials and systems with lower factors will become more expensive over time. The natural result is that industrial processes will shift their resources toward creating construction materials and systems that embody the virtues of sustainable design, including those of increased recyclability, safer manufacturing, local sourcing, well-managed harvesting and mining procedures and more efficient shipping methods. Within each local and regional environmental system, the metrics for evaluating these factors will be different given the uniqueness, and perhaps, the vulnerability of each system's natural resources. As a result, aesthetic outcomes will no longer be elevated to a Platonic view of beauty, but will be connected to the designer's understanding of how a project is conceived, built and occupied within the complex web of global ecosystems in which it exists.

NOTES

1 James Surowiecki, "Waste Away," *The New Yorker*, May 6, 2002. Surowiecki describes McDonough's view of a closed loop cycle as being comprised of two types of products. The first type is made of biological nutrients that completely degrade, using the waste to create the ingredients for new products – a perfect self-supporting cycle, setting aside the moral dilemma raised by encouraging a throw-away culture. The second type, technical nutrients, are designed products such as steel, plastics, glass, polymers, etc. that can be reused over and over.

2 For more on this see: Walter R. Stahel and Geneviève Reday, "The Potential for Substituting Manpower for Energy," *The Product Life Institute* (1976), available at http://www.product-life.org/en/cradle-to-cradle (accessed February 2011). Stahel and Reday predated McDonough's "cradle-to-cradle" philosophy by nearly two decades when they argued that by increasing the period over which products and goods are used, the amount of waste produced and resources used will decrease. They labeled this approach as "product-life extension" that would support business opportunities such as reuse, repair, reconditioning and recycling. This would create a self-replenishing economy that in turn would reduce dependence on raw materials while creating new business opportunities.

3 Salman Azhar, Michael Hein and Blake Sketo, "Building Information Modeling (BIM): Benefits, Risks and Challenges" (paper included in the Associated Schools of Construction International Proceedings of the 44th Annual Conference, Auburn University, April 2, 2008). To paraphrase the Azhar, Hein and Sketo article, Building Information Modeling (BIM) represents a process of design development and the use of a computer model to simulate the planning, design,

construction and operation of a facility. The resulting model, a Building Information Model, is a three-dimensional digital representation of the facility that contains data of key building components and its projected energy use. By generating and analyzing this information during the design process, decisions can be made about the construction and facility operations.

4 Wei Shi, Haiyan Xie and Raja R.A. Issa, "Integration of BIM and RFID in Steel Construction," *Journal of Building Information Modeling, Whole Building Design Guide* Spring (2010): 29-30. Available at: http://www.wbdg.org/references/jbim.php (accessed February 2011). This article describes how Radio Frequency Identification (RFID) tags can support the tracking of building material deliveries to a construction site as well as their installation. BIM components that include references to RFID tags can automatically update building product and erection process data when linked to mobile scanning devices. RFID can also help the BIM team develop an optimal sequencing plan, decreasing the duration of the project and meeting technological, budgetary and safety requirements.

5 John Przybyla, "The Next Frontier for BIM: Interoperability With GIS," *Journal of Building Information Modeling, Whole Building Design Guide* Fall (2010): 14-18. Available at: http://www.wbdg.org/references/jbim.php (accessed February 2011). Since BIM models tend to be context free, facility owners are starting to use Geographical Information Systems (GIS) to reference their buildings to a given environmental context. The open architecture of GIS makes it especially useful as a "geographic window" into the building data that exists in BIM models.

6 For more on this see Nadav Malin, "Building Information Modeling and Green Design," *BuildingGreen.com, Environmental Building News* (May 1, 2007).

Available at: http://www.buildinggreen.com/auth/article.cfm/2007/5/1/Building-Information-Modeling-and-Green-Design/ (accessed January 2011). As an example, the popular and user-friendly Google SketchUp offers a 3D modeling interface and the ability to assign characteristics to design objects. Most CAD software packages have some capability to import models from the SketchUp software and to export simplified models out to it. To ease the transition between SketchUp and energy modeling software, the U.S. Department of Energy (DOE) has released a plug-in for its EnergyPlus modeling engine, which is available for both the free and the full versions of SketchUp.

7 For more on this see Supplier Management, United Parcel Service of America, available at: http://ups-scs.com/transportation/supplier.html (accessed February 2011). UPS's Supply Chain Solutions allow users to track packages from the point of shipment, through distribution channels and to the end users. They manage and monitor documentation for regulatory compliance, service and repair of customers' products. By providing feedback to point-of-origin suppliers, designers could evaluate the environmental impacts of building materials and the track chain of custody requirements using a similar, but open source system.

8 For more on this, see the Recommended Format for Material Safety Data Sheets (MSDSs), available at http://www.osha.gov/dsg/hazcom/msdsformat.html (accessed May 2011). MSDSs follow a standard 16-section format established by the American National Standards Institute (ANSI). The information of greatest concern to workers is featured at the beginning of the data sheet, including information on chemical composition and first aid measures. More technical information that addresses topics such as the physical and chemical properties of the material and

toxicological data appears later in the document. However, ecological information is not yet required to be included on the form, though one would hope that this will soon change.

9 Paul Hawken, *The Ecology of Commerce: A Declaration of Sustainability* (New York: Harper Collins Publishers, 1993), 171. Hawken describes how a new "green tax" could be substituted for income, payroll and corporate taxes. The purpose is to move away from taxing goods and start taxing pollution, environmental degradation and non-renewable energies that are the result of industrial processes. The obvious challenge is trying to calculate the actual costs of these outputs, but by including them in a final price, consumer costs would increase in direct proportion to the amount of environmental degradation caused by a product's manufacture. Prices would decrease for those products that cause less environmental harm.

10 For more on this, see The Footprint Chronicles, Patagonia, Inc., available at http://www.patagonia.com/web/us/footprint/index.jsp?slc=en_US&sct=US (accessed February 2011). By selecting a garment on the company's website, one can find out how much energy was consumed by its manufacture, transportation and delivery to the Patagonia distribution center; the distance that the raw material traveled from its original source to the center; and the total CO_2 emissions and the amount of waste generated.

11 For more on this see About LEED Online, Green Building Certification Institute available at http://www.gbci.org/main-nav/building-certification/leed-online/about-leed-online.aspx (accessed May 2011). Through LEED Online, project teams can manage project details, complete documentation requirements for LEED credits and prerequisites, upload supporting files, submit applications for review,

receive reviewer feedback and earn LEED certification. It provides a shared network where members of a project team can work together to document compliance with the applicable rating system.

12 For more on this, see the new iPhone Red Laser Barcode Scanner at Adazon, Inc., available at http://www.adazonusa.com/blog/how-to-information/new-iphone-red-laser-barcode-scanner (accessed January 2011). The software behind Red Laser allows a user to receive, move, ship, adjust or take a physical inventory with a mobile barcode scanner. The scanner tracks items where they are located rather than at one central station and provides detailed information about each product, including off-site inventory, overstocking reports and transaction details.

13 For more on this see: About FSC – Forest Stewardship Council available at http://www.fsc.org/about-fsc.html (accessed April 2011).

14 Kimon Onuma, “Integration Today Using Open Standards: BIMStorm™, Rotterdam to Los Angeles and Beyond,” *Journal of Building Information Modeling, Whole Building Design Guide* Spring (2008):14-18. Available at http://www.wbdg.org/references/jbim.php (accessed January 2011). Onuma created BIMStorm™, an open source collaborative tool for modeling buildings without requiring proprietary software. It is scalable in the sense that it can be used by any number of users and allows architects, designers and engineers to work on the same model from different cities or countries. Through a cloud computing collaborative process, it leverages the web-based BIM capabilities of Onuma’s software to enable data sharing among multiple software programs including BIM, GIS systems, Google Earth and other sources.

15 Chris Anderson, "The End of Theory: The Data Deluge Makes the Scientific Method Obsolete," *Wired* June (2008). Available at http://www.wired.com/science/discoveries/magazine/16-07/pb_theory (accessed January 2011). Anderson argues that at the petabyte scale (1,000 terabytes), information has moved beyond the classic scientific structures of analysis and understanding. It is only through mathematical models, data crunching and powerful processors that useful information can be distilled out of the massive amounts of data at our disposal.

16 Al Gore, *Earth in the Balance: Ecology and the Human Spirit* (New York: Houghton Mifflin Company, 1992). Gore describes how the military system of categorizing conflicts as *local* skirmishes, *regional* battles and *strategic* conflicts can be used for understanding environmental crises (strategic conflicts including struggles that threaten a nation and must be considered in the global context). For example, air and water pollution can usually be considered *local* crises; acid rain, contaminated aquifers and oil spills tend to be considered *regional* crises; and increased global warming due to CO_2 emissions can be considered a *global* crisis.

17 Michael Conard and Kubi Ackerman, "Designing a Foodshed for New York," *Oculus* Winter (2009/2010): 30-31.

18 Christian Norberg-Schulze, *Genius Loci: Towards A Phenomenology Of Architecture* (New York: Rizzoli International Publications, Inc., 1980). Norberg-Schulz defines a place as the totality of concrete things having material substance, shape, texture and color; together these things determine the environmental character and atmosphere of a place. By moving away from abstract concepts and mental constructions, the phenomena of place take over as the way we perceive our environments, whether rural or urban.

Contributors

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Cover Image by Haru Ji & Graham Wakefield

Artificial Nature: Fluid Space is an evolving art installation that is a programmed, self-sustaining, digital ecosystem as an immersive environment, with organisms that consume, grow, metabolize, reproduce and respond to activities within an endless fluid environment. An artificial nature is not a simulation: it is a new realm with its own logic, life forms and relational dynamics.

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This book deals with the aesthetic potentials of sustainable architecture and its practice. In contrast to the mechanistic model, the book attempts to open a new area of scholarship and debate on sustainability in the design and production of architecture. In many instances, the key principles behind environmental concerns and sustainability in architecture are often misunderstood and misrepresented. Many often consider sustainability within a limited set of choices or still regard it as yet another inconvenience that hinders development. Certainly technical improvements help alleviate the problems at hand. But fundamental questions remain in regard to architecture: What are the structural issues behind the consciousness on sustainability and how do we address them in design? And what kind of opportunities can we find in its aesthetics for the revision of our industrial model? The book traces and underscores how the consideration of environment and sustainability is directly connected to aesthetic propositions in architecture.

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