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Sustainability = Good Design

Kevin Stelzer

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Article abstract

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SUSTAINABILITY = GOOD DESIGN

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KEVIN STELZER
ASSOCIATE
BREGMAN + HAMANN ARCHITECTS

ABSTRACT

Sustainable design is fundamentally a subset of good design. The description of good design will eventually include criteria for the creation of a healthy environment and energy efficiency. These goals will be achieved by an emergent paradigm of design practice: integration. At every level design interests will come together to facilitate common goals for the creation of a rewarding present and a healthy future. Interdisciplinary design teams will flourish. Inter-accommodating and fluidly communicating political structures will grow. Coalescing social values and economic forces will propel integrated strategies. Unique and innovative solutions will increasingly become the objective. One eventual outcome of this integrated or sustainable design practice will be the development of buildings that produce more energy than they consume.

RÉSUMÉ

Le concept de durabilité dans la conception (design) est une des contraintes conceptuelles fondamentales que l'on trouve dans une bonne conception. La description d'une bonne conception englobera éventuellement des critères de santé environnementale et de rendement énergétique. Ces buts seront atteints par la voie d'un paradigme émergent dans la pratique conceptuelle : l'intégration. À tous les niveaux, la pratique conceptuelle englobera des objectifs communs pour la valorisation du présent et d'un futur plus sain. Les équipes interdisciplinaires de design deviendront plus importantes ; les structures politiques s'adapteront mutuellement à travers des canaux de communication fluide. La réunion des valeurs sociales et des forces économiques mettra en branle des stratégies intégrées. De plus en plus, les solutions originales et innovatrices formeront l'objectif de ce processus. Un des résultats à venir de la pratique intégrée ou de la conception durable sera le développement de bâtiments qui produiront plus d'énergies qu'ils n'en consomment.

Plurality, unity, energy: the three faces of matter
Teilhard de Chardin, **The Phenomenon of Man**

INTRODUCTION

William McDonough, the highly respected and renowned eco-design architect, talks about the questionable notion of sustainability. He adamantly questions a global system that propagates toxic material production and needless expenditure of energy. Why would we want to make this kind of system a sustainable proposition? It is of no interest to him the desire for a sustainable future that continues on a path of poor design; because this is how McDonough sees it: our current system of production is based on poor design. His prime evidence in his argument against our global production system is the very notion that we place such emphasis on recycling. Recycling is evidence of poor design and lack of vision. Recycling at best ameliorates the tremendous waste that we create. Waste is a fundamentally flawed product of our society. It is unintelligent. Waste is something for which natural systems have no understanding. There is no such thing as waste in the biosphere; that is, not before human civilization.[1]

The issue of ensuring our collective futures is one of sustainability; however, sustainability is a highly layered issue: what do we want to sustain of our culture, our industry, our society? This remains for us an issue because of an apparantapparent collective desire to leverage the resources of the future for gains in the present. We seem selfish and our actions indicate that we tend to abuse our resources.[2]

This can change; and when it does, sustainability will no longer be an appropriate term for discussion. The topic will be: how do we activate seriously responsible design? How do we increase the wealth of the world for all at present whilst increasing the prosperity for future generations? How will the future world become a more beautiful place? Sustainability is a question of philosophy as much as pragmatics; and all these questions get addressed through true and committed sustainable design. Sustainability will become the accepted practice; and it will be deemed common sense.

Sustainability is primarily a subset of design. Design is an exercise in meeting the challenges inherent in any situation that requires improvement or mediation. Ultimately any design solution will need to create products and environments for a living earth with limited resources. The criteria for successful design will be the creation of a healthy present and a prosperous future; and thus by extension the attainment of sustainability is a question of good design.

Under the aegis of desiring a more beautiful and more sustainable future I want to discuss the future of sustainable architecture. How will we live up to our responsibility to ensure the built environment remains healthy and responsive to the public? Our constructed social environment represents some of the largest capital investments and energy embodiments of our culture. Its role in mediating our relationship to the greater natural environment is fundamental. Sustainable architecture will become essential in establishing a living and healthy balance between what is natural and artificial.

Artificial economies vie for the same energy that ecosystems require and as such must represent appropriately the value of that energy. These energies cannot be subsidized; nor can their value be manufactured to suit the interest of one sector of the globe over another. The true cost of energy must be born by those that use it. Artificial Economies can structure themselves in ways similar to natural economies and develop increasing levels of energy efficiency and creativity of resource use. Global economies can develop depth of services and simultaneously reduce physical resource depletion. We can do more with less. Sustainable design facilitates such efficiency and conceptual lightness.

A primary method of how we can develop increasing economic activity while decreasing our physical commodity usage is through the development of increasing levels of design integration. The more we integrate broader realms of specialization the less material we will need to employ to achieve our goals. We can employ virtual energies of networking, teamwork, information organization and design research to improve the performance of the materials that we eventually utilize to create our artificial world. Efficiency will assume a new meaning as we strive to integrate systems into innovative and finely tuned design. An emerging paradigm of interdisciplinary participation will ensure that the materials and energy that construct our products, buildings and cities will be efficient, safe and amenable.

One possible outcome of this emerging design integration paradigm is the design and construction of buildings that generate more power then they consume.[3]

Presently buildings represent one of largest sectors of energy consumption. Reducing and ultimately reversing this trend is within our capacity by implementing good, sustainable design. We can tune our own economies to interface fairly with local and global energy systems, we can integrate our skills and vast information networks and then we can design buildings that, while producing a net surplus of power, give us healthy and beautiful places to live, work and recreate.

THE REALM OF SUSTAINABLE DESIGN: INTERFACE BETWEEN ARTIFICIAL AND NATURAL ECONOMIES

In terms of sustainability there is no difference between natural and artificial systems.[4]

They both exist within the closed system of the earth and so with respect to energy the distinction is erroneous. Further to this solely perceptual distinction is the fact that all artificial economies are ultimately based on commodities extracted directly from the earth. Both natural and artificial systems require that a fair balance be established between all participating elements within the global eco-market; and this balance once struck benefits human interest and non-human interest alike.

Artificial economies can develop enormous wealth and longevity when they are allowed to develop currencies that register value within the overall global ecosystem. When the cost of resource depletion is carried fully then the value of resource generation can be weighed in context. Within this new energy currency we can develop a *Great Economy* whereby the divisions that separate the world into resource rich and resource poor zones are transformed into zones of resource diversification. These regional precincts will increase local awareness and generate ecologically specific information systems.[5]

The opportunities of regional differentiation activate new layers of economic commerce and trade. Sustainable design uses the rich diversity of context to develop solutions that are fitting and enriching. In fact this locality is fundamental to developing sustainable design.

GLOBAL DESIGN REQUIRES GLOBAL PERSPECTIVE

The true cost of energy needs to be represented. The true cost of unrestrained growth will be born by future generations. The current models of economics do not incorporate the eventual cost of purchasing western wealth with the undervalued labour and resources of developing regions. One part of the globe cannot grow rich whilst other parts undersell themselves. One part of the globe cannot become cleaner while other parts become more polluted. If this behavior continues then the eventual cost of energy might become unbearable. Emergent paradoxical economic paradigms are evolving and are conflating. On one hand global trade is expanding and opening more opportunities for international competition whilst on the other hand regional trading blocks and singular currency markets are developing like NAFTA and the European Union to safeguard particular economic/geographic economies. These strategies undermine the creation of a truly all encompassing economy where energy is traded at a more realistic value.

Sustainable design brings the artificial economies of industry into the total global wide energy exchange. Sustainable design is what registers the energy value of our production, allowing it to participate in an equivalent manner.

MORE DESIGN FOR LESS CONSUMPTION

The wealth of human economies can continue to flourish if they move away from scale based growth and linear expansion and move towards a growth in depth. Similar to any natural system, the creativity of multiple layers of interconnectivity is a way of sharing and developing further efficiencies of energy distribution. Instead of continuing upon a mode of production that makes useless byproducts like waste we can move towards a system that reincorporates all of it's byproducts for re-utilization. Sustainable design strives to facilitate this distribution. Wealth will continue to grow as more operations are performed on the same amount of 'stuff'. Each interaction assumes an economic value; and so as the web of interaction intensifies so does the virtual value of the system. The number of interactions growss, the depth of interconnectedness grows and so wealth grows.[6]

This strategy, as a countermeasure, is in strict opposition to scale increasing linear expansionism and our current resource limited commodity based economies. Sustainable design moves the current design thinking into a mode where virtual action can improve the conceptual depth of design and allow it to improve the efficiency and energy performance of what we construct. Sustainable design allows us to do more with less.

WHAT IS SUSTAINABLE DESIGN?

Sustainability equals good design. The pragmatics of production is the purview of design; and now the pragmatics of sustainable production is the governance of sustainable design. Sustainable design involves a very intimate understanding of the specific and contingent aspects of a problem – a problem that is unique. A sustainable design solution is one where the very particular and often idiosyncratic aspects of a situation govern the evaluation of the design solution success. When we look at the realm of sustainable design we are asking the question: what is good design for this earth? What are the criteria for evaluating successful design? Sustainability sets forth the criteria of success: responsible use of materials and energy for the benefit of today and tomorrow.[7]

Sustainability is the ultimate criteria of design. We have reached a point whereby we can foresee longer term ramifications of our design decisions. Good design looks at any situation and strives to make that situation more suitable and more amenable. Good design examines the situation and sets goals: What can be made better? What is lacking? What can be made more desirable? With this in mind we can look at sustainable design as being a desire to expand the scope of design interest to include a look at the whole future of the planet when considering the locality of the individual project. The goals for evaluation now include the role the project plays in a planet wide ecosystem. The planet is a system to which we are connected. Our designs play within a grand mechanism of interconnectivity. Our designs need to respond to this. Designs that eschew their place in the global economy of energy are simply poor designs. They are conceptions of little value that very quickly lose any sense of purpose and become a burden.

GOOD DESIGN IS ABOUT INTEGRATION

Sustainable design strives to generate the most appropriate solution for the task at hand. This requires a robust knowledge of universal design principles in tandem with a fine awareness of the specific aspects of the problem; a unique understanding of the particulars of site, client and function. Sustainable design uses information and skills integration to achieve this. Unique solutions require the most informed design teams that network together from the outset to integrate their cumulative experiences and skills. All the literature surrounding sustainability encourages this in common: develop a strong holistic based teamwork centred design process.[8]

Integration is important on multiple levels, theoretically and practically. The more intelligent the design the more integrated it's components. The more robust the system, the more integrated its interactive elements. Systems develop redundancy, strength, efficiency, and elegance through integration.

INTEGRATION: THEORY

A theoretical examination of the concept of integration bears relevance in order to carefully orient our design activities. Inherent within the concept of integration is the notion of efficiency. Highly efficient systems tend to exhibit a high degree of component integration. Efficiency can be a very powerful propellant. It is a seductive idea and implies intelligence and elegance. For the most part efficiency is something to be pursued but we don't want to service our compunction in this regard more than it deserves. Efficiency for its own sake can become dangerous; and this notions needs to be tempered. Efficiency needs to be examined in a more objective manner.

In the most essential way efficiency can be described as a matter of thermodynamics. Energy is neither created nor destroyed. This is the first law of thermodynamics. Energy innately wants to move, but only in one direction. It moves in the direction of entropy. It moves 'naturally' towards a state of **non-usability**; to a state of dispersion. This is the second law of thermodynamics. If energy is domesticated then that conversion to usability will cost a given efficiency. It costs a certain loss of that usable energy. There is no such thing as a perfect thermal machine. Efficiency is an invented notion – a concept – to describe our observance that in order to use energy we must discard some of it. This is the third law of thermodynamics.[9] This is to suggest that energy is easy to release but hard to tame.

Achieving efficiency has a cost – this cost can be virtual work. We work to establish an efficiency ratio. There is an inherent efficiency ratio for all systems and processes. It is inherent within the relationship of the parts to the whole. We can modify or augment that system and alter the efficiency but we need to work hard in order to do so. For example, an automotive engine has been designed and manufactured and exhibits a measured efficiency of petroleum fuel consumed versus power output. This engine may be modified to increase its efficiency however it will require tighter seals and gaskets, lower tolerances, intake manifold pressure charging, high output heat exchangers or higher strength engine castings. All these elements will have a cost, not least of which will be the 'virtual' energy of the minds of the engineers. The engine designers carefully analyze the prototype and categorically and empirically evaluate the engine performance. Based on the analysis, propositions are made and speculations forwarded to change the performance in some way or another. These activities of analysis and design are energetic – they consume energy. This is to suggest that there are desirable and undesirable ways in which we want to spend energy. We need to be intelligent in our spending habits. Any passionate designer will attest that we have bundles of virtual energy to spend on improving the efficiency of our world. We should use this surplus energy to help our actual, material world consume less. This is efficiency.

Coupled to this foundational idea of efficiency, integration uses conceptual depth (virtual work) to attain material lightness (efficiency).[10]

Within this strategy of integration is the eschewing of the fetishization of highly embodied energy technology. High 'concept' technology can produce new configurations of historically proven products or methods in conjunction with the most current innovation. Furthermore, the inappropriate use of highly embodied technologies in a design solution is considered reprehensible and unsustainable. The expenditure of thought energy through analysis, design and information networking can result in vast material and energy savings. Sometimes these solutions will rely on emergent technological mechanisms; yet other times a technology hundreds of years old might be simpler and more effective. The considered arrangement of a building on a site, for example, might allow free cooling from prevailing winds. This is a time honored solution. Conversely, in this case, the application of a sophisticated, forefront refrigeration system, no matter its mechanical 'efficiency' may not, in fact, be the most appropriate response. This expenditure of virtual energy and information networking to find the most appropriate solution is an act of integration – an integral component of sustainable design.

INTEGRATION: PRACTICE

Integration is key to the notion of sustainability because it acts to synthesize all the talents and skills we have developed. The power of specialization has proven tremendous, sweeping and insidious. The results of specialization now need to be brought to bear in a cross examination and cross pollenization where the true ramifications of our actions can be evaluated and directed responsibly. Integration brings disparate information systems together and establishes micro-cultures of information. These micro-cultures are virtual worlds of design whereby the most intimate knowledge of site, microclimate, available building resources, and client needs are assembled and through a subtle combinatorial analysis design solutions are developed. This is integration – this is good design.

Specialization is Powerful but Myopic. The categorical sciences that were pioneered in the 18th century, and continue to flourish, rely on a system of organization – a powerful conceptual mechanism - that allows for the intensive development of highly specialized realms of research and inquiry. This capacity to concentrate such intensive intellectualism on such finely circumscribed areas of phenomenon creates enormous empirical storehouses of information. The organization of these warehouses needs to be addressed. The independent development of such categories needs to be compared. The interaction and cross-disciplinary synthesis of the intensive scientific informational agglomerates needs to be performed.[11]

Integration requires teamwork and teamwork requires Integration**.** Guidance is necessary to bring about the interaction of the various social and discipline divides of science and engineering. This guidance will not be generated by pseudo-demagoguery or by visionary leadership and charisma. It can be generated by teamwork and by systems and informational integration. Networking of resources right from the outset of design problem identification is paramount to successful resolution of the challenges posed by true sustainable development. Leadership in teamwork establishes a context for the input of various streams of information; and within this context the separate streams gain relevance.[12]

Many of the tools and techniques of sustainability have been around for a long time. The importance of knowledge of micro-climate alone is something that has been undervalued within the last century. We need to bolster these databases of information. The tools exist and we need to enact them. New technologies will continue to widen the techniques available but they will be employed in conjunction with the exiting, historically proven design models and solution strategies. Sustainable design recognizes that energy, whether embodied in building materials or expended through air conditioning systems should be carefully spent in the most effective way.

Integration shouldn't be limited to within the architectural design scenario. Integration needs to include all levels of design and industry, including urban design, regional planning and national policy-making. Communities, municipalities, regulatory bodies, regional governments, nation-states need to integrate information and goal orientation. Integration doesn't limit itself. New solutions that respond to the unique situations of individual nations, cities, neighborhoods require all levels of social agency to work together towards common goals of life improvement and sustainability.

REGIONAL ASPECTS OF SUSTAINABILITY

As an architect who designs buildings the most specific aspects of a site are of most immediate interest. The technique involved in the conventional design and construction of buildings warrants reinvention and renewal, modification and evolution no matter how particular they are to individual building circumstances. The orientation of a building to the sun, the prevailing winds of the region, the microclimate of the site, the built urban surroundings, the urban prominence of the project, the local expertise in construction materials and methods, etc. are all factors that influence the design of any given project. Having said this, there are pervasive and sophisticated political and governmental structures that influence the design of individual buildings independent of the aforementioned particulars. These structures range from the governing building code, site zoning, local municipal by-laws and permit applications to regional planning objectives, political riding and constituency aspirations, and inter-municipal authorities. These factors are generated by goals not inherently site specific but regional, provincial, even national. All of these factors must come under the consideration of sustainable design. None working alone will bring about the change that will truly renew our building and construction practices. Sustainable design at the architectural level cannot be isolated. It requires the involvement and cooperation of all the scales of urban and environmental study.

NATIONAL OPPORTUNITIES

Here stems a strong and important role for the political and policymakers to engage sustainability. The growing market of sustainable design and construction requires leadership. The industry looks towards government for guidance and prudence; to set the acceptable standard of performance. The government needs to apply regulation, to not only enforce, but encourage the development of private responsibility and sustainable asset and energy management. The free market requires standards for operability and profit generation. This can be the role of government: to encourage energy effectiveness through incentive programs and mandate increasingly stringent performance based code requirements for energy efficiency.[13]

There are existing programs that have garnered much success. The Commercial Building Incentive Program is an excellent example. These types of programs need to be expanded as core programs towards the development of a deep seeded and healthy economy.

PLANNING OPPORTUNITIES

Planning is an area of immediate and urgent interest for the ultimate goals of sustainability. All the methods utilized by a single project can be ramified enormously to service larger geographical zones. The densification of our urban centres requires strong planning regulation. Inter-urban transit and transportation needs to be managed by effective planning measures. Local urban power production can be encouraged through regional planning such that macro-regional levels of power production are coordinated and balanced with micro-production or cogeneration. Regional planning can serve as a means to encourage power usage reduction by mandating industrial zoning for minimal transportation and maximum distribution. Regional planning protects our arable lands and manages our natural water cycles. The sustainable opportunities at a regional scale are innumerable; and in many ways sustainability must starts at a regional level because a total energy policy strategy needs to be enacted. The government has the range and jurisdiction to implement this kind of strategy.

URBAN OPPORTUNITIES

There are opportunities within urban areas for sharing energy and micro-production of power. Cities can structure themselves such that districts that require perpetual cooling can link to districts that require heating. This can be accomplished through government initiated and regulated and user-fee-taxed infrastructural systems similar to potable water supply, sewage treatment or electricity distribution. As an example hHeat can be dumped into a central loop by the heat generating central business cores and then the heat is removed by surrounding residential districts.

In typical urban environments solar access is not equivalently distributed. Urban projects that might use passive schemes based on the sun's radiation might not have access. Guidelines and urban zoning envelopes based on access to sunlight can be developed. New strategies for the equivalent distribution of access to solar radiation, perhaps called urban solar zoning, can become a framework for encouraging urban solar architecture.[14]

BUILDINGS AND SUSTAINABILITY

The ultimate goal for architecture is to design a real environment that engenders all the abstraction and virtual work – all the integration — embodied in sustainable design. All the national programs, regional plans, urban zoning and municipal codes are integrated into a seamless set of governance compliance. The specifics of the project site like location, orientation, access, micro-climate and topography are integrated into a spatial possibility envelope. The requirements of the client, the public and future occupants are integrated into a highly resolved programmatic matrix. All this analytical integration is the starting point for the design team to integrate their skills and experience and to generate unique solutions that make effective the intersection of all these realms of influence. The future of architecture and sustainability is rich. Global principles are integrated with local opportunities.

One enormously exciting outcome for architecture and sustainability is to design buildings that generate more power then they consume. Buildings embody, generate and manage large energy flows. Intelligent design can utilize these latent fluxes to the advantage of energy effectiveness. Buildings also create energy intensive micro-climates that can be controlled and utilized in an overall building energy strategy. The sun's energy, the heat of the earth, the velocity of the wind all can intertwine to produce usable energy for buildings. These energies in combination with multiple advanced technologies like active, high performance building skins, and geothermal heat pumps can result in an overall energy balance in the positive.

The notion of buildings producing energy shouldn't be a universal expectation for all buildings. Certain buildings given their use and siting make them ripe for fulfilling such a goal. Buildings of a certain scale and public programme start to envelope large scale energy flows. These flows can be harnessed in useful ways. As a singular example of how buildings already produce large amounts of energy I would cite how presently the commercial office complexes that populate the urban cores of our largest North American cities require high powered cooling all year round. Their enormous scale, large number of occupants and huge expanses of sun exposed facades make them impressive heat sinks. Thousands of tones of cooling are needed to prevent them from overheating even in the midst of the coldest months. These buildings produce energy; and there should be no reason to spend energy in cooling to discard the unwanted heat energy. We can harness this ‘excess’ energy.

The object of this paper has been more conceptual in nature; but sustainability has no bias towards the theoretical. The technical appendix is intended as a brief showcase of the numerable methods and technologies that are available for implementation to make power producing architecture. Philosophy and pragmatics should merge to achieve the aims of integrated sustainable design.

TECHNICAL APPENDIX

1.0 CARBON NEUTRALITY

Buildings need to become carbon neutral.[15] It is imperative to, firstly, halt and ultimately reverse the build up of greenhouse gases in the atmosphere. The systems of weather that support the global ecosystem might be disrupted to a level where they respond erratically and unpredictably. The global ecosystem has enormous redundancy and flexibility; however, it is a natural system and follows physical laws of chaos and complex behavior. We are coming to understand that complex systems behave in unique ways. They have a wide range of inputs and steady state responses to those inputs that feed them. Conversely complex systems have sophisticated responses to some types of inputs. Increased frequencies of stimulus often lead to vastly reconfigured system response. Complex system can suddenly, systematically reorganized to better suit the stimulus energy inputs and outputs. The globes’ ability to absorb growing amounts of greenhouse gases should not be taken for granted. If the earth indeed has a limit of greenhouse gas absorption, that limit might be reached in a catastrophic way. We need to curb production of CO_2. This is not negotiable.

The construction of buildings produces greenhouse gases in many ways. It is one of the largest, most encompassing sectors of the economy; representing an enormous investment in capital and energy. The products needed to make buildings need to be vastly less energy embodied. The energy and waste created to produce, ship and install building materials is of serious concern. To explain, raw materials like wood, bauxite, iron, silica, lime, etc. are extracted form the earth. This process has wide reaching effects. There is the immediate disturbance of ‘virgin’ earthly territory that support large natural ecosystems; and this alone merits confinement. Many tonnes of carbon dioxide need to be produced to mine and harvest these materials and ship them to be refined into usable products. This refinement, be it smelting, reducing, oxidizing, milling, chemically treatment, or any other of many means of synthesizing is highly energy intensive. Much electricity needs to be produced to power these processes. The further refined products or components need to be shipped again to the specific job site for installation, fabrication, erection or placement. This further burns fossil fuels that produce carbon dioxide. All of this is collectively referred to as embodied energy. It is a measure of the ‘effort’ required to use any given material or product. The more embodied energy, thean the greater negative impact upon the greater environment.

Concrete is a wonderful building material. Let's examine its embodied energy. Concrete needs sand, aggregate, water and Portland. Aggregate is usually 'mined' in an open pit which strips arable land. It is usually locally extracted which reduces the cost of transport. They same is true of sand. Water used is needs to be clean. Potable water is usually used. The waste water needs to be treated and is unhealthy for return to natural aquifers. Most dangerous is the production of the Portland. This process has been cited by some sources to produce nearly one third of the world's CO_2 emissions. Furthermore, when concrete is cast it requires formwork to mold its final configuration. The formwork is usually wood that is discarded subsequent to the concrete casting. Concrete needs to be rethought, reworked, and recycled. There are ways to reduce the impact this material plays on the global ecosystem and we need to enact those methods. Modified Concrete Mixes, recyclable formwork, recycled reinforcing steel, recycled aggregate, non potable water usage, etc. all can contribute to the reduction of the environmental 'footprint' of concrete.

2.0 MATERIALITY

2.1 Recyclable materials

Materials used in construction need to be segregated into two categories: biodegradable and recyclable. Materials used for shorter term installation need to be healthy for full biodegradation. Materials that require high levels of precision, durability and strength, or contain toxic and non-biodegradable elements need to be fully recovered within an artificial cycle that removes them from any natural cycle.[16]

Certain chemicals need to be totally removed from use - indefinitely. A list of prohibited chemicals needs to be compiled and enforced; including: urea formaldehyde, asbestos, PVC, etc. These chemicals can be categorized as carcinogens, mutagens, toxic, etc.

Volatile Organic Compounds need to be removed from buildings. Indoor Air Quality needs to improve to healthy levels. Buildings need to become environments for people to enjoy, heal and re-create.

Sustainable design strives to employ the least amount of resources possible to achieve the assigned objective. In terms of materiality this means utilizing the least amount of physical material for the task. If systems can be left exposed, if typical ornamental items like facings, ceilings, built up finishes can be avoided, if materials can be utilized in a strictly quantified, functional way then these methods are adopted. The advantage of exposing thermal mass is inherent; but beyond this, if components can do without fascias or paneling, then they will be left without.

3.0 ENERGY PERFORMANCE

Buildings can become energy sources; feeding into thenergy grid. Buildings represent an excellent opportunity to generate energy rather then merely consume it. A net gain in energy means an obvious advantage to society as a whole. Not all buildings can and will generate a net gain of energy. The buildings that can produce a surplus can supplement the loads imposed by other energy consuming buildings or industry etc.

There are many strategies and technologies that can be employed to design and construct buildings to meet our collective expectations of energy production, beauty and healthy indoor environmental quality. They range from recent, advanced technology to ancient, time proven methods. They can be categorized roughly into passive and active systems.

3.1 ACTIVE SYSTEMS

3.1.2 Solar Architecture

The closed system of the earth is feed by an energy stream by the sun. This source of energy can be directly and indirectly converted into useful forms. Solar radiation can be directly converted into electricity through photo-electrolysis and into heat through reflection and absorption

3.1.3 Sun Producing Electricity

Integrated photovoltaics convert sunlight into electricity. Arrays of these cells built into panels can easily be incorporated into the envelope of buildings. This energy can be used to power lights, fans (if necessary), emergency systems, equipment, etc. The concept of building as an active receptor of sun energy can be further extended and integrated. It is common to feel the heat of the city. The city is a hot microclimate. It is surfaced with hard dark elements that absorb the sun's energy. These heat absorbing surfaces then heat up and release that energy by radiating back and creating a synthetic microclimate. Within the glazing of the façade, integrated photovoltaics can be manufactured to shield the interior whilst converting that precious energy into electricity.

3.1.4 Active Solar Ventilation

The internal thermal currents within buildings can be harnessed to move air heat energy around in desirable ways. With the help of solar radiation being 'trapped' within a building through the intelligent use of glass, a designer can reduce the need for mechanically driven fans to move treated air throughout a building. Dedicated 'thermal chimneys' and automated ventilation chambers can work in concert to encourage the buoyancy and increase the velocity of air within the envelope of the building.

3.1.5 Decentralized Heat Pumps

These systems rely upon a network of heat pumps arranged within the building in rational zones. The concept is to capture heat where it is present and transport it to other areas of the building where it is needed. If it is hot in southern fenestrated zones then the local heat pumps remove the heat and dump it into a central loop. In colder northern zones of the building the local heat pumps recover the heat from the central loop and deposit into their zones. The heat pumps require electricity to power their compressors, however they can run at high efficiencies whereby the energy required to transfer the heat from zone to zone is negligible compared to the required energy to generate the required heating and/or cooling. This system works very effectively in shoulder season modes where heat can be easily extracted from or dumped to the outdoors from the central loop with very little energy loss. In high temperature differential modes the central loop can be 'topped' up with heating or cooling by small high efficiency boilers or chillers that run only a fraction of the time compared to conventional systems.

3.1.6 Ground Source Conditioning

These systems utilize the constant temperature of the earth to heat and cool buildings. In the winter the earth below the frost line is warmer then the outdoor air. In the summer the earth below the frost line is cooler than the outdoor air. The system runs a loop of heat transfer medium, like air or water through the earth below the frost line. The medium moves heat from the ground into the building in the winter, or it runs heat into the ground in the summer. Similar to the decentralized heat pump systems the energy needed to transport the heat is little compared with the energy needed to produce the heat.

3.2 PASSIVE SYSTEMS

3.2.1 Stack Effect and Natural Ventilation

Warm air rises. This effect in buildings, especially tall buildings is called stack effect. Air pressure builds towards the top of buildings. This natural tendency for air to rise can be utilized to move air passively throughout inhabited spaces.

Displacement ventilation is a technique of enormous interest and development. It reduces or eliminates the need for mechanical fans to push treated air into spaces thereby reducing a major electricity demand. Fresh air is a fundamental requirement for healthy, functioning buildings. The air is typically pumped into buildings by fans. The air needs to be heated and humidified before reaching the inhabitants. The fans require electrical power, and energy needs to be expended to condition the air prior to it being breathed by people. Displacement ventilation utilizes large plenum spaces, spaces that are not occupiable like underfloor cavities or crawlspaces to allow unconditioned, oxygen rich, outdoor air to flow unforced. The rooms will be heated through efficient convective or radiant means which will allow the underfloor relief air to 'naturally' convect up through the space. The air will generate buoyancy and rise as it heats up mixing with and replenishing the indoor conditioned environment.

3.2.2 Passive Lighting

Buildings can be designed to be illuminated with natural daylight. Considered fenestration, shallow floor plates and light shelves can provide more than adequate light levels for most uses. Natural Lighting reduces the cooling loads by reducing the heat of lighting. Natural light is healthier for occupants and contributes to worker productivity and reduces absenteeism.

Atriums are a common and effective design strategy to get natural light deeper with buildings. Atria are excellent tools to structure buildings around natural light and natural ventilation as well as providing interior nodes for orientation and way finding. Atria also provide excellent opportunities for interior gardens and water features that contribute to greater air quality and freshness. Interior meeting spaces of high quality provide for social spaces and formal and informal assembly spaces. Idea interchange and strong community values are fostered further bolstering the value of sustainable architecture towards renewed healthy and productive living and working spaces.

3.2.3 Thermal Mass

The temperature cycles of the day that impose loads on buildings can be moderated by allowing the materials of the building to absorb some of the excess available energy and release it later, and at a slower rate to improve the thermal conditions throughout the day. For example, the building can be flushed out and cooled down through the night and because it has thermal inertia (large expanses of exposed concrete is one strategy) it will stay cool as the outdoor air heats up during the day. In the same way the building can absorb heat during the day and give off that heat slowly through the night despite the cool outdoor night air. This operates as a rudimentary thermal battery saving energy for release at more opportune times in the daily cycle.

4.0 LEED GREEN BUILDING RATING SYSTEM

LEED is an acronym for Leadership in Energy and Environmental Design. This is an empirically based evaluation tool for establishing benchmarks in building design and performance. The notion of substantiating green building performance is essential to ensure that targets for sustainability are met and continue to progress. The building sector relies upon standards to maintain quality and performance. In the absence of government codes the United States Green Building Council established the LEED system to evaluate and encourage development of sustainable design. A Canadian chapter of the council now exists and administers a Canadian LEED version.

LEED is a system that rates sustainable building design upon a point system. There are four graduations within LEED to distinguish the extent of performance: certification (26-32 points), silver (33-38 points), gold (39-51 points) and platinum (52 plus). The points are achieved in five categories intended to encompass in the broadest aspects environmental performance. The categories reward achievement of a variety of criteria relating to the categories; provided mandatory prerequisites are fulfilled.

Sustainable Sites: LEED recognizes the importance o densifying our urban environments and protecting our precious farmland and sensitive enclaves of bio-diversity. Green filed sub-urban development is discouraged. Buildings that are developed on flood plains, ecologically sensitive sites or pristine nature reserves cannot receive LEED certification. Developments on rehabilitated sites, within urban mass transit networks, and have reduced development footprints are rewarded.

Water Efficiency: LEED recognizes the importance of water management in an overall strategy of ecological design. Projects that reduce water consumption, farm rainwater or grey water for re-use or employ innovative strategies to treat their sewage are rewarded.

Energy and Atmosphere: LEED rewards projects that are energy efficient recognizing the negative impact over consumption of energy can have on the atmosphere. All LEED projects must meet a minimum energy efficiency – a benchmark standard set by LEED – but projects that exceed this level gain further points. Performance is determined through an empirical process whereby an applicant design measures its energy consumption against a national energy standard: MNECB (The Model National Energy Code for Buildings). This comparison is facilitated by a sanctioned computer modeling program. Buildings that employ CFC refrigerants cannot receive LEED certification.

Materials and Resources: LEED rewards buildings that strive to reduce the amount of materials they require. Recyclable materials and materials that are biodegradable are encouraged. Reduction of construction debris is encouraged; and buildings that are designed for longevity and ease of repair are rewarded. Buildings that make no provision for the occupants to recycle cannot receive LEED certification.

Indoor Environmental Quality: LEED recognizes that buildings need to be healthy environments for people. Energy efficient or highly recyclable buildings that perform poorly for their intended function are not considered an appropriate investment of their embodied energy and are not capable for LEED certification. LEED certified buildings must exhibit minimum air quality standards. Buildings that provide exceptional air quality, user controllability of the environment and highly naturally illuminated spaces are rewarded.

Innovation and Design Process: This is one final category which remains a flexible avenue for highly innovative or unusual projects to apply for points. This category is a method category to encourage projects to quantify the areas that make them outstanding. Typical innovation credits are awarded to projects that substantially exceed the requirement of existing category points; as in exemplar energy efficiency or radical sources of renewable power.

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NOTES

[1]McDonough, William & Michael Braungart. *Cradle to Cradle: Remaking the Way we Make Things*. North Point Press, New York, 2002. Chapter 4. McDonough and Braungart in their admirable, and highly influential text, *Cradle to Cradle*, set forth the concept that waste is an artificial creation and within itself a non-sustainable concept. Waste is a product in itself that endangers any conception of systems survival. Looking at natural systems it can be clearly seen that all 'products' of natural systems are incorporated within other natural systems such that the entire globe operates as a contained and closed system; with the only exception being the influx of solar radiation. In order that we truly engage sustainability it is posited the notion that **waste equals food**. All forms of production need to remain as useful products; at the very least the useful inputs for other systems i.e. food for bacteria. All the output of industry needs to be converted to production with no useless or toxic byproducts – no waste.

[2] Wright, *A short Histroy of Progress.* Anansi Press, Toronto, 2004. pp. 1-28. Wright introduces his ideas of civilization and the sublimation of the 'savage' within humanity around Gauguin's painting *D'Ou Venons Nous? Que Sommes Nous? Ou Allons Nous?* The propellant desires within a civilized society revolve around power and wealth and the immediate satisfaction of such desires. Do we lack the foresight to hem such desires? Wright depicts several examples of human civilizations that have been unable to do so.

[3] Gissen, David. *Big & Green*. Princeton Architectural Press, New York, 2002. pp19-45. This book structures itself around various aspects of responsible 'green' design including: water usage, natural lighting & ventilation, energy efficiency, etc. The reference here is to the section that describes real and theoretical buildings designed to reduce dramatically their energy consumption with the full intent of providing a research platform for the development of buildings that generate a net surplus of energy; ultimately leading to certain buildings becoming **energy suppliers** to the power grid.

[4] DeLanda, Manual, *1000 Years of Nonlinear History*. Swerve, New York, 1997. DeLanda, with precision, uses history as a framework to describe his philosophy that all processes that have shaped our world are fundamentally reducable to energy flows. Concentrating on these energy flows and fluxes, natural and artificial systems are treated no differently. Magma flows and currency markets are similarilysimilarly described as energy exchanges. The deference to artificial social constructs in the delineation of conventional histories is rendered obsolete.

[5] Berry, Wendell. *Home Economics*. North Point Press, San Fransico, 1987. pp 54-75: Two Economies. I can't approach Berry's precision and style in identifying the basic flaws of our industrial economies and his perspicuity in describing a solution through his concept of the "Great Economy". Unlike the many artificial specializations that separate people from the performance of work – that separates knowing from working. **Great memberships** of arts and sciences converge to implement work rather than separate into abstract camps unable to perform useful labour. Fundamental to this is the concept that all sectors of social interchange have access to value generation. The challenge being formulating an economy that, for example, places an adequate valuation on the depletion of diversity in the deep Amazon rainforest over the value of prestigious, old growth tropical wood stock for modern manufacturing purposes – which is more valuable?

[6] Milani, Brian. *Designing the Green Economy*. Rowman & Littlefield, Lanham. MA. 2000. Introduction. Milani opens the discussion of reinventing the 'green'the 'green' agenda by framing the issues not around opposition and antagonism but around the notion of opportunity and design. A wealthier economy will be better designed and fruitful longer term because it takes advantages of the enormous latent economic network that would structure itself around renewable resources, green power, sustainable technology and earth-healthy design. The strategy of design will move from quantity to quality.

[7] Van Hinte, Ed, Marc Neelen, Jaques Vink and Piet Vollard. *Smart Architecture*. 010 Publishers, Rotterdam, 2003. pp 7-8: Preface; The Green Challenge. The nomenclature associated with architecture of sustainability including eco-architecture, green architecture, environmentally responsible design, etc. leaves the authors disappointed because as they survey buildings designed under such headings they realize that styles and attenuated philosophies tend to restrict the appropriate solutions more than liberate them. In response, the playful but simple proposition of 'smart architecture' is forwarded to encompass an unpretentious design attitude with all the necessary technological savvy, lightness, vibrancy and optimism of an architecture that seeks to better our future.

[8]McLennan, Jason F. *The Philosophy of Sustainable Design*. Ecotone Publishing Company, Kansas City, Miss. 2004. Chapter 8: Respect for Process: The Holistic Thinking Principle. New solutions require new thin-

king. The emphasis of building design needs to release the attitude of sufficiency and engage the notion of efficiency. A commitment by all the participant design professionals needs to be made to engage each other in a continual learning curve. Team work from the absolute inception of projects will engender the needed level of information rich and contextual environments for innovation.

[9] ASHRAE, *Green Guide*. Chapter 3: Background and Fundamentals. Developed for the practicing design engineer the Green guide is also a seeming pantheon of technological and conceptual tools for industry wide energy innovation and worthy of a perusal by any architect. Before discussing more specific aspects of 'green' engineering the guide quickly reacquaints the reader with the roots of energy design: the laws of thermodynamics. In this regard the notion of efficiency is objectively described as a means to convert potential energy into usable energy. Thermal engines of high efficiency (see Carnot cycle) require advanced and intensive levels of design and engineering.

[10] Daniels, Klaus. *Low-Tech, Light-Tech, High-Tech*. Birkhauser, Berlin, 1998. Preface. This elegant books succinctly sums up many of the emergent issues involving sustainable architecture. The preface simply and aptly describes the concept that through strong process driven, teamwork based design major innovation can be achieved to gives us more amenity for less material and energy. This book clearly conveys the understanding that high technology need not be misinterpreted with high embedded energy. In fact Daniels lays bare the common fetishization of technology that often leads to unfettered wastages.

[11] Wilson, Edward O. *Consilience: The Unity of Knowledge*. Vintage Books, New York, 1999. pp 58-60. Wilson stakes the claim that the incisive tools of scientific reductionism are powerful and insidious. Careful wielding of this scientific power has not been exercised and has lead to insular and independent scientific cultures unable and unwilling to interact with each other. The interconnection of the information of specialized scientific fields will lead to profound contextualisations of the such information for far reaching progressive implementation.

[12] Norretranders, Tor. *The User Illusion*. Norretranders invents the concept of **exformation**. He postulates that the universe is composed of infinite information. Our brains choose to place what we encounter of informational phenomenon into a context, or network of meaning. What is important in this notion of meaning creation is the **context** that places the ubiquitous bits of information in relationship to each other. The more meaningful the piece of information the more context is established by it. This context establishment is crucial and explains the importance of philosophy and belief structures in society. Norretranders bucks the conventional belief that we need more information, as we are inundated by it, but that we need more meaningful information – more exformation.

[13] McDonough, William. *Principles, Practices and Sustainable Design, Towards a New Context for Building Codes*. Perspecta 35, 2004. Code compliance is tytpicallytypically seen as meeting a minimum standard. This is usually a consensus benchmark that does little to encourage innovation. In fact, it often does the opposite, stifling unique, unconventional solutions by enforcing traditional practices and methods. Codes can serve as powerful tools to service responsible design only after their original intent, which has been co-opted by successful complacency, is realized by a growing desire for highly contextual and principled design.

[14] Knowles, Ralph. *Sun Rhythm Form*. Knowles presents a very well developed urban zoning method for establishing equitable access to sunlight. These solar envelopes have a geometry based on the specificity of the site and orientation tuned to the circadian rhythms of geography. The method is objective and seeks to establish an egalitarian urban landscape.

[15] Buildings must become carbon neutral by 2050. This is an imperative set by Edward Mazria. His extensive research into the effect of the built environment on the global ecosystem is vast. His research sets a goal for sustainable construction that is achievable and necessary. His research is well known and easy to access. Please see as a start. His writing on solar architecture is notable.

[16] McDonough, William & Michael Braungart. *Cradle to Cradle: Remaking the Way we Make Things*. North Point Press, New York, 2002. Introduction. Another fundamental notion clearly and aptly brought to light through this landmark book. It is made obvious that the synthesis of raw natural materials through modern industrial methods renders these newly melded substances highly concentrated or noxious to organic systems. These materials if deemed absolutely important and useful must be segregated from ever returning to the natural biosphere. They can become elements to sustain a fully artificial 'ecosystem'. In contradistinction all other material production must be completely biodegradable and healthy food for the biosphere – discarded with pleasure.