Green Design

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1. Saving our environment is the most vital issue that humankind must address today, feeding into our fears that this millennium may be our last.

For the designer, the compelling question is: How do we design for a sustainable future? This question, similarly, concerns industry. Companies now anxiously seek to understand the environmental consequences of their business, to envision what their business might be if it were sustainable, and to seek ways to realize this vision with ecologically benign strategies, new business models, production systems, materials and processes.

If we have an ecologically responsive built environment, it will likely change the way we work and our current ecologically profligate way of life. Presented here are some propositions addressing this idea.

2. The ecological approach to our businesses and design is ultimately about environmental integration.

If we integrate our business processes and design and everything we do or make in our built environment (which by definition consists of our buildings, facilities, infrastructure, products, refrigerators, toys, etc.) with the natural environment in a seamless and benign way, there will be no environmental problems whatsoever.

Simply stated, ecodesign is designing for bio-integration. This can be regarded at three aspects: physically, systemically and temporally. Successfully, achieving aspects is, of course, easier said than done, but herein lies our challenge.

3. We start by looking at nature. Nature without humans exists in stasis. Can our businesses and our built environment imitate nature's processes, structure, and functions, particularly of its ecosystems?

For instance, ecosystems have no waste. Everything is recycled within. Thus by imitating this, out built environment will produce no wastes. All emissions and products are continuously reused, recycled within and eventually reintegrated with the natural environment, in tandem with efficient uses of energy and material resources. Designing to imitate ecosystems is ecomimesis. This is the fundamental premise for ecodesign. Our built environment must imitate ecosystems in all respects.

4. Nature regards humans as one of its many species. What differentiates humans is their capability to force large-scale devastative changes to the environment. Such changes are often the consequences of manufacturing, construction and other activities (e.g. recreation and transportation).

5. Our built forms are essentially enclosures erected to protect us from the inclement external weather, enabling some activity (whether residential, office, manufacturing, warehousing, etc.) to take place.

Ecologically, a building is just a high concentration of materials on a location (often using non-renewable energy resources) extracted and manufactured from some place distant in the biosphere, transported to that location and fabricated into a built form or an infrastructure (e.g. roads and drains), whose subsequent operations bear further environmental consequences and whose eventual after-life must be accommodated.

6. There is also much misperception about what is ecological design today. We must not be misled by the popular perception that if we assemble in one single building enough eco-gadgetry such as solar collectors, photo-voltaics, biological recycling systems, building automation systems and double-skin facades, we will instantaneously have an ecological architecture.

The other misperception is that if our building gets a high notch in a green-rating system, then all is well. Of course, nothing could be further from the truth. Worse, a self-complacency sets in whereupon nothing further is done to improve environmental degradation.

Although these technological systems are relevant experiments, perhaps, towards an ecologically responsive built environment, their assembly into one single building does not make it automatically ecological.

7. In a nutshell, ecodesign is designing the built environment as a system within the natural environment. The system's existence has ecological consequences and its sets of interactions, being its inputs and outputs as well as all its other aspects (such as transportation, etc.) over its entire life cycle, must be benignly integrated with the natural environment.

8. Ecosystems in a biosphere are definable units containing both biotic and abiotic constituents acting together as a whole. From this concept, our businesses and built environment should be designed analogously to the ecosystem's physical content, composition and processes. For instance, besides regarding our architecture as just art objects or as serviced enclosures, we should regard it as artifacts that need to be operationally and eventually integrated with nature (See (4) above).

9. As is self-evident, the material composition of our built environment is almost entirely inorganic, whereas ecosystems contain a complement of both biotic and abiotic constituents, or of inorganic and organic components.

Our myriad of construction, manufacturing and other activities are, in effect, making the biosphere more and more inorganic, artificial and increasingly biologically simplified. To continue without balancing the biotic content means simply adding to the biosphere's artificiality, thereby making it increasingly more and more inorganic. Exacerbating this are other environmentally destructive acts such as deforestation and pollution. This results in the biological simplification of the biosphere and the reduction of its complexity and diversity.

We must first reverse this trend and start by balancing our built environment with greater levels of biomass, ameliorating biodiversity and ecological connectivity in the built forms and complementing their inorganic content with appropriate biomass.

10. We should improve the ecological linkages between our designs and our business processes with the surrounding landscape, both horizontally and vertically. Achieving these linkages ensures a wider level of species connectivity, interaction, mobility and sharing of resources across boundaries. Such real improvements in connectivity enhance biodiversity and further increase habitat resilience and species survival.

Providing ecological corridors and linkages in regional planning is crucial in making urban patterns more biologically viable.

Besides improved horizontal connectivity, vertical connectivity within the built form is also necessary since most buildings are not single but are multi-story. Design must extend ecological linkages upwards within the built form to its roofscapes.

11. More than enhancing ecological linkages, we must biologically integrate the inorganic aspects and processes of our built environment with the landscape so that they mutually become ecosystemic (See (4) above). We must create "human-made ecosystems" comptatible with the ecosystems in nature.

By doing so, we enhance human-made ecosystems' abilities to sustain life in the biosphere.

12. Ecodesign is also about discernment of the ecology of the site. Any activity from our design or our business takes place with the objective to physically integrate benignly with the ecosystems (See (4) above).

Particularly in site planning, we must first understand the properties of the locality's ecosystem before imposing any intended human activity upon it. Every site has an ecology with a limiting capacity to withstand stresses imposed upon it, which if stressed beyond this capacity, becomes irrevocably damaged. Consequences can range from minimal localized impact (such as the clearing of a small land area for access), to the total devastation of the entire land area (such as the clearing of all trees and vegetation, leveling the topography, diversion of existing waterways, etc.).

13. To identify all aspects of this carrying capacity, we need to carry out an analysis of the site's ecology.

We must ascertain its ecosystem's structure and energy flow, its species diversity and other ecological properties. Then we must identify which parts of the site (if any) have different types of structures and activities, and which parts are particularly sensitive. Finally, we must consider the likely impacts of the intended construction and use.

14. This is, of course, a major undertaking. It needs to be done diurnally over the year and in some instances over years. To reduce this lengthy effort, landscape architects developed the "layer-cake" method, or a sieve-mapping technique of landscaping *mapping. This enables the designer to map the landscape as a series of layers in a simplified way to study its ecology.*

As we map the layers, we overlay them, assign points, evaluate the interactions in relation to our proposed land use and patterns of use, and produce the composite map or guide our planning (e.g. the disposition of the access roads, water management, drainage patterns and shaping of the built form(s), etc.).

We must be aware that the sieve-mapping method generally treats the site's ecosystem statically and may ignore the dynamic forces taking place between the layers and within an ecosystem. Between each of these layers are complex interactions. Thus, analyzing an ecosystem requires more than mapping. We must examine the inter-layer relationships.

15. We must also look into ways to configure the built forms and operational systems for our built environment and our businesses as low-energy systems.

In addressing this, we need to look into ways to improve internal comfort conditions. There are essentially five modes: Passive Mode (or bioclimatic design), Mixed Mode, Full Mode, Productive Mode and Composite Mode, the latter being a composite of all the proceding.

Designing means looking at Passive Mode strategies first, then Mixed Mode to Full Mode, Productive Mode and to Composite Mode, all the while adopting progressive strategies to improve comfort conditions relative to external conditions.

Meeting contemporary expectations for comfort conditions, especially in manufacturing, cannot be achieved by Passive Mode or by Mixed Mode alone. The internal environment often needs to be supplemented by using external sources of energy, as in Full Mode.

Full Mode uses electro-mechanical systems or M&E (mechanical and electrical) systems to improve the internal conditions of comfort, often using external energy sources (whether from fossil-fuel derived sources or from local ambient sources).

Ecodesign of our buildings and businesses must minimize the use of non-renewable sources of energy. In this regard, low-energy design is an important objective.

16. Passive Mode is designing for improved comfort conditions over external conditions without the use of any electro-mechanical systems. Examples of Passive Mode strategies include adopting appropriate building configurations and orientation in relation to the locality's climate, appropriate façade design (e.g. solid-to-glazed area ratio and suitable thermal insulation levels, use of natural ventilation, use of vegetation, etc.).

The design strategy for the built form must start with Passive Mode or bioclimatic design. This can significantly influence the configuration of the built form and its enclosural form. Therefore, this must be the first level of design consideration in the process, following which we can adopt other modes to further enhance the energy efficiency.

Passive Mode requires an understanding of the climatic conditions of the locality, then designing not just to synchronize the built form's design with the local meteorological conditions, but to optimize the ambient energy of the locality into a building design with improved internal comfort conditions without the use of any electro-mechanical systems. Otherwise, if we adopt a particular approach without previously optimizing the Passive Mode options in the built form, we may well have made non-energy-efficient design decisions that will have to correct with supplementary Full Mode systems. This would make nonsense of designing for low-energy.

Furthermore if the design optimizes its Passive Modes, it remains at an improved level of comfort during any electrical power failure. If we have not optimized our Passive Modes in the built form, then when there is no electricity or external energy source, the building may be intolerable to occupy.

17. Mixed Mode is where we use some electro-mechanical (M&E) systems. Examples including ceiling fans, double facades, flue atriums and evaporative cooling.

18. Full Mode is the full use of electro-mechanical systems, as in any conventional building. If our users insist on having consistent comfort conditions throughout the year, the designed system heads towards a Full Mode design.

It must be clear now that low-energy design is essentially a user-driven condition and a life-style issue. We must appreciate that Passive Mode and Mixed Mode design can never compete with the comfort levels of the high-energy, Full Mode conditions.

19. Productive Mode is where the built system generates its own energy (e.g. solar energy using photo-voltaics, or wind energy).

Ecosystems use solar energy, which is transformed into chemical energy by the photo-synthesis of green plants and drives the ecological cycle. If ecodesign is to be ecomimetic, we should seek to do the same. At the moment the use of solar energy is limited to various solar collector devices and photovoltaic systems.

In the case of Productive Modes (e.g. solar collectors, photo-voltaics and wind energy), these systems require sophisticated technological systems. They subsequently increase the inorganic content of the built form, its embodied energy content and its use of material resources, with increased attendant impacts on the environment.

20. Composite Mode is a composite of all the above modes and is a system that varies over the seasons of the year.

21. Ecodesign also requires the designer to use green materials and assemblies of materials, and components that facilitate reuse, recycling and reintegration for temporal integration with the ecological systems (See (4) above).
We need to be ecomimetic in our use of materials in the built environment. In ecosystems, all living organisms feed on continual flows of matter and energy from their environment to stay alive, and all living organisms continually produce wastes. Here, an ecosystem generates no waste, one species' waste being another species' food. Thus

matter cycles continually through the web of life. It is this closing of the loop in reuse and recycling that our human-made environment must imitate (See (2) above).

We should unceremoniously regard everything produced by humans as eventual garbage or waste material. The question for design, businesses and manufacturing is: What do we do with the waste material?

If these are readily biodegradable, they can return into the environment through decomposition, whereas the other generally inert wastes need to be deposited somewhere, currently as landfill or pollutants.

Ecomimetically, we need to think about how a building, its components and its outputs can be reused and recycled at the outset in design before production. This determines the processes, the materials selected and the way in which these are connected to each other and used in the built form.

For instance, to facilitate reuse, the connection between components in the built form and in manufactured products needs to be mechanically joined for ease of demountability. The connection should be modular to facilitate reuse in an acceptable condition.

22. Another major design issue is the systemic integration of our built forms and its operational systems and internal processes with the ecosystems in nature.

This integration is crucial because if our built systems and processes do not integrate with the natural systems in nature, then they will remain disparate, artificial items and potential pollutants. Their eventual integration after their manufacture and use is only through biodegradation. Often, this requires a long-term natural process of decomposition.

While manufacturing and designing for recycling and reuse within the human-made environment relieves the problem of deposition of waste, we should integrate not just the inorganic waste (e.g. sewage, rainwater runoff, wastewater, food wastes, etc.) but also the inorganic ones as well.

23. We might draw an analogy between ecodesign and prosthetics in surgery.

Ecodesign is essentially design that integrates our artificial systems both mechanically and organically, with its host system being the ecosystems. Similarly, a medical prosthetic device has to integrate with its organic host being – the human body. Failure to integrate well will result in dislocation in both.

By analogy, this is what ecodesign in our built environment and in our businesses should achieve: a total physical, systemic and temporal integration (See (4) above) of our human-made, built environment with our organic host in a benign and positive way.

24. Discussion here on some of the key issues will help us approach the ecological design of artifacts and our businesses to be environmentally responsive.

There are of course other aspects. There are still a large number of theoretical and technical problems to be solved before we have a truly ecological built environment.