Regenerative Design:
Toward the Re-Integration of Human Systems within Nature

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Introduction

Current practice in green design and building focuses primarily on minimizing damage to the environment and human health, and using resources more efficiently - in effect, just slowing down the degradation. A much more deeply integrated systems approach to the design and construction of buildings and human settlements (and nearly all other human activities) is needed if we are to reverse the degeneration of the earth's natural systems. The challenge is not just technological since it requires altering our assumptions, attitudes, and understanding. It is necessary to move from our current view of humans as standing apart from and using nature to participating and co-evolving with nature. The self-organizing, self-healing, and regenerative capability of natural systems is diminished by human-created systems designed from the dis-integrated viewpoint that we are outside of nature and thus free to act on it with only limited understanding of consequences or effects.

Our scientific, technological, industrial, and economic systems continue to encourage human activity that undermines this regenerative capability by disregarding the fundamental principles that govern natural systems. To design regenerative systems we need to better understand both the bases of the regenerative capability of natural systems and how human systems can engage these systems in a manner that provides meaningful, useful, and health catalyzing interconnections. The apparent success of the industrial revolution is based, almost entirely, on our exploitation of the natural wealth (natural capital) that has accumulated over the several billion years that life has existed on Earth. To continue to thrive and evolve we need to redesign our systems to obey the laws of nature, including the laws of gravity, thermodynamics, biology, and ecology, to create systems that can co-evolve with and enhance the evolutionary capability of natural systems.

This requires a shift in thinking and in language, as most modern languages lack words to describe humans in relationship with nature. And most of the terminology of the "green" or

"sustainable" building and development movement blurs rather than sharpens our understanding of the challenge we face. We would like to suggest the use of the term "regenerative," because it suggests the self organizing and self healing properties of living systems. But we also want to suggest that what we are concerned with can be better understood by considering other terms, like dis-integration, integration and re-integration. Dis-integration might be though of as similar to dismembering, that is, cutting something into pieces. Thinking of dis-integration in that way makes clearer that integration and disintegration are opposites. Introducing the term re-integration, then, offers a meaning that might be akin to re-membering – which can have three meanings here, recalling a past state, re-awakening to something we already knew, or perhaps most important in this context, becoming a member again, literally, rejoining the community of life.

The Art and Necessity of Place-making

> *"The question that must be addressed…is not how to care for the planet, but how to care for each of the planet's millions of human and natural neighborhoods, each of its millions of small pieces and parcels of land, each one of which is in some precious way different from all the others. Our understandable wish to preserve the planet must somehow be reduced to the scale of our competence – that is, to the wish to preserve all of its humble households and neighborhoods...."*
>
> *Wendell Berry*

Though humans have not always lived in conflict with the rest of the natural world, the dis-integrated world view of humans as separate from nature (and the resultant damage) has a long history. However, the industrial revolution exponentially accelerated our "progress" in exploiting and "managing" the world's natural resources for material gain and improved human living conditions. It also speeded the degeneration of the planet's living systems and depletion of non-renewable resources. Industrialization gave us standardization and ever-increasing mobility, for people as well as resources, seemingly freeing us to replicate what seemed to work in one place anywhere else. It also gave us access to what appeared to be relatively benign, inexhaustible and inexpensive sources of energy, enabling both the transport of materials around the globe and the ability to disregard climate and other conditions in the design of our buildings and communities. Suddenly, "place" became much less important across the whole continuum of the design and building process, from the issues of siting and orienting a building, to sourcing its materials, operating and maintaining it, and ultimately, disposing of it at the end of its life.

Looking to an earlier time we can find a different model for design and construction that yielded buildings and towns much better suited to the full spectrum of local factors. In what we presume to be a simpler past we see an example of the kind of more deeply connected thinking needed as we move into a more complex future. Prior to the industrial revolution, master builders were primarily responsible for the built environment. These individuals were responsible for both the design and the oversight of the building of their creations. Their design and building process was inherently embedded in local natural and human resources, as well as the full range of local context. Their intimate knowledge of local materials, local work force skills, the local economy, culture, and traditions, as well as local conditions such as microclimates and soil conditions, led them to produce buildings and communities that were truly integrated with their environment. That so many of these buildings survive and are

revered centuries later as timeless parts of the landscapes and communities in which they exist indicates something of the life and quality resulting from such a design process.

In trying to understand what is required to begin the shift toward regenerative systems, it may be easier to think about an agricultural example, rather than one involving the built environment. Wendell Berry, American farmer, writer, and philosopher has expressed the critical importance of place in much of his writing. In discussing the necessary requirement for agriculture to be productive, he notes the importance of the context of that productivity. (Chapter "Nature as Measure" What Are People For) Berry explains that *being* productive is only one of three equally important requirements. The other two are that for agriculture to *remain* productive, those who use the land must preserve the soil and its fertility and ecological health, and to do that they must be motivated to use it well, know it well enough to do so, know how, have time, and be able to afford to use it well.

"Industrial agriculture…has dealt with nature…in the manner of…an orator. It has not asked for anything, or waited for any response. It has told nature what it wanted, and in various clever ways has taken what it wanted." "…On the other hand, an agriculture using nature, including human nature, as its measure, would approach the world in the manner of a conversationalist." "…On all farms, farmers would undertake to know responsibly where they are and to 'consult the genius of the place'. They would ask what nature would be doing there if no one were farming there. They would ask what nature would permit them to do there, and what they could do there with the least harm to the place and to their natural and human neighbors. And they would ask what nature would *help* them do there. And after each asking, knowing that nature will respond, they would attend carefully to her response." "…When we adopt nature as measure, we require practice that is locally knowledgeable. The particular farm, that is, must not be treated as any farm. And the particular knowledge of particular places is beyond the competence of any centralized power or authority."

If we are ultimately to develop regenerative systems for the design and construction of buildings and sustainable communities, we will need a similar kind of understanding of what we are doing and where we are doing it; a knowledge of many interconnected relationships grounded in real places, not abstract principles, ideas, or rules.

Where We Are

> *"Not everything that counts can be counted, and not everything that can be counted counts."*
> *sign over Albert Einstein's desk at Princeton*

> *"Optimizing components in isolation tends to pessimize the whole system."*
> *Paul Hawken, Amory Lovins, and L. Hunter Lovins – from the book Natural Capitalism*

The industrial era has been an age of reductionist thinking, as our growing scientific proficiency led us into more and more specialized ways of understanding, using, and managing the world. This led to the division of the world into separate disciplines as the study of separate parts, functions, and processes became ever more important to technological progress. This led to the loss of the inherent integrity of the ‘management structure’ of the master builder. Things became too complex and dynamic to rely on the knowledge and competence of a single person to know and manage the design and

construction process. Resources could come from anywhere, new materials and technologies were rapidly and continuously introduced. Specialists were needed to resolve and implement the complex aspects of electricity, lighting, municipal waste systems, indeterminate structural analysis, automatic climate control, 'smart' buildings, etc. Where once we had *one* mind internalizing and integrating local building issues, now we have anywhere from dozens to several hundred companies or organizations or individuals involved in designing and making decisions on issues ranging from zoning policy, stormwater management, building product design, energy efficiency, construction methods, and so on. We have moved from a time of common sense integration to a century of "its-not-my-job" dis-integration.

This dis-integration manifests itself in the design and building realm, for individual structures, developments, and entire communities, in the much higher trust in and emphasis on engineering and economic models and calculations than ecological and natural system values, or even concerns about human health and welfare. This is true in part because these living and natural systems are much more complex and less easily understandable and measurable, and in part because they confront us with real limits, both in our understanding and in the biogeochemical world within which we all live. Thus, we discount the importance of the very things that enable the whole system to continue to evolve into the future with us in it.

Today, the emergence of systems science and advancements in ecological understanding (including growing recognition of the limits of our knowledge and understanding about both the actual consequences of any of our actions and how high the stakes might be for the future health of any species or ecosystem) has led us back toward trying to see the world whole, or at least in terms of the relationships of intricately interconnected systems. This highly integrative view is also leading us back toward a much more holistic understanding of how living and non-living natural systems interact with and relate to humans and the systems we have created. We are beginning to see that no single entity can be understood without understanding how it is connected to the many other systems that support and interact with it.

The path toward a prosperous and healthy future lies, of necessity, in our ability to re-integrate our thinking, our systems, and our selves into the natural systems and limits in which they have existed, albeit in stark denial of that reality, all along. Trusting that more clever technology will solve the problems that have been largely amplified and complicated by previous versions of technological solutions recalls the definition of insanity as doing the same thing and expecting a different outcome and Einstein's famous quote about not being able to solve a problem with same kind of thinking that created it. We need both a different kind of thinking and a thorough re-evaluation of our assumptions and priorities.

Integrated Design – a Realization of Systems Thinking for the Building Industry.

> *"English does not contain a suitable word for 'system of problems.' Therefore I have had to coin one. I choose to call such a system a 'mess.' The solution to a mess can seldom be obtained by independently solving each of the problems of which it is composed.*
> *Russell L. Ackoff*

The first major evidence of a shift beyond the age of disconnected specialization is the emergence of integrated design as a strategy for dramatically improving the quality and performance of buildings. Integrated design grew out of the insight that a building is a system

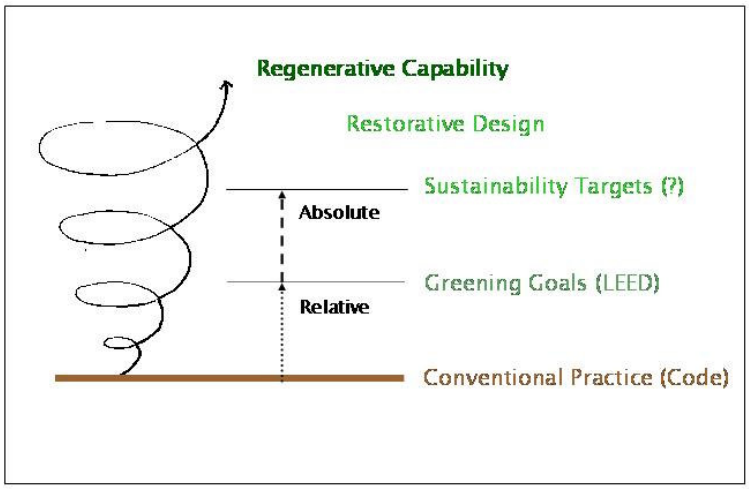
of systems. The green building movement is making its greatest gains as a result of the benefits of integrated design, including enabling designers and builders to overcome the transition problems and costs associated with the fragmented introduction of new materials, technologies and design concepts. It also allows effective optimization of the individual systems and components by recognizing them as interactive and interdependent elements of an integrated whole.

This requires engaging in a non-linear design process. One capable of simultaneously addressing the range of variables and desired outcomes in order to identify and maximize potential synergies between the parts of the system as the design of the whole system is evolving. This also requires the development of a different set of skills and collaborations for the design team – helping the design team become a modern version of the master builder. In this integrated process, the emergent properties of the whole system can be recognized, explored, and experimented with as the design evolves. Today's sophisticated modeling software for energy-efficiency and lighting help reveal relationships between the building location and form, the size, placement and orientation of windows, the performance of the building envelope, the loads and uses of space within the building, and the sun, prevailing winds and other climate conditions throughout the year.

Taking this to the next level we see that buildings and settlements are not 'objects' or assemblages of technologies and materials, but amalgamations and concentrations of many systems with energy and material flows, not unlike living organisms with metabolisms (electric lines, solar resources, materials, prevailing winds, soil health, ground water, roadways, social network systems, etc.)

As we begin to recognize the limits of industrial approaches to satisfying human needs, we have also started to recognize the benefit of optimizing resources and systems. Terms like eco-efficiency, and eco-effectiveness are being more widely used, but the next step requires that we begin working with natural systems on their own terms, not the ones still, at least partially, embedded in the dis-integrated world view. Thus integrated design, as promising and necessary as it is, is only a first crucial step toward regenerative design.

Building Capability Not Things



Building Capability, not Things

Figure 1

The above graphic illustrates likely thresholds the building industry (and society) will need to move through as we develop understanding of the integral relationship between human and natural systems.

The graphic builds on a diagram by Ray Cole illustrating the trend of rating systems based on the *relative* efficiency improvements in resource use to lead, logically to *absolutely no use* of scarce resources and problematic toxins (BREEAM, LEED, etc.). This raises the question, is the diminution of resource use sufficient to achieve sustainability? No one can say for certain – but likely not. Even if it was so, the Factor 10 society proposed by some environmental scientists - a 90% reduction in western society's impact by 2050 – is not likely to be achieved if we continue our relationship to natural systems in the overly simplistic terms of impact reduction. This "limiting the damage" approach is based on the ingrained attitude that humans and natural system health are antithetical to each other. The conservation ethic – "let nature alone" – is a result of this view; an understandable first line of response considering the impacts of the last 500 years of human activity.

We are more likely to achieve large improvements if we *participate* with nature on its own terms. Even the consideration of nature as a model is a concept that prescribes a perceived boundary, regenerative design requires that we *participate* with nature in a mutually beneficial relationship. This means instead of trying to *stabilize* natural systems by brute force and the creation of "manageable uniformity" (Lyle), we must identify the key systems (living and geologic) involved in a "place" and understand what permits these systems to maintain viability over time and allows them to evolve in relation to each other (a continuous birth, life, death cycle). In other words, long-term stabilization of both human and natural systems results from the seeming messiness of complex system diversity and an acknowledgment of slow change over time (an evolutionary construct).

> Focusing on technical solutions to make societal development independent of nature will not lead to sustainable solutions (Holling and Meffe 1996). Instead efforts should be made to tune and create synergies between economic development,

> technological change and the dynamic capacity of natural resource base to support societal and economic development.
> "Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations," Folke at al.

Natural systems are extremely effective at healing themselves. If we want to achieve health for the planet in the shortest amount of time the following two principles sum it up pretty well:
1) Natural systems have the self organizing capability to heal themselves – if we let them.
2) We are nature.

The practical implementation of these principles leads to place-based design. Place-based design not only uses resource efficiency as an approach but requires an awareness of what gives health to a place – using the smallest watershed as a basic unit. Inextricably, it requires humans to understand how they need to realign their activities in that place so that the systems (human and natural) have an opportunity to self heal. And this requires much less hubris and much more humility about our ability to "manage" natural systems in order to override the very real limits of natural systems and places.

Energy Flows, Self Organizing Natural Systems - Howard Odum
In order to shift to regenerative systems we need to understand the basis for regenerative processes in nature. Much of the foundational work that is critical to this redesign was done by Howard Odum, who provided the theoretical framework for understanding natural systems by proposing to use energy as the "currency" to study and quantify both man-made and natural systems, processes, and products. In so doing, Odum provided a way to begin to measure energy flows, conversions, distribution, and storage, the life-blood of living systems. His framework also provides a way to reconcile human economics with natural economics – the economy of the bio-physical transactions that occur in natural systems independent of human monetary or other economic systems.

One of Odum's greatest contributions is his use of the second law of thermodynamics to describe the viability of systems. The second law of thermodynamics states that, in a closed system, any physical process will result in the loss of some useful energy – some energy is always wasted. Since the first law of thermodynamics states that energy can be neither created nor destroyed, what the second law refers to as "wasted" energy is the degradation of the quality of the energy, a diminished ability for that energy to do work. The second law is often referred to as the law of entropy, the tendency for potential energy to degrade and diffuse, or the tendency for systems to move from order toward disorder. However, it is also possible for some amount of energy in a system to be upgraded to more concentrated forms as well, creating the extraordinary possibilities for life and order. This upgrading always results in a net degradation of energy in the whole system, however. On earth, the degradation of energy in the sun's thermonuclear processes provides the possibility for upgrading the quality of energy on earth and the creation of order instead of disorder.

Using the second law as a tool to measure what is happening in natural and human systems we can reveal how efficient and effective they are and make informed decisions about them. Odum's work aimed to clarify the importance of understanding not just the quantity of energy available or used, but the quality of that energy and the significance of the energy transactions. This led to his interest in embodied energy. He pointed out that complex work requires high-quality energy and the tendency to think of energy requirements just in terms of fuel ignores the range of other energy inputs including the energy embodied in materials, in

human labor, and in the fuel itself. Recent research in the U.S., for example, demonstrates that the production of ethanol, a corn-based fuel additive promoted on the basis that it will help reduce U.S. dependence on foreign oil, actually requires more petroleum-based energy to produce than it yields when burned. Odum similarly noted that taking the whole system into account, nuclear power actually uses or degrades more useable energy than it produces.

Our success in shifting to regenerative systems will be based in part on our ability to shift our systems to lower rather than higher energy systems. Odum wrote "We will find that the long term basis of our economy is ultimately the use of effective self-organizing solar converters: forest ecosystems, and lower-energy agricultural patterns that have long been with us." Odum, Energy Basis for Man and Nature, p. 9. When resources and sinks aren't local, the costs of procurement and waste disposal become inordinately high. The broken nutrient cycle of current agricultural practice is a good example. Nutrients are taken up into plants from the soil. Those plants are harvested and some of the nutrients are shipped to cities, where they are eaten, and eventually end up in the wastewater systems of the cities. A varying, though significant, percentage of the nutrients end up nutrifying water bodies while only a small fraction is returned to the soil from which it came. This means huge investments of fertilizers are needed to replace the lost nutrients in the soil, while other investments are required to deal with the water issue. The whole system requires massive amounts of energy to transport everything.

A similar analysis of the materials and energy that go into buildings would reveal the same situation. The challenge as we deplete our non-renewable high-energy fuels, will be to shift to lower-energy, more local and more deeply integrated systems.

One way to get to lower-energy systems is suggested by John Lyle, in his book Regenerative Design for Sustainable Development. Lyle listed a number of general principles for design, starting with Let Nature Do the Work. Designing to take advantage of natural processes and flows typically results in systems that conserve resources, do less damage, and are less expensive to create and to operate. But, instead they require greater care, consideration, attention, and sophistication – in people, rather than in technology. This is the opposite of our modern industrial approach which tries to put all the sophistication in the system, material, or component, and reduce the human interface to the lowest level of sophistication possible. Designing to let nature do the work demands place-based knowledge, understanding, and participation because nature doesn't work in the abstract, only in real places.

The Essentials

> *"Caminante no hay camino se hace camino al andar" – The road is not made; we make it as we walk along.*
> *Antonio Machado*

The first step toward regenerative design is to really understand ourselves as integral with nature. This means understanding our past relationship to nature and the potential of this relationship in the present and in the future. The western view of humans as distinct from nature must ultimately be changed for our species to survive. In reality humans have been actively influencing nature around the world for 30,000 years. We need to get beyond two widely held beliefs. First, that we are only capable of doing harm to natural systems, and second that we are capable of understanding natural systems sufficiently well to maintain

them in the manner of a piece of machinery, both of which shape and mislead our current actions and interactions with nature.

This shift doesn't give humans justification to destroy living systems, or undermine their capacity to thrive and evolve, or to abandon the protection and care for wild places. It might give us the justification to see ourselves as partners with other living systems, seeking the deeper roles and exciting possibilities of co-evolutionary relationships; relationships whose end results or outcomes are not controlled or predetermined by humans for strictly human ends. It would appear that nature and natural history has not been carefully plotted out in advance in great detail. Rather, it apparently unfolds as a result of uncountable interactions between countless actors, in relationships that change and evolve constantly at every scale from the sub-atomic, to the micro-organism, to living individuals, to communities, to nations, to the global, and beyond.

We can manifest our relationship with nature in different ways. For example, we can compare Western society's taxonomy for classifying living things as a very object-oriented system based on what things look like. In contrast, we can look at Aboriginal taxonomies which classify based on a process-oriented approach, such as grouping plants based on what animals pollinate them. We can look at the Western tendency to focus on how humans are different from other animal species, for example claiming that humans are the only tool makers, or the only animals with cognitive abilities, or well developed social systems, or sophisticated memory. Yet scientific research continues to reveal that other animals have some of these abilities as well.

We also must look at the degree to which we have been influenced by our understanding of Darwin's work. Out of an expectation that the world is a hostile place where scarcity and competition are the common and constant realities against which we must all fight for survival, we have expected to find competitive systems and we have found them. But in reality, symbiotic relationships, the sharing of information and nutrients, the abundance of cooperative relationships in nature are vastly more prevalent. We haven't seen them because until relatively recently we weren't looking for them.

This translates into our language as well, as we have no word that summarizes the oneness of all things. In order to even communicate about this we have to bridge that gap by saying "human and natural systems" Some indigenous cultures have one word for the oneness of the variety of human and natural relationships because they have lived in those types of relationships.

There are other misconceptions that we will need to deal with, such as our notions about restoration. We have been attempting to 'manage' nature. As John Lyle put it, "Where nature has evolved to a level of infinite diversity, humans have chosen to design for readily managed uniformity." We attempt to stabilize systems and make them act in a uniform, predictable manner. Nature evolves, self organizes, and adapts. Stability in natural systems is a result of diversity of the relationships, more than diversity of the elements. An example from G.M. Day, "The Indian as an Ecological Factor in the Northeastern Forest, *Ecology* 34(1953) discusses American Indians and their inextricable relationship with pre colonial chestnut/oak forests in Eastern North America:

> For 5,000 to 10,000 years 80% of the eastern US forest was a Chestnut, Hickory, Hemlock, Oak forest (thick bark trees). If left unattended, this forest would have quickly evolved into a Beech Maple forest (thin bark trees). It didn't, because the native peoples were managing this ecosystem with frequent burnings of the detritus on the forest floor. This "managed" system was natural and it included human intervention colonial settlers report being able to drive wagons through the forest as if it was a manicured park. It was this way until white man settled this area and moved these peoples out of this ecosystem – thus changing it to the forest system we have today.

We will need to overcome our tendency to generalize, meaning that the design of regenerative systems will always be place-based. Generalizing minimizes the ability for systems to reach their natural potential of self-regulation because each situation and location is unavoidably unique. This is why prescriptive solutions are inadequate. There is a corollary, which is almost the opposite of this. It is to seek optimum levels for multiple functions, rather than optimizing components in isolation, which generally tends to drive the system towards lower levels of diversity and performance.

Finally, it is important to conceptualize natural processes in terms appropriate to living systems and avoid the generalization of mechanical and cybernetic constructs. The terms "input-output," "cradle to cradle," "feedback loops," "ecological balance," and such, have led us to think about ecological issues in important new ways. However, these terms still identify us as a society and as a species separate from nature, acting to manage natural systems as though they are machines or businesses. Success, from the perspective of these terms, can only be gauged by looking at a myopic snapshot of what we, with hubris, consider the correct ecological construct. Instead, healthy ecological systems don't maintain a stasis; they have a spiraling, complex growth pattern that has continuous and changing birth/life/death cycles. Living and natural systems are not merely closed loop systems, but continually evolving open systems. We can learn to co-evolve and co-create with them, and must do so if we are to create regenerative systems that will empower a more abundant future in which healthy human communities thrive.

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