Integrated Design

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In case you haven't heard, the age of specialization is dead. Perhaps more accurately: the age of *disconnected* specialization is dead. After 150 years, the pattern of isolated thought processes and activities that has typified the industrial era has reached a wall of unavoidable consequence. No natural system or human activity can be considered apart from any other. Everything is connected. Everything and everyone are in some kind of relationship with everything else. The growing awareness of these interrelationships has led to a different way of designing buildings—seeing them as systems and subsystems embedded in larger systems. This has led to a much more integrated design process.

For centuries, high quality buildings were designed and built by master builders guided by intimate knowledge of the place in which they lived and worked. The result was buildings and communities so beautifully integrated into their place that we envy and often try to imitate them today.

The industrial age has been an era in which humankind has generated more information than any one person can possibly absorb, even in his or her specific area of expertise. We certainly cannot, for instance, fully understand the consequences of the interactions between resource extraction, energy production, manufacturing, agricultural systems, transportation, land development, social systems, economic systems and our life support system . . . nature.

In all of society, and specifically at all levels of the building industry, we find ourselves attempting to address these complex interrelationships with inadequate knowledge and fragmented management approaches—holdovers from an era when we assumed that there was a simple cause and effect for every activity in which we were engaged.

To understand the kind of connected thinking we will need to embrace as we move into an increasingly complex future, we are well advised to look back upon what we often think of as a "simpler" past. Prior to the industrial revolution, our buildings and communities were built through a different process than the one we now use. Local resources, both natural and human, were the basis for what was designed and built, and master builders took primary responsibility for the built environment. They designed and built based on their understanding of local issues. Their intimate knowledge of the region's materials, work-force skills, economy, culture and traditions, as well as unique environmental considerations such as microclimates and soil conditions, enabled them to produce build-

ings and communities that were truly integrated with their habitat. The result was buildings that lived and breathed and became a part of their place—communities that we often envy today and even build theme parks after in an effort to capture some hint of their life and qualities.[1]

The coming of the industrial age resulted in the loss of the management structure that included the master builder. Things became too complex and too dynamic. Resources could come from anywhere and 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., etc. Where once we had one mind internalizing and integrating local building issues, now we have anywhere from dozens to several hundred organizations and individuals involved in design, making decisions on issues as diverse as zoning policy, stormwater management, energy efficiency, construction methods and so on. We have progressed from a time of common sense integration to a century of "its-not-my-job" dis-integration.[2]

The Character of Integrated Design

Integrated design requires open lines of communication during the design process between the client, architects, designers, engineers and the construction team in considering the complex interconnections between all the systems of the building and the natural systems with which it will coexist. A forum and methodology is provided that engages all team members in seeking mutually beneficial design solutions, whether in their field of expertise or not. Unlike the standard, linear design model in which an architect or someone else designs the building and then turns the plans over to specialists—structural, mechanical electrical and civil engineers; an interior designer; and a landscape architect—to accomplish the design, the specialists instead work together in a process that encourages an understanding of how their individual pieces fit into and affect the whole of the design.

Communication of this sort may not come naturally, but it is critical to the outcome. Proper communication in the context of integrated design requires that each participant not only be willing to explore and embrace different possibilities than their stock, conventional solutions, but also to carry that appreciation of the whole project and all its parts into his or her own area of work. This is especially important when we consider the challenge of integrating the project goals and requirements with the local and site characteristics such as soils, prevailing winds, sun angles, ground water hydrology, the quality of municipal utilities, resource burdens, plant and habitat ecosystems, and the human activities for the site being addressed. In order to achieve the kind of integration that master builders brought to their projects, all of the building professionals involved in the design process must become, in effect, composite master builders.

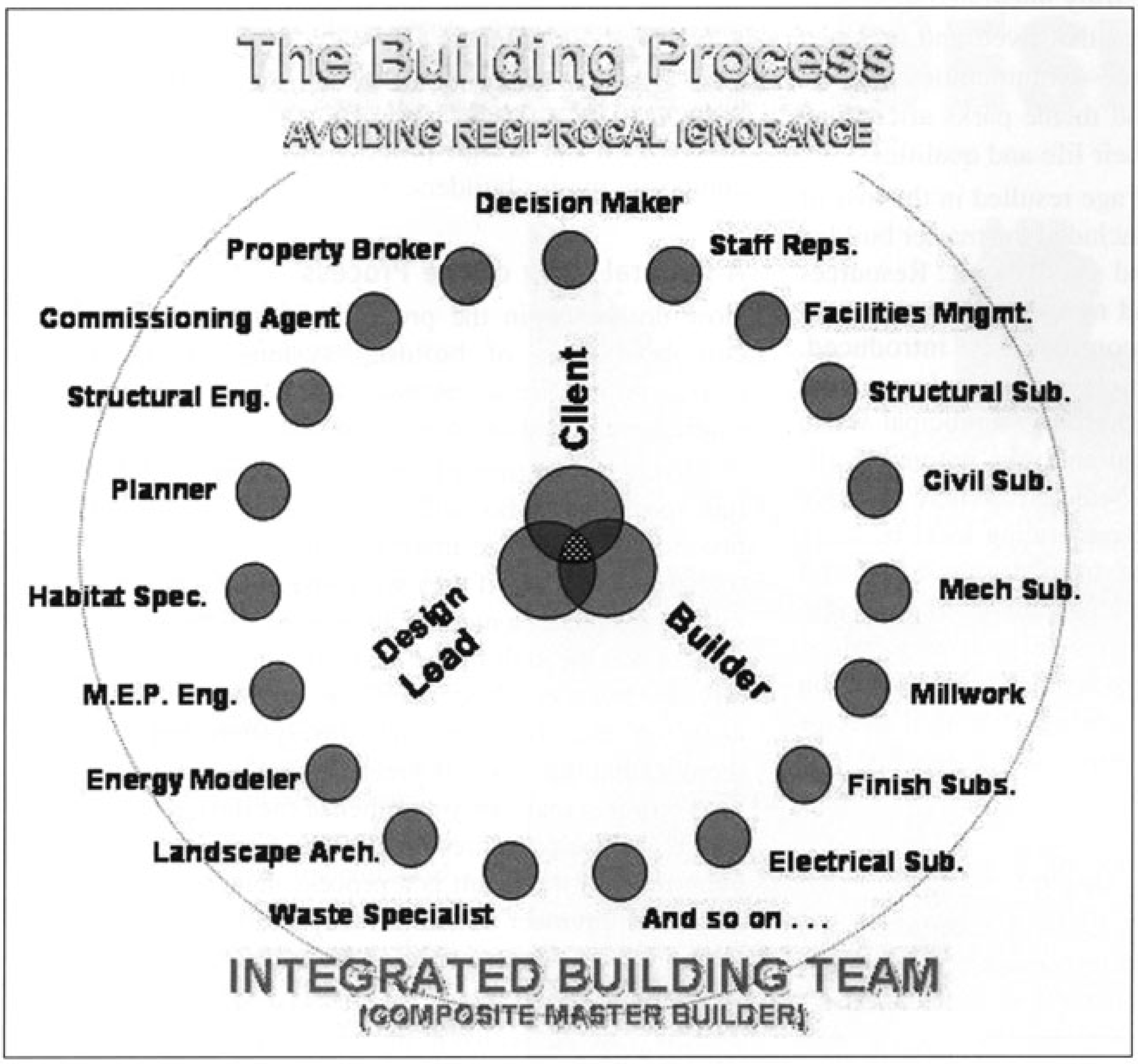
A General View of the Process

How do we begin the process of integrating the many complex issues of building systems, environmental responsibility, life-safety concerns, function, budget considerations, speed of construction, etc?

First, a commitment is required to bring together all of the specialists who will be involved in the building process and organize them in a manner that will enable them to function as if they were one mind. Once this commitment is made, a method appropriate to the nature of the project and the skill of the design team is needed to structure the process. "Integrated" or "whole system" design analyzes each building and site system and integrates them so that the whole is greater than the sum of the parts. This requires that every member of the design team understands and helps address the issues faced by every other member, and the result is a process that ameliorates what structural engineer Mario Salvadori terms the "reciprocal ignorance" of diverse specialists in the design and building field.

This can be realized through a design process that invites the client, community members, appropriate designers and consultants, and general contractor to participate from the very beginning of the project in a focused and collaborative set of brainstorming sessions known collectively as a design charrette.[3] The design charrette is a proven way of engaging all of the participants in a reciprocal learning process. Participants learn about the needs of the client, take stock of opportunities and constraints, and help conceive and "buy into" the solutions. The education process is accelerated, decisions are verified, adversity is diminished, the nuances of organizational issues are learned and the design process is expedited. A final solution is not necessarily produced, but most of the issues are explored with all the key parties present so that potential conflicts between different goals or disciplines are revealed and can be resolved together.

The first charrette is usually used for setting system performance goals such as energy and water use; stormwater quality; resource efficiencies; the control of toxins and pollutants; management of transportation requirements; and other issues of potential impact on habitat site and regional ecologies. An example would be the mechanical and electrical engineers collaborating with the



The design team in an integrated design process ideally includes the builder and all the consultants and engineers as well as the client and architect. This team works together in a deeply integrated process, collaboratively creating a design that meets the client's needs and desires while taking full advantage of opportunities for efficiencies and cost-effective solutions. A primary goal is to have all decisions serve multiple needs and create multiple benefits.

architect to help reduce the building energy load rather than increase the HVAC capacity. The architect might suggest a design that allows more natural daylight into the building in order to reduce the electric lighting loads while controlling solar heat gain through proper orientation and shading and more energy-efficient glazing and insulation. The engineers may then be able to reduce mechanical system sizing significantly (in some climates, to virtually nothing), offsetting some or all of the costs of the higher efficiency building envelope.

A site-related example might be using constructed and existing landscape features and pervious paving to reduce stormwater run-off coefficients, thereby reducing the size of detention basins and affording additional ground water recharge than would have been possible with a conventional design. In addition to their stormwater-related functions, features such as living roofs and cisterns to collect water for irrigation and toilet flushing also, respectively, add green area to the site and reduce cooling loads, and reduce potable water use. Thus, multiple benefits are derived from the full integration of one concept that typically is addressed in the form of a sizable (and ugly) retention basin.

Engaging in the Process

Integration of the design and building processes is well underway in the building industry. The lessons of conflict dispute resolution and organizational development techniques have been applied to design and planning teams since the 1960s. These techniques (pioneered by Caudill, Rowland and Scott for school design) originally helped large architectural teams get beyond ego issues to develop a common vision and value system in order to address specific design tasks. The benefits were readily recognized and the implementation of integrated practices continues to grow. New Urbanism practitioners, for example, use the charrette process to engage members of communities more quickly. Design-build contracts and community design charrettes are now part of established design processes—an inevitable movement away from the seemingly single-minded pursuit of aesthetics or return on

investment as the most important aspect of the building effort.

The fundamental system goals of green design require an even more highly integrated design process. Buildings and their sites must be evaluated as a whole system of interrelated environmental functions. It is an oversimplification and does great disservice to cost, efficiency and quality of life to analyze buildings by independent practice disciplines (e.g., civil engineering, architecture, mechanical engineering). It is much more effective in terms of ultimate performance and lifecycle costs to consider systems of activities[4] (e.g., habitat systems, water quality/conservation systems, energy systems, indoor environmental quality systems), which is why the US Green Building Council's Leadership in Energy and Environmental Design rating system is organized in the way that it is.

For a variety of reasons, code officials have generally not been seen as collaborators in the integrated design process. From the perspective of many owner and design teams, the role of code officials is seen as obstructionistic rather than proactive. One explanation for this is that many building codes are typically prescriptive rather than performance-based. Another is that code approval is part of the standard, linear, "dis-integrated" process. There is, however, an excellent opportunity for including code officials in the integrated design process.

Imagine a representative of the building department trained in performance approaches to code compliance; trained to participate in the integrated design process; and perhaps also knowledgeable about green designs, materials and methods of construction. The participation of such a code official could result in code-related issues being resolved, as other problems are, during the design process rather than after the building is fully conceptualized and the plans and specifications are completed and submitted for approval. The building department would then be serving as a community asset for optimized design, rather than in its more traditional role of building safety police. The department could also bill for their participation, as do all the other professional consultants, and the developer or building owner could potentially reap enormous savings of both time and money since their plans, when submitted, would be virtually pre-approved.

Conclusion

Making the above scenario a reality will probably require that governing bodies restructure their codes or enforcement practices to embrace both prescriptive and performance-based approaches and give latitude to code officials to evaluate project systems rather than focusing on individual building elements or components. In which case, understanding the overall and large-scale impacts of building and development on the environment and helping the public understand how small decisions can have broad ramifications on the overall health of environmental systems will be among the most important function of code officials in the 21st Century.

The age of disconnected specialization is over. We are now aware that we are connected to everything else. We should, however, be hesitant to say that we are entering the "age of integration." That would imply that integration is a passing frame of reference. It is not. It is a fundamental principle that—once apprehended and accepted—is the basis for creating sustainable buildings and communities, and thereby ensuring long-term quality of life. ◆

Notes

1. The quality of timelessness has nothing to do with style. It is about buildings and communities that have a living and informed relationship with their environment.
2. We should be careful not to put too fine a point on the "native intelligence" of the master builder process. While the process was certainly more integrated, the knowledge base of actions/reactions in relation to the

Strategies for Engaging Code Officials in the Integrated Design Process

- Have code officials involved from the beginning of the project.
- Make code officials part of the design team. Have them be engaged early in the design process (certainly at the first charrette) and at appropriate times thereafter.
- Expect building departments to charge for their time involved in the design process in addition to, or as a replacement for, fixed fees.
- Empower building officials to evaluate projects based on system performance criteria rather than prescriptive solutions (this will require the cooperation of law makers to be fully effective).
- Grant code officials a creative role on the design team, enabling them to look for opportunities to improve the broad range of environmental systems.

overall environment was less informed. Those living before the industrial age did, however, have the advantage of a slower and more deliberate pace of activity, which often allowed them to observe mistakes in relation to the cycles of nature and fix problems before too much local damage occurred. The frenetic pace of modern society means that extensive damage can be caused before we even realize that it is occurring. The lesson is that we need to include a feedback system in our development and building processes that will give us, in effect, a post-occupancy review of long-term social and environmental impacts. Of course, we must also take the time to pay attention to such feedback. This, along with legal mechanisms allowing faster changes and flexibility of practice in response to unique local conditions, would result in a process that will allow us to respond and adapt much more efficiently to the evolution of our natural and social environments.

3. The term originates in the late 1800s. When student architectural projects were due at the *L'Ecole des Beaux Arts* in Paris, a custodian would pull a four-wheeled cart (*charrette*) through the studio and finished drawings were to be placed on the cart as it passed. Students often wanted to continue refining their drawings until the last possible moment and would jump on the cart to work for a few more feverish moments while being pulled along. Hence, "*en charrette*" (on the cart) is a term used by architects for fast and intense work. More generally, a charrette may be defined as a rapidly paced work session involving many stakeholders.
4. The word "system" here refers to anything that functions as a whole by the interaction of organized parts *(Energy Basis for Man and Nature*, Howard T. Odum and Elisabeth C. Odum, 1976, p. 15.).

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The views expressed here are those of the author and do not necessarily reflect the opinion or agreement of the International Conference of Building Officials.