Drivers for Change: An Organizational Perspective on Sustainable Construction

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Introduction

Sustainability is emerging as a guiding paradigm to create a new kind of built environment: one that meets the needs of humans in the present without compromising the ability of future generations to meet their own needs. However, despite legislative and social pressures to increase the environmental and resource-friendliness of our built environment, many construction organizations continue to operate in a "business-as-usual" fashion, failing to realize the potential advantages of taking a proactive approach to sustainability. To incorporate sustainability as a guiding principle, the construction industry needs both a convincing reason and a strategy to do so.

This paper presents a model for organizational change to increase the sustainability of the built environment. The model includes a breakdown of the reasons that propel decision makers to consider sustainability in the context of built facilities, and identifies key strategic entry points for incorporating sustainability as a decision criterion over the whole life cycle of built facilities. In terms of the problem solving process used by built environment stakeholders, the model provides an overview of considerations for sustainability in terms of the life cycle of built facilities. The paper concludes with recommendations for creating execution plans to meet sustainability objectives and goals, and guidelines for surmounting barriers to change in the Architectural/Engineering/Construction (A/E/C) industry.

Setting the Stage for Change: A Rationale for Built Environment Sustainability

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Built facilities are complex technological systems that meet critical human needs, persist over significant lengths of time, and involve multiple diverse stakeholders. Their interrelations with the technological and ecological systems that surround them have significant impacts on those systems. These impacts have not always been noticeable on the scale of individual facilities, but their cumulative effects on the planet over time have been increasingly well documented. For example, buildings are responsible for over ten percent of the world's freshwater withdrawals, twenty-five percent of its wood harvest, and forty percent of its material and energy flows (Roodman & Lenessen 1996). 54% of U.S. energy consumption is directly or indirectly related to buildings and their construction (Loken et al. 1994). 30% of all new and remodeled buildings suffer from poor indoor environments caused by noxious emissions, off-gassing, and pathogens spawned from inadequate moisture protection and ventilation, resulting in $60 billion annually in lost white-collar productivity from Sick Building Syndrome (SBS) in the U.S. alone (Kibert et al. 1994). Nearly one-quarter of all ozone-depleting chlorofluorocarbons (CFCs) are emitted by building air conditioners and the processes used to manufacture building materials (Energy Resource Center 1995). Approximately half of the CFCs produced around the world are used in buildings, refrigeration and air conditioning systems, fire extinguishing systems, and in certain insulation materials. In addition, half of the world's fossil fuel consumption is attributed to the servicing of buildings (Zeiher 1996). The average household is annually responsible for the production of 3,500 pounds of garbage, 450,000 gallons of wastewater, and 25,000 pounds of CO_2 along with smaller amounts of SO_2, NO_X, and heavy metals (Barnett and Browning 1995). Lighting accounts for 20-25% of the electricity used in the U.S. annually. Offices in the U.S. spend 30 to 40 cents of every dollar spent on energy for lighting, making it one of the most expensive and wasteful building features (Energy Resource Center 1995). Finally, the construction industry is responsible for 8-20% of the total Municipal Solid Waste (MSW) Stream, 14% on average (Tchobanoglous et al. 1993).

These cumulative impacts have resulted in increased attention by government agencies, private owners, and non-profit organizations to the role played by built facilities and infrastructure in the problems of natural resource depletion and degradation, waste generation and accumulation, and negative impacts to ecosystems. Since built facilities are a major direct and indirect contributor to these problems, they now face increasingly restrictive environmental conservation and protection laws and regulations, international standards to address environmental quality and performance, and substantial pressures from civic groups, environmental organizations, and citizens. As a result, facility stakeholders face new, complex and rapidly changing challenges imposed by these laws, regulations, standards, and pressures at all life cycle stages. Negative impacts to natural ecosystems have begun to enter into decision-making in the construction industry. Forced by environmental legislation such as the National Environmental Policy Act of 1970, many U.S. projects now require an Environmental Impact Assessment of the project to be completed before construction can proceed. Still, however, many project planners, designers, and contractors see environmental considerations as an obstacle to be overcome rather than a way to achieve benefits for themselves and others (Kinlaw 1992). Many actions taken to mitigate environmental impact of projects are typically only applied as end-of-the-pipe measures, not changes to the environmentally damaging processes themselves (Liddle 1994). These traditional strategies of mere environmental regulatory compliance or reactive, corrective actions such as mitigation or remediation have proven to be consistently costly, inefficient, and many times ineffective (Vanegas 1997).

Other drivers for change center around resource depletion and degradation. For example, many municipalities have adopted energy codes to promote energy efficiency in new facilities. While not widely enforced, these codes nonetheless represent an evolutionary step for the construction industry. In other cases, increased scarcity of resources such as dimensional lumber have forced the industry to seek alternatives to traditional materials, including engineered wood products, steel framing, recycled plastic lumber, and stress-skin panels. These products make use of materials formerly considered to be waste, including sawdust, post-consumer plastic, and wood pieces too small to be otherwise incorporated as structural members, and result in products that are structurally superior to the materials they replace. Alternative framing practices have also become more commonplace as constructors seek to minimize the use of raw materials. A positive side effect of some of these new trends is increased energy efficiency due to decreased thermal bridging and integrated insulation (BSC 1995).

A third driver for change is the increasingly noticeable impacts of the built environment on human health. Many humans spend most of their time indoors, nearly 90% of an average day (Kibert et al. 1994). Building-related threats to human health include the carcinogenic properties of asbestos and the neurologically damaging effects of lead-based paint. Yet these products were common components of buildings during the period between 1950 and 1970. More recent evidence supports the carcinogenic effect of low-level electromagnetic radiation, which is generated by all electrical appliances (Rousseau & Wasley 1997). Some individuals are highly sensitive to irritants and/or toxins such as off-gassed volatile organic compounds (VOCs), formaldehyde from adhesives and fabrics, and molds, bacteria, and dust accumulating in and resulting from building products (ibid.). The cleaning and maintenance products used during facility operation, including pesticides, solvents, and chlorine, present another set of irritants that cause reactions in an increasingly large portion of the population (ibid.). Given the complex combinations of materials and chemical products being incorporated into built facilities, the potential of buildings to have negative impacts on human health is significant. The number of potential irritants and toxins is growing rapidly with the proliferation of synthetic chemicals present in almost every product used by humans. Thus, threat to human health is a third significant category of drivers that reflects the need for change in the way built facilities are created and operated, along with the building technologies, systems, products, and materials used within them.

Sustainability as a Response to the Need for Change

In response to these drivers of evolution, sustainability has emerged as guiding paradigm to create a new kind of built facility: one that meets the needs of humans in the present without limiting the ability of future generations to meet their own needs (after WCED 1987). At present, the industries responsible for the built environment are cost-driven, with minimization of first cost and implementation time as primary objectives, meeting quality and performance goals as secondary objectives, and minimizing negative impacts as a tertiary objective (Vanegas et al 1998). The shift to a sustainable built environment does not necessarily eliminate these objectives of traditional construction, but rather embeds them in a larger context of sustainability-related life cycle objectives including minimizing negative impacts to resource bases and ecosystems while meeting the needs of stakeholders of the system.

To move toward sustainability, the Architecture/Engineering/Construction industry requires significant changes in the way it currently delivers facilities and civil infrastructure systems projects, and also, in the way manufacturers and vendors supply the building technologies, systems, products and materials it uses. Specifically, sustainability goals, concepts, principles, and guidelines need to be explicitly and systematically integrated in a project, at all stages of its life cycle, particularly the early funding allocation, planning and conceptual design phases. The challenges are: how can this be done? Where can one begin?

Modes of Organizational Change

Modes of change within an organization itself or outside the organization in its environment or context fall into four primary classes, based on whether the triggers of change occur internal or external to the organization and whether the organization itself is proactive or reactive. Figure 1 shows examples of potential triggers which initiate the four modes of change in an organization. The primary difference between proactive and reactive organizations is that proactive organizations seek to address potential problems preventatively, before the operation of the organization breaks down. Reactive organizations, on the other hand, resist change until forced by internal breakdowns or external direction to take action.

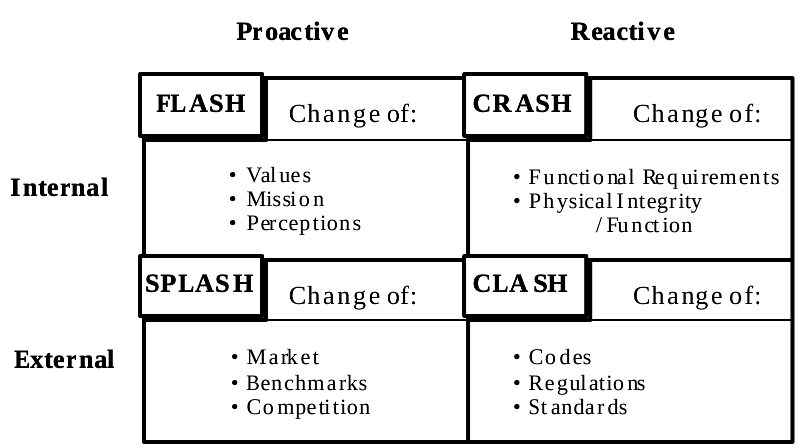

Figure 1. Modes and Triggers of Organizational Change

The first type of trigger, originating internally in a proactive organization, can be characterized as a “Flash”, similar to a flash of insight. Examples of **Flash triggers** are changes in the internal values, missions, or perceptions of organizational entities, or at least for those entities who make decisions about interventions leading to future organizational states. Interface Corporation provides an interesting example of a company undergoing change to improve sustainability based on a Flash trigger. After reading *The Ecology of Commerce* (Hawken 1994) that talks about market changes for sustainability, the CEO of Interface Carpet Corporation, Ray Anderson, undertook a top-down initiative to make his entire 6000 person company more sustainable (Anderson 1998). His change in personal values based on reading the book, combined with his position as the chief decision maker for the corporation, represented an internal proactive stimulus which has resulted in a dramatic change in how the company operates and conducts its business.

In contrast, **Crash triggers** represent an internal set of stimuli for change in reactive organizations. For these organizations, change is resisted until a literal breakdown occurs, i.e., ceasing of physical integrity or function of organizational entities. Crash triggers can also occur if the functional requirements of entities within the organization change to the point where the organization can no longer meet the needs of those entities. While crash triggers may seem to be the hallmark of unsuccessful organizations, they nonetheless afford the opportunity for positive change with respect to sustainability by rendering the status-quo option infeasible. For example, a facility manager may not consider replacing an inefficient incandescent light bulb with a more efficient compact fluorescent bulb until the original bulb burns out. In most cases, to do so would be a waste of resources, given that the incandescent bulb has not only a large investment of embodied energy and materials but also remaining utility in its current function. However, when the bulb burns out, this “crash” affords the facility manager an opportunity to consider other alternatives and the one which is selected may represent an improvement in the state of the organization with respect to a variable such as sustainability.

Splash triggers comprise the third type of crisis initiators, originating outside a proactive organization. These triggers are like a “splash” from the competition, and represent the opportunities for improvement afforded by a “Keeping up with the Joneses” mentality. Examples of splash triggers include changing markets, benchmarks, or competing organizations. Organizations responding to splash triggers keep their eyes on their competitors and take proactive steps to stay at the leading edge. For example, Company X notices that Company Y is now using recycled materials to construct its products, thus capturing a new segment of the market which is concerned with environmental issues. Not to be outdone, Company X also begins to use recycled materials, perhaps even a higher percentage than Company Y. In this way, Company X is driven to change its processes by being splashed as Company Y passes it by.

The final category of crisis initiators, **Clash triggers**, result from changes in the external context of a reactive organization. The most common types of clashes include the imposition of new codes, regulations, or standards which are not presently met by the organization. In this case, the organization itself does not literally break down from inside, but instead the requirements imposed on it from outside change such that the organization no longer functions as needed. This clash results from the contrast between a organization which was at one moment acceptable, and the next moment was rendered unacceptable by some externally imposed change in the rules. An example of a clash is the imposition of new emissions limitations on existing vehicles: a car that is legal to drive on March 31 may suddenly become illegal on April 1, even though the car itself has not changed at all.

These four classes of triggers represent the spectrum of factors which can lead to change within a organization. In addition, organizations are not limited to only one type of change initiators but may be subject to more than one kind of trigger simultaneously. In moving toward built environment sustainability, organizational change based on Flash or Splash triggers are the modes most likely to govern change in industry today, given that sustainability itself is not mandated or externally imposed. By and large, companies are adopting principles of sustainability to guide their practices either to keep up with their competitors in pursuing the "green" market (Liddle 1994, Schmidheiny 1992) or because of potential economic benefits such as higher efficiency and productivity along with protecting the environment and moving toward a higher level of quality of life for stakeholders and non-stakeholders alike (Kinlaw 1992, Liddle 1994, Schmidheiny 1992).

Implementing Change for Sustainability in the A/E/C Industry

Project stakeholders who take a sustainability approach to construction will be rewarded with reduced liability, new markets, and an Earth-friendlier construction process, which will help future and current generations to achieve a better quality of life (Kinlaw 1992, Liddle 1994). Given the potential benefits of sustainability in addressing the global drivers of change affecting the industry, A/E/C organizations seeking to proactively move toward sustainability can achieve their goal by implementing the following four elements: 1) A global policy that articulates the owner's vision for sustainability; 2) Specific strategic objectives that address each element of the global policy; 3) Specific measurable goals to evaluate progress toward the objectives; and 4) A clear and detailed execution plan for each goal.

Figure 2 shows a unified framework for implementing change for sustainability in the A/E/C industry, in terms of the realization process for built facilities with which all stakeholders are involved. The first element of the framework is an overall vision for all stakeholders within a specific organization or affiliated with a specific project that defines the principles of sustainability to govern all decisions and actions. Five main considerations serve as a starting point for defining a global sustainability policy: 1) internal and external contextual compatibility; 2) environmental benign-ness; 3) long-term sustainability; 4) enhanced life cycle product and process performance; and 5) planned end-of-service-life transition. Integration of perspectives within and across organizations in terms of a global policy is key to achieving project sustainability.

Within the global policy for sustainability, eight components provide the foundations for structuring practice- or project-specific strategic objectives and measurable goals in terms of sustainability principles. The first two components define the entire project and set the stage for all project decisions.

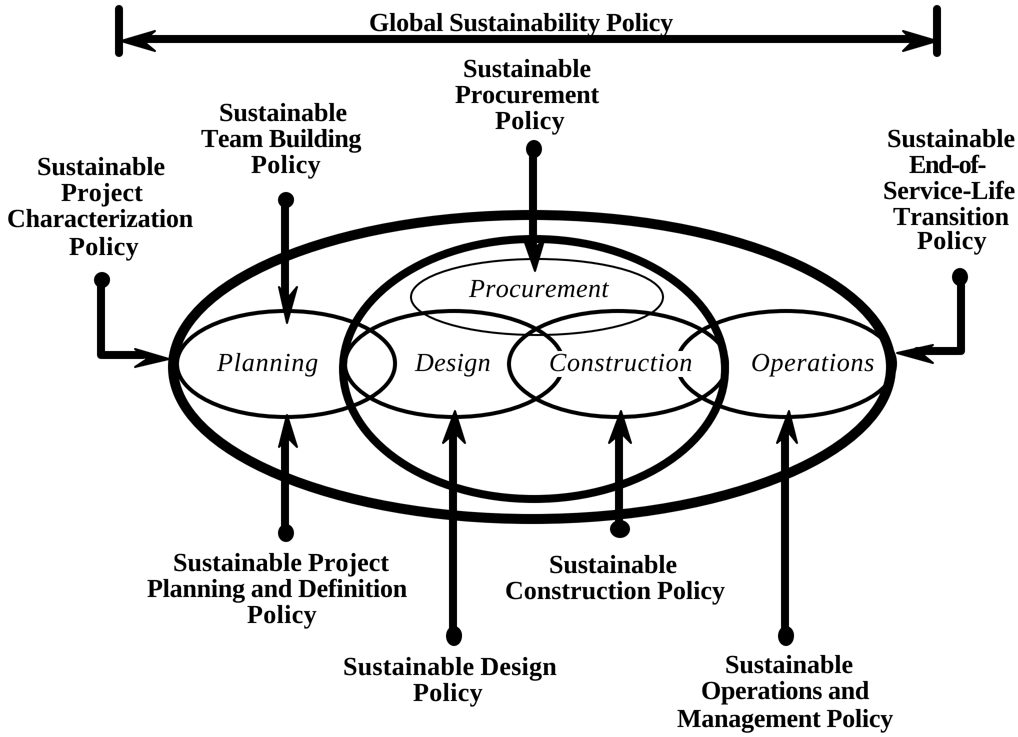

Figure 2: Unified Framework for Sustainability in the A/E/C Industry

Component 1: Sustainable Project Characterization – The first component lays the foundation for the degree, breadth, and depth of sustainability efforts throughout the whole process. This process involves systematic specification of the attributes, characteristics, and qualities of a given project from a sustainability perspective in terms of a) industry sector represented (real estate development, residential, civil infrastructure, industrial, and building construction), and b) type of project (e.g., new construction, rehabilitation, retrofit, etc.). The outcome of project characterization enables a project to be defined with a level of sustainability appropriate to its context.

Component 2: Sustainable Team Building – The second component ensures that all key project stakeholders have a common ground for understanding sustainability principles and concepts, as well as the training to operate as high-performance teams. Specific elements that should be considered include sustainable problem solving, partnering, team dynamics, and team maintenance (Vanegas et al. 1998).

These first two components are a starting point for establishing strategic objectives, measurable goals, and execution plans for project sustainability, and must include all project stakeholders to be effective. The next four components define considerations that guide the complete *delivery* of the project in terms of sustainability criteria established in the global sustainability policy.

Component 3: Sustainable Project Planning and Definition - The Planning Phase includes an initial needs assessment and setting of preliminary objectives; preliminary planning and funding approval; analysis and definition of project scope, and in some cases, it includes the development of the conceptual/schematic design, which marks the transition into design. This phase has the greatest potential to influence overall project sustainability at lowest cost. Specific elements that should be considered include sustainable site selection, framing of project needs, and compatibility of project scope with contextual requirements (Vanegas 1997; Pearce 1999).

Component 4: Sustainable Design - The Design Phase continues with detailed design and the development of contract documents, and in some cases, includes bidding or negotiation, and award of the construction contract, which marks the transition into construction. This phase also affords opportunities for influencing project sustainability before any actions begin on site. Specific elements that should be considered include integration of building systems, passive design strategies, material sustainability, and indoor environmental quality (PTI 1996).

Component 5: Sustainable Procurement - The Procurement Phase bridges the gap between design and construction, in which materials, construction resources, and facility components specified by designers are obtained to physically realize the facility. While at this point the nature, levels of performance, and desired attributes of facility components have been fixed by the project design, considerable impact can still result due to the sources of specified materials and how they are brought into the project. Specific elements that should be considered include reduction or elimination of packaging, recycled content, waste minimization, and environmental benignness of manufacturer processes (Vanegas 1997; PTI 1996).

Component 6: Sustainable Construction - The Construction Phase includes construction planning, execution, and start–up and commissioning, which marks the transition into operations. Construction is the bridge between concept and reality, and offers additional opportunities for increasing sustainability of the project. Specific elements that should be considered include site disturbance, indoor environmental quality, construction recycling, and construction health and safety (PTI 1996).

Components 3-6 provide a structured framework of considerations appropriate to different temporal phases of built facilities as they are delivered. Explicitly, formally, and systematically, both from systems and temporal perspectives, considering sustainability principles should be an ongoing part of the activities occurring in each phase, and should be consulted at all times by all involved stakeholders. The final two components also involve active consideration of sustainability principles by involved stakeholders and deal with the use and end-of-service-life of the facility.

Component 7: Sustainable Operations and Maintenance – Following Construction, the Operation Phase includes full operation, maintenance, and management of the facility, until an end-of-service-life decision is made. Sustainable operations and maintenance involves effective planning and allocation of resources over the operational life of the facility. Specific elements that should be considered include indoor air quality, thermal comfort, light quality, energy, water, and resource conservation, and waste management (PTI 1996).

Component 8: Sustainable End-of-Service-Life - The final component of the framework deals with the end of the useful life of the facility. Explicit consideration of this component should be considered by all stakeholders during the project life cycle, since actions during all previous phases can impact actions at this final point of the facility's life. Specific elements that should be considered include disassembly/reuse of components, material recovery/recycling, and site reclamation (Yeang 1995).

To effectively achieve sustainability, each of these components has to be operationalized in terms of (a) specific objectives, (b) measurable goals, and (c) detailed execution plans to address each set of considerations. In operationalizing sustainability in terms of objectives and related measurable goals, each component of the framework provides both (a) a point of reference for changing organizational behavior in terms of existing practices familiar to A/E/C organizations; (b) boundaries for scoping and managing information in terms of its relevance to both the project and sustainability considerations appropriate for the phase in question; and (c) a means of maintaining an overall vision for sustainability which can be reached incrementally and realistically by improving performance project by project. After an overall objective has been established that reflects the organization's overall sustainability policy, each objective can be operationalized into a specific measurable goal that is appropriate contextually in terms of sustainability parameters and realistically in terms of the organization's current practices. For example, in terms of the objective "strive for zero waste," an appropriate but realistic goal for early projects from a construction standpoint might be to establish a recycling program to reduce waste to landfills by 25%. As the organization meets this goal, it can be made incrementally more rigorous until the initial objective is met.

Clear and detailed execution plans are the final element of the framework for achieving organizational change for sustainability. Execution plans provide procedural guidance necessary to meet the measurable goals specified for the project. Important components of execution plans for sustainability are:

- Phased processes that include: (a) parallel development of solutions of all the disciplines involved in a given project; and (b) coordination and integration of results among disciplines occurring at the conclusion of each of the phases
- Mechanisms to regulate the flow of data and information from phase to phase and among stakeholder entities as needed, including: (a) analysis, generation, evaluation, selection, and specification processes; (b) conflict resolution; and (c) decision making.
- Provisions at each phase for performance parameters check, including: (a) physical and non-physical contextual compatibility and response; (b) manufacturability, procurability, constructability, operability, usability, and maintainability performance; and (c) short-

term and long-term functional, formal/physical performance, risk, cost and schedule, safety and security, and quality, reliability, and sustainability performance.

- Mechanisms for: (a) formal input of sustainability knowledge and experience (e.g., via training, third party reviews, etc.); and (b) capture of lessons learned to contribute to the sustainability knowledge base.

Incorporating these procedural considerations ensures that when the project reaches the end of each life cycle phase, all key decisions have been made within the context of sustainability. Once the execution of procedures for each phase begins, the common elements of monitoring/control and feedback capture provide the capability to adjust procedures as needed to steer the project toward sustainability.

Conclusions

The unified framework provides a complete picture to guide all project stakeholders in the process of achieving change both within and across their organizations. However, agents of change must realize that no matter how ambitious their plan for change, sustainability cannot happen overnight. Resistance to change is inherent in any organization, and provisions must be made for incremental change to facilitate the process. This paper provides a roadmap for organizations that are interested in moving toward sustainable facilities and infrastructure systems. By using current practices as a point of departure and enhancing them with feasible actions that gradually begin to shift the current paradigm, the A/E/C industry can make incremental but eventually significant progress toward built environment sustainability. All change begins with a first step, and the first step for the A/E/C industry is to acknowledge that sustainability is a desirable state for the built environment.

Acknowledgments

The authors are grateful for intellectual support and other resources provided by the National Science Foundation, the GE Fund, the Georgia Research Alliance, the Institute for Sustainable Technology and Development (formerly the Center for Sustainable Technology), the Georgia Tech Research Institute, and the Army Environmental Policy Institute.

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