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Sustainability: The View from a Practitioner's Perspective*

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This paper summarizes the author's keynote address to a workshop on sustainability and design education held at Harvey Mudd College in May 2009. The remarks draw upon the author's experience applying sustainable design to buildings and communities over the past thirty years of professional engineering practice. Key points include: the need to include 'right brain' concepts into the study of sustainability; the opportunities for increasing sustainable impacts at a community scale (rather than a single building); the need to incorporate holistic 'closed loop' thinking into sustainable design solutions; and the need to provide today's engineering students with tools and concepts that will enable them to expand the application of sustainability.

Keywords: meaning of sustainability; practice of sustainable design; systemic view

1. INTRODUCTION

THIS PAPER IS in some ways the story of the professional journey that I've been on for the past thirty-plus years towards a practice in sustainable design, which has led me to places and projects that I would never have imagined. It is also an anecdotal history of the evolution of the 'sustainability' concept in recent Western society, as seen through the lens of this engineer's professional practice.

By way of background, I am a consulting engineer whose practice focuses on the built environment: buildings and communities. I am a professional engineer registered in Civil, Mechanical and Electrical Engineering, and I am also a graduate of the general engineering programs at Harvey Mudd and at Dartmouth . . . so I tend to look at the world in a cross-disciplinary way. But the consulting world is structured in a very siloed, single-discipline focused manner—so much of my career has been an effort to create assignments in which I could escape that narrow focus, and to foster cross-connections among disciplines.

Since the OPEC Oil Embargo of the mid-1970's, my consulting practice has been engaged in issues of energy efficiency in buildings. This has taken us through a dizzying range of technologies and approaches: passive solar architecture, active solar thermal systems, sophisticated energy analysis, intelligent buildings and digital controls, high performance heating ventilating and air conditioning (HVAC) systems, daylighting of buildings, natural ventilation, thermal displacement ventilation, computational fluid dynamics, integrated design, sustainable communities, building commissioning, photovoltaic solar energy, etc. But for the most part, each of these has been an isolated application which could not achieve its true potential because it was being applied in a framework in which many of the other variables and constraints didn't change to allow the project to optimize the whole.

In the early 1990's, a new concept began to be talked about: 'green buildings' or 'sustainable environments'. I had previously worked on several such projects, but they didn't have a 'name'—they were just considered 'energy efficient buildings', so I was intrigued by this new terminology, and my firm became one of the early engineering firms involved in green buildings. This gave us the opportunity to expand our practice, both physically and intellectually, into the whole new world of sustainability. At first it seemed like a lot of environmental jargon, but the more we looked into it, the more real and important and challenging it became.

2. DEFINING 'SUSTAINABILITY'

To begin, it is useful to start with a definition of the term 'sustainability', and here I will refer to two separate definitions that span widely different times and contexts, but which come to the same conclusion:

- Brundtland Commission (1987) definition: 'Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs' [1].
- Native peoples' saying: 'We do not inherit the earth from our ancestors; we borrow it from our children' [2].

Perhaps another way of saying it is that 'the essence of sustainability is thinking about and resolving the impacts on others, in both time and space'.

In the field of building design, 'green' and 'sustainable' are often used interchangeably, even

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though there are many nuances separating the two, and for the most part in this paper I will inter-mix the two terms for simplicity. However, it is worth noting that although the advent of 'green building' methods has done much to raise awareness of, and interest in, the larger issues of sustainability, most green buildings are not yet sustainable. Until we can extend and evolve green design to a much higher level, every new building still places added stresses on the environment. The ultimate goal is to create environments which are *net positives* to the environment. This is a great challenge to the planners, designers, builders and users of the built environment, and it must be met soon.

As my firm started learning and applying the concepts of sustainability, several aspects of this new world view were particularly significant:

- Green buildings embraced the concept of 'integrated design', where every design variable was considered as part of the whole.
- Energy efficiency went from something that was adopted for purely economic reasons to a central element driving a green building's basic fabric and concept.
- The green building design process created a framework for discussing and evolving a design that cross-pollinated energy with siting issues, with materials selection issues, with water and with indoor environmental quality, and many other cross-cutting issues—all considered as a unified whole, where each could enhance the others if done right.
- The discussion and decisions focused on so called 'triple bottom line' metrics, where various rigorous left-brain analytic metrics were weighed alongside more squishy environmental and social ('right brain') impact metrics to make design decisions.

3. EXPANDING PROJECT SCALE

In the past few years, this evolution of our practice has gone even further, expanding the concept of a green building to that of a *sustainable community* — in which the *scale* of the problem (and of the impacts/benefits) is multiplied many times. Interestingly, the issues and challenges that confront the design of a sustainable community are notably different than those for a single green building:

- A sustainable community requires an entire green infrastructure that looks differently at transportation, energy, water and storm water, solid waste, food production, density and walkability. Some examples of each of these would include:
  - If the basic land plan is developed so that people can walk from their homes to shops, schools, libraries, and other community services, the transportation needs of the community can be radically reduced.
  - If the area is planted with trees that provide shade cover and effectively reduce the solar albedo of the community, the cooling needs of the community are significantly reduced.
  - If landscape selections are made which allow for reduced use of irrigation, and if that irrigation uses reclaimed water and only operates when the plants need it (no sprinklers on during rainstorms), the potable water usage and the stormwater effluent of the community are both radically reduced.
  - If the buildings are designed to minimize the heating and cooling loads, by making appropriate use of shading, solar orientation, daylighting, natural ventilation, etc., the energy demands of the buildings can be radically reduced. In fact, with the development of more efficient and lower cost photo-voltaic (PV) solar electricity, the buildings can become 'zero net energy' buildings on an annual basis.
  - If you set aside a small amount of land for food production, all the fruits and vegetables used by the community could be grown locally, with radically reduced embodied transportation energy in the food being consumed.
- I could go on and on, but let me generalize these examples of cross-cutting interactions into the following points:
  - Investments in systems at the community scale can radically reduce costs at the building scale, and *vice versa*.
  - District energy systems, which only make sense in a high density development pattern that is designed and developed in an integrated manner, can radically increase the thermodynamic efficiency of a community.
  - The larger the scale of the community or systems being designed, the more it seems to demand more sustainable solutions for the systems with which it interacts.
- Of course, to engineers, the idea of a large-scale system which is comprised of many smaller systems is natural enough. But for a number of reasons, in the built environment, the opportunity to treat the system as a unified whole has largely eluded us. Instead, each sub-system is optimized within the constraints of the systems which affect it but over which it has no control . . . and the result is a decidedly sub-optimal large-scale system.
  - I am happy to report that this is beginning to change, and there are numerous so called 'eco-cities' being designed around the globe. Only time will tell how well these succeed, but at least there is the hope of achieving a higher global optimum.

4. GLOBAL IMPLICATIONS

Speaking of global, another major driver for this higher-level of thinking is *global climate change*

(GCC). As GCC has become more thoroughly embraced as a (if not the) major issue of this century, it is taking its place as a dominant motivator of more holistic design. Conflating GCC with control of greenhouse gas (GHG) emissions, the assessment, minimization and management of GHG's (with 'carbon' as the focal topic) is taking on a hugely important role in the built environment. This is beginning to have a radical effect on the design goals and decisions of many of the projects on which I am working, and we are just at the earliest stages of this change! Some examples of these effects include:

- Public Policy, such as California's Global Warming Solutions Act (AB-32), which requires that projects commit to mitigation of GHG emissions over the *life* of the project.
- Carbon Positive Cities (a global program just announced by the Clinton Climate Initiative and the US Green Building Council to encourage the development of carbon neutral (or better) new cities.
- Zero Net Energy (ZNE) building codes now being developed for use in California by 2020.
- Zero Carbon Goals (90% reduction per capita required in US to achieve our global share!). (It could be argued that this is even more ambitious than President John F. Kennedy's 'moon shot' goal to put a man on the moon in the 1960's in terms of scale, cost and the limits of our current knowledge of how to achieve the goal. It also has the added impetus of being global and being an imperative to our survival, instead of merely an aspiration for exploratory accomplishment).

Dropping back to green buildings, let me make some other observations:

- One of the most striking aspects of sustainable environments is a qualitative sense of peace and tranquility that one derives from being in the space. I don't know if this is the result of a more fully developed and integrated design that addresses more of the user's needs, or if there is some 'Zen of sustainability' that affects the occupants of the space. What I do know is that words like joy, delight, beauty, peacefulness, and comfort are often used to describe such spaces, much more frequently than for spaces designed without sustainability in mind. I would argue that there is something going on in a right brain way that makes those spaces better than they would otherwise be, and that to ignore or dismiss this phenomenon is to potentially miss something precious that we should be striving to understand and replicate.
- Another observation about the evolution of the interest in green buildings over the past decade is the role of competitive market forces in raising the demand for sustainability. The green building rating system that has been at the center of the action over the past decade is the LEED (Leadership in Energy and Environmental Design) Green Building Rating system developed by the US Green Building Council. It awards increasing levels of LEED ratings (from Certified to Silver, Gold and Platinum) for increased levels of documented environmental performance. The remarkable thing is that the marketplace has responded to this by competing for the highest levels of LEED ratings for various projects—literally, financially-driven real estate types making decisions based upon getting a better LEED rating for environmental performance than their competitor down the street! This in the context of real estate, which has always been an industry very slow to change and very focused on first cost above all else. I don't know exactly what the lesson to be drawn from this is, but I would argue that there is something fundamentally different going on when this kind of radical transformation of values occurs . . . and that we would do well to try to understand it. And my bet is that it is the combination of several factors:
  - An approach that produces better buildings and better environments for people AND
  - Offers a positive solution to large scale environmental problems.
- Another concept that I want to suggest to you is that of the 'unsustainable remainder' . . . the price to be paid by the planet for an incomplete solution, or for a design that leaves unsustainable dross for society to clean up by defining that dross as 'outside the span of control of the project.' Historically, most new buildings and communities draw a boundary around the project and declare that anything that occurs outside that boundary is someone else's problem (see Fig. 1). Thus, emissions of GHG's needed to support the energy usage of the building, and the transportation energy usage and gridlock created by getting to and from the building, and the sewer and storm water systems needed to deal with the effluent from the project, etc.—are all somebody else's problem. But of course, the rest of society pays to solve those unresolved problems. Economists refer to these as 'externalities', and they always seem to be radically under-priced by the project and yet very expensive to society. One of the benefits of sustainable design is that it basically disallows such sleight of hand, and forces a designer to deal with those externalities—either by eliminating them or by

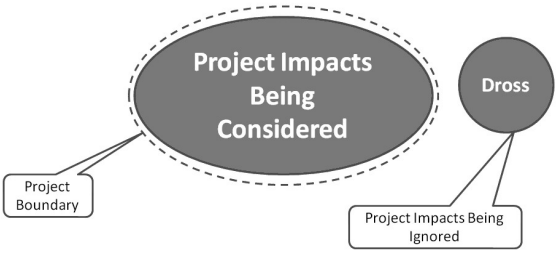

Fig. 1. Definition of 'unsustainable remainder' concept.

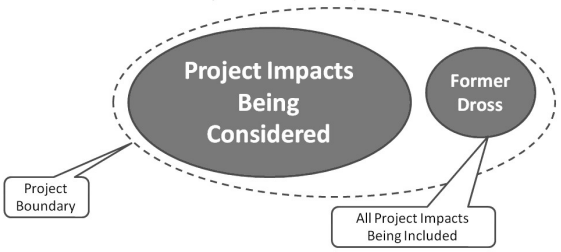

Fig. 2. Re-Definition of project boundary to include all impacts.

including them in the complete design solution (see Fig. 2). This enforces a discipline and a concern for larger scale impacts which motivates different design decisions and leads to better results.

5. CHALLENGES AND OPPORTUNITIES

I could easily spend the rest of this paper elaborating the design challenges and opportunities for sustainability in the built environment, but I want to make some comments to set a more general stage for the discussions of sustainable design at this MDW VII workshop. As I reflect upon the sustainability challenges facing society, I see several areas where I believe that the academic engineering and design community has a unique opportunity to make seminal contributions:

- Development of a calculus of sustainability that truly enables 'triple bottom line' (TBL) analysis.
  - How do we enable decisions that give value to right brain attributes (such as beauty, joy, delight) alongside the traditional left brain metrics of efficiency and economy?
- Development of sustainability systems theory that shows the benefits of closed loop systems (as compared to traditional open loop models in which the waste (the 'unsustainable remainder') is discarded to the environment).
  - How do we ascribe appropriate project value (or cost) to so-called 'externalities', which are currently outside the typical scope of decision metrics for projects, but which are surely borne by society as soon as the project is implemented?
  - Could we take the concepts of entropy or exergy and apply them to the externalities that we would prefer to ignore, so as to have a more holistic set of metrics?
- Inculcation of sustainability concepts and metrics into traditional engineering coursework.
  - How do we address and develop techniques for measuring and maximizing the sustainability of a design in a larger global framework, rather than settling for local optima which ignore the opportunities to solve a bigger problem more optimally?
  - How do we perform this type of optimization when some of the variables relate to human behaviors and reactions to environments and designs?

Each of these topics deserves further discussion, but my limited space is almost filled, and I have two closing points to make.

6. CLOSING THOUGHTS

My closing points relate to the engineering design profession and to the work force of the future.

- Regarding the profession, it is my sense that we as engineers have allowed the problems on which we work to be defined for us, in very narrow ways, rather than responding to the real problems facing society. We need to develop the ability to expand or reframe those assignments, and to be able to use new techniques to solve them and new metrics to measure their success or failure. As this type of content is developed and added to academic offerings, it will be a prelude for transforming the ways that our profession contributes to creating a sustainable society. By the way, although I have used examples in the built environment because that is what I know, I am convinced that many of the same principles apply to other fields of application as well.
- Second, for the past several years, I have been seeing a remarkably talented, motivated, passionate and eloquent cohort of students coming through colleges and universities—who are convinced of the shortcomings of the unsustainable approaches of the past, and who are searching for new approaches to generating sustainable solutions to society's problems. They are actually thinking more about the heritage that they will leave to their children, and to their children's children, than we have been. They are ready to take up the baton and move society forward towards a more sustainable future, but they don't yet have all the tools that they want and need to do this. The education of engineers needs to provide them with those tools.

I hope that the discussions of this workshop will be an important step towards addressing both of these needs.

REFERENCES

1. Report of the World Commission on Environment and Development: Our Common Future (Brundtland Commission), United Nations Document A/42/427, Section I.3.27.
2. Ancient Indian Proverb. www.ilhawaii.net/quotes.html

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