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White Paper

Engineering Design Processes for Achieving Extraordinary Sustainable Performance

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Summary

The purpose of this paper is to introduce a new business model for achieving extraordinary sustainable performance from projects for the built environment, and to set priorities for the FIDIC Sustainable Development Committee for developing the model components.

The model incorporates seven processes and tools to assist engineers in delivering projects which achieve high levels of performance across one or more dimensions of sustainability. The overall business model is designed to deliver value to all parties and to share risks and rewards equitably.

Work needs to be done on all seven processes and tools in order to make them fully operational and disseminate them to engineers and project owners. Of the seven, the three top priorities for the Committee are:

- Revise the Project Sustainability Management Guidelines (#1)
- Develop a procurement process for selecting and engaging integrated project teams (#2)
- Develop tools and methodologies for creating, designing and delivering holistic solutions (#4)

The Committee has set up three individual task groups to address these priority items. Two additional task groups have been formed: Sustainability Emergency Response, and IT and Communications.

This paper is divided into two parts. Part I describes the new business model, and Part II describes the current set of tasks for the Sustainable Development Committee.

FIDIC Sustainable Development Committee Organization

The proposed Committee organization is shown in Figure 1.

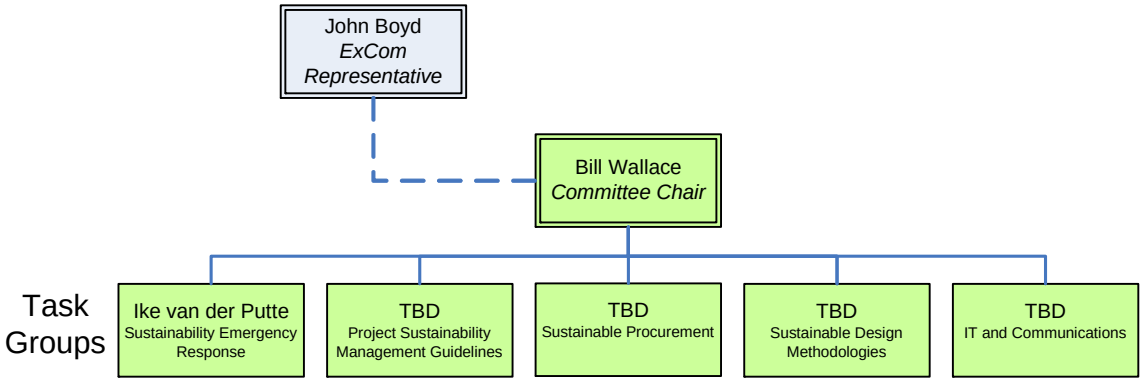

Figure 1: FIDIC Sustainable Development Committee Organization

Bill Wallace (United States) will serve as committee chair and will oversee the work of the five Task Groups. The roles, responsibilities and work products are summarized below.

- **Sustainable Emergency Response**. Research and develop papers on issues related to emergency response and disaster management, and design for resiliency. Ike van der Putte (The Netherlands) chairs this task group. Continue to develop relationships with relevant international organizations and IFIs.
- **Project Sustainability Management Guidelines**. Based on user input and lessons learned, revise and republish the Guidelines as described in Part II of this document. Work with relevant international organizations to promote the application of PSM.
- **Sustainable Procurement**. Develop an initial discussion document on sustainable procurement for engineering and construction services based on the description in Part II. Add outside members to the Task Group from client organizations and IFIs to obtain their input and buy-in. Research the issue more fully, looking for examples from other disciplines, other organizations. Study the EU Procura model of sustainable procurement for engineering and construction services.
- **Sustainable Design Methodologies**. Develop an initial discussion document describing a proposed approach for developing holistic design methodologies. Identify the input and coordination points needed from FIDIC and others to work on a more detailed set of methodologies. Identify key issues, e.g., developing and environment for innovation, "gainsharing/painsharing," convincing key stakeholders. Connect with relevant FIDIC Committees, e.g., Business Practices Committee.
- **IT and Communications**. Establish web-based collaboration among the task groups using the FIDIC tools. Identify an participate in key conferences.

Part I

Description of the Business Model

Introduction

The FIDIC Sustainable Development Committee has been charged with advancing the practice of sustainable engineering, using as its platform, the *Project Sustainability Management Guidelines*, published in 2004. The Guidelines presented at the FIDIC 2004 Fall Conference in Copenhagen and received considerable support. Since then members of the committee have given dozens of presentations and seminars in over 12 countries. Hundreds of copies of the Guidelines have been sold.

FIDIC has had a long and continuing interest in sustainable development. The federation has published several guidance documents including the *FIDIC Business Guidelines for Sustainable Development* and *Sustainable Development in the Consulting Engineering Industry: FIDIC Strategy Paper*. The organization has contributed the UNEP multi-stakeholder consulting engineering industry sector report to the World Summit on Sustainable Development 2002, and sustainable development has been the focus of several FIDIC annual conferences since 1990. Finally, FIDIC collaborates with UNEP, the International Chamber of Commerce, and ICLEI in the development and dissemination of Environment Management Systems for industrial facilities and for urban administrations.

Although feedback about the PSM framework and approach has been positive, many users have told us that the PSM sustainability objectives and measures need improvements in both structure and specificity. More significantly, many users have been frustrated by their inability to incorporate PSM into their clients' projects. The difficulty lies in the way projects are developed and opened to engineering firms for proposal. By the time requests for proposals (RFPs) are released, project scope and sustainability objectives are pretty much set, making further discussions about sustainable performance irrelevant.

Too low on the sustainable project "food chain"

The Committee considered this problem and concluded that the problem had something to do with PSM per se, but more to do with the position of the consulting engineering firm in the client's project development process. When it comes to sustainable strategies development and project scoping, the consulting engineer is essentially at the bottom of the client's project "food chain." That is, consulting engineering services are generally procured after sustainability goals and strategies have been established, capital budgets have been set, and the scope, objectives and general approach of project have been fixed. See Figure 2 below. In all likelihood, the project tasks have broken out into relatively simple and conventional pieces, a reflection of the litigious nature of the consulting engineering business and the engineers' penchant for risk avoidance in project delivery.

Ironically this is happening in an environment where engineering knowledge and skills combined with risk taking are a prerequisite for success. Making progress towards sustainability requires the application of new and relatively untried technologies. In this environment, both the client and the engineering firm need to work together as a team, setting stretch goals for sustainable performance, trying new and more sustainable technologies, and sharing risks and rewards for subsequent performance. Unfortunately, under current practices, the owner, the engineer and the contractor operate in what could be described as a perpetual state of conflict, with each seeking to protect their respective interests, often at the expense of the others. Adding subcontractors to the mix only serves to exacerbate the situation.

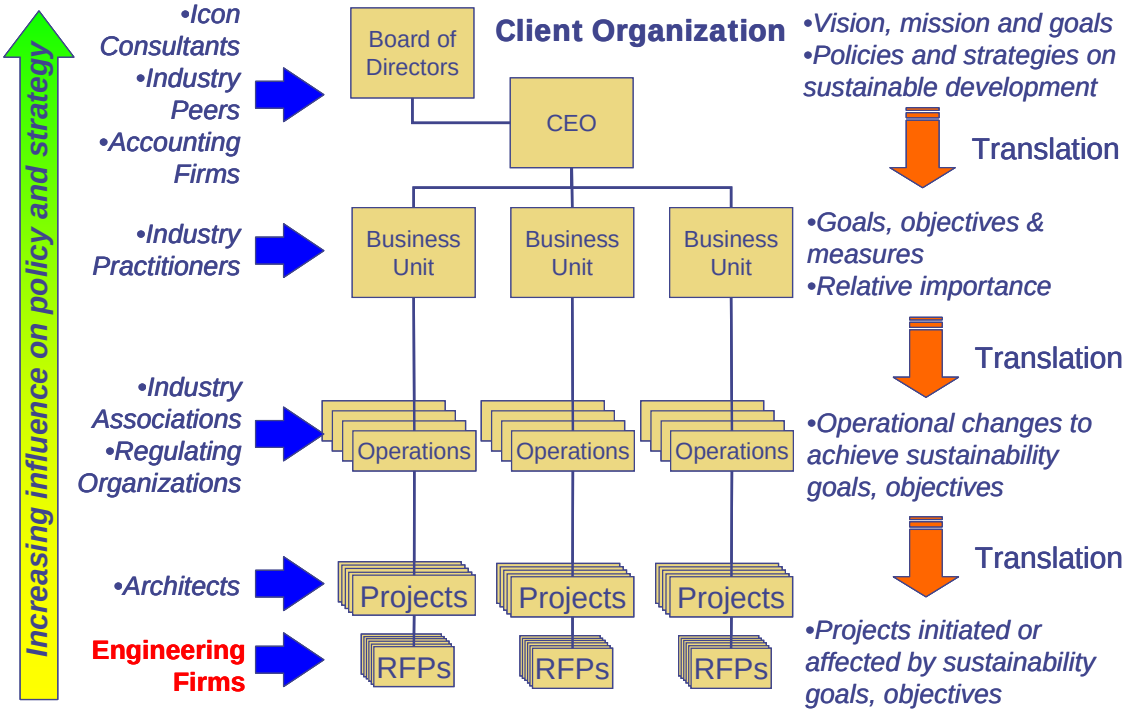

Figure 2: Engineer's Role in the Sustainable Projects

A new business model for sustainable project delivery

The purpose of this paper is to introduce a new business model for sustainable project delivery, one that delivers value equitably to all parties, fairly shares risks and rewards, and provides a mechanism for improving sustainable performance. Unfortunately today, there are few project teams that exhibit those characteristics. Most are engaged in defensive engineering, with each discipline working carefully within their respective technical domains. Communications and knowledge sharing are more about caveat than enlightenment.

In order to work, the model requires a new relationship between the client and the engineering team selected to deliver the project. This also requires a new form of project team, one in which involves a multiple disciplines all working together in an integrated fashion.

The new business model has seven components:

1. A framework and process for setting sustainability goals, objectives and metrics

To quote Lewis Carroll, "If you don't know where you are going, then any road will get you there." In order to make progress toward conditions of sustainability it is essential to define the set of parameters by which sustainability is measured, in order to guide efforts for making progress toward conditions of sustainability.

FIDIC's Project Sustainability Management (PSM) Guidelines offer a framework and process for setting overall project goals, coupled with measurable objectives and associated metrics. PSM is unique in that it uses the UN Commission on Sustainable Development's (UNCSD's) objectives and measures as a platform, but then allows additional sustainability goals, objectives and indicators to be added as deemed necessary. The UNCSD based its objectives and measures on Agenda 21, the UN's blueprint for action on sustainable development. It was developed in 1992 and adopted by 179 countries.

What makes PSM unique is its bias for action and continuous improvement. Other current schemes for measuring project sustainability are static, giving awards reaching certain predetermined benchmarks.

The next revision of PSM will contain more specific goals, objectives and metrics as well as benchmarks for sustainable performance. Our intent is to make the document more usable for project managers as they seek to raise sustainable project performance.

2. A procurement process for engaging knowledgeable, collaborative high performance teams

Absent a huge and unprecedented investment by governments and/or multi-national organizations, advances toward conditions of sustainability will be made project by project. The rate at which those projects make advances will be determined by our aggregate ability to invent develop and apply new and more sustainable designs and technologies to projects. In turn, that ability is governed by (1) the knowledge of the project teams doing the work, (2) the degree to which those teams and project owners can work collaboratively, and (3) the equity in how those corresponding risks and rewards are shared.

From these assertions, the question becomes this: How do we encourage the creation of such "high performance" project teams, especially in an environment where innovation and risk taking are decidedly not the norm. To employ innovative and relatively new technologies we must have a procurement process that enables the selection of knowledgeable project teams. These are fully integrated, multi-discipline teams that treat sustainable design holistically, not as a linear string of single discipline designs.

A new approach for identifying and selecting integrated, "high performance" teams is outlined in Part II of this document. This new approach to procurement gives new meaning and emphasis to quality-based selection procedures. Not only must the team be selected on quality (e.g., knowledge and experience), but it must be judged on its ability to work as a collaborative, integrated team.

3. A project management process for cost-effectively applying new, more sustainable technologies

Managing so called high performance project teams to achieve the desired sustainable performance improvements requires a new form of project management, one that replaces the traditional hub and spoke model to an open network model. In this model, all participants work together, sharing knowledge of their particular discipline as well as the ideas and insights developed through regular interaction with others on the team. Managing and guiding this level of team collaboration, meeting agreed upon project objectives, and staying within budget will require new kinds of team processes, measures and controls.

There is also a need to identify and manage stakeholders, many of whom are key to the success of the project. For sustainable projects, stakeholders are likely to be more numerous and play a bigger role than for conventional projects. To the extent that a sustainable project involves new technologies, suppliers, constructors and users need to be involved early in the design stage.

Managing the construction on a sustainable project will also require new levels of oversight. Being relatively new, the equipment and systems used in such projects are unfamiliar to the constructors and installers, requiring closer supervision. Furthermore, meeting sustainable performance objectives in the construction phase (e.g., construction waste separation and recycling) will require extra supervision.

4. Tools and methodologies for creating, designing and delivering holistic solutions

While some efforts toward improving sustainable performance have been made, most of the improvements to date have been relatively small, limited by the scope of the approaches taken. To improve performance, practitioners have focused on replacement and reconfiguration strategies, i.e., replacing conventional fixtures and equipment with ones that use less energy, water or virgin materials, or generate less pollution. Clearly these efforts are helpful, but they do not yet capture the full potential of sustainable engineering. They are really extensions of conventional design, involving the replacement or reconfiguring of components to gain some performance improvements. Real breakthroughs on the journey towards sustainability will likely come about by addressing engineering design problems holistically, by reexamining the basic variables and design assumptions and/or by inventing entirely new approaches to addressing the design problems.

There has been much discussion about holistic design as well as some notable accomplishments. However, few if any methodologies exist. A proposed approach for developing these methodologies is described in Part II

5. Tools for visualizing, modeling and simulating holistic solutions

Engineers seeking to deliver a more holistic design need to have a broad (holistic!) view of all of the project components. Robust visualization tools are needed to enable the project team to see how the components interact, and to recognize opportunities for improvement as well as previously unforeseen constraints. Visualization tools combined with modeling and simulation software will serve as a platform from which multi-

discipline teams can collaborate: sharing knowledge and developing new insights for improving the overall design.

Strong modeling and simulation software are also needed to support design decisions. Designs for enhanced sustainable performance, especially those that offer dramatic improvements over conventional designs, will be subjected to intense scrutiny. For example, substantial reductions in energy and water usage for a given building or facility will run up against long-held electric and water utility design assumptions about equipment and distribution system sizing, a substantial contributor to capital costs. These assumptions can only be countered effectively with detailed design information and calculations that prove definitively that the reduced demands are realistic and can be met with smaller systems.

Interestingly, most of the current work in visualization, modeling and simulation has been done by the architectural community. Building information models (BIMs), computer models that manage and share the physical and functional building information, are receiving considerable attention and support from the public and private sector. They look at cost and performance throughout the building life cycle, and provide a common platform for viewing and optimizing overall building and systems design. The advantages of using an integrated project team working on a shared project model are being promoted by this community.

6. Tools for maintaining, enhancing sustainability performance

Facilities and infrastructure projects that raise the bar in one or more dimensions of sustainable performance will likely employ to some extent, new and more sustainable technologies. These could be in the form of advanced materials, equipment, processes and/or systems, any or all of which may not conform construction, operation and maintenance norms. Furthermore, sustainable technology, in high demand but still in its infancy, will continue to advance at a relatively rapid rate.

Two problems arise: (1) The tendency towards "backsliding," i.e., inappropriate operations and maintenance that doesn't understand or take into proper account how the applied sustainable technologies function, and (2) getting "locked in" on a particular technological approach and being unable to take advantage of new technologies that offer substantial performance improvements. Backsliding can be addressed by through training programs and O&M manuals as part of an organization-wide sustainability management system. Maintaining flexibility in order to take advantage of new and improved technologies starts at the design stage and continues through the project life cycle. A well thought out sustainability management system will track technological developments, identifying promising new technologies for possible future application.

The utility and importance of an organization's sustainability management system extends well beyond single projects. Properly structured, it provides the organization with a set of goals, objectives and controls that will enable it to make a real contribution towards sustainability. Where environmental management systems are primarily concerned with reducing environmental impacts, sustainability management systems are concerned with driving an organization towards conditions in which its use of materials and carrying capacity are well below ecological limits.

7. High level commitment of all parties to a shared project model

In order for this new business model to succeed, all of the parties involved must commit significantly to making it work. This means agreement at the highest levels of each organization involved, that their representatives on the project will act in a integrated and collaborative manner, share risks and rewards equitably, be transparent, and resolve problems collectively rather than seeking to assign blame.

Project team chartering processes need to incorporate this level of organizational commitment.

PART II

FIDIC Sustainable Development Committee Tasks

1. Revision of the Project Sustainability Management Guidelines

Work of the Task Group

1. Review the current Project Sustainability Management Guidelines
2. Locate and review the new version of the Equator Principles.
3. Review PSM user experience. Discuss with John Boyd, Bill Wallace, Ike van der Putte, Jeremy Boswell, Matt Simmons.
4. Modify the current set of PSM indicators.
    a. Consider breaking the indicators out into three sets based on project location (1st, 2nd or 3rd World)
    b. Restructure the indicators so that they are associated with sustainability goals and objectives
    c. Expand the goals, objectives and indicators so that they reflect the current sustainable development parameters and the current state of the practice.
5. Consider adding tools and methodologies for setting project goals, objectives and metrics.
6. Modify the PSM Guidance manual to reflect changes, and republish.

Background

FIDIC's Project Sustainability Management (PSM) Guidelines were designed as a framework and process for setting project sustainability goals, plus measurable objectives and associated metrics. Since their publication and presentation at the FIDIC 2004 Fall Conference in Copenhagen, the Guidelines received considerable support. Members of the committee have given dozens of presentations and seminars in over 12 countries. Hundreds of copies of the Guidelines have been sold.

In developing the Guidelines, it was reasoned that achieving conditions of sustainability will be a huge undertaking, more or less a complete overhaul of the world's infrastructure. Furthermore, unless there is some huge and unprecedented investment by the public and/or private sector, the journey towards sustainability will proceed one project at a time, determined ad hoc by project owners and their engineers. Thus there is a tremendous need for project level guidance on how to determine the extent to which (or even if!) a project is truly contributing to sustainability.

In reviewing the literature, we uncovered a number of systems for setting sustainability goals, objectives and metrics. Many, however, were designed to measure the performance of companies or communities. Only a few measured project contributions towards sustainability, and of those, most were either closed and proprietary, or

essentially static in their sustainability objectives. Furthermore, no system of goals and objectives was truly traceable back to the critical measures of sustainability.

What makes PSM unique is its bias for action and continuous improvement. Other current schemes for measuring project sustainability are static, giving awards reaching certain predetermined benchmarks. PSM uses the UN Commission on Sustainable Development's (UNCSD's) objectives and measures as a platform, but then allows additional sustainability goals, objectives and indicators to be added as deemed necessary. The UNCSD based its objectives and measures on Agenda 21, the UN's blueprint for action on sustainable development. It was developed in 1992 and adopted by 179 countries.

The current design of PSM

PSM consists of a framework of project-oriented measures, coupled with a process for adding or modifying those measures to suit the particular project. What the Committee did was to take the UNCSD's indicators and convert them to indicators more relevant to projects. For example, the UNCSD indicator, "Percent of population living below the poverty line," was converted to the PSM indicator, "Proportion of local workers, companies employed on the project or operation as compared to other workers, companies."

Importantly, the indicators take into account the current state of the practice, and the need to "raise the bar" on sustainable performance. The current state of the practice is defined as the conventional performance currently being achieved using conventional technologies and practices followed by engineers and other practitioners. Here we reasoned that progress made on a given sustainability indicator would be made as practitioners, motivated by the goals of the project owner, employ new technologies to achieve higher levels of sustainable performance. Such achievements, in turn, would spur others to do the same or achieve higher levels, eventually raising the state of the practice. See Figures 3 and 4 below.

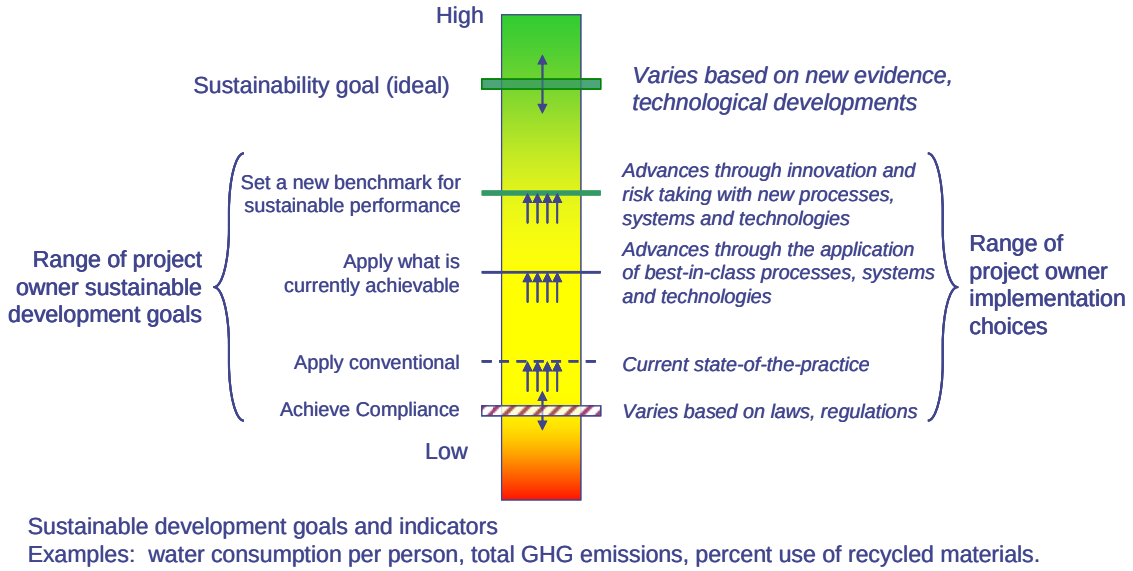

Figure 3: Concept of PSM Sustainable Goals, Objectives and Indicators

Under this scheme, progress toward conditions of sustainability becomes the focus, as opposed to achieving some qualitative certification against a point score.

Need for revision

Although feedback about the PSM framework and approach has been positive, many users have told us that the PSM sustainability objectives and measures need improvements in both structure and specificity. On April 24, 2007, Bill Wallace and John Boyd met at the Golder Associates' offices in Mississauga, Ontario, to discuss the status of the Committee, future plans and priorities. The two met with several people from Golder who have applied PSM to client projects and got their feedback and suggestions.

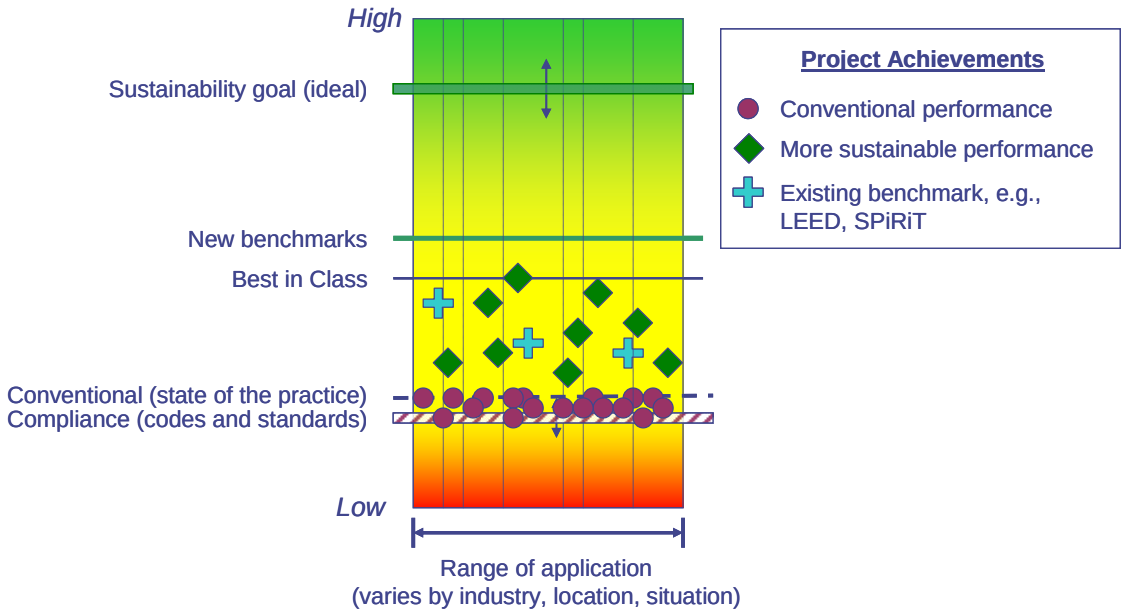

Figure 4: Examples of "Raising the Bar" on Sustainable Performance

On the positive side, the PSM framework offered a useful way of working through the important variables of sustainable development for a given project. The benefits of this approach is that PSM project sustainability metrics map directly back to what the world's societies effectively decided were its most critical issues in sustainability. On the negative side, the current set of indicators were not seen as useful. They were too oriented to 3rd World problems and were not all that relevant to normal projects. This and other feedback suggests that a major revision to PSM should be considered.

The next revision of PSM should contain more specific goals, objectives and metrics as well as benchmarks for sustainable performance. Our intent is to make the document more usable for project managers as they seek to raise sustainable project performance.

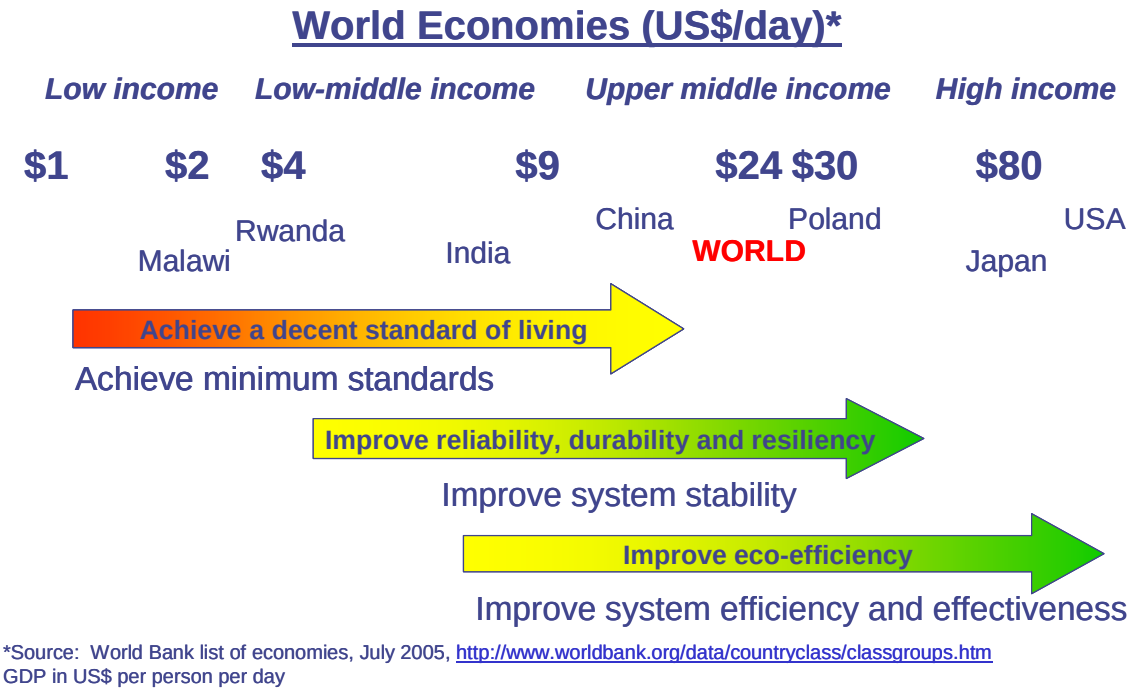

Figure 5: Different Sustainable Development Priorities Based on Level of Development

At the same time, it is important to recognize the country differences in applying PSM. In Beijing, the Committee presented a diagram (see Figure 5 above) that depicted the different priorities of various nations, depending on their level of development.[1]

[1] Matt Simons of Lorna Walker and Associates has written and presented a paper on the application of PSM to developing countries.

2. A Procurement Process for Engaging Knowledgeable, Collaborative High Performance Teams

Work of the Task Group

1. Review and critique the discussion and proposal below.
2. Develop additional procurement procedures, as warranted
3. Work with the Procurement Practices Committee to determine format and audience.
4. Develop proposed contract language that coincides with the proposed procurement process

Background

One of the biggest barriers to an effective process is the current engineering services procurement process. Without a radical change, engineers will have no incentive to try new technologies in order to achieve stretch goals for sustainable performance. In an environment where claims of negligence are judged on the basis of "did you do it like everyone else does it," engineers will be very reluctant to try anything new.

Cost-effective delivery of projects that improve sustainability performance requires a new form of engineering services procurement, one that fosters the creation of "high performance" multi-discipline project teams, and selects teams on the basis of their sustainability application knowledge, and their ability to work together as an integrated team, sharing knowledge among the disciplines and identifying opportunities for improving sustainability performance. Such teams are true partners with their project owners clients, exchanging knowledge and advice, and sharing risks and rewards for improved sustainable performance.

The concepts and benefits of having an integrated project team are starting to appear. A new Integrated Project Delivery (IPD) Task Force has drafted a paper which spells out the definition, principles and project work flow of integrated project delivery.[2] They define integrated project delivery as "a project delivery approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to reduce waste and optimize efficiency through all phases of design, fabrication and construction."[3] While the paper emphasizes the need for an integrated team approach, it does not address the procurement process needed to establish an integrated team environment. The elements of sustainability are also not addressed.

Examples where an IPD approach has been used successfully are beginning to appear. The National Museum of Australia in Canberra was delivered using an approach which followed the principles of IPD along with a corresponding procurement and selection

[2] "Integrated Project Delivery: a Working Definition," paper published by the Integrated Project Delivery Task Force, an interdisciplinary group sponsored by McGraw-Hill Construction and The American Institute of Architects, California Council. Source: http://www.infrastructureblog.com/IPD_ltr_final.pdf

[3] Ibid, page 4.

process. However, the best example in which IPD, sustainable design principles and sustainable architect/engineering procurement practices were combined successfully is the continuing work of the Poudre School District in Fort Collins, Colorado, USA. Since 2000, the District has used a unique process to procure architect and engineering services for the design and construction of sustainable schools. It also has applied effectively the principles of IPD, and has achieved new levels of sustainable performance. In addition, the design and build costs have averaged 10-15% lower than the cost of conventionally-built schools, and their operating costs are 40-50% below conventional. Their accomplishments have won numerous national awards.

With each successive school built, the District continues to improve its performance. On a recent visit to one of the District's schools, Stu Reeves, the District's Energy Coordinator, told us that they continue to reduce energy use with each subsequent school being built. At the 2004 FIDIC Conference in Copenhagen, our Committee reported that the most recent Poudre school building had reduced its energy consumption to 25,000 BTUs/ft^2 (90,000 BTUs/ft^2 is the ASHRAE standard for similar building in this climate.). Today the energy consumption is around 16,000 BTUs/ft^2.

The processes used by the District are somewhat constrained by the fact that the District is a public agency, and as such has certain government procurement rules to follow. Nevertheless, the continuing successes and lessons learned from the District provide a useful construct for a new procurement process for achieving improved sustainable performance in projects.

A new procurement process

We see this new procurement process[4] has having four components:

1. *Project owner readiness*. Work by the project owner to determine what sustainability means to their organization, and the goals and metrics they will use to measure progress.
2. *Sustainable design competition*. A process designed to challenge project teams to raise the bar on sustainable performance.
3. *Proposal evaluation and winning team selection*. A process to evaluate not only the technical aspects of the teams proposals, but how the various member firms perform as an integrated team.
4. *Negotiation*. Special considerations for negotiating with the winning team regarding risk and reward sharing and achieving sustainable performance.

1. Project owner readiness

Many owners want their facilities and infrastructure projects to make a measurable and significant contribution to sustainable development. For such an undertaking, the owner must first make some decisions on several issues:

- what sustainable development means to their organization,

[4] This process was derived from the work done by the Poudre School District in Fort Collins, Colorado, USA.

- what of level contribution they intend to make to sustainable development , and
- what business risks they are willing to assume.

All these decisions are components of their internal business case for achieving more sustainable performance. The PSM Guidelines can help frame the definition of sustainable development. However, owners must decide for themselves their level of contribution as well as their appetite for risk. Such decisions must be based on good knowledge of sustainable practices and technologies, translated into sustainability goals and objectives for the organization. These goals and objectives reflect the current state of the practice for sustainable processes and technologies, along with the expectations and aspirations of the owners' organization.

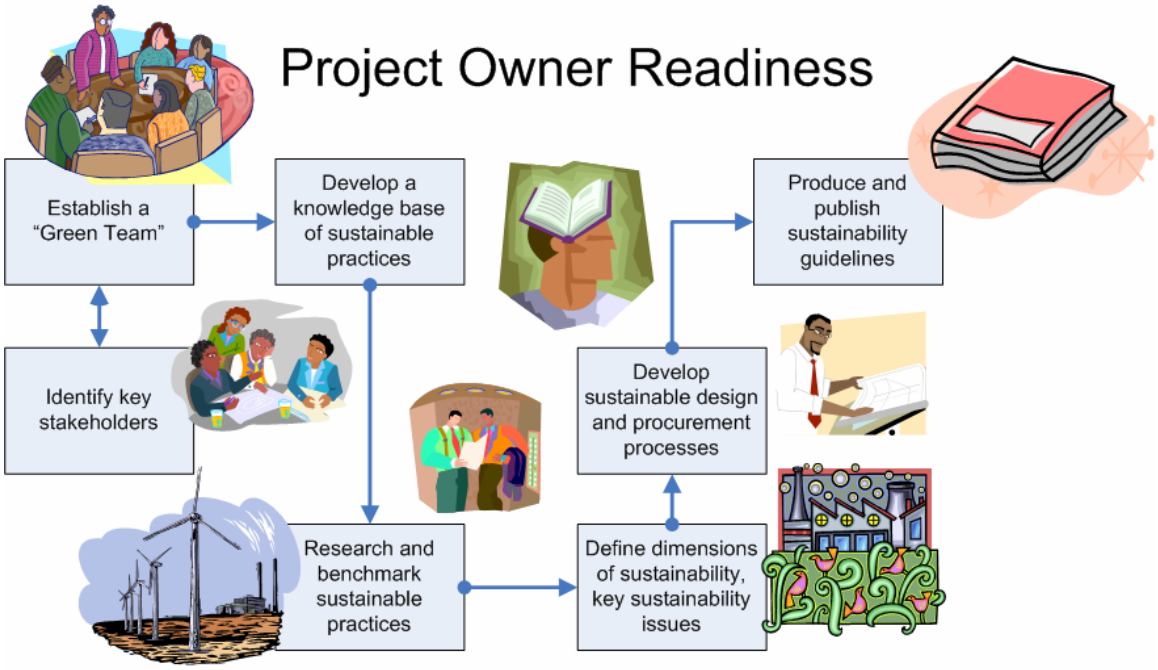

Figure 6: Project owner readiness process

In order to make these determinations, the owner needs to gather and assess pertinent information about the state of sustainable practices and technologies, balanced against the goals, strategies, operational requirements of the organization. Once assessed, the owner needs to determine its sustainability goals, policies practices, and communicate those to its stakeholders. To accomplish this, the owner should do the following:

1. establish a owner "green team,"
2. develop a knowledge base of sustainable technologies and practices, and
3. prepare and publish a set of sustainability guidelines that represent the organization's goals, aspirations and processes for improving their sustainable performance.

Each of these are described below.

Establish an owner "green team"

The owner should first set up a so-called "green team" composed of representatives from all parts of the organization. Membership would include the users, operations and maintenance, planners, management, in short, anyone in the organization that would influence or be affected by the projects. Representatives on the team should be very knowledgeable about their own areas of responsibility. If possible, they should be considered "thought leaders" by others in the organization. In addition, they should be interested and relatively knowledgeable about the issues of sustainable development, or very willing to learn.

Affiliated with the organization's green team should be a set of key stakeholders − external representatives who also would influence or be affected by the ensuing projects. Such stakeholders would include representatives from local government, utilities, citizen groups, and others. They would not be members of the green team but would be called upon for advice and opinions regarding the organization's goals, objectives, programs and projects.

Once the members are selected, the team should be chartered in order to clarify responsibilities and working arrangements. Importantly, each member of the team should be treated as an equal, regardless of organizational role or college degree. In other words, a master plumber is equal to a master environmental engineer.

Develop a sustainability knowledge base

The first task of the green team is to develop a working knowledge of sustainable practices and technologies relevant to the organization. Members of the team should be tasked to research the current state of sustainable practices in each of their respective fields. Research should not only include on-line searches for publications, but should include interviews and site visits, talking to people who are working in the field and have implemented sustainable designs.

Information collected from this work will be incorporated into the organizations sustainable guidelines. However, the accumulation and assessment of this kind of knowledge should be a continuing process and a key responsibility of the "green team."

Produce sustainability guidelines

Once information on sustainable practices and technologies are collected and assessed, the green team should prepare sustainability guidelines for the organization. By design, these guidelines are not prescriptive. Instead, they give performance outcomes that are both desirable, based on the organization's goals and aspirations, and feasible, based on the research conducted by the green team. A sample outline is provided below.

Sample Outline of and Organization's Sustainable Design Guidelines

- Front Matter
  - Forward
  - Acknowledgements
  - How to use the document
  - Table of contents

- The Sustainable Design Process
  - Overview of the owners sustainable design philosophy and policy
  - Principles of integrated design
  - Hiring the right design team: the procurement process
  - Applicability of other sustainability standards
- Sustainable Design Features
  - (List of sustainable design features along with a description, rationale, design parameters, benefits, benchmarks, best-in-class performance, and examples of applications.)

The guidelines should begin with a discussion of the organizations overall design philosophy for sustainability. This provides the user with a sense of why the organization has chosen to follow sustainable development principles as well as the extent to which the organization believes they can be applied. Supporting information such as examples of performance achieved at other locations will reinforce the discussion.

This opening section should be followed by a discussion of processes: the organization's overall process for sustainable design, procurement of sustainable engineering and architectural services, and project management. While this may seem too pedantic, it is important to note that these processes are markedly different from conventional processes and deserve special attention.

The sustainable design process

Improving sustainable performance involves the application of processes, systems and/or technologies which increase performance in one or more dimensions of sustainability without diminishing overall performance. The extent to which sustainable performance is improved depends upon the makeup and proficiency of the design team. More importantly, it depends on the owner's desire to raise the bar on sustainable performance as well as his/her willingness to share risk and rewards.

Small improvements in sustainable performance can be achieved by simple substitution at the specifications stage, i.e., replacing conventional materials and equipment with those that have more sustainable characteristics. For example, compact fluorescent lighting can replace conventional lighting, resulting in tangible energy savings. Similarly, low water use devices can be substituted for conventional devices, resulting in savings in the use of fresh water.

Profound improvements in sustainable performance along with savings in both resources and money can only be achieved through holistic design processes involving highly collaborative, multi-discipline teams. Redefining the boundaries of the design problem, understanding of system interdependencies and the consideration of the full project life cycle are all part of holistic design. Furthermore, in highly collaborative, multi-discipline teams, everyone is involved in most every aspect of the design. In such teams, conflicts, overlaps or unnecessary redundancies are discovered and corrected early in the process. Likewise, opportunities for reducing materials or energy usage, finding new ways to improve operating performance, or creating synergies among systems are more easily discovered.

Sustainable procurement

Different policies and procedures are required for identifying, qualifying and selecting the kind of collaborative team needed to achieve the desired levels of sustainable performance. The project sustainability guidelines should provide that process, detailing the steps the owner will follow to bring the most qualified team on board.

Sustainable project management

The guidelines should identify the characteristics of a sustainable project that deserve special attention through design and construction. For example, sustainable projects often will use new and relatively untried technologies, which may result in operating performance that is below expectations. In such cases, stakeholders need to be aware of these possibilities. At the same time, when applying such technologies, it is incumbent upon the project manager to look for examples where these technologies have been applied and understand any lessons learned.

Sustainable performance parameters

Once the stage is set, the guidelines should address the expected performance outcomes, not as prescriptive objectives to be achieved, but as areas that offer opportunities for improvement along with suggested approaches and tools that may be useful. Backing up these approaches with information on what others have achieved is recommended. In this way, the guidelines encourage the designers to raise the bar on sustainable performance, addressing areas of owner interest, seeing what others have accomplished in this area, and pushing performance to new levels.

2. Sustainable design competition

Asking design teams to be innovative is one thing; achieving it is another. Because of the litigious nature of the work, engineering firms have become highly conservative, defining their deliverables by contract specification and the current state of the practice. Their survival skills has been honed by many years of claims and litigation. Here, their primary defense is essentially "did you do it like everyone else does it." Such a business environment does not promote innovation, especially the application of new and relatively untried technologies, regardless of their ability to improve sustainable performance. It also encourages compartmentalization of engineering disciplines on projects, with each discipline working carefully to stay within its boundaries and not opening the door for others to sue on the basis of missed expectations.

For owners, this creates several challenges:

- How do you encourage the creation of project design teams that are truly integrated?
- How do you challenge teams to raise the bar significantly on sustainable performance?
- How do you convince the teams that you are really serious about improving sustainable performance and not setting them up for future litigation?

- How to you stimulate the development and application of new and relatively untried technologies to achieve new levels of sustainable performance?
- How do you share risks and rewards with the selected project team for what they have achieved?

The answers to these challenges are found in the following procurement process steps.

Prequalification

The purpose of prequalification is to quickly narrow down the list of prospective project teams to those that understand the issues of sustainable development and the requirements for an integrated project team. Without this step, the owner will be forced to deal with a number of unqualified teams who are simply responding to the opportunity.

The prequalification request should include a description of the project scope as well as a full qualification and selection process. Importantly, it should include a description of the philosophy of integrated sustainable design, along with a description of the criteria that will be used in determining the short list of prospective teams.

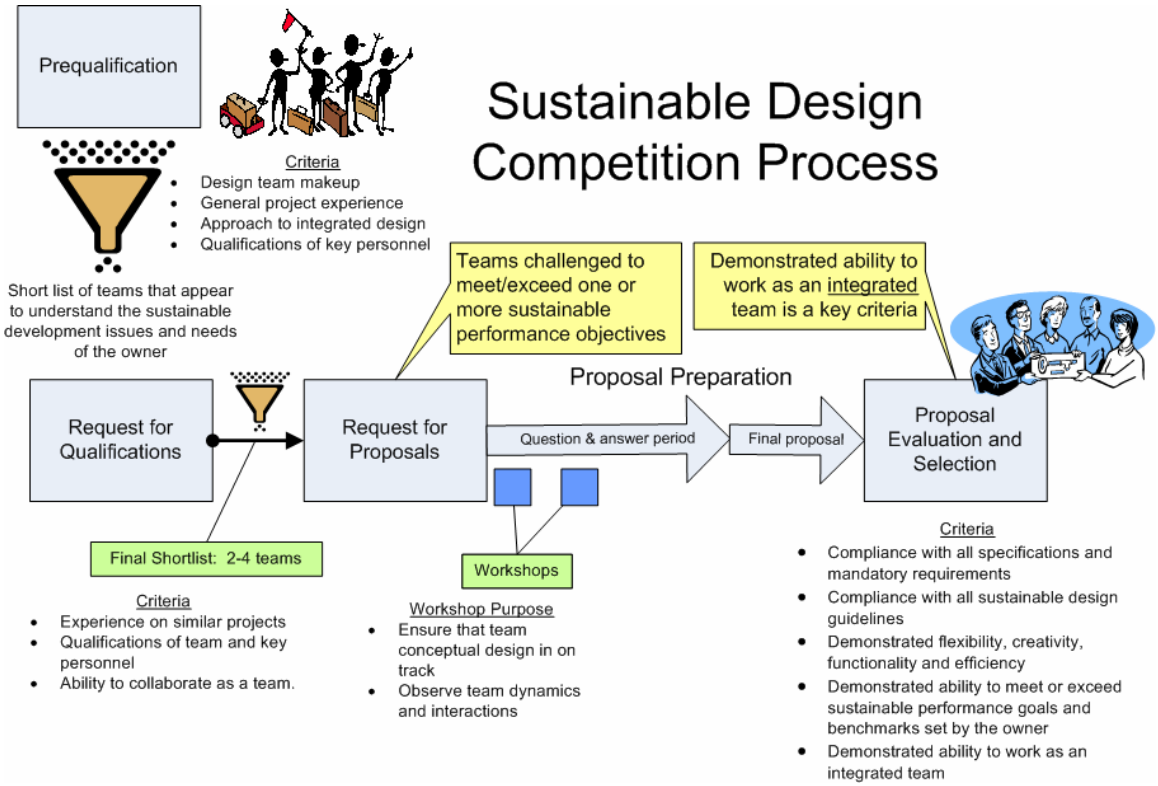

Figure 7: sustainable design competition process

Request for qualifications

The purpose of this step is to better understand the qualifications of the entire team: their organization and management approach, their experience in working together on similar

projects, the qualifications of key personnel and their understanding of integrated approaches to sustainable design. The owner will evaluate the submissions and further narrow the prospective teams down to a final short list of two or three teams.

Request for proposals

In this step, the finalist teams are given a request for proposal along with full, detailed supporting documentation for the project. The period of competition, the time the teams have to prepare and deliver the proposal is set longer than normal to allow the teams to fully understand the intent of the owner, to clarify any issues and to respond to questions.

Proposal preparation

For the first part of the competition period, each team may submit questions in writing to the owner, who will then provide a timely answer. Questions and answers will be provided to all the finalist teams. At some point, prior to the deadline for proposal submission, the question and answer period will be discontinued. During that final period teams will complete their proposals and submit them to the owner.

During the competition period the owner may conduct separate design concept review workshops with each of the teams. The purpose of these workshops is to ensure that the team's conceptual design is on the right track to achieve the design that will meet the needs of the owner. It will also allow the owner to observe team dynamics and interactions, i.e., how the team works together in an integrated fashion.

It is suggested that the owner offer an honorarium to each of the finalist teams in order to help defray proposal preparation costs. Because of the additional interaction between the owner and the teams, proposal preparation costs will likely be higher than normal. Payment of the honorarium should be contingent upon the team's successful completion and submission of a proposal.

3. Proposal evaluation and winning team selection

Proposals should be evaluated on the following criteria:

- Compliance with all specifications and mandatory requirements
- Compliance with all sustainable design guidelines
- Demonstrated flexibility, creativity, functionality and efficiency
- Demonstrated ability to meet or exceed sustainable performance goals and benchmarks set by the owner, e.g., energy efficiency, water conservation, use of renewable materials, etc., as compared to reasonable sustainable benchmarks or achieved best-in-class performance.
- Demonstrated ability to work as an integrated team

4. Negotiation

Contract negotiation should be handled in a normal fashion, but with emphasis on the following areas:

- Agreement on sustainable performance goals. The owner and the project team should agree succinctly on the performance goals as set out in the team's proposal, but at the same time, agree on conditions under which change is acceptable.
- Sharing of risks and rewards. The owner and the project team should agree on a formula for sharing both risks and rewards. This is most important for projects in which the owner desires and the teams agrees to achieving levels of performance which exceed best-in-class performance. Performance-based contracting method is recommended.
- Managing change. In spite of all the parties' best work in setting achievable performance goals, unanticipated problems are still likely to arise. For these instances, it is important to have agreed-upon procedures for managing change.

4. Tools And Methodologies for Creating, Designing and Delivering Holistic Solutions

Work of the Task Group

1. Establish the current state of play. Review the discussion below. Conduct a high level study on how design for the built environment is done today in order to establish a baseline design process. Obtain this information from the architect and engineering (A&E) community, relevant institutions and academia. Identify and examine existing sustainable design processes and tools, and case examples in which sustainability principles were applied to engineering designs, giving specific attention to holistic design. Develop a framework that describes the current approaches used in sustainable engineering design, and a proposed holistic approach and methodologies for sustainable design.
2. Develop procedures and methodologies for sustainable design. Devise a detailed set of procedures and methodologies that will enable practitioners to create more holistic designs which follow the principles of sustainable development. This will be accomplished through a series of workshops (perhaps three) in which the participants will be asked to create a set of systematic approaches and design exercises that will lead to more holistic designs. Most of the participants will be recognized experts in engineering design, with good knowledge of the principles of sustainable development. Representatives from key stakeholder groups will also be included. The results of the workshops will be recorded, summarized and assessed.
3. Prepare and publish a sustainable engineering design tool. Prepare a handbook on procedures and methodologies for holistic design. The handbook will be organized in a way that will enable practitioners to organize and conduct sound processes for delivering more holistic designs. Review and endorsement will be sought from key professional and trade associations, and government agencies.

Background

Making our form of economic development more sustainable has been identified as an important and urgent issue for the 21st century. However, achieving conditions of sustainability over the long term is a huge undertaking, requiring, more or less, a complete overhaul of the built environment, replacing legacy materials, processes, systems and structures with those that are increasingly more sustainable. Absent some unprecedented commitment and investment at a global or multi-national scale, that changeover will likely happen incrementally, based on the objectives and resources of the project owners and the capabilities of their engineers.

Some progress toward sustainability for the built environment is being made. Energy efficiency in buildings is increasing as designers replace old fixtures and equipment with those that use less energy. Designers are also incorporating more daylighting and making more use of natural heating and cooling. But while these efforts are helpful, they do not yet capture the full potential of sustainable engineering. They are really extensions of

conventional design, involving the replacement or reconfiguring of components to gain some performance improvements. Real breakthroughs in the journey towards sustainability will likely come about by addressing engineering design problems holistically, by reexamining the basic variables and design assumptions and/or by inventing entirely new approaches to addressing the design problems. See Figure 8.

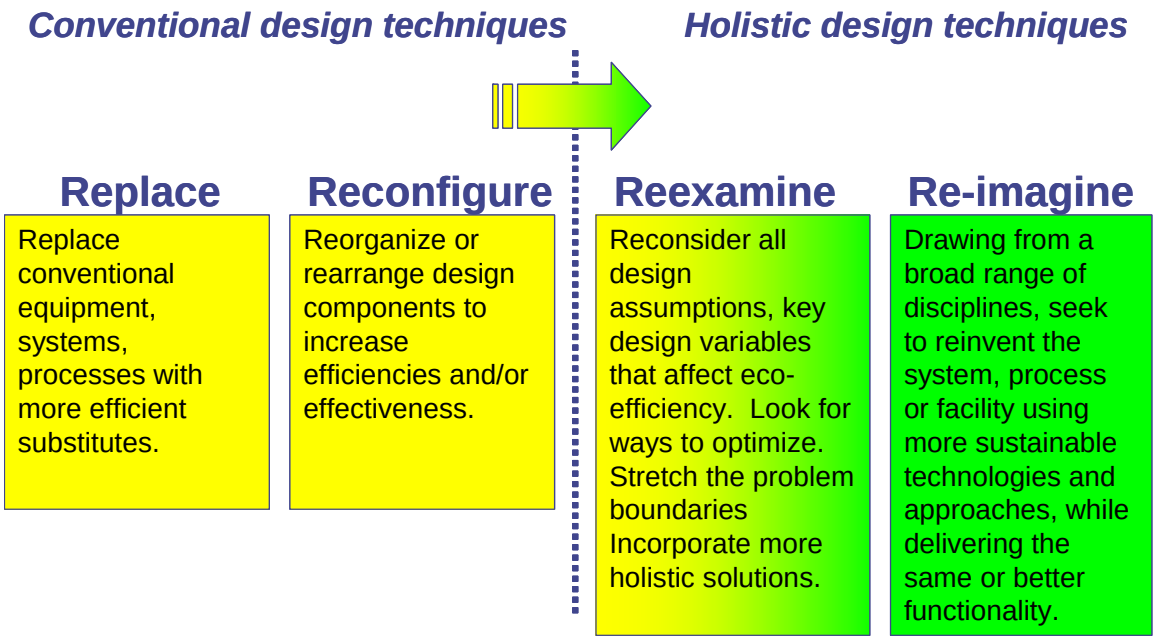

Figure 8: Transition to holistic design

An example of holistic design that has become a classic in sustainable engineering is a facility design by Dutch engineer Jan Schilham. By recognizing the key variables driving energy consumption in fluid flow, he was able to reduce power requirements for fluid pumping by 92% by using large, short pipes with very few tees and elbows.[5]

Thus by applying holistic design principles to engineering projects, enormous efficiency gains and breakthroughs are possible. Unfortunately, there is no strong or robust methodology for incorporating those principles, making it difficult for designers to develop more holistic designs.

The Schilham case, while clearly a fine example of what can be done when bright minds work on a problem, is unfortunately unique in engineering design. What is needed is a sound set of procedures and methodologies for holistic engineering design, one that will enable practitioners to work through systematically all of the reasonable design approaches and uncover greater efficiencies and achieve higher sustainable performance. Once this tool is available, practitioners will be able to organize and facilitate their design efforts, bringing in a broader range of disciplines and stakeholders to develop a design that produces much greater efficiencies and superior performance.

[5] Paul Hawken, L. Hunter Lovins and Amory Lovins, *Natural Capitalism: Creating the Next Industrial Revolution,* (Little Brown and Company, 1999), pp 116-117.

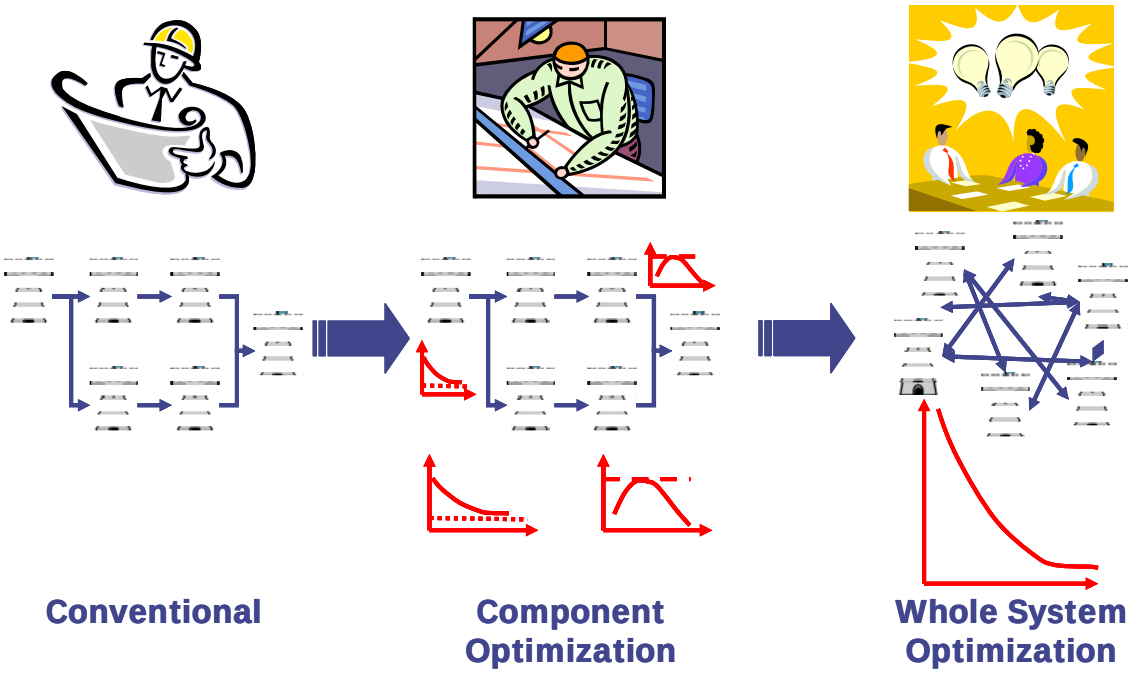

Figure 9: Transition from Conventional Design to Holistic Design

The structure of this new design process is expected to follow generally design procedures that are familiar to the practitioners. The differences are likely to be in the use and configuration of design charrettes and in the processes used to examine the key variables in the design. For example, new elements in the design charrette will include: (1) pushing the design problem boundaries as far as reasonably possible to see if overall performance can be improved, and (2) driving the design as far as possible down one or more eco-efficiency pathways (e.g., reduce energy intensity, reduce toxics dispersion, etc.) to see what additional benefits can be achieved. Other approaches and design exercises that will uncover new efficiencies and better performance will be sought.