Built Environment Sustainability:
An Integrated Approach to Education, Research, and Outreach

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Abstract: To achieve Built Environment Sustainability (BES), the Architecture, Engineering, and Construction (A/E/C) industry requires significant changes in the way it currently delivers, operates, and maintains Facilities and Civil Infrastructure Systems (F&CIS), and also, in the way manufacturers, vendors, and suppliers provide the building technologies, systems, products and materials used in them. Specifically, sustainability principles, concepts, heuristics, strategies, guidelines, specifications, standards, tools, best practices, and/or lessons learned need to be formally, explicitly, systemically, and systematically integrated within the capital asset delivery and management processes, at all stages of the life cycle of a capital asset, particularly the early funding allocation, planning and conceptual design phases. The challenge is: how can this be done?

This paper presents the results of current efforts in the Construction Engineering and Management Program (CEM) in the School of Civil and Environmental Engineering (CEE) at the Georgia Institute of Technology (GT), which is actively seeking answers to this question through an integrated approach to BES education, research, and outreach. This effort, which is being executed in partnership with other organizations within the U.S. and internationally, targets the complete education pipeline, from K-12 education, through undergraduate, graduate, and doctoral studies education, to continuing education for professionals and the general public.

1.0 Introduction

Organizations in the private and in the public sectors currently face serious external challenges and influences that affect their ability to fulfill their vision, mission, goals, and objectives. These challenges and influences are currently affecting (1) the *capacity and capability of the basic infrastructure* that an organization requires to achieve its vision, mission, goals, and objectives, so it can exist and operate successfully indefinitely; (2) the *compatibility and compliance of the fundamental processes, practices and operating procedures* that an organization requires to execute and support its vision, mission, goals, and objectives, with both its internal and external contexts; and (3) the *integrity, quality, and availability of the resource base* required by an organization to sustain its basic infrastructure and fundamental processes, practices and operating procedures, i.e., natural, social, industrial, built, and economic capital. These external challenges and influences are local, regional, national, and global, in nature (i.e., they have a *spatial scale*), and they are present today, and as trends indicate, they will continue to grow into the future (i.e., they have a *temporal scale*). They stem from three types of systems within which an organization exists and operates (i.e., its *contextual envelope*). These systems are: (1) *social, cultural, political, and regulatory systems*; (2) *economic and financial systems*; and (3) *environmental and ecological systems.*

Organizations in the Architecture, Engineering, and Construction (A/E/C) industry are not exempt from these challenges and influences, and face two additional challenges and influences:

- First, the increasingly constrained availability of economic resources for private and public sector owners of Facilities and Civil Infrastructure Systems (F&CIS) capital assets is forcing them to (1) demand higher levels of capital project effectiveness, efficiency, productivity, and return on investment; and (2) expect higher technical and management performance in the delivery, operation, and maintenance of F&CIS over their complete life cycle, and of the functional and

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physical performance of the technologies and materials used in them.

- Second, as the principal provider of F&CIS and their life cycle custodian, the A/E/C industry has been identified as a major direct and indirect contributor to problems of global nature (e.g., natural resource depletion and degradation, waste generation and accumulation, environmental impact and degradation, among others). As a result, architects, engineers, and constructors, as well as the manufacturers, vendors, and suppliers that provide the building technologies, systems, products and materials specified and used, face increasingly restrictive environmental conservation and protection laws and regulations, the emergence of international standards to address environmental quality and performance such as ISO 14,000, and substantial pressures from civic and private environmental groups, in A/E/C projects.

Over the last two decades, and as a direct response to these challenges and influences, *Sustainable development* has emerged as a paradigm to ensure, as the World Commission on Environment and Development (WCED) stated in 1987, that we are *"…meeting the needs of the present without compromising the ability of future generations to meet their own needs*" (WCED, 1987, p. 8). *Sustainability* transcends the scope of this definition, adding a broader spectrum of complexity, and creating the challenge that any substantive discussion on sustainability necessarily needs to be framed within four dimensions: (1) economic, (2) social and cultural, (3) ecological and environmental, and (4) technological. Furthermore, these dimensions have both temporal and spatial scales.

Consequently, sustainability (1) needs to be addressed in the present, keeping in mind the future; (2) needs to be addressed at a local level, keeping in mind a global perspective; and (3) requires a clear understanding of the intellectual foundation of sustainability (Carpenter & Vanegas 1998; Vanegas 1999). In addition, sustainability cuts across existing disciplines and cultural practices, each tending to have its own specialized vocabulary, disciplinary composition, and selective focus. This has made interdisciplinary collaboration difficult, and it also has resulted in distinctive, and many times opposing, conceptual frameworks, models, or points of view for sustainability. However, bringing together economists, social scientists, and ecologists, with planners, architects, engineers, and builders, in a discussion of sustainability is imperative to begin taking down old disciplinary boundaries, and creating the cross-disciplinary, and truly new interdisciplinary, approaches required for effective implementation of built environment sustainability. In addition, in recent years, a very large amount of sustainability data, information, knowledge, and experience has been generated. Some of these data have been represented as sustainability principles, concepts, heuristics, and strategies; some as sustainability guidelines, specifications, standards, best practices, and lessons learned; and some embedded within tools. Knowing how to access and select what is relevant and applicable from this extensive body of knowledge is not an easy task.

Despite this challenge, no other concept has brought together, in a relatively short period of time (the last 15 years), such a wide range of constituencies: (1) *organizations in the private and public sectors* ranging from the companies in the Business Roundtable that represent corporate America, to multiple federal, state, and local government agencies, to the military services, to non-governmental organizations (NGOs) and civic activist groups; (2) *practitioners, researchers, and educators* in the physical, life, and social sciences, in the many disciplines of engineering, architecture, and city planning, in the healthcare, financial, agricultural, manufacturing, and industries, and many more; and (3) *individuals*, *families*, and *communities*, in urban, suburban, and rural settings. Although the convergence of this broad range of constituencies in discussing sustainability is very positive, the broad diversity of stakeholders involved and the wide range of different perspectives they bring to the discussion have generated numerous definitions and conceptualizations on what sustainability is; some of which are aligned, and some of which are in direct conflict with each other.

A comprehensive examination of the existing and constantly evolving body-of-knowledge on sustainability reveals three general areas of consensus: (1) *what* to sustain, *where*, and *when*; (2) the *status quo is not sustainable* in the long term, and *needs to change today*; and (3) the *contextual envelope that surrounds the status quo is complex today*, and *will be more complex* in the future. For the A/E/C industry, to achieve sustainability of F&CIS, i.e., Built Environment Sustainability (BES), these areas of consensus have two main implications:

- First, the principal stakeholders in F&CIS (i.e., owners, users and operators, architects and engineers, constructors, manufacturers, vendors, and suppliers, and many external parties), face significant changes in what they do (i.e., the product), how they do it (i.e., the process), and with what (i.e., the resource base). This will enable F&CIS to face better the influences they face at various spatial and temporal scales, and to mitigate or eliminate the impacts they pose (i.e., ecosystem impacts, resource base impacts, and human impacts). Figure 1 illustrates the complex dimensions of BES.

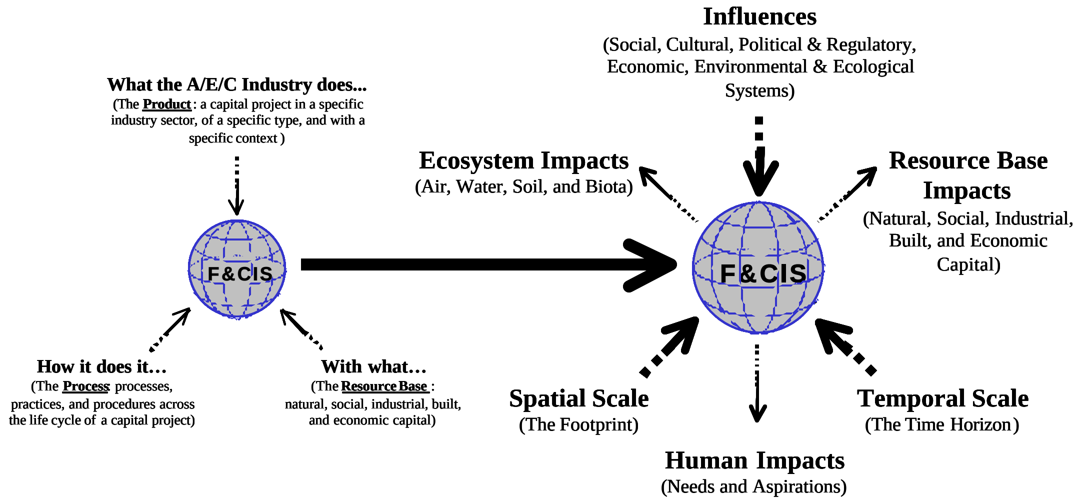

Figure 1: The Dimensions of Built Environment Sustainability

- Second, sustainability principles, concepts, heuristics, strategies, guidelines, specifications, standards, tools, best practices, and/or lessons learned need to be formally, explicitly, systemically, and systematically integrated within the capital asset delivery and management processes, practices, and standard operating procedures (SOP's) at all stages of the life cycle of a capital asset. Figure 2 illustrates the sustainability entry points in the life cycle of F&CIS.

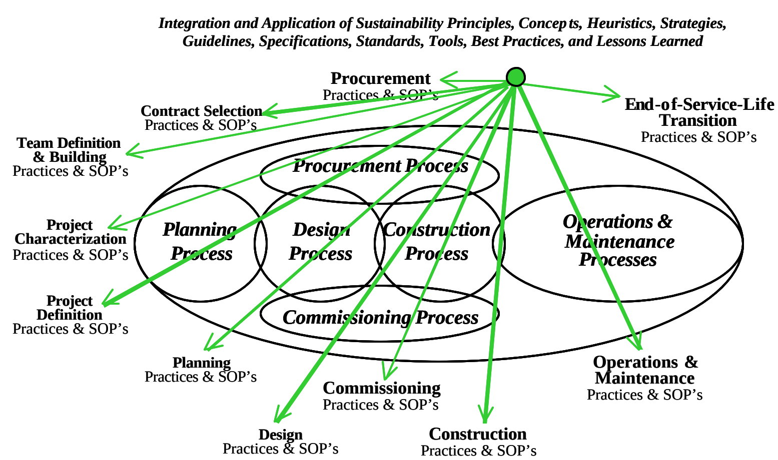

Figure 2: Sustainability Entry Points in the Life Cycle of F&CIS

The challenge is: how can BES be achieved? This paper presents the results of current efforts in the Construction Engineering and Management Program (CEM) in the School of Civil and Environmental Engineering (CEE) at the Georgia Institute of Technology (GT), which is actively seeking answers to this question through an integrated approach to BES education, research, and outreach. This effort, which is being executed in partnership with other organizations within the U.S. and internationally, targets the complete education pipeline: from K-12 education, through undergraduate, graduate, and doctoral studies education, to continuing education for professionals and the general public.

2.0 The Challenge

An active education and research program in sustainability over the last decade within CEM/CEE/GT has identified several areas of needs and opportunities that emerge as critical to achieving BES. These include:

- *Improved analysis and evaluation* methods that provide for an integrated, systems perspective for F&CIS
- *Better assessment* (current and past) and *prediction* (future) of life cycle performance and sustainability of F&CIS, which includes virtual and rapid visualization, modelling, prototyping, and simulation of the total or any component of F&CIS at any life cycle stage
- *Science and technology-based guidelines* for policies, standards, codes and regulations that promote sustainable F&CIS
- More *effective institutional structures* for the delivery, management, and renewal of sustainable F&CIS
- *Market-efficient financing strategies* that incorporate the true costs of delivering and managing sustainable F&CIS
- More *effective, efficient, and integrated processes for delivery* (i.e., planning, design, procurement, construction, and commissioning and start-up), *and management* (i.e., operations and maintenance, and end-of-service-life decision) of sustainable F&CIS
- More *sustainable and cost-effective technologies, products, materials, and methods* used in F&CIS
- *New methods for real-time continuous measurement and management* of F&CIS life cycle performance and sustainability, including approaches for assessing deterioration or damage
- *Formal and informal education* in sustainable F&CIS (K-12, undergraduate and graduate education, continuing education and training, public outreach, and life long learning)

One problem in attempting to satisfy these needs or to capitalize on these opportunities is that current approaches to both basic and applied research in F&CIS, as well as towards education, are not totally responsive to the complex nature of BES. Although many researchers and educators have made great strides in developing innovative approaches in addressing specific issues within many of these areas listed above, the following research and education characteristics still prevail:

- Research in F&CIS in general tends to be:
  - *Problem-specific* – focused on very specific problem areas with narrowly-defined scopes and boundaries
  - *Discipline-specific* – driven by individuals or teams from very specific engineering or science disciplines with limited participation from disciplines outside the specific domains of the research team
  - *Fragmented and isolated* – either basic or applied, but rarely both; limited integration not only between engineering and science, but also among the multiple disciplines within each; and rarely having a cradle-to-grave vision, much less a cradle-to-cradle vision
  - *Contextually-independent* – self-centred with limited participation of the ultimate users and customers of research findings as active participants in the research process
  - *Short-term* – with very short or limited time frames
  - *Evolutionary* – conservative and built upon today's knowledge base, rather than taking risks and pursuing the next-generation knowledge
  - *Funding source-dependent* – responding to the specific requirements of a funding agency, which many times is the cause of these characteristics
- Education in F&CIS in general tends to be:
  - *Discipline- and course-specific* – driven by very specific math, science, engineering, and

humanities discipline areas; having narrowly-defined scopes and boundaries within each course in a curriculum; and providing limited opportunities for interdisciplinary interaction among students and educators from various disciplines

- *Contextually-independent* – emphasize the theoretical side of topics with limited exposure to their practical side; provide limited opportunities to bring the "real world" into the classroom; or of bringing the classroom into the "real world"
- *Teaching-driven* – focus on the role of the educator in delivering course content material, instead of focusing on the role of the educator in enabling learning outcomes based on course content
- *Linear* – having a hierarchical structure that builds upon previous levels of education; lacking mechanisms for reflection, synthesis, and integration as students progress towards higher levels of education; and having minimal involvement, input, and feedback from those that have reached the higher levels of education
- *Ineffective and inefficient* – based on pedagogical models that worked adequately in the past, but that are no longer responsive to the challenges facing society; having limited access and exposure for educators and students to the technological requirements for professional practice in business, industry, and government; emphasizing research at the expense of teaching and practical experience, especially in undergraduate education; increasingly bureaucratic and costly, while resources are becoming increasingly scarce; and increasingly competitive and costly for students, limiting their accessibility to the educational process
- *Fragmented and isolated* – limited institutional collaboration among and within educational institutions engaged in K-12 education, undergraduate education, and education for life long learning; lacking integration of curricular content among and within these three education levels
- *Institution-dependent* – respond to the specific context and culture of the educational institution, which many times is the cause of these characteristics
- *Non-diversity-oriented* – not attractive to members of society who will constitute the largest increase in population and workforce over the next several decades; put simply, F&CIS is not an area that currently attracts large numbers of women and minorities

Developing effective strategies for dealing with these research and education issues requires a broad range of specialized knowledge, experience, and tools, which unfortunately are widely spread and fragmented among the different stakeholders in the A/E/C industry, who each have their own set of objectives, resources, and actions. This situation creates three critical needs and opportunities. The first is to integrate and leverage objectives, resources, and actions of the multiple stakeholders. The second is to facilitate processes of change. The third is to create a locus of BES data, information, knowledge, experience, and tools through the implementation of information acquisition, synthesis, and dissemination strategies. A response to these critical needs and opportunities will enable these stakeholders to better address, manage, and /or overcome the inhibitors, barriers, or obstacles to the implementation of BES that exist, including (Pearce 1999; Pearce et al. 2000):

- The lack of consensus on what sustainability means for the built environment
- The lack of understanding of how specific sub-concepts map onto the larger concept of sustainability (e.g., environmental management, compliance, "green")
- The lack of understanding and myths associated with the economic impacts of sustainable building practices
- The difficulty of measuring sustainability, and the subsequent challenge of decision making for sustainable facilities
- The difficulty in breaking out of traditional stakeholder roles and relationships; resistance to change
- Managing information overload in seeking innovative or non-traditional solutions and conversely, finding sufficient and reliable data on which to base decisions

- Finding effective and appropriate strategies to increase facility sustainability
- Integrating solutions for whole system optimisation; overcoming traditional disciplinary barriers

The response to the challenges discussed in this section is a comprehensive program in BES, encompassing *education*, *research*, and *outreach*. This effort has been conducted to date within an active collaborative partnership between CEM/CEE/GT and the Sustainable Facilities and Infrastructure (SFI) Branch of the Safety, Health, and Environmental Technology Division (SHETD) of the Georgia Tech Research Institute (GTRI).

3.0 The Response – Education

The on-going development of the BES Educational Program between CEM/CEE/GT and SFI/SHETD/GTRI is guided by a new paradigm for education in BES that complements, supplements, and adds value to the existing education infrastructure within civil and environmental engineering. Its goal is to enable stakeholders in the built environment to become agents of change, through activities targeted at K-12 education; undergraduate, graduate, and doctoral studies education; continuing education for professionals; and education for the general public. Rather than attempt to change the current approach within civil and environmental engineering education, especially given the scope, magnitude, and complexity of such an effort, resources and focus are oriented toward specific activities and actions, general dissemination and outreach efforts, and the development of an information management and communications technological infrastructure. This new paradigm, as synthesized in Figure 3 (next page), contains the following unique elements and needs:

- *K-12 Education Foundation* – The robustness of any educational effort in BES aimed at trade school and on-the-job education/training (informal path), and at undergraduate and graduate education (formal path), depends on the quality of the educational foundation at the K-12 level. Therefore, there is a need to examine carefully the skills of K-12 students as they relate to these two potential career paths in the A/E/C industry.
- *Trade School/On-the-Job Education/Training Foundation* – Not everyone who works in the A/E/C industry goes through a professional education path. For example, many people who work in construction, maintenance, or operation activities for F&CIS, after their K-12 educational experience, mostly rely on two-year trade school or college education programs, specific in-house programs of their employers, or miscellaneous "on-the-job" training opportunities. Therefore, there is a need to explicitly acknowledge the importance and help strengthen this type of BES education.
- *Undergraduate and Graduate Education Foundation* – The core of any formal educational effort aimed at BES is the undergraduate level, supplemented with graduate education. Therefore, to fully prepare the next generation of professionals that will serve the A/E/C industry, there is a need to support the implementation of an integrated pedagogical strategy that contains the following three elements:
    - A *strategic framework for curriculum development*, which includes: (1) <u>fundamental education</u> composed of mathematics, sciences, engineering, and humanities; (2) a <u>systems-based core BES education</u>, which includes introduction and exposure, in an integrated way, to selected topics relevant to BES in civil and environmental engineering, other engineering disciplines, city planning and architecture, economics, finance, public policy, management, and sustainable development and technology; and (3) <u>specialized BES education</u>, which enables possible specialization in the areas of assessment, planning, design, construction, or operation of F&CIS. Systematic mechanisms for motivation and scaffolding, and for reflection, synthesis, and integration, link these three bases.
    - A *strategic framework for achieving learning outcomes* (i.e., the student perspective), which includes: (1) an introduction, exposure, and proficiency in <u>fundamental knowledge, skills, and tools</u> sets; (2) individual and team development and application of <u>core BES knowledge, skills, and tools</u> sets to establish the intellectual foundation for contextual understanding of BES problems, for solving problems in BES, for designing solutions in BES, and for understanding and applying technology; and (3) individual and team development and application of <u>specialized BES knowledge, skills, and tools</u> sets.

- *A strategic framework for enabling learning outcomes* (i.e., the instruction perspective), which includes: (1) specialized faculty with access to general resources in math, science, and engineering; (2) integrated interdisciplinary faculty teams composed of faculty from multiple fields as needed, with access to case studies from industry and academia, in addition to previous resources; and (3) integrated interdisciplinary faculty/practitioner teams composed of faculty and practitioners from multiple fields as needed, with access to lessons learned and best practices from industry and academia, in addition to previous resources.

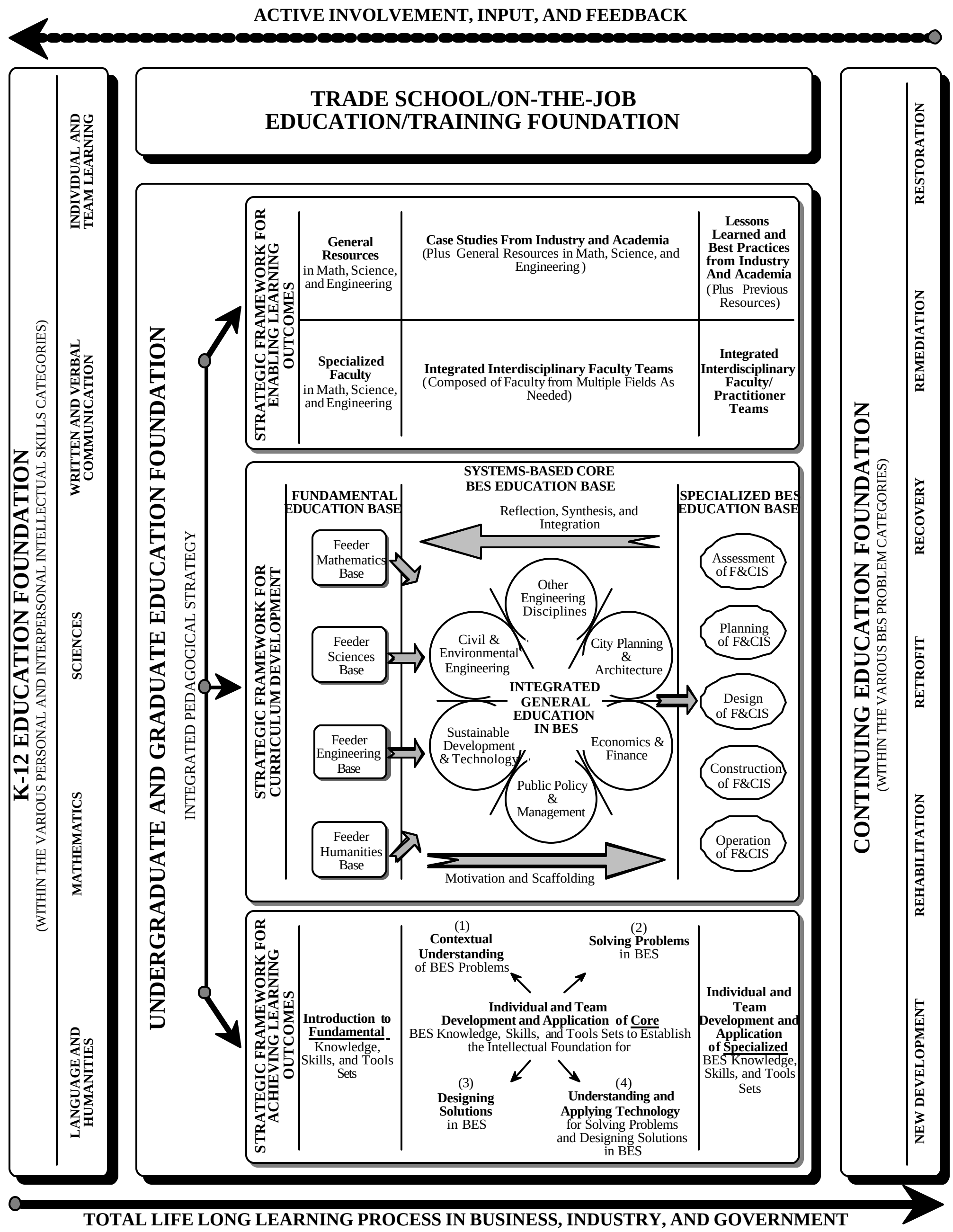

Figure 3: Long-term Vision of the BES Education Program at CEM/CEE/GT

- *Life Long Learning Foundation for Practice in Business, Industry, and Government* – The ultimate measure of success of any educational effort aimed at BES is the performance of the individuals educated both informally and formally to serve business, industry, or government, and their ability to engage in life long learning. Therefore, there is a need to support the opportunity for these individuals to further their personal and professional development through continuing education programs in the areas of (a) new developments, (b) rehabilitation, (c) retrofit, (d) recovery, (e) remediation, and (f) restoration. Finally, these same people should have mechanisms for active involvement, providing input, and giving feedback to each of the levels of education that preceded their current status.

One specific example of the type of courses being developed within this framework is a required graduate-level course on *Environmentally Conscious Design and Construction* (CEE6120). This course has been opened recently to selected undergraduate students. Building on the results of a campus-wide multi-disciplinary initiative that focused on educating engineers in sustainable development, funded by the GE Fund and the National Science Foundation, this course focuses on preparing the future generation of civil engineering, and of construction engineering and management, to work toward achieving BES. The course provides an introduction to the strategies, analysis methods, and processes of sustainable planning, design, construction, operation, deconstruction, and assessment of built facilities. The course presents a systematic framework for problem solving, decision making, and design using the principles of sustainability as guiding objectives. It also exposes students to tools, methods, and techniques for gathering information, generating, analysing, and evaluating alternatives, and developing implementation strategies. Course activities include a combination of lectures, in-class discussions and exercises, and several out-of-class group and individual laboratories, projects, and/or assignments. This course is listed in the Georgia Tech Catalogue (https://oscar.gatech.edu/cat/ccatalog.htm#CEE).

4.0 The Response – Research

The evolving BES Research Program between CEM/CEE/GT and SFI/SHETD/GTRI is focused on specific responses to the challenges and barriers listed in Section 2.0, within a pervasive theme of systems thinking to replace traditional reductionism. This program has four points of departure:

- Identification and characterization of the principal *stakeholders in BES*
- Identification and characterization of *BES typologies and problem contexts*
- Identification and characterization of *processes for delivery and life cycle management of F&CIS*
- Identification and characterization of *technologies and products used in F&CIS*

The ultimate goal of the BES Research Program is to provide owners and users of facilities and infrastructure systems in the public and private sectors, A/E/C professionals, manufacturers, vendors, and suppliers, and other relevant or interested parties, with tangible products and deliverables, resulting from the on-going development of:

- A consistent, theory-based *conceptual framework* for understanding sustainability in terms of variables meaningful for F&CIS
- A *taxonomy* for systematically identifying, classifying, obtaining, and managing the kinds of data, information, knowledge, and experience needed to solve problems, satisfy needs, and realize opportunities in F&CIS, in a sustainable manner
- A *web-based multimedia system* for acquisition, storage, and retrieval of sustainability principles, concepts, heuristics, strategies, guidelines, specifications, standards, tools, best practices, and/or lessons learned for F&CIS, including a *roadmap* for understanding the relationships among them
- *Models* for integrated analysis, evaluation, and development of guidelines and recommendations for policies, standards, codes, and regulations influencing or affecting F&CIS, from a life cycle sustainability performance perspective
- A set of systematic and bounded *processes for problem-definition, problem-solving, analysis, and decision-making* that incorporate understandable scientific methods for evaluating the sustainability of F&CIS and their components

- A *toolbox* for evaluating the economic impacts of sustainable F&CIS alternatives and actions, including methods for clearly understanding those impacts in terms of the language of economics-driven decision-making
- A set of s*trategies, tools, technologies, and methods* for increasing the sustainability of F&CIS, according to project type and life cycle phase, with virtual and rapid visualization, modelling, prototyping, and simulation capabilities to compare alternatives
- Advanced *sensing and control technologies* for real-time continuous measurement, documentation, and management of sustainability performance (e.g., indoor air quality, energy use and efficiency, water quality, waste generation, etc.)
- A set of *operational strategies* for proactively addressing resistance to change and the limitations of traditional stakeholder and organizational roles
- *Alternative new products and materials* for F&CIS made from recovered construction demolition waste, and/or other waste sources
- *Alternative new construction technologies, equipment, and methods* for F&CIS that minimize negative environmental impacts
- *Modular design and construction solutions* for disassembly, recycle and/or reuse of F&CIS
- A comprehensive *technology transfer and dissemination program* for the A/E/C industry on sustainable F&CIS, and sustainable building technologies, systems, products and materials

5.0 The Response – Outreach

The on-going BES Outreach Program between CEM/CEE/GT and SFI/SHETD/GTRI is focused on two main types of activities:

- A professional continuing education series in Sustainable Facilities and Infrastructure, under the direction of Dr. Annie Pearce, designed to meet the needs of built environment stakeholders who are seeking to make their facilities more sustainable: architects, engineers, contractors, builders, developers, planners, owners, and others. Information on this series can be found at http://maven.gtri.gatech.edu/sfi/conted/conted.html. The seven courses in the SFI series highlight the opportunities that sustainability offers to save money for built environment stakeholders; to reduce their liability; to attract new customers; to open new markets; to increase their competitiveness over the long term; and to teach them to:
  - Understand what sustainability means and how it might benefit their enterprises
  - Measure the sustainability of current and future projects
  - Understand the economic costs and benefits of this new approach
  - Work with diverse teams to make sustainability happen
  - Use state-of-the-art tools and resources for analysis, design, and problem solving
  - Prioritise and apply potential specific strategies for improving project sustainability
- Active participation and support from Dr. Jorge Vanegas, to the U.S. Army, and various national and international technical committees, commissions, task groups, and forums, that are addressing sustainability, including:
  - The American Society of Civil Engineers (ASCE) *Subcommittee on Sustainability* of the *Technical Activities Committee* *(*http://www.asce.org/inside/techcomm.cfm?#scs*)*The American Society for Engineering Education (ASEE) *The Engineers Forum on Sustainable Development,* co-sponsored with ASCE (http://www.asee.org/neic/efs/)The International Association of Bridge and Structural Engineers (IABSE) *Working Commission 7 on Sustainable Engineering* of the *Technical Committee* *(*http://www.iabse.ethz.ch/about/about_f.html)The International Council for Research and Innovation in Building and Construction (CIB) *Task Group 48 (TG48) - Social and Economic*

Aspects of Sustainable Construction of the *CIB Commission on Sustainable Construction* (http://www.cibworld.nl:591/cib/FMPro?-db=commission.fp3&-format=commissions%5fdetails.htm&-lay=entry%20commission%20www&-sortfield=Title&commission%20no=TG48&-recid=32804&-find=)The National Center for Construction Education and Research (NCCER) *Subcommittee on Sustainable Construction* of the *Image Steering Committee* *(*http://www.nccer.org/Industry_Image/industry_whatsnew.asp)Leadership for Environment and Development International, Inc. (LEAD) *Curriculum Advisory Committee* http://www.lead.org/lead/training/curriculum/cac/tor.htm#List%20of%20Members)Urban Genesis Institute (UGI) *Technical Advisor*http://www.urbangenesis.com/advisorspartners.html)The U.S. Army Environmental Policy Institute (AEPI) *Sustainable Army Installations* (SAI) - *Facilities, Infrastructure Ranges, and Ecosystems* (FIRE) *Initiative* (http://www.aepi.army.mil/index.htm)**Conclusions**

Sustainability of F&CIS (or BES) is a complex knowledge domain that requires that the principal stakeholders in F&CIS within the A/E/C industry find and implement new ways in their products, in their processes, practices, and procedures, and in their resource base, so that they may address better the influences they face at various spatial and temporal scales, and to mitigate or eliminate the impacts they pose to ecosystem, the resource base, and humans. An integrated approach to education, research, and outreach is necessary to facilitate, implement, and achieve these changes.

Through a collaborative partnership, CEM/CEE/GT and SFI/SHETD/GTRI have begun a quest toward a more sustainable future for the built environment. By engaging and educating students, by educating and training professionals, and by working with public and private sector organizations, this partnership has proven to be rewarding and fruitful, and is starting to make a visible difference in the students, the professionals, and the organizations that have participated in the various initiatives, programs, projects, and events. The path to BES may be long, but at least the journey has begun.

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