Sustainable Facilities & Infrastructure Training for the Military: An Air Force Reserve Command Case Study

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Overview of the Training

This paper contains the results and recommendations of the Sustainable Facilities and Infrastructure (SFI) training that Georgia Tech Research Institute (GTRI) performed for the HQ – Air Force Reserve Command (AFRC) at Warner Robins Air Force Base (AFB), Georgia on April 10 and 11, 2000. Thirty-five participants chosen by HQ AFRC took part in the two-day training session. The objective of this paper is to provide the reader with conclusions and recommendations in the following areas:

- Assessment of learning and team alignment
- Suggestions for sustainability objectives to be adopted by AFRC/CE
- Barriers likely to be encountered in implementing sustainability in AFRC capital projects
- Set of sustainability strategies with likelihood of success on AFRC capital projects
- Specific action items to be undertaken to implement sustainability on AFRC projects, along with responsibilities and target dates
- Recommendations for future activities to implement sustainability, including training and technical support recommendations

The basis for these conclusions and recommendations was provided by trainees during the training sessions. Interactive class participation took place in several forms during the training, including think-pair-share activities, group discussions, round robins, and completion of individual input sheets. This paper includes both raw data generated by these activities (included in the Attachments) and summaries generated by the trainees as part of the exercises. Further analysis is provided in the sections corresponding to each exercise, as well as in Part 3: Conclusions and Recommendations.

Table 1 shows the content covered during the two days of training. The training began with an overview of the context of sustainable capital projects, in which the participants were introduced to the basic theoretical concept of sustainability and how it pertains to built environment systems. This module included a Think-Pair-Share exercise to assess the participants' initial understanding of the concept of sustainability with respect to the built environment. This module was followed by an overview of seven categories of sustainable facility strategies, including:

- Site-related strategies
- Energy-related strategies

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- Water-related strategies
- Material- and system-related strategies
- Indoor environment and user-related strategies
- Project management strategies

Day 1 of training concluded with a session on the barriers to project sustainability, including an interactive exercise to elicit individual and group reactions to and perceptions of the benefits and risks of sustainability for AFRC capital projects.

Day 2 began with an introduction to sustainable decision making and introduced concepts of problem framing and challenges of information management. This module was followed by an introduction to the LEED building rating system, the most widely used sustainability assessment tool in the United States. The LEED system contains five categories of points, each of which was discussed in turn:

- Sustainable sites
- Water efficiency
- Energy and atmosphere
- Materials and resources
- Indoor environmental quality

The LEED module included two related interactive exercises. First, after each of the five LEED point categories was presented, participants were asked to choose which three points they believed would be most easily implemented in AFRC capital projects using a Think-Pair-Share voting technique. The votes were tallied to identify the three (or four) most easily implementable points for each category. The second part of the exercise involved dividing the trainees into five teams (corresponding to the five LEED categories) and tasking each team to identify the key barriers, benefits, and next step toward implementation for each of the top ranking points. At the end of this exercise, a spokesperson for each team papered the findings to the class as a whole.

The LEED module was followed by a presentation on the economics of sustainable facilities and infrastructure that covered assessment of project sustainability, expectations of the costs of sustainable projects, and strategies for achieving economically sustainable projects. The final session of Day 2 addressed the challenges of implementing sustainability for AFRC capital projects. The training concluded with two exercises to identify action items to increase the sustainability of AFRC projects and to articulate specific personal commitments from each trainee toward the goal of increasing the sustainability of AFRC projects. Table 2 shows the nature and purpose of the six interactive exercises that were conducted over the course of the training.

Table 1: Training Content

Day 1 – Introduction to Sustainable Facilities & Infrastructure **Monday, April 10, 2000**
Continental Breakfast and Welcome – 7:30 a.m. - 8:00 a.m. "Opening Remarks on Sustainability and the Built Environment"
Session 1 – 8:00 a.m. - 9:45 a.m. (105 minutes) "The Context for Sustainable Capital Projects" Lecture and active learning exercises to include: • Motivation for making the built environment more sustainable • The impacts of built facilities on humans and the environment • Sustainability from a systems perspective: Impact and flow model • Project planning, design, and execution processes in a typical capital project • Strategic entry points for sustainability in the capital project realization process
9:45 a.m. - 10:00 a.m. – Coffee Break (15 minutes)
Session 2 – 10:00 a.m. - 12:00 noon (120 minutes) "Sustainable Facility Strategies, Part 1" Lecture and active learning exercises to include: • Planning for sustainable capital projects • Mitigating impacts to site ecosystems • Identifying and integrating site resources • Sustainable energy systems
12:00 noon - 1:00 p.m. Lunch Break (60 minutes)
Session 3 –1:00 p.m. - 3:00 p.m. (120 minutes) "Sustainable Facility Strategies, Part 2" Lecture and active learning exercises to include: • Alternative building materials and systems • Sustainable water and wastewater systems • Indoor environmental quality • Project management strategies for sustainability
3:00 p.m. - 3:15 p.m. – Coffee Break (15 minutes)
Session 4 – 3:15 p.m. - 5:00 p.m. (105 minutes) "Barriers to Project Sustainability: Integrated Strategy Design" Lecture and active learning exercises to include: • Typical barriers to implementing sustainability in capital projects • The role of strategy integration Facilitated discussion on: • Barriers to sustainability in Air Force capital projects
5:00 p.m. Dismissal

Day 2 – Assessment and Economics of Sustainable Facilities & Infrastructure
Tuesday, April 11, 2000

Continental Breakfast and Welcome – 7:30 a.m. - 8:00 a.m.
"Recap of Strategies for Built Environment Sustainability"

Session 1 – 8:00 a.m. - 9:45 a.m. (105 minutes)
"Decision Making and Selection Strategies for Project Sustainability"

Lecture and active learning exercises to include:

- The role of measurement in making decisions for project sustainability
- The AGES process for identifying and prioritizing sustainability strategies
- Selecting indicators and managing data streams for tracking project impacts
- Introduction to the LEED Green Building Rating System

9:45 a.m. - 10:00 a.m. – Coffee Break (15 minutes)

Session 2 – 10:00 a.m. - 12:00 noon (120 minutes)
"The LEED Green Building Rating System"

Lecture and active learning exercises to include:

- Structure of the LEED rating system
- LEED point categories
- Calculating a LEED rating and preparing documentation
- Prioritizing opportunities using the LEED system

12:00 noon - 1:00 p.m.
Lunch Break (60 minutes)

Session 3 –1:00 p.m. - 3:00 p.m. (120 minutes)
"Economics of Sustainable Facilities & Infrastructure"

Lecture and active learning exercises to include:

- Myths and realities of the economics of sustainable capital projects
- Point of departure: how built facilities cost money
- Project classification by cost: The 3-D quantitative/qualitative cost model
- Itemizing, pricing, and comparing costs for capital project alternatives
- The cost of costing and the strategic value of information for sustainable capital projects

3:00 p.m. - 3:15 p.m. – Coffee Break (15 minutes)

Session 4 – 3:15 p.m. - 5:00 p.m. (105 minutes)
"Implementation: Avenues for Change"

Lecture and active learning exercises to include:

- Articulating and supporting project recommendations using sustainability cost-benefit analysis
- Basics of organizational change
- Sustainable project teams
- Project team alignment for sustainability

Facilitated discussion on:

- Strategies for incorporating sustainability into Air Force capital projects

5:00 p.m.
Course Evaluations and Dismissal

Table 2: Interactive Exercises Conducted during the Training

	Module	Exercise	Purpose
1	The Context for Sustainable Capital Projects	The meaning of sustainability for the built environment (Think-Pair-Share)	To assess initial understanding and alignment of trainees with respect to built environment sustainability
2	Barriers to Project Sustainability	Reactions to, benefits of, and risks of implementing sustainability (Individual input sheet; Small group discussion and round-robin)	To assess participants' perceptions about sustainability for AFRC capital projects following an introduction to the concept and specific project strategies
3	The LEED Green Building Rating System	Ease of implementation rating of LEED points (Individual ranking of points within categories; Think-Pair-Share selection of top three points for each pair; Selection of top three points for each category based on pair votes)	To identify specific LEED-related strategies that have the greatest likelihood of success on AFRC capital projects
4	The LEED Green Building Rating System	Barriers to, benefits of, and next steps for implementing top-ranking points (Small group discussion; paper back to group)	To identify challenges, motivations, and action items for implementing specific LEED strategies
5	Implementation: Avenues for Change	Action Items Input Sheet (Input sheet completed and submitted by individuals)	To identify action items that trainees feel AFRC must take to increase the sustainability of their capital projects, along with benefits, resources required, actions, and target dates
6	Implementation: Avenues for Change	Personal Commitment Input Sheet (Input sheet completed and submitted by individuals)	To identify specific commitments that each trainee is willing to undertake to increase the sustainability of AFRC capital projects

Findings from the Training and Recommendations

The final section of this paper describes the overall conclusions drawn from trainees' input during active learning exercises and makes recommendations for further activities to be undertaken by AFRC to increase the sustainability of their capital projects. This part of the paper includes an assessment of learning and alignment of the HQ-AFRC/CEV team, suggested sustainability objectives to be adopted as part of policy development, recommended project strategies and overall action items, barriers that should be addressed to successfully implement sustainability, and additional recommendations.

Assessment of Learning and Team Alignment

The initial benchmark established in the first interactive learning exercise revealed that most of the trainees had a good overall understanding of the meaning of sustainability for the built environment. The broad spectrum of answers identified in the Think-Pair-Share exercise also illustrated the need for a common operational definition or concept of sustainability as it pertains to buildings, i.e., one that is meaningful in terms of the kinds of facilities commonly encountered by AFRC practitioners. The common occurrence of terms such as "environmentally friendly" leaves room for multiple interpretations of sustainability. While room for interpretation may be key to successfully implementing sustainability on the diverse projects encountered by AFRC, more specific, measurable objectives should be established to aid in evaluating the success of actions taken to increase sustainability on future projects. The next section describes several suggested objectives in greater detail.

Team alignment is another factor that will be critical for successful implementation of sustainability objectives. From a strictly subjective standpoint, many training participants seemed to be actively engaged in the training process, providing one indication that these participants are interested in the concept of sustainability and willing to align themselves with the objective of making capital projects more sustainable. The quality of questions posed to the instructors showed that trainees were comprehending the material being presented and accurately identifying areas where more information was needed. On the other hand, not all participants were willing to complete personal commitment input sheets, and several were unwilling to sign their names to the sheets. This indicator may reflect the real challenge recognized by many participants of implementing the concept of sustainability – significant personal commitment, management backing, economic investment, and training will be required to undertake the necessary actions. Without full confidence that all resources will be in place, some individuals may not be ready to personally commit to the topic, and some may not yet have a clear picture of what such a commitment will entail.

One step towards clarifying the requirements of committing to project sustainability is the development of clear and measurable objectives to apply both at the level of individual projects as well as across the organization as a whole. The next section identifies suggested objectives that can serve as a starting point for developing an AFRC-specific vision, mission, goals, and statement of objectives for capital projects.

Suggested Sustainability Goals, Objectives, and Recommendations

Among the policy tools necessary to implement sustainability for capital projects are a common organizational vision, mission, overall goals, and specific objectives. Having completed the two days of training, AFRC personnel now have a basis for understanding the concept of sustainability and how it applies to capital projects. One specific step that should be taken at this point is to begin the process of developing these necessary policy tools. As a starting point for this process, this section identifies several goals along with specific, measurable objectives that could form a part of the AFRC's policy for sustainable capital facilities. These goals and objectives derive from participant inputs during the training, and fall into two basic categories: organizational/management goals and objectives, and project-specific goals and objectives. Tables 3 and 4 list suggested goals and objectives in these two categories. The two categories also correspond to recommended AFRC Action Items (Table 3) and Recommended Sustainability Strategies for AFRC Capital Projects (Table 4).

Barriers to Implementing Sustainability for AFRC

Several key themes emerged throughout the training as potential barriers to implementing sustainability. Proactively addressing these barriers will be important to further aligning the HQ team with the objective of sustainability, and will enhance the probability of successful implementation. These barriers are:

- Perceived Economic Impacts - participants have concerns that sustainable projects will cost more, if for no other reason than more research and management will be required in the early part of the learning curve and/or sustainable materials, contractors, and A-Es are difficult to find.
- Regulatory and Code Restrictions - getting approvals for less conventional technologies and materials may prove to be more difficult, and must be planned into the process.
- Individual and/or Organizational Resistance to Change - always a factor, particularly when some individuals have a stake in the status quo or when not everyone believes there is a need for change
- Lack of Necessary Knowledge - as with any new concept, participants feel a need for more education and training before implementation, to reduce the potential for failure, mistakes, or other embarrassment. Some participants are also concerned that without awareness of sustainability goals on the part of *all* project stakeholders (e.g., from top management down to the trenches), project team members may inadvertently work against each other.
- Lack of Management Buy-In - some participants are not yet confident that their forays into sustainable capital projects will be backed fully by management support, particularly if traditional metrics of project success (e.g., budget, completion time) do not prove to be favorable. Moreover, some participants have concern about changes in command, and are unwilling to commit to significant change given the possibility of a shift in management philosophy with personnel changes.
- Risk of Failure - participants do not want to be known as the champion of "the next asbestos"; wanting to wait until new technologies are demonstrated elsewhere is a common barrier to innovation.
- Lack of Appropriate Measures of Project Success - as with management buy-in, this barrier will require top-down rethinking of project metrics and support for projects that do not meet traditional project success metrics.

Table 3: Organizational/Management Goals and Objectives

GOALS	OBJECTIVES
Establish a common vision and mission for sustainability for AFRC capital projects	• Draft, circulate for review, and revise a vision and mission statement for AFRC project sustainability. • Revisit vision annually and revise to reflect new knowledge or project experience.
Establish the knowledge base necessary to implement sustainability in capital projects.	• Allocate <budget amount> for the purchase of sustainable facility reference materials. • Allocate <budget amount> to send <# of personnel> to LEED training to become LEED certified. • Allocate <budget amount> for in-depth training on sustainable facility practices for selected personnel. • Allocate <budget amount> for periodic refresher training for all AFRC/CEV personnel. • Establish a small working group to champion sustainability in AFRC projects, and give them authority to audit processes/projects and make recommendations for change.
Establish awareness of and alignment with sustainability vision/mission among all AFRC personnel and project team members.	• Develop and disseminate web site or other promotional materials to describe vision/mission to all AFRC personnel. • Conduct brief lunch n' learn sessions to introduce local personnel to sustainable facility principles. • Incorporate sustainability criteria in A-E and contractor selection.
Increase the sustainability of future AFRC capital projects	• Utilize the LEED rating system on all applicable future projects, and require a minimum rating of <bronze, silver, gold, or platinum>. • Identify at least one project per fiscal year to be developed as a showcase sustainable facility (achieving at least a <specified level> LEED rating), and develop interpretive displays, web sites, or other informational materials to illustrate the sustainable features of the facility. • Consider allocating <budget amount> and/or shifting responsibilities to allow sufficient resources for material and technology research on showcase projects. • Develop sustainability design review criteria, assign responsibility for checking compliance with these criteria, and establish and incorporate into contracts penalties and/or rewards to motivate compliance with the criteria.

Table 4: Project-Specific Goals and Objectives

GOALS	OBJECTIVES
Avoid development of inappropriate sites and reduce the environmental impact from the location of a building on a site.	Do not develop buildings on portions of sites that meet any of the criteria specified in LEED Site Credit 1, Requirements.
Conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity	• On greenfield sites, limit disturbance including earthwork and clearing of vegetation to 40 feet beyond the building, primary roadway curbs, and main utility branch trenches; OR, on previously developed sites, restore a minimum of 50% of the remaining open area by restoring the health of the soil and planting native or adapted vegetation. • Reduce the development footprint (including building, access roads, and parking) to exceed the local zoning's open space requirement for the site by 25%.
Limit disruption of natural water flows by eliminating storm water runoff, increasing on-site infiltration, and reducing contaminants.	Implement a stormwater management plan that meets LEED Site Credit 2 Requirements.
Limit or eliminate the use of potable water for landscape irrigation.	• Use high efficiency irrigation technology; OR use captured rain or recycled site water to reduce potable water consumption for irrigation by 50% over conventional means. • Use only captured rain or recycled site water for an additional 50% reduction (100% total reduction) of potable water for site irrigation needs; OR, do not install permanent landscape irrigation systems.
Maximize water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.	• Employ strategies that in aggregate use 20% less water than the water use baseline calculated for the building (not including irrigation) after meeting Energy Policy Act of 1992 fixture performance requirements. • Exceed the potable water use reduction by an additional 10% (30% total efficiency increase).
Achieve increasing levels of energy performance above the prerequisite standard (see LEED category 3) to reduce	Exceed the requirements of ASHRAE Standard 90.1-1999, demonstrated by a whole building simulation, by <x%>.

GOALS	OBJECTIVES
environmental impacts associated with excessive energy use.	
Verify and ensure that the entire building is designed, constructed, and calibrated to operate as intended, with third party quality control assurance.	Implement comprehensive best practice commissioning which at a minimum includes qualified, third party review of the following: basis of design, construction documents, and selective review of system-critical contractor submittals.
Reduce ozone depletion and support early compliance with the Montreal Protocol.	Install building level HVAC and refrigeration equipment and fire suppression systems that do not contain HCFCs or Halon.
Provide for the ongoing accountability and optimization of building energy and indoor environmental quality performance over time.	Comply with the installed equipment requirements for continuous metering as stated in Option B: Methods by Technology of the US DOE's International Performance Measurement and Verification Protocol (IPMVP) for the systems stated in LEED Energy Credit 5 Requirements.
Extend the life cycle of existing building stock, conserve resources, retain cultural resources, reduce waste, and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.	Reuse large portions of existing structures during renovation or redevelopment projects to levels specified by LEED Materials Credit 1 Requirements.
Divert construction, demolition, and land-clearing debris from landfill disposal. Redirect recyclable materials back to the manufacturing process.	Recycle and/or salvage at least 50% (or 75%) of construction, demolition, and land clearing waste.
Increase demand for building products that have incorporated recycled content material, reducing the impacts resulting from extraction of new material.	• Specify a minimum of 25% of building materials that contain in aggregate, a minimum of 20% post-consumer recycled content material; OR a minimum of 40% post-industrial recycled content material. • Specify an additional 25% of materials (50% total) that meet the aforementioned requirements.
Increase demand for building products that are manufactured locally, reducing the environmental impacts resulting from transportation and supporting the local economy.	• Specify a minimum of 20% of building materials that are manufactured regionally within a radius of 500 miles. • Of these regionally manufactured materials, specify a minimum of 50% that are extracted, harvested, or recovered within 500 miles.
Encourage environmentally responsible forest management.	Use a minimum of 50% of wood-based materials certified in

GOALS	OBJECTIVES
	accordance with the Forest Stewardship Council guidelines for specified wood building components.
Provide capacity for indoor air quality monitoring to sustain long term occupant health and comfort.	Install a permanent carbon dioxide monitoring system that provides feedback on space ventilation performance in a form that affords operational adjustments, AND specify initial operational set point parameters that maintain indoor carbon dioxide levels no higher than outdoor levels by more than 530 parts per million at any time.
Reduce the quantity of indoor air contaminants that are odorous or potentially irritating to provide installer and occupant health and comfort.	Paints and coatings must meet or exceed the VOC and chemical component limits of Green Seal requirements.
Provide a high level of individual occupant control of thermal, ventilation, and lighting systems to support optimum health, productivity, and comfort conditions.	Provide a minimum of one operable window and one lighting control zone per 200 sq. ft. for all occupied areas within 15 feet of the perimeter wall.

Barriers, cont'd.

- Project Procurement Processes - existing checks, balances, and fragmentation of responsibilities among organizational departments makes the smooth integration of a new concept very difficult. One participant remarked, "Congress will have to release control to implement [this concept]".
- Potential Conflicts with Mission Requirements - without careful definition of sustainability goals and objectives, some participants were concerned that mission requirements might take second priority.

Additional Recommendations for Breaking Barriers

In addition to the actions recommended in Tables 3 and 4, each of the barriers identified in the previous section can be addressed in various ways. The following subsections describe suggested barrier breakers for each of the nine barriers described in the previous section.

Perceived Economic Impacts

Given the fact that the A/E/C industry is still in the early part of the learning curve, the perception that sustainable projects cost more is a valid one. In most cases, sufficient data does not exist to support or refute this perception. Given the degree to which most projects are cost-driven due to budget processes, one way to address real or perceived economic barriers is to explicitly build in a cost factor to address potential additional cost items such as time for research or collection of information, delays or additional costs for acquiring unusual materials or building systems, premiums for hiring knowledgeable A-E firms or contractors, and the cost of sustainability evaluation for facility projects.

An alternative approach is to begin with low- or no-cost sustainability solutions in order to establish a history of project economic success. Such solutions could include reuse of existing structures such as in the Homestead project, or elimination of irrigation systems via the use of native plantings. In other cases, projects with rapid payback (e.g., within a single budget cycle) can provide the basis for demonstrating economic success with sustainable projects.

In either case, documentation of the economic impacts of project sustainability is paramount. Additional training that includes more case studies with economic data can also help to ameliorate perceptions that sustainable projects cost more.

Regulatory and Code Restrictions

The concern that sustainable projects may have a more difficult time with code approval can be a real barrier, depending on the familiarity of enforcement officials with alternative building technologies and their willingness to appreciate alternative interpretations of the building codes. Strategies for addressing this barrier include compilation of case studies/success stories from similar buildings, locating precedents in other states, localities, or installations, and taking responsibility for demonstrating the viability of proposed alternative approaches to enforcement officials. Options include providing background information to the code official and demonstrating viability via simulation, modeling, or bench scale testing.

Individual and/or Organizational Resistance to Change

Many reasons to resist change exist, including difference in perceptions, additional burdens or new responsibilities, lack of management support, or incongruence with organizational or personal norms. One approach to minimizing resistance to change is to explicitly articulate the costs and benefits that can result from the change, thereby providing better information as a basis for a more sound reaction to the possibility of change. As discussed in Module 4 of the training, more information and a clear articulation of the vision behind the change can increase alignment of the team behind the change. Identification, education, and top management support of key players is critical to generating the momentum necessary for change. Also critical to facilitating change is the provision of necessary resources, tools, policies, and procedures to ensure that everyone has the same understanding of what the change entails and how to implement it. Finally, choosing battles wisely to ensure short-term victories is important to avoid demoralizing even the most ardent champion of change.

Lack of Necessary Knowledge

Lack of necessary knowledge is an underlying barrier to many of the other barriers described in this section. While the introductory training for HQ stakeholders has provided a point of departure for establishing a common knowledge base and vision for capital project sustainability, it is likely that additional training will be needed to provide the tools and techniques for actually implementing sustainability techniques for real projects. Additional information in the form of case studies, field trips, and other examples can also help to bridge the gap between idea and implementation, as well as overcome misperceptions about likelihood of success, economics, or stakeholder buy-in.

Alternatives for providing necessary knowledge include establishment of a resource center for HQ personnel (e.g., reference materials, product samples, case studies), follow-on training for specific project strategies, refresher training on a periodic basis, or development of customized, detailed procedures and guidelines for sustainable projects. Finally, nothing works better than actual experience, which may be attained by trial of new strategies or by adding experienced personnel to the HQ or project teams.

Lack of Management Buy-In

Lack of management buy-in was frequently mentioned by participants, and stems from the very real concern about what will happen with change of command. This barrier can be addressed by emphasizing policy trends at a federal level that are increasingly requiring sustainability concerns to be considered in capital projects. Other approaches could include establishing a sustainability functional unit or working group of permanent staff that can provide continuity in the event of a change in command. Ultimately, the only way to address this concern is to establish the organizational infrastructure that can sustain itself without management buy-in in the long term. Training, promoting successes, investment in knowledge resources, and creating awareness of (and subsequent demand for) the benefits of sustainable facilities among *all* facility stakeholders can help to achieve this end.

Risk of Failure

Risk of failure is a real concern with respect to any innovation, and can be addressed in two primary ways. First, more information (e.g., raw data, case studies, analysis tools) can lead to

better decisions with a lower risk of failure. However, obtaining and processing that information will require an expenditure of additional resources. A second strategy is to manage the penalties associated with failure, particularly when it stems from an attempt to be innovative while seeking to achieve sustainability objectives. Establishing a knowledgeable core team that can provide guidance and review of decisions will help to minimize the risk of failure from innovation.

Lack of Appropriate Measures of Project Success

Traditional metrics of project success such as total installed cost or attainment of schedule are sometimes a barrier to achieving project sustainability. Consideration should be given to establishing additional project metrics that are performance based (e.g., via whole project commissioning to ensure functionality to design specs), life cycle oriented (i.e., that take into account not only front end costs but also operations, maintenance, and end of life cycle costs), and environmental (i.e., that weight as important issues of ecological impact and human health, safety, and livability). While such metrics may be a challenge to calculate, they may significantly impact the perceptions of success at all management levels for facility projects.

Project Procurement Processes

The way in which projects are initiated, scoped, contracted, and turned over for occupation can be a significant barrier to sustainability. Fragmentation and failure to convey information between parties as a project passes from initiation to contracting can result in sustainability features being "value engineered" out of a project in the interest of reducing installed costs, while significantly increasing life cycle costs.

Changes in policy to improve the procurement process is one way to address this barrier, although such changes will likely only take place over time. More immediate strategies include training and education of *all* project stakeholders about the AFRC's vision and mission for project sustainability, better documentation of design decisions that gets passed on to contracting, and feedback review of downstream changes. Application of life cycle-based metrics of project acceptability can also ensure that both contracting and engineering are making decisions on the same basis.

During the early phases of a project, special attention to articulation of a sustainability vision, development of project-specific sustainability objectives, and allowing all team members to provide input and achieve ownership in the project goals can also help to reduce the barrier of project procurement processes.

Potential Conflicts with Mission Requirements

The final barrier stems from the possibility that implementing sustainability strategies for a project may compromise the ultimate performance of the facility with respect to mission requirements. Two approaches can help to mitigate this barrier: better knowledge, and reframing of the mission to include sustainability. First, better knowledge about the likely performance of sustainable facility technologies and strategies can provide a greater confidence that they will perform as intended. The strategies described under "Lack of Necessary Knowledge" can help to provide this knowledge.

Second, reframing the mission of the AFRC to include sustainability is in alignment with the established mission of the Air Force in that the health of its people and their environment is basic to the survival of the United States (see *US Air Force Environmentally Responsible Facilities Guide*). Increasing the health and productivity of Air Force personnel is not only a key facet of facility sustainability, but also a method for increasing mission capability. The basic requirement is to understand that sustainability is an anthropocentric–i.e., people-centered–concept, just as is the Air Force mission. With an alignment of sustainability with the Air Force mission, the implementation of sustainability will enhance, not degrade, the ability of our forces to meet mission requirements.