2009 BFRL Project Description

Project Title: Economic Support for BFRL

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Principal Investigator: Robert E. Chapman, x2723

Co-Investigator(s): Douglas Thomas, x4918
David Butry, x6136

BFRL Program: Cybernetic Building Systems

Objective: To provide delivery through the ASTM Building Economics Subcommittee, the measurement science to help the building community evaluate new technologies, choose economic material/design combinations, and choose cost-effective, life-cycle management practices, while constructing affordable buildings that optimize building life-cycle performance.

Problem:

What is the problem? The problem is that essential methods, metrics, and tools needed for measuring economic performance are unavailable (1) for industry to choose the most cost-effective building technologies, designs, and practices, and (2) for the energy, fire, and homeland security agencies to choose the most cost-effective technologies, policies, and equipment for energy conservation, for protecting first responders and potential victims from injury and death, and for reducing disaster-related losses to constructed facilities. The need for this work is directly traceable to the Scope of ASTM's Building Economics Subcommittee, which describes industry's need for "…standards that serve as guidelines for making building and infrastructure choice, design, construction, operations, cleanup, and disposal decisions based on economic analysis." The Scope further states that standards will include "…definitions of economic techniques and terms; practices or methods related to economic evaluation; guides to help in the selection of appropriate economic methods and techniques; classifications of building, construction, and site related elements or components; and adjuncts of data, software, techniques, and other aids that support use of the standards."

Why is it hard to solve? These problems are hard to solve because it is difficult to find any one or group of organizations that has the will to tackle these problems and can muster the technical capability, industry respect, experience in writing draft standards, and financing to provide these metrics and tools.

How is it solved today, and by whom? The problem has not been solved, although significant progress has been achieved through the efforts of the ASTM E06.81 Subcommittee on Building Economics. Today government agencies and building industry decision makers typically make

building choices on the basis of the best available information and their historical practices. The resulting, *ad hoc* decision making contributes, for any given budget, to a lower level of building performance and safety, however, than might be obtained with standardized, technically correct measurement tools, as supported by this project.

Why NIST? Given BFRL's measurement science capabilities in building energy technologies, disaster resilient construction, and economic methods, and given its mission/vision to be the source of solution-enabling tools to promote innovation, it is ideally situated to develop these critical economic measurement tools. This project supports the strategic goal "Measurement Sciences for Net Zero Energy, High-Performance Buildings" and it aligns with the core competency "Measurement Science for Building Energy Technologies."

Approach:

What is the new technical idea? The significant idea behind this research is the provision of a suite of services and products, administrative and technical, which together achieve greatly improved and widespread benefit-cost measurements of new building technologies. The approach combines identification of needed project measures of merit (collaborations with industry); developing a technically-correct, user-friendly way of implementing the measures (technical research and development to produce draft standards and software tools); and shepherding the product through a consensus process to assure acceptance and use (ASTM leadership). BFRL is uniquely positioned to lead in carrying out each step in developing this integrated, interdependent suite of economic methods, metrics, and tools because of its economics expertise and experience, and because of its leadership in the standards community. The technical challenge is to develop practical standard methods and tools that will enable decision makers to compute acceptably accurate measurements of benefits and costs of alternative technological choices, within a reasonable time period, and at reasonable expense and effort. The administrative/leadership challenge is to achieve through the ASTM structure a body of consensus standards that industry and government will promulgate and use.

Why can we succeed now? Three attributes of the staff will help BFRL succeed in bringing these new metrics, methods, and tools to successful implementation. Staff have the required technical economic/programming skills, the experience in shepherding standards from draft to completion, and the administrative ability and positions in standards committees to facilitate standards development. Furthermore, the 45 members of the ASTM E06.81 Subcommittee on Building Economics and over 600 ASTM E06 Committee members on Building Performance and Constructions provide an excellent user base as well as industry marketing spokespersons for BFRL's research embodied in standards and supporting software products.

What is the research plan? Chapman will continue the administrative and technical leadership within the ASTM E06.81 Subcommittee on Building Economics as permanent secretary to the Subcommittee and as permanent chair of the Techniques Task Group responsible for standard economic methods. With continuing collaborative OA funding from DHS and DOE, Chapman

will revise and shepherd through balloting standards associated with natural and man-made hazards as well as standard methods applicable to energy conservation. The primary mechanism for widespread dissemination of the measurement methods we develop will be through ASTM standards in the form of economic methods, guides, classifications, metrics, and technically-correct, user-friendly software tools for implementing the measurement methods. The project team will continue to provide consulting in economics, statistics, and operations research in support of the BFRL staff, and Thomas will update the macroeconomic data on building and construction for use by BFRL Headquarters and staff in making program presentations and measuring BFRL impacts. Chapman and Butry will collaborate with Helgeson and Huang on the production of a suite of archival journal articles treating theoretical and empirical considerations in environmental economics. Thomas will produce an article describing the construction industry macroeconomic data methodology and submit it to an archival journal. Chapman will produce an article describing the benefits of using ASTM building economics standards on a large construction project and submit it to an archival journal. Throughout the course of this project, Chapman will identify BFRL research products—metrics, data, protocols, and software—suitable for submission to ASTM as draft standards. Chapman will select products for submission to ASTM from BFRL's economics portfolio of STRS and OA projects with an objective of promoting the dissemination of our research on energy conservation, sustainability, integration and automation, fire, and disaster resilience to industry practitioners.

Recent Results: Accomplishments in FY 2008 include production of a white paper on macroeconomic construction data for BFRL management use, major revisions to an ASTM sanctioned workshop on how to apply Standard Guide E 2506, and teaching of the workshop under the auspices of ASTM in collaboration with the DHS Science and Technology Directorate.

Output: Thomas, D.S., and R.E. Chapman. "2007 Construction Industry Statistics: Preliminary." June 2008. White Paper.

Output: Taught ASTM-sanctioned course *Economic Tools for Developing a Cost-Effective Risk-Mitigation Plan for Reducing Damages to Constructed Facilities from Natural and Man-Made Hazards* September 2007.

Output: Revised ASTM-sanctioned course *Economic Tools for Developing a Cost-Effective Risk-Mitigation Plan for Reducing Damages to Constructed Facilities from Natural and Man-Made Hazards* February 2008.

Output: Taught ASTM-sanctioned course *Economic Tools for Developing a Cost-Effective Risk-Mitigation Plan for Reducing Damages to Constructed Facilities from Natural and Man-Made Hazards* April 2008.

Standards and Codes: The development of most ASTM E06.81 standards was funded directly by this project. Benefits from these standards have accrued to individuals, businesses, and governments in the form of reductions in the costs of energy and in the total costs related to disasters, i.e., protection costs combined with reduced property damages, deaths, and injuries.

Outcome: Development of ASTM E06.81 standards.
Impact: Industry adoption and use of ASTM building economic standards.