

## **Integrated Processes in Building Construction**

### **A Leadership Opportunity for the Federal Sector**

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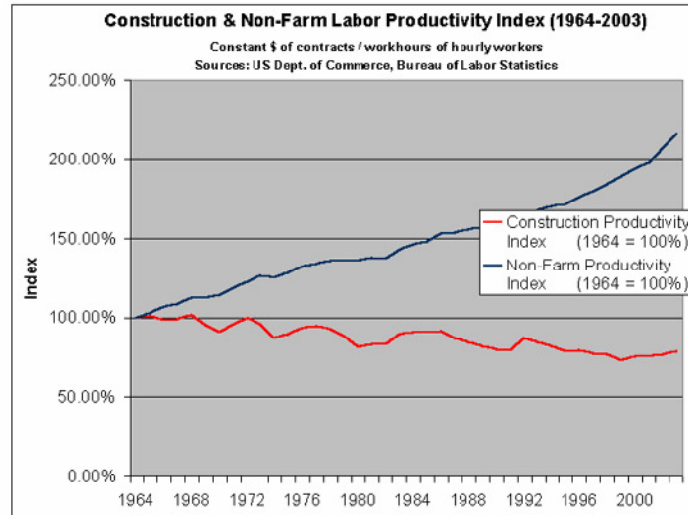
### **Abstract**

The business model of the construction industry remains essentially unchanged since the Renaissance. The challenge for building owners is to create a new integrated business model that optimizes the likelihood of successful results on our projects – while maintaining the valuable historical attributes of the construction industry culture.

As the largest consumer of design and construction services in the world, the United States Government is uniquely positioned to benefit from improved efficiency in the construction industry. Agencies are beginning to explore ways to change their business process by leveraging the benefits of new technology – and their influence will be profound.

## Overview

The business model of the construction industry remains essentially unchanged since the Renaissance. Team members are identified by trade or professional specialties that have their origins in medieval guilds. The awkward and fragmented structure of the industry leads to inefficiencies and communication problems which reduce our productivity. The challenge for building owners is to create a new integrated business model that optimizes the likelihood of successful results on our projects while maintaining the valuable historical attributes of the construction industry culture.



*Labor productivity for non-farm U.S. Industry*

In the past 25 years, most U.S. industries have experienced a significant increase in productivity gained by the effective use of technology. Based on U.S. Bureau of Labor Statistics, Stanford University compiled a graph showing that, in stark contrast to other U.S. industries, the construction industry experienced almost no gains in productivity in the past 30 years. Although electronic tools are used routinely in design and construction today, our fragmented business model prevents us from benefiting from productivity gains as much as others. Supporting evidence came from the 2004 NIST publication *Cost Analysis of Inadequate Interoperability in U.S. Capital Facilities Industry* claiming that \$15.8 billion per year is lost in the construction industry due to lack of interoperability in software platforms used for design and construction operations.

Building owners took note. The Construction Users Round Table AEC Productivity Subcommittee, chaired by Gertrude Brietkopf of GSA, published a white paper entitled *Collaboration, Integrated Information and the Project Lifecycle in Building Design, Construction and Operation* in August 2004 which concluded that “The goal of everyone in the industry should be better, faster, more capable project delivery created by fully integrated, collaborative teams.” Their four recommendations:

- Owner leadership
- Integrated project structure
- Open information sharing

- Building information models

As the largest consumer of design and construction services in the world, the United States Government is uniquely positioned to benefit from improved efficiency in the construction industry. Approximately \$ 900 billion per year is spent for maintenance and operation of the federal government's vast real estate assets. The Department of Veteran Affairs is the largest operator and owner of medical beds in the United States. The U.S. Postal Service is the largest owner of commercial real estate in the world. U.S. Government agencies are beginning to explore ways to change their business process by leveraging the benefits of new technology and their influence will be profound.

### The Government has a History of Leadership in Construction Process Innovation

Leadership in the construction sector is not new to the U.S. Government. Important process tools such as CPM scheduling were developed under government programs. Today, several agencies are actively modifying their construction programs with good results.



#### *The Pentagon Renovation Program operates under a unique aspirational contract*

In 2001, the Pentagon renovation program, led by DBIA CEO Lee Evey, wrote an aspirational design-build contract that focuses on results and motivates team participants to solve problems. Section C of this innovative contract states:

*“The Government expects to be involved in design decision-making as these solutions are determined, but recognizes the Contractor's essential role. The Government, in turn, has established an incentive structure that will readily and meaningfully reward these behaviors, but reward must be earned--there is no guaranteed profit or fee. Trust that each partner will act in accordance with these expectations is*

*essential to maintaining the relationship that will enable this contract to succeed.... The Contractor must understand that both parties will view the contract and the relationship similarly--if the Government is greatly pleased with the Contractor's performance, the Contractor will be greatly pleased with the Government's reward. The converse is obviously true as well."*

Under the leadership of General Charles Williams, the State Department's Overseas Building Operations (OBO) department embarked in 2002 on an ambitious construction program called Standard Embassy Design (SED) that will ultimately replace 213 U.S. embassy facilities. The SED program uses design-build procurement, and each project is based on a repeatable kit-of-parts design methodology, or template design. OBO internal planning staff provides preliminary design and site plan information for each project. The performance criteria, adjacencies and materials are essentially identical for each project, after taking local factors such as climate and seismic zone into consideration. Speed of construction is essential to this program and current construction schedules range from 24-40 months. The State Department wants to get its personnel out of harm's way as quickly as possible.

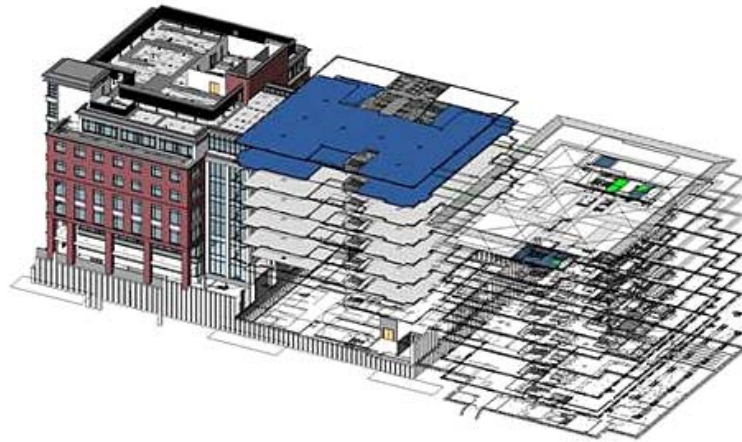
GSA is committed to experimenting with effective ways to use building information models. Encouraged by the efficiencies and team collaboration experienced in the Eugene, OR Courthouse which was delivered on time, on budget and with minimal RFIs, GSA is including requirements for the BIM models through the conceptual design phase in their new construction projects. One of their current pilots, the Jackson, MS courthouse uses virtual walk-throughs and 3D extrapolations in a specially configured screening room to replace the plywood courtroom mock-up that was previously standard for GSA Courthouse projects.

The U.S. Coast Guard has developed a database of geospatial and architectural information to provide an enterprise-wide strategic asset management program. Although they do not engage in as much construction work as other agencies, their success with technology and ready access to geospatial data allowed them to perform exceptionally well during Hurricane Katrina rescue operations.

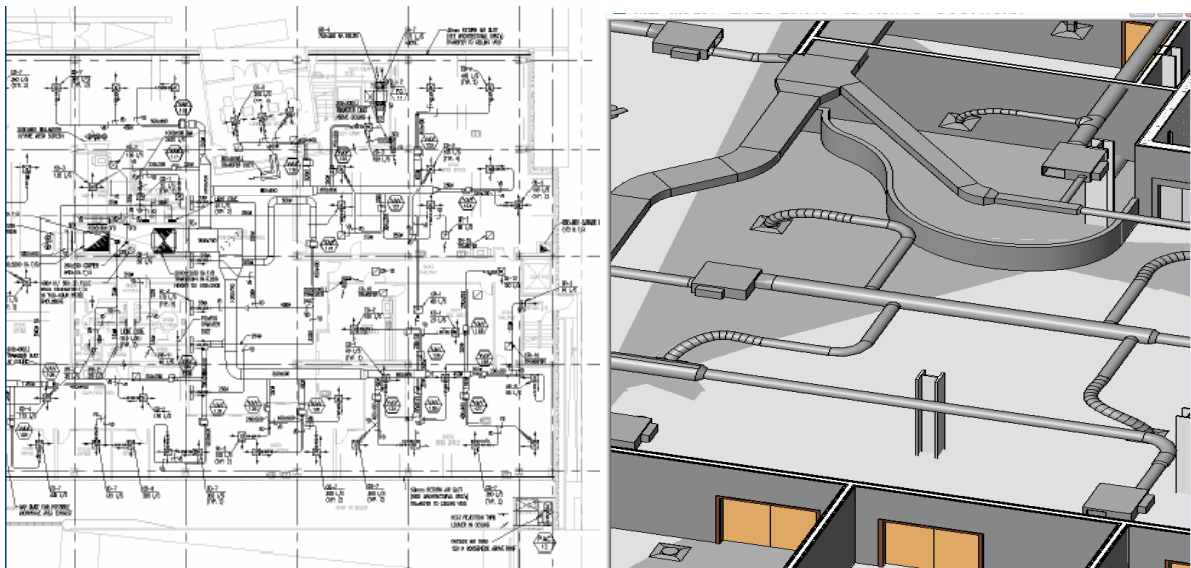
## **The Benefits of Building Information Models**

Building information models (BIM), recommended by the CURT Subcommittee, are vehicles for changing the nature of design and construction. The essential difference between BIM and CAD is through the use of objects rather than abstract shapes. A door is not merely a line and an arc in a BIM model; it is a graphic object with mathematical and other properties that reside in a database. Once a door is created, the software automatically includes it in the door schedule. If the door is graphically changed on the drawing, the attributes in the schedule are automatically adjusted.

The most immediate and profound attribute of a BIM model is its ability to facilitate visual decision making. Geometrically accurate 3D representations of any portion of the building can be quickly derived. Unlike 2D drawings which are frequently schematic in nature, BIM models require precise information at an early stage of design. Complete and geometrically accurate 3D views of design allow for quicker and more informed decisions by all members of the project team. Design alternatives are easier to generate and understand.



*A building information model*



*Traditional 2D coordination drawings (left) are difficult to interpret. The ease of finding conflicts and errors in 3D (right) is one of the significant benefits cited by early adapters of BIM technology and leads to fewer RFIs and change orders.*

The ability of BIM software to solve complex geometric equations and process large amounts of data allows it to identify spatial conflicts between building components, which enables the design team to correct these problems well in advance of construction operations. Early adopters of this technology uniformly report a reduction in RFIs, change orders and site conflicts. The program excels when computationally intense information is required. Reports of floor areas, building volume, material quantities and space utilization can be instantly generated. Life cycle costing is readily achievable. Simulation applications exist to analyze structural properties, energy consumption, blast resistance, acoustics, fire containment and other attributes.

When subcontractors and fabricators are involved in the early stages of design development, their specialized knowledge is captured in the model. Construction sequencing and fabrication can be evaluated at the DD phase. Unlike the 2D drawing process, the first object drawn in a BIM design may still be present in the final construction documents. Virtual construction sequencing, also known as 4D, allows contractors to understand the spatial dimension of their critical tasks, to avoid conflicts between trades and to choreograph the job site efficiently. The Contractor can initiate staging and sequencing plans at an early stage with BIM.

Of particular relevance to design-builders is that BIM lends itself to an integrated project delivery method. It is a supply chain solution.

## Saving Money

Real time cost estimates derived from BIM models are on the horizon. In addition to that profound change, BIM has the inherent capability to reduce costs in the following manner:

- It accelerates the design process so that changes can be made early in the design process without a huge impact to cost.
- The accuracy of the model and its ability to communicate effectively to subcontractors reduces the number of RFI's during construction.
- A bill of materials and quantity take off data can be automatically generated by the model which produces a cost estimate much more quickly than the conventional process.
- If the model survives beyond the construction phase and is incorporated into the facility management, including assignment of spaces and occupancy, much effort and expense can be saved.

Because the technology is relatively new and its implementation is a significant departure from existing standard practices, it is not easy to establish hard metrics to demonstrate benefits. There are anecdotal reports of significant accomplishments on unique projects, such as Disney Concert Hall and the Denver Art Museum, but few have sufficient history using BIM on iterative projects to calculate savings with certainty.

One owner, who wishes to remain anonymous, has made an effort to document the benefits of BIM for their company. This media/entertainment giant has constructed many sophisticated roller coasters in the past decade and used their first experience with BIM as an opportunity to measure the difference between their historic experience with roller coaster construction and their new process. They believe that they achieved a budgetary savings of 25% and a schedule reduction of 15%. They also believe that their performance will improve more as they gain more experience with the technology.

Geometric accuracy in BIM technology facilitates decision making. The section of track and associated framing in the model (left) are almost identical to the constructed section (right)

## Opportunities for Owner Leadership

Building owners are the largest beneficiaries of a BIM-enabled process. In addition to better budget management, it is easier to make informed decisions. As de facto CEO of the construction project, the building owner is in a position to create an appropriate business environment that will optimize the use of the technology and produce the best possible result. Owners are also the best positioned to take a hard look at current business practices and change them if they do not add value to the process. The following suggestions indicate ways in which federal owners can improve their business model.

### **Eliminate out-dated language in standard contracts**

Many boilerplate contracts contain a hodgepodge of language that was developed in response to historic or unique circumstances that are not useful for an integrated process. Eliminate unnecessary or onerous contract clauses and tailor contract language to establish a foundation a trust among team members. The DC Court of Appeals, currently embarking on a \$110 million renovation and addition, decided to completely revise their boilerplate contract and incorporate industry standard language from AIA Documents. A review of their existing boilerplate contract, which was based on a generic DC Government procurement contract, revealed six separate anti-collusion and anti-bribery clauses, two sections related to a drug-free environment, a lengthy and poorly worded requirement for an apprentice program and no mention of shop drawings, construction administration or substantial completion.

### **Develop new contracts to foster collaboration and trust**

As stated by GSA's Steve Hagan and Kristine Fallon of Kristine Fallon Associates in AIA's Report on Integrated Practice, "Delivery models must motivate all participants to optimize value of the end result, realizing that motivation derives from financial gain. There is a need to articulate project goals, define metrics and experiment with contract alternatives that link participant's financial rewards with project goals."

### **Establish buffers to deal with inevitable changes**

Construction projects are complex and highly variable. The process requires agility to endure labor problems, material shortages, sudden price increases and bad weather. Establish rules and a project structure that allow the project to manage problems well.

### **Team roles**

How will information be shared on the project? Who manages the model? What kind of electronic project management and collaboration software will be employed? The Owner is the entity best positioned to make these decisions for the entire team.

### **Coordination and conflict resolution**

Develop a process that tracks problems and resolves them quickly. Anticipate unforeseen issues and make conflict resolution a routine part of the business process.

## **Procurement**

The time-honored tradition of mandating competition through generic specifications is not a bad practice, but it is time consuming to administer the bidding process for the multitude of products required on a large capital project. For certain key components it may be better to establish a long term relationship with trusted vendors and execute an agreement that includes favorable pricing. Many government agencies utilize GSA Schedules or other vehicles of pre-qualification for this purpose.

### **Include team IT costs in your budget**

BIM requires intensive computer resources and computer infrastructures will require investment and upgrade. The owner can establish requirements for IT platforms and evaluate their capability early in the project so that difficulties during the inevitable crisis and deadlines mode are avoided. Requirements for training users and retaining software consultants should be included in the project budget.

### **Develop content for mission critical components**

Expertise is difficult to find in the early stages of technology adoption. The chance for failure expands if these sophisticated tools aren't employed with sufficient planning and guidance. The federal owner can minimize the A/E/C learning curve by providing a technological toolbox. If agencies develop libraries of objects or modules for their template designs with embedded or hyperlinked specifications, it will create fewer opportunities for deviation from the project goals, make the model leaner and lessen the work load for the A/E.

## **Asset management**

The government maintains its real estate assets for an indefinite period of time and has complete responsibility for property management. Life cycle costs and maintainability are key concerns. On February 4, 2004, OMB issued an executive order to establish policy regarding "the efficient and economical use of America's real property assets". Federal owners are uniquely positioned to develop an asset management solution that is an extension of the BIM model.

BIM technology is well suited for asset management. The program can instantaneously report changes in floor areas due to design changes.

The task before the construction industry is business process re-engineering and it is not a small task. What will the new process look like? It's impossible to predict. We need time to implement and evaluate new systems. However, when we achieve our overall goals of improving performance and reducing cost, everyone will benefit.

**About Barbara Golter Heller**

Barbara Golter Heller, FAIA, is CEO of Design + Construction Strategies, LLC, and an expert in the field of architectural and construction information management. In her distinguished career as founder of Heller & Associates and current president of Heller & Metzger,

Heller participated as an architectural consultant on more than 500 construction projects for a wide range of building types. She served on the AIA Documents Committee for 15 years. Heller received a B.S in architectural studies from the University of Illinois and is registered in the District of Columbia.

**About Design + Construction Strategies, LLC**

DCStrategies is dedicated to business technology implementation and the creation of IT-enabled culture in the AEC community.

Our clients include the U.S. Department of State, the General Services Administration, the International Code Council, Autodesk, Inc. and Greenway Consulting.

More information is available at [www.dcstrategies.net](http://www.dcstrategies.net).

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