Interoperability, the ability to share electronic information seamlessly among all participants on a construction project, and building information modeling (BIM), the computer-assisted design process whereby 3-D and 4-D images are developed, will forever change the way we design and construct buildings.

Looking at the Last Several Decades

It was the federal government’s Telecommunications Act of 1996, which permitted local telephone companies to compete for customers with long-distance carriers, that was at the forefront of an information explosion as each of these new telecommunication companies sought to build their own fiber-optic infrastructure to connect Internet users around the world.

One such fiber-optic company, Global Crossing, gambled that these local, national, and international phone companies would have a huge demand for transmission lines, and banking on an explosion in the new digital technology, began laying fiber-optic cables to bind the globe together. Though Global Crossings itself is no more, the fiber-optic networks they installed now connect the world, and are only beginning to reach their potential.

The fiber-optic infrastructure and “open protocols” allow digital devices to “talk” to each other, resulting in a global communications network. With the advent of HTML (Hypertext Markup Language), URLs (uniform resource locators) that locate and display web pages universally, and HTTP (Hypertext Transfer Protocol) to move these documents around,
the need for interoperability became apparent as new software and program developers began to introduce their own proprietary language. By the end of the 1990s, 2-D design had progressed to 3-D, affording architects, engineers, builders, and owners the opportunity to view a virtual model of the construction product.

Construction software company Autodesk®, with their product Revit®, produced a CAD system that was data-based so that a Bill of Quantity list of materials incorporated in the design would be produced as the project progressed. Figure 16-1 is a composite of three components produced by the Autodesk® design process: a plan view (lower right), a take-off of materials (upper left), and a 3-D model of the building (upper right). Any change in design is then reflected in a change of the list of building materials and the 3-D model. The global fiber-optic network permitted various segments of design to be outsourced anywhere in the world, with the potential to not only reduce costs but to speed up the entire design process. The end of the workday in New York is now the beginning of the workday half way around the world.

Eventually, off-shore engineering companies in India began to advertise their services over the Internet. As one company said: “We offer a top-flight engineering service. Why pay $53,240 for a CAD drafter in Los Angeles, when we can supply fully qualified people at about $12,000 per year?” Another site stated: “They have a 35-hour workweek in Europe. Here in India we have a 35-hour workday.”

**Contractors Slow to Embrace Technology**

Many contractors were, and still are, reluctant to embrace these new technologies with their ability to store and retrieve information electronically. Builders cited many reasons for hanging on to paper documents. The following lists a few of them:

- The cost of hardware and software is still too expensive.
- They still don’t have full confidence that information won’t be lost through computer “crashes,” or from a temporary loss of power.
- The old say: “We’ve always done it that way. It works, so why change?”
- Contractors routinely communicate with subcontractors and vendors who don’t use computers for anything other than payroll and accounting functions.
- Local, county, and state offices frequently require some paper format and documentation for filing.
- Requirements for original seals/signatures on documents filed with various government agencies are still out there.
FIGURE 16.1  Autodesk® Revit® software showing plan view, bill of quantities and 3D image. (By permission: Autodesk® Revit® Structures U.S.A.)
The use of electronic media on the construction site by employees not accustomed to the medium is inefficient and therefore prone to inaccuracies.

Belief that paper records are more official and are legally more acceptable than stored electronic data.

There is no real incentive to work electronically.

The Construction Finance Management Association (CFMA) reported in a recent study that EXCEL is the most widely used software application in today’s businesses, and that predominant construction industry software includes AccuBid, Bidmaster Plus, McCormick Estimating, and Precision Collection. The most common forms of project management software is Primavera Enterprise and Expedition and Prolog Manager. Only 25 percent of the construction firms surveyed by CFMA used collaborative software such as Buzzsaw, Constructware, or Meridian Project Talk. The scheduling software used is primarily Suretrak and Primavera.

**Interoperability—what is it and why is it so important?**

One definition of interoperability is the ability to exchange and manage electronic information seamlessly, and the ability to comprehend and integrate this information across multiple software systems. Another definition is “an open standard for building data exchanges.” Interoperability simply means that your system can “talk” to mine, and we can all “talk” to the designers, contractors, subcontractors, vendors, and owners’ representatives in the same electronic language. There is little interoperability in the AECO (architect, engineer, contractor, owner) community today, but many organizations, recognizing its importance, are aggressively attacking the problem—a problem not confined to the design and construction communities.

One German automobile manufacturer was alerted to the problem of interoperability after receiving a fair amount of customer warranty complaints about various system component failures in the electronics installed in their high-priced models. Apparently, there was no central protocol in place governing or controlling the “language” of computer chips supplied by each of those disparate component vendors, and when all of these parts from a variety of suppliers were installed, they could not “talk” to each other, which manifested itself, in the eyes of the customer, as a system failure. It took some time to uncover the cause and correct the problem, but in the meantime there were a lot of very unhappy customers.

Recently, several trade and private organizations have begun to recognize the missed opportunities and tremendous cost of not fully
embracing interoperability and the resultant seamless integration of the entire project’s database—from design to construction to commissioning and continuing, on through the building’s entire life cycle.

The NIST report. In 2002, the National Institute of Standards and Technology (NIST) concluded their study to quantify the cost for inefficient interoperability in commercial, institutional, and industrial facilities for both new and “in place” construction. According to NIST, this inability to seamlessly exchange and manage electronic information in the construction industry adds an astounding $6.18 per square foot to project costs in addition to operations and maintenance costs of $0.23 per square foot. In total, inefficient interoperability cost the construction industry, per this report (see Fig. 16-2), a whopping $15.8 billion in 2002. The manufacturing sector has dealt with this problem with considerable success, but it should be kept in mind that, on the whole, they deal with a flow of similar products in a controlled environment, and they also enjoy economies of scale. The construction industry is mainly a one-off product and even when a similar product is built, say a motel chain project or a fast food restaurant, various zoning and building regulations and site conditions frequently impact the structure’s basic design.

In the September 2004 issue of Architectural Record magazine, Mr. Ken Sanders, FAIA, author of the mid-‘90s book The Digital Architect, 

<table>
<thead>
<tr>
<th>Stakeholder Group</th>
<th>Planning, Design, and Engineering, Phase</th>
<th>Construction Phase</th>
<th>Operations and Maintenance Phase</th>
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<td><strong>9,093.3</strong></td>
<td><strong>15,824.0</strong></td>
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Source: RTI estimates. Sums may not add to totals due to independent rounding.

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<th>Mitigation Costs</th>
<th>Delay Costs</th>
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</table>

Source: RTI estimates. Sums may not add to totals due to independent rounding.

FIGURE 16.2 NIST Study of cost of interoperability. (National Institute of Standards and Testing, Gaithersburg, MD).
in his article entitled “Why Building Information Isn’t Working . . . Yet,” compared the difference in technology use between the automobile and aerospace industries and the construction industry, stating “. . . most importantly, cars and planes are the products of an integrated design-build process. The designer and builder are one and the same. This is rarely the case with building design and construction.”

Why contractors are slow to embrace information management. The NIST study uncovered many reasons why the construction industry suffers from inefficiency in information management, often operating in isolation and not effectively communicating with other internal and external partners in the design and construction process.

- Collaboration software is not integrated with a contractor’s other systems. Some builders use collaborative software, but it is generally not integrated with other systems—it is used in a stand-alone application, defeating the purpose of the software.
- Many parties work together on only one project, so there is little incentive to invest in long-term collaborative software, each project frequently being unique, having different participants, scope, workforce, and teams, and operating in a different location.
- Life-cycle management processes are fragmented and not integrated across the project’s life cycle.
- There are inefficiencies and communication problems when participants to the project from all parts of the life cycle have various versions of the same software or different software.
- A lack of data standards inhibits the transfer of data between different phases in the life of a project and their associated systems and applications.
- Internal business processes are fragmented and inhibit interoperability. NIST found that in some firms: an estimated 40 percent of engineering time is dedicated to locating and validating information gathered from disparate sources.
- Many firms use automated and paper-based systems to manage data and information, while hard-copy construction documents are routinely used on the jobsite.
- Many smaller construction firms do not employ, or have only limited use of, technology in managing their business processes and information.

The federal government push for interoperability and BIM. On January 24, 2005, the General Services Administration sent out a Request For Information (RFI) to the capital facilities industry (design consultants,
general contractors, subcontractors, and vendors) with the following statement:

Interoperability problems in the capital facilities industry stem from the highly fragmented nature of the industry’s continued paper-based business practices, a lack of standardization, and inconsistent technology adoption among stakeholders. Based on interviews and surveys, it is found that $15.8 billion in annual interoperability costs were quantified for the capital facilities industry in 2002. Of these costs, two-thirds are borne by owners and operators, which incur most of these costs during on-going facility operation and maintenance (O&M).

The United States General Services Administration (GSA)/Public Buildings Service (PBS) is seeking information from industry partners on Industry Foundation Classes (IFC)-Based Integrated and Interoperable Building Information Model (BIM) technology as part of its effort to improve project deliveries in the capital construction program. The GSA/PBS currently has an active pipeline of more than 200 major capital construction projects conclusively exceeding a value of $11 billion.

The GSA, in this RFI, proclaimed an opportunity for firms in the design, construction, and facility management and real property industries to submit suggestions on the use of IFC-BIM technology. This information will be used by the government to establish potential sources in the marketplace that have knowledge and experience in the use and practice of this state-of-the-art technology. Look for some future government projects to require bidders to have interoperable software, and the ability to provide BIM modeling as part of their qualifications package.

The industry movement toward interoperability. The International Alliance for Interoperability (IAI) has held discussions with industry leaders in 19 countries to define a single building information framework. Using heating and cooling as an example, IAI asked ASHRAE in the U.S. and their counterparts in CIBSE in England, and DIN in Germany, to get together and define a process for calculating a building’s HVAC requirements. They wanted to develop a generic model for systems development in order to provide a seamless flow of information for mechanical systems across all national boundaries.

This is a process termed Industry Foundation Classes (IFCs) that must be repeated by other design and construction teams to develop the specific non-graphic common language required for interoperability. Each IFC thereby becomes a dictionary for project component information to be shared by owners, architects, engineers, general contractors, and specialty contractors.

Just like how the HTML and HTTP protocols allowed the transmission of web pages to become a universal event, a new technology is
needed to generate the cross-referencing and dissemination of design and construction information on a global basis.

The current state of affairs. FIATECH is a nonprofit research and development consortium based in Austin, Texas that focuses on developing and delivering technologies to the construction industry to improve the design, engineering, and construction of capital projects. Recently, they have been working on several approaches to advancing the interoperability of construction software.

Extensible Markup Language (XML) is a simple, flexible text format originally designed to meet the needs of large-scale publishing, but which now plays a major role in exchanging data over the Internet. AecXML was chartered in 1999 to promote and facilitate interoperability among software applications for information exchange in architecture, engineering, and construction. AgcXML, a program sponsored by the Associated General Contractors of America, and planned for delivery in 2006, will create an XML schema (plan) to deal with the following common construction documents:

- Requests for Information (RFIs)
- Submittals
- Purchase orders
- Contracts—both AGC forms and other industry standard forms
- Pay applications
- Change order requests (CORs) and change order approvals
- Punch lists
- Daily reports
- Addendum notifications
- Meeting minutes
- Requests for Proposals (RFPs) and pricing

The Open Building Information Xchange (oBIX) is a movement backed by facility managers and industry sources to use the programming of XML for seamless Internet- and intranet-based communications between building systems in order to run a building on standard protocols and techniques, thus creating a format by which buildings, facility managers, and owners can interface with the Internet.

The civil engineering profession has developed LAND XML to tackle this problem, while the steel industry has created an interoperability protocol called CIS/2.
In 2004, the American Institute of Steel Construction, Inc. (AISC) issued a white paper entitled “Interoperability and the Construction Process” in which they explained their efforts, and that of the steel industry, toward achieving interoperability. AISC initiated the CIMSteel Integration Standards Version 2 (CIS/2), enabling designers and specialty steel contractors to exchange data. CIS/2 is compatible with other software programs such as Bentley, RAM, GT Strudl, Robot and ISS drafting software, Tekla and Design Data detailing software, and Fabtrol shop fabrication software.

ASCI, in their report says “The neutral file format allows stand-alone programs—such as structural analysis and design, detailing and manufacturing information systems, as well as CNC driven fabrication equipment—to communicate with each other by translating a program’s native format into a neutral format to allow data interchange across multiple platforms.”

Dealing with the coordination problem. A structural engineer can now design a steel structure in the BIM (3-D) mode, and concurrently and instantaneously transmit the design to the architect and MEP design consultants so they can begin to incorporate their work into this “skeleton” framework. If a general contractor is on board at the time, a copy of the 3-D design can be forwarded to them, and possibly onto their steel fabricator. The design consultants will then be able to “talk” to each other and to the general contractor and subcontractors in a paperless fashion. Suggested changes offered by any member of the team can be distributed, reviewed, and addressed immediately, and changes can be effected and distributed so that steel shop drawings are then produced quickly and e-mailed to the engineer of record for approval, bypassing the old paper trails and thereby dramatically speeding up the process.

Interference problems are thus highlighted early in the design process and corrections made before the design is completed rather than uncovering these difficulties during construction.

All of this is accomplished without having to handle rolls and rolls of design and shop drawings, without the time-consuming tasks of packaging and repackaging, and the delivery charges incurred back and forth. The potential savings as a result of fewer reproducibles and reduced handling and shipping costs may be minute on small projects, but on larger ones it could mean tens of thousands of dollars.

Designs that really work, that eliminate the need for RFIs to resolve questions, are thus addressed and resolved during design development, not after the construction contract award, resulting in a set of drawings that are really coordinated—one of the goals of 3-D modeling.
Just think how many more projects each participant could manage, and how much more time could be spent focusing on the project at hand, and not getting bogged down in paper pushing and generating of RFIs, RFCs, and hundreds of transmittals, when this process becomes commonplace.

Interoperability and BIM as envisioned by the steel industry. According to Tom Faraone, Senior Regional Engineer for AISC Marketing, LLC, an organization affiliated with the American Institute of Steel Construction, the steel industry is already using bar codes to speed up product fabrication and delivery, and is working on other ways to utilize these devices more effectively. There is an increased interest in radio frequency identification devices (RFID), a micro radio transmitter providing fabrication data, that can be affixed to each structural steel member as it enters the fabricator’s shop. Upon leaving the shop it could then convey to a computer-operated crane its precise position within the structural framework.

The goal of AISC is to develop a system in conjunction with its members that will accelerate the entire design-fabricate-deliver-erection process of a structural steel building. If time is money, then it surely applies to this industry as well.

The New York Times, in an article dated April 13, 2005, reported on a project in Boston called the Charles Street Jail, which consisted of the redevelopment of this historic building into a four-star hotel. The developer budgeted the project at $50 million in 2003 but was devastated by the sharp increase in structural steel that occurred at the time. An eight-month redesign was required to reduce the updated cost of $74 million down to a more manageable $64 million. Although the consumer price index (CPI) showed an inflation rate in the 2 to 3 percent range, this wasn’t so in the building business, where some estimating services pegged inflation in the industry at 12 percent for the year 2004.

The final design of the Charles Street Jail required the architect to delete the planned basement, reduce the floor to floor height and add a 15th floor. Mr. Richard Friedman, CEO of Carpenter & Company, the developer, summed it up in four words: “It’s been a nightmare.”

A more rapid design and review cycle can become an effective guard against the forces of inflation, and AISC says their CSI/2 system can produce a 50-percent savings in scheduling.

Case study—the Lansing community college project, Lansing, Michigan. The interoperable process, by maximizing efficiencies between designer and fabricator, allowed the Lansing Community College Health and Human Services Career and Administration Building project to lower their costs to add a 4th floor by $315,000 or $2.35/sf, according to AISC. The electronic transfer of information between the designers and fabricator permitted the building team to rapidly review alternative design schemes,
make changes, and get them reviewed and approved, resulting in the elimination of 700 members and a savings of 190 tons of steel. Without this interoperability process, changes of this nature would have required multiple manual re-entries of data, long delays in the revision, review, and approval of shop drawings, and, almost certainly, a justifiable delay in completion, the cost of which might have completely negated all or much of the savings that would accrue with the design change.

Larry Kruth, Engineering and Safety Manager at Douglas Steel Fabricating Corporation, the contractor that fabricated and erected the project’s structure, is sold on interoperability. On an unrelated project, Larry said that the design engineer had specified several large rolled sections, W44 × 265s, which were only available at a mill in Luxembourg. Larry quickly notified the engineer, suggesting a switch to a W40, available in this country. The design change was made quickly electronically, and the project’s progress continued—seamlessly.

The Denver art museum project—another example of 3-D/interoperability success. The addition to the Denver Art Museum was a 147,000 square-foot structure consisting of 16,500 pieces of steel with a total combined weight of 2,750 tons. There were 3100 pieces of primary steel sections, 50,000 bolts, and 28,500 pounds of field and shop welds. The intricate connection information was passed from the design team to the detailer using simple sketches of each individual connection. Each sequence of steel fabrication was detailed in a 3-D model, and two-dimensional shop drawing details were created. Then, as each sequence of shop drawings were completed, the detailer provided the design/construction team with 3-D electronic models in addition to the hard copy drawings so that the architect could verify and check the geometric control and coordination with other architectural elements. The end result of this design/fabricate/erect process was

- 3-D graphic aids were freely shared by designer/contractor/subcontractor to facilitate each one’s own work and thus improve the overall product.
- Minimal shop issues were encountered due to the level of coordination during the 3-D design.
- Minimal field issues were encountered and erection proceeded without any major field adjustments or fixes.
- The fast track approach of overlapping design, fabrication, and erection resulted in a faster start and more rapid completion.
- The preliminary interactive work by all members of the team during design smoothed out the fabrication and erection process resulting in the completion of erected steel three months ahead of schedule.
Interoperability and Building Information Modeling (BIM)

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In the AISC white paper, they quote Mr. David I. Ruby, P.E., a principle in the firm of Ruby & Associates, who described the current process of steel design:

The architect would present a defined building concept to the structural engineer who would design the structure utilizing a structural analysis program, prepare design drawings, and submit (them) to the fabricator. The fabricator would take the drawings, (and) have a material specialist prepare a full take-off by hand to determine the material required for the structure. The fabricator would review all of the material from the engineer—page by page, sheet by sheet, floor by floor. They'd take a yellow crayon and mark off every beam, and another person would re-check with a red crayon indicating it was checked again so the fabricator knew that the shop bill accounts for all the materials. Manually, this process took a week or more. And we're not talking just 40 hours of labor, but two or three people putting in 40 hours or more to pull that all together. With interoperability, this process takes just a few hours. We can now send files at noon, and by 3 o'clock the fabricator has the bill of materials to order.

Mr. Ruby goes on to say:

You always want to purchase at the best cost, and the best cost comes from purchasing mill material which is normally rolled and/or stocked between 40 and 60 feet long. So you have to multiply it. That means if you need three 18-foot beams, you don’t order exact pieces—you order one 55-footer and cut it to length in the shop. All of these calculations used to be done by hand.

What Is Building Information Modeling All About?

Building Information Modeling (BIM) is the transition from 2-D to 3-D design and is sometimes used synonymously with Virtual Building Model (VBM) or Virtual Design and Construction (VDC), each of which refers to the ability to produce a three-dimensional view of a construction project as building components are designed, modified, or deleted.

Figure 16-3 displays the sequencing from 2-D to 3-D and 4-D computer-assisted design.

Coordination and interference issues addressed

Most project specifications include a requirement for the general contractor to prepare “coordination” drawings, such as:

The general contractor is fully responsible for coordinating the work . . . Coordination space requirements and installation of mechanical and electrical work are indicated diagrammatically on the drawings. Prepare coordination drawings for all areas where close coordination is required for installation of products and materials . . .
This is where interference problems occur. Piping and ductwork often must be rerouted or resized to avoid interference with structural members or other systems. Ceiling heights may need to be lowered to ensure that all above-ceiling MEP work is fully concealed, and when lots of things don’t fit, added costs and delays add to the frustration of all parties.

Building information models create a digital database that can be shared by all parties on the construction project and can be distributed from the architect to the engineer, and to the contractor and the contractor’s subcontractors and vendors—all through file sharing. The two-dimensional plan can be displayed in 3-D fashion as each layer of design is added (Fig. 16-4), allowing both architect and engineer to comment on coordination issues, and suggest and make changes with a certainty that all other affected components are adjusted accordingly. Just as important, all members of the construction team are instantly apprised and buy into these changes.

When a “negotiated” project is underway, these changes, when a data-based design system like Autodesk’s Revit® is employed, allows the general contractor to review the revised quality take-off (Fig. 16-5) and verify or adjust their estimate.

Some recipients of BIM information will be read-only, while others can review and recommend changes which, if implemented, will be reflected in all parts of the design affected by that change or changes.

This means that the time normally spent manually checking all of the drawings by design consultants, and by the contractor and their

![Diagram](image_url)
Interoperability and Building Information Modeling (BIM)

Autodesk Revit Structure: Greater Efficiency

Coordinate...analysis results more reliably with structural design

Reduce errors...through dynamic linking to industry-leading analysis software

FIGURE 16.4 A 3-dimensional display as layers are added to the structural design. (By permission: Autodesk, U.S.A.)
Figure 16.5  Leveraging BIM in quantity take-off process. (By permission: Autodesk® Revit® Structures, U.S.A.)
subcontractors, will be reduced considerably or totally eliminated, giving all parties additional time for project management, quality control, and scheduling matters.

3-D modeling brings all of these interference problems to the fore during the design stage, and not during the hectic construction process as the design passes from structural engineer to architect to MEP design consultants. Thus, conflicts will be immediately identified and resolved through a collaborative effort.

This is certainly a more cost-effective way of dealing with interference problems than squeezing a duct size to fit under a beam or punching through a structural member while in the field.

4-D modeling. 4-D modeling adds a time factor to a 3-D model, allowing display of the design's progression during the construction cycle. CPM schedules can thus be transformed into living breathing presentations where the actual progression of construction over a period of time, such as a week or a month, can be displayed against an as-planned schedule. Schedules become more than just paper presentations when 4-D modeling is used. At weekly project meetings, the general contractor can now visually display specific parts of the “planned schedule” and graphically show the “as built” field condition at that point in time.

These presentations allow all parties to view problems, seek acceptable recovery methods, and look at the results of their efforts in next week’s 4-D presentation. Delay claims can be either strengthened or defended against by using selected sequences of a 4-D presentation of actual versus planned events. And imagine a 4-D Two-Week Look Ahead schedule that’s presented at one subcontractor meeting and then viewed at the next to see if everyone’s goals have been achieved.

BIM—its promises and its problems. As a project management tool, the ability to effectively coordinate drawings and highlight any systems interference problems has a profound impact on the project by:

- Reducing or possibly eliminating Requests For Information (RFIs)
- Reducing or possibly eliminating Architects Supplementary Instructions (ASIs)
- Drastically reducing changes orders related to coordination/component conflict (interference) problems
- Reducing the potential for cost overruns by allowing more control over the factors that generate or create change orders
- Reducing delays in design and construction schedules
Interoperability and Building Information Modeling (BIM)

As a single source for building information, a data-based CAD BIM system presents many advantages:

- Plans, elevations, wall sections, and schedules are always consistent—change one, and all related work is changed.
- The coordination across different disciplines eliminates the problems previously associated with ensuring that everything fits in its allotted space—horizontally and vertically.
- Schedules for finishes, doors, windows, and hardware are easily generated and updated as changes occur in plan and elevation design.
- The ability to generate quantities of materials during design facilitates the procurement and, particularly in a design-build or negotiated project mode, tracking design with the budget.
- The data created by BIM continues to have a useful life during both commissioning and the continuing operation and maintenance of the building.

**BIM can impact quality.** Because changes to one system or one item are reflected back through the data base to related systems, we may have finally gotten rid of that typical problem where a window size may have changed, but no corresponding change was made to the exterior masonry opening. That 3070 door in Room 507 changed to a 3468 did not update the door schedule. With BIM, these problems that created confusion and ate up man hours may no longer exist or, at least, will be dramatically reduced. And because it is a data base system and one change is recognized and adjusted throughout the design automatically, architects and engineers may find that they have a little more time to review and tweak their designs. The contractor relieved somewhat, or completely, from the task of issuing RFIs to questions relating to coordination or missing data can spend more time on processes, schedules, and quality.

Owners, tired of the finger pointing that happens whenever errors and omissions type change orders occur, will have one less argument to resolve—and one less cost to pay.

**Cause and effect.** A recent survey of general contractors in the southeastern United States engaged in traditional design-bid-build projects revealed that 78 percent of the respondents reported the following frequency of problems:

- Problems with specifications—100 percent
- Unrealistic schedules—84 percent
- Physical interference problems—75 percent
- Tolerance problems—73 percent
This same survey revealed that 75 percent of responding general contractors attributed constructability problems to their inability to provide input during design. It’s likely that these same problems affect contractors throughout the country, and by employing 3-D and 4-D database modeling, many of these problems affecting the entire industry can possibly be avoided.

Both developers and contractors look with dismay at the high cost of construction today. The $15.8 annual cost attributed to the inadequacy of today’s interoperability (as reported by NIST) is too large an amount to be ignored. The federal government and the private sector of design professionals and contractors need to embrace this interoperability process as an effective way to deal with those rising costs.

BIM, with its promise of 3-D and 4-D modeling, may become more prevalent in the industry and make design and construction even more cost-effective.