ProNet Practice Notes

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Building Information Modeling:
Now that you know how to spell BIM, is it right for you and your project?

I. Introduction

What is Building Information Modeling?

Building Information Modeling (BIM) is the process of developing a virtual, three-dimensional, information-rich model to design, construct, and maintain a building project. BIM is much more than software used to produce a pretty 3D graphic. Because a variety of information can be embedded into the model, BIM can also be used to manage the project's construction schedule (4D); to track project costs (5D); and, once constructed, facility management (6D).

There are varying levels of BIM adoption and use, from an initial pilot project with one player using BIM tools to a team process with agreed-upon collaborative BIM process goals. In ideal process, all project participants share information.

These times are a changin'...

Because BIM is about process and not just software, it gives designers and constructors a unique opportunity to eliminate the barriers to collaborative thinking. One example is found in the redundancies inherent in the shop-drawing process. In this case, the goal of the BIM process is to abolish the wasteful practice of having to draw the entire project twice. Because BIM facilitates teamwork, many see BIM as an opportunity to reach out across disciplines and reconsider the traditional paradigm. Make no mistake, we still need experienced architects, engineers, contractors, and owners to deliver a successful project. But in today's BIM-enabled world, the process is becoming more collaborative, which in turn redefines the project team's risk profile.

II. Factors to Consider

Deciding whether to use BIM is an important task. This section provides the decision makers with a framework in which to consider this issue by addressing BIM's practical challenges, technical constraints, and cost considerations. We also explore how BIM changes some of the ways we currently do business and price our services. The section concludes with a discussion of some of the benefits that owners, design professionals, and contractors may reap from delivering projects using BIM technology.

Practical challenges

Goals: The reasons are as clear as…

Perhaps the most important factor to consider when deciding whether to implement BIM technology is the establishment of a clearly stated objective. To an owner, the idea of visualizing a space before it is built may be a key goal. To a designer, developing BIM capabilities may ensure staying competitive in the A/E marketplace. To a contractor, the ability to evaluate multiple construction schemes to determine the most efficient approach may give the builder an edge over the competition. Whatever the motivation, participants should have a clear understanding of what they intend to receive from this investment.

Type of Project: Three factors…

In today's market, BIM is a good choice for some projects, but not all. The team should consider three project-type factors in deciding whether to use BIM. First, the building type can determine whether BIM is the right approach. A complex building, such as a university laboratory, is a better BIM candidate than a simple building, for example a retail shopping center. Second, consider the construction requirements for the project. A new building construction project is often a better choice for BIM in comparison to a fit-out project, which may be completed faster and with less rework utilizing existing 2D documents. Finally, the project's size matters. The more square footage, the more likely the project is a viable BIM candidate.

Timing: The early bird…

Likewise, timing is an important factor to consider. Ideally, the decision to use BIM should be made prior to commencing design. If, however, the team is well into the design development process, it may not make economical sense to switch to BIM. Nevertheless, there are exceptions. For complex projects, a contractor may decide to re-create the project's 2D construction documents into 3D to take advantage of "Clash Detection," BIM's ability to detect interferences between building systems.

Teammates: Choose your friends carefully…

Not all BIM is the same. Thus, another key consideration involves the project team's collective experience using BIM for the specific type of project being developed. For example, the level of detail and coordination necessary to design and construct a hospital is much different than that required for a prison. Accordingly, the "Dream Team" for any BIM project involves a mix of professionals: those who understand how BIM works (including its limitations) as well as those who understand the industry for which the project is being developed.

As with any professional relationship, it is essential that members of the BIM team work and play well with others. Most successful BIM projects require, to some degree, that the team colocate, working side by side in a central location, or virtually use web-hosting technology. Thus, it is essential that you approach team selection as though you are picking a college roommate. If individual team members are territorial about their work product, then, despite individual talent(s), the project will suffer.

Project Delivery Method: Build it and they will come…

The method of project delivery also has a direct impact upon deciding whether or not to use BIM. Of all of the conventional project delivery methods, design-build is best suited for BIM because it encourages project collaboration and provides an environment where both the designer and the contractor are able to load the model with data in a way that meets both of their requirements.

Projects delivered using the traditional design-bid-build (DBB) method may avail themselves of the benefits of BIM but often require multiple models — one for design and another for construction. The contractor's absence during the DBB's design phase typically means that its needs (that is, estimating, constructability, and pricing) are not addressed by the designer. The design and construction of a simple wall system illustrates the point. During design, a building's architect may be content to fold each component of the system (drywall, insulation, studs, etc.) into one design element. By contrast, the contractor needs to treat each component of the wall separately for purposes of estimating, scheduling, and sequencing the trade contractors.

Another conventional delivery system, CM-at Risk, has the potential to offer both designers and contractors an opportunity to shape the model to meet their respective needs. With CM at-Risk, the contractor may contribute to the model's design while simultaneously providing the owner and the designer with constructability reviews, and pricing information, among other things.

Integrated Project Delivery (IPD) is a new and revolutionary project delivery process that is particularly well suited to BIM. In IPD, all of the project's key participants are bound by a single contract that collaboratively shares risk and reward among all concerned. The IPD process has only recently taken root and has yet to be widely accepted in the industry.

Design fantasy: You can build anything I design…

BIM opens lots of doors to design creativity that may not be possible with 2D tools; however, whether the design is physically constructible must be considered. Because of its exacting standards, BIM can result in a false sense of design security. For example, a BIM that depicts a series of complex mechanical shafts, pipes, and ducts all fitting within the confines of a very tight pipe chase may not be constructible. The 3D graphic may show that they all fit, but it may be impossible or impractical to build. Designers must be aware of the practical constraints of their design, and the contractor needs to communicate clearly such restrictions during the design process.

Legal risk: The lack of established precedent...

Law lags technology. BIM represents cutting-edge technology. Thus, it should come as no surprise that the law is still catching up to BIM. In fact, the design and construction industry are just now developing the contract forms necessary to address some of the unique risks associated with a BIM project. Those desiring to use BIM should anticipate spending a little more in a legal effort to draft and negotiate the risk-shifting contract provisions that properly allocate risks to the party best able to manage them. Additionally, case law interpreting these provisions is still a long way off. Accordingly, the absence of established legal precedent particular to BIM transactions adds an element of unpredictability to the contracting process.

Technical Constraints

The technical requirements needed to implement a BIM system can be intimidating. The size of the electronic files and the horsepower it takes to generate a 3D rendering require in most cases, replacing and/or supplementing existing computer hardware and software. Both designers and contractors must also consider that BIM requires a significant investment in training. Initially, training may be outsourced, but doing so is not a long-term solution. In the long-term, all employees should be trained to produce a consistent BIM output to meet the customized company standards. Finally, the content and details libraries must also be converted to use with BIM software.

Additionally, no "one size fits all" BIM software meets the needs of all parties. The optimum software for coordinating construction activities is ill suited for designing interior spaces or analyzing structural elements. Most attempts to share electronic files across different vendor platforms typically results in a loss of some data. Thus, when deciding to use BIM, the team must collectively consider the model's intended purpose and carefully evaluate all of their software options.

Cost Considerations

The cost of BIM depends upon its use. For example, for owners intending to use the BIM for life cycle facilities management (6D), the model must capture the project's as-built conditions and be populated with a significant amount of data (that is, specifications of key equipment, location of circuitry, warranty information, etc.). The long-term benefits of a 6D model to a facilities manager are significant but costly to develop. The value, however, of the 6D model pays for itself over the long term. Thus, it is necessary to weigh the first dollar costs against the financial (but difficult to quantify) value, more fully described below.

Projects designed using BIM typically follow a flatter cost curve than those using a conventional 2D design. In 2D design, the construction documents phase is typically the most costly phase because of the energy it takes to develop the details necessary for construction. Not so in BIM. When using BIM, the design team must create the construction details at the same time that it is developing the building's features. Thus, a greater amount of effort (and design fee) is required in the model's early design phases. This may be a challenge for lenders accustomed to upward trending cost curves.

Benefits

Properly used, the benefits of BIM can be substantial. Below, we summarize some of the benefits that can be realized by each stakeholder to a BIM project:

Visualization

BIM allows the team to visualize the design before construction even begins. This attribute takes on increased importance when it comes to demonstrating to others, such as investors and/or regulatory officials, what the project will ultimately look like. BIM can also be paired with animation technology to create "virtual mock-ups" of the design. Much like a video game, an owner can now experience a fully rendered virtual space and recommend changes before the space is actually built. In addition, designers are able to ensure a predictable result for the client because they receive visualization comments earlier in the process.

Time

Time is money. BIM increases the predictability of on-time and on-budget performance through advanced clash detection. Improperly coordinated building systems can result in significant impacts to cost and schedule. By identifying these problem areas early during the design process, contractors can expect to encounter fewer costly delays and less aggravation during construction, and owners can accelerate the project schedule.

The overall project development cycle may be reduced by using innovative BIM delivery techniques. One such technique is Integrated Project Delivery (IPD), where key members of the project team collaboratively develop the project's design model in real time. IPD shows promise by promoting efficiency and time savings, thus reducing overall costs.

Information Management

BIM can provide an interactive library of the facility's product data, warranty information, and maintenance records. 6D BIM increases a building's value by providing managers with a ready source of information regarding the building's systems. Similarly, BIM can be a helpful tool for existing facilities (that were not originally developed using a model) when analyzing the building for renovations. By interfacing with laser-scanning technology, BIM can be used to develop a 3D plot of the building's existing conditions, which can then be manipulated virtually.

Design

For designers, the financial return on a BIM investment is not easily quantifiable as designers are typically not paid extra for their BIM services. Nevertheless, the investment in technology and training is necessary to keep pace with the industry and competitors.

A significant advantage of BIM for designers is the ability to share a single workspace so that the entire discipline's design teams are working inside one model. The team contributions are saved in a central location so that even teams working in different offices are always working with the most current and coordinated information.

The designer's ability to make changes in one view and have all other views automatically reflect that change cannot be underestimated. Some researchers have opined that architects utilizing CAD software spent as much as 60 percent of their time on these kinds of redundant drafting tasks. Accordingly, BIM provides designers with more time to focus on bigger-picture project development.

A technical benefit to using BIM is the ability to experiment with various design options (building orientation, daylighting, surface finishes, etc.) without the need to revise multiple views.

Analysis

Engineers also benefit from using a virtual model to test their design. Provided they use compatible software, mechanical engineers can use BIM to lay out ductwork and model air flow throughout the building. Structural engineers can use the BIM to test various framing and bracing systems for load distribution and efficiency. One New England engineering firm is streamlining the steel "shop drawing" process by sharing a more detailed design model with the contractor and performing virtual reviews of the fabrication models in 3D. Consolidating this process eliminates redundancy, improves quality and coordination, and allows the engineer to offer full-service documentation under one roof.

Waste Reduction

BIM can also reduce waste and enable a lean construction/procurement processes by facilitating the use of prefabricated modular building components. The BIM database allows easy tracking of quantities and offers estimators a simpler way to compare costs between projects. The ability to embed hyperlinks in the BIM gives contractors ready access to web-based product information and the ability to order materials directly from the database. BIM can also reduce the cost of nondiscretionary change orders that result from lack of coordination of design disciplines.

New Scope

BIM provides specialty trade contractors with a new opportunity to participate in the project's design. For example, a plumber involved in the construction of a project where pipe spools are built off-site can develop a three-dimensional plumbing construction model that minimizes dimensional errors and waste through prefabrication. Designers are also finding new service opportunities, including providing an information-rich model for use after construction.

Risk Allocation

BIM changes our behavior. Thus, it should come as no surprise that it represents a new risk frontier. Unfortunately, traditional contracts are not well suited for the BIM environment. To address this conundrum, the design and construction communities have each developed their own "bolt-on" BIM rider to amend their respective family of standard contract forms.

It's all in the contract…

The publishers of the ConsensusDOCS family of contract forms created the 301 BIM Addendum. This document amends the base contract's terms with a number of risk-shifting provisions specifically related to BIM. The BIM Addendum also relies upon the creation of a second contract rider, a BIM Execution Plan, to more precisely define the parties' roles and responsibilities; however, there is currently no standard industry template for creating a BIM Execution Plan.

Separate from the ConsensusDOC's family of forms, the American Institute of Architects (AIA) developed its own BIM rider, the E202 Model Progression Specification. Notably, this document does not modify any of the base contract's terms. Instead, the rider functions as a technical specification that defines the amount of detail and information that the model must contain to qualify for a particular Level of Development (LOD). For example, to qualify for an LOD 100, the BIM must embody certain design elements and contain a specific level of detail for each design phase. To upgrade to a LOD 200, the BIM must contain additional design elements and be further along on the design continuum. The matrix tops out at LOD 500, which may be compared to an "as-built" drawing because it contains all of the information for the completed project.

Below, we analyze how each of these two riders address some of the more important kinds of BIM-related risks. We begin with a discussion on those contract provisions designed to limit a party's liability.

Contract limitations clauses, typically fall into one or more of three categories; they can (1) limit the amount of damages for which someone may be liable (for example, a fixed sum, the contract value, the amount of insurance, etc.), (2) limit the type of remedy someone may recover (for example, liquidated damages for delays), and/or (3) restrict or waive the kind of damages someone may recover (for example, consequential damages).

One particular kind of damage that is frequently the subject of debate in a construction context involves consequential damages. Consequential damages are losses that do not flow directly from the wrongful act but instead arise as an indirect consequence of such conduct. For example, lost profits, lost rent, additional interest on loans, and loss of reputation are just a few of the kinds of consequential damages that may be incurred when one party fails to perform its contract obligations.

These damages can, subject to certain legal defenses, be waived by contract.

The BIM Addendum provides an express bilateral waiver of future consequential damages arising out of the injured party's improper use of the model. Specifically, with respect to the issue of a waiver of consequential damages, Section 5.2 provides the following:

» The Governing Contract shall govern the issue of any waiver of consequential damages arising from a Contribution, and

» Each Party waives claims against the other Parties to the Governing Contract for consequential damages arising out of or relating to the use of or access to a Model, including but not limited to damages for loss of use of the Project, rental expenses, loss of income or profit, costs of finance, loss of business, principal office overhead and expenses, loss of reputation or insolvency.

Another type of contract clause, the disclaimer, allocates risk among the parties by disclaiming liability for certain types of conduct. Most disclaimer clauses fixate on responsibility for certain unauthorized conduct. For example, the AIA's Model Progression Specification uses a disclaimer clause to limit liability when someone uses the model for a purpose greater than what is intended. In this case, Section 4.1.3 provides the following:

» Any use of, or reliance on, a Model Element inconsistent with the LOD indicated by Section 4.3…shall be at their sole risk and without liability to the Model Element Author.

The BIM Addendum has a similar provision that also disclaims responsibility for unauthorized use of the model. Section 5.6 states the following:

» No Party involved in creating a Model shall be responsible for costs, expenses, liabilities, or damages which may result from use of its Model beyond the uses set forth in this Addendum or fully executed amendments hereto.

The difference between the riders is that the AIA form uses the LOD matrix to create an express warranty of accuracy and completeness (See Section 4.1.2). Conversely, the BIM Addendum fails to definitively benchmark the model's intended use and level of detail. Accordingly, the best practice is to document the model's intended use at the onset of the project, using AIA's Model Progression Specification.

Because BIM is generally considered a collaborative process, one issue that always floats to the top of the lawyer's list of risks involves responsibility for the model's accuracy and completeness. The BIM

Addendum attempts to addresses this point equitably by holding each party responsible for its own contributions to the model. Section 5.1 states the following:

» Each Party shall be responsible for any Contribution that it makes to a Model or that arises from that Party's access to that Model. Such responsibility includes any Contribution or access to a Model by a Project Participant in privity with that Party and of a lower tier than that Party.

From a practical standpoint, holding each party responsible for its own contribution(s) to the model becomes increasingly difficult as the degree of collaboration among team members increases. Absent a true IPD collaborative environment (where risk and reward are contractually shared jointly among the parties), it may be necessary to institute certain protocols to identify where one party's contribution begins and another ends. At the risk of sounding overly parochial, we suggest that team members consider the following guidelines: Parties could institute the software's user identification function when appropriate; one party should never make changes to another party's model; team members may want to consider merely "linking" their own model(s) to a federated model containing the contributions of other team members.

We recognize that some of the above suggestions may have a chilling impact on the collaborative design process. Nevertheless, legal protections may be inserted into the parties' contracts that may accomplish the BIM Addendum's objective to hold each party responsible for its own contributions (that is, covenants not to sue). However, we wish to emphasize that such provisions do not bar someone who is not a party to the contract from attempting to recover damages resulting from negligent design.

The BIM Standard of Care

In most jurisdictions, design professionals are required to perform their services in accordance with the standards of practice of like professionals who perform similar services on projects within the same geographic area. This level of competence is commonly referred to as the "professional standard of care" and is typically defined through expert testimony. The designer's failure to perform in accordance with this standard serves as the foundation for a claim of professional malpractice.

The AIA Model Progression Specification is silent when it comes to defining the professional standard of care for BIM projects. The BIM Addendum does little more than refer the question back to the parties' underlying contract or the law of the applicable jurisdiction. Specifically, Section 5.4 states in pertinent part:

» The standard of care applicable to each party regarding that party's contributions to or use of a model shall be in accordance with that party's governing contract or common law, as applicable.

There are two general schools of thought on how to apply the professional standard of care to a BIM project. Under one theory, BIM elevates the standards of all design professionals (whether or not they use BIM) because the technology is gaining wider acceptance throughout the industry on a variety of projects. A more narrow view suggests that BIM creates its own standard of care that applies only to projects using BIMenabled technology.

One additional thought on the standard of care involves geography. Because BIM is becoming the norm in limited parts of the country, we are creating pockets of BIM designers; however, until BIM gains widespread acceptance, defining the professional standard of care presents geographic challenges. Thus, the informed contract draftsman uses care to ensure that the owner/designer agreement recites the most descriptive standard to measure the designer's performance.

Intellectual Property Rights: It's all mine…

As a general rule, the copyright to the project's drawings and specifications is owned by the designer, but the owner is granted a license to use them to build the project. Article 6 of the BIM Addendum alters this paradigm by granting to each contributor of the model a nonexclusive license for the sole purpose of carrying out project duties and obligations. Model contributors are able to use other project participant's models through a limited, nonexclusive sublicense for the current project only. Owners should contractually require a model license from all of the model's contributing parties so that they can use the BIM for the facility's future operations.

Insurance: You're in good hands…

Section 1.6 of the BIM Addendum attempts to disclaim a contractor's responsibility for design. It remains to be seen, however, whether this disclaimer can effectively deflect liability when the contractor has in fact been actively participating in the design model's development. One way for the contractor to manage this risk is to obtain errors and omissions insurance.

Another type of insurance not always discussed in the context of construction projects is Valuable Paper Insurance. The AIA rider does not address insurance; however, Section 5.7 of the BIM Addendum specifically requires any party that contributes to a model obtain valuable papers and records insurance coverage. Nevertheless, the reference to paper in these kinds of policies is a misnomer because, in today's insurance market, some valuable paper coverage disclaims responsibility for destruction of electronic data. Accordingly, model participants should consider purchasing an electronic records insurance policy to address this risk.

Force Majeure: It's not my fault…

Force majeure clauses attempt to evenly allocate risk among each of the contracting parties when an extraordinary event or circumstance occurs that is beyond each party's reasonable control. The underlying notion is that if the risk could not have been prevented, each party should the share in the responsibility of its occurrence. One such risk involves software failure. The AIA does not specifically address the risk of software failures. However, in the BIM Addendum, a software failure is considered force majeure.

Specifically, Section 5.8 proclaims that none of the parties are responsible for delays due to software defects. In such circumstances, each of the parties is given a time extension. Notably, the rider does not address the cost implications resulting from software defects. Accordingly, the contract should specifically identify how this risk should addressed.

BIM Execution Plan

This section describes the orphan component of the family of BIM contract documents, the BIM Execution Plan. As the name suggests, the purpose of the BIM Execution Plan is to provide details on how the project team intends to implement the BIM process. Surprisingly, no standard industry template assists the parties in preparing such a plan. This section seeks to describe a few of the more important items that should be considered when developing a BIM Execution Plan.

Why another document?

The need for a separate BIM Execution Plan is largely one of timing. Sections 4.1 and 4.2 of the BIM Addendum recommend that the Execution Plan be developed no more than 30 days after the parties have entered into a base contract. This postcontract arrangement may be the result of a staffing concern, as the people needed to coordinate the plan's technical details may not have been assigned to the project at the time that the contract is executed. Nevertheless, pursuant to the ConsensusDOCS' scheme, the plan is intended to be (but does not have to be) treated as a contract amendment.

As noted above, the AIA created its own rider, the Model Progression Specification. This Specification creates a hierarchal system of LOD ratings to benchmark the model's content at various phases of its development. Because the ConsensusDOCS' BIM Addendum fails to adequately address such benchmarks and because the AIA's Model Progression Specification fails to identify the details necessary to implement BIM, we suggest that the contract draftsman use the AIA Specification together with the ConsensusDOCS Execution Plan to serve as a best practices protocol.

The BIM Execution Plan should, at a minimum, recite the intended goals of using BIM, identify how many models will be created and for what purpose, allocate responsibility for maintaining and revising the model(s), and define how electronic data will be exchanged between team members. The plan should also identify what kind of computer hardware and software the parties will be required to use to develop and ultimately use the model(s). As noted above, the plan is typically developed after the governing contract has been negotiated and is retroactively added to the contract as an amendment.

A contract is a contract is a contract…

One issue that frequently arises during the creation of the BIM Execution Plan involves defining the contract documents, more specifically, which model(s) should be ordained as "contract" documents as opposed to merely "reference" documents. The BIM Addendum takes an all-inclusive approach, stating in Section 2.3 that "…all design models are contract documents unless otherwise specified in the execution plan." In practice, not all design models are intended to be contract documents. Accordingly, it is important that the authors of the BIM Execution Plan take care to identify the contract document models.

When things go wrong…

The Execution Plan should also addresses interoperability malfunctions. Interoperability is the successful sharing of model data across software platforms. For example, a structural engineer may need to use information from an architectural model to perform a load analysis using steel design software. If the architect's design software is not completely compatible with the structural engineer's analysis software, some information may be lost in the translation.

One simple way to manage interoperability issues is for the plan to establish a commitment by all concerned to use compatible software. Nevertheless, a time will come when, despite the best of intentions, some data is lost. One way to address this risk is to assign responsibility to a single source to manage and verify that a complete data exchange was successful. The most logical party to perform this task is the Project's information manager (as defined in Section 3 of the BIM Addendum). The information manager's role should also include the responsibility to maintain frequent backup files.

Location…location…location…

Another key element to the plan is determining whether and/or where the BIM team members will be colocating. Because of logistics or cost, it may not be practical to gather all team members in one location. Thus, it may be necessary to create a computer-aided virtual environment (CAVE) so that all members can work remotely in real time. Resolution of this issue should be made early so that the Execution Plan can include a communication protocol.

Copy cat…

The absence of an industry template to develop a BIM Execution Plan has led some universities to pool their resources and share their work product. Examples of BIM Execution Plans may be found online from Penn State University, Indiana University, and the Los Angeles Community College District. Nevertheless, the reader is cautioned that, because each BIM project is unique, it is critical to custom-tailor a plan to fit the particular dynamics of both the project and the project team.

Host a BIM kickoff!

The timing of the BIM Execution Plan is also critical to a successful BIM project. Ideally, the plan should be developed as early in the design process as possible. Early commitment by the project's key participants may eliminate the need for multiple or redundant modeling. One way to ensure timely creation of a plan is to host a BIM kickoff meeting where all parties sign the plan prior to commencing design.

The project's chosen delivery method impacts the planning of a BIM kickoff meeting. Because design-build requires that all of the essential parties participate from the project's inception, there need only be one kickoff meeting. By contrast, a design-bid-build project requires two BIM kickoff meetings because the contractor is typically not on board during the project's design phase. Thus, with design-bid-build, one kickoff meeting should be held at the beginning of design (with the owner and the design team) and a second immediately after the contractor and key subcontractors have been hired.

Potential BIM Uses – The last page of this newsletter is a sample list to be distributed to all team members prior to a BIM Project Kickoff Meeting.

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Potential BIM Uses

The following list should be distributed to all team members prior to a BIM project kickoff meeting.

Design Phase Uses

» As-built laser scanning
» Project vision/goal planning
» Program and square footage analysis
» Community outreach
» Marketing rendering/presentation images
» Project budget/cash flow development
» Site survey/phasing analysis
» Landscape model
» Circulation analysis
» Architectural massing and materials analysis
» Specifications
» Structural analysis
» MEP analysis
» Building envelope/glazing
» Acoustic analysis
» Life safety – fire protection model
» Security system model
» Data communications model
» Code/regulatory compliance
» Governmental approvals (variances, permits, regulatory compliance)
» Project schedule development

Green Building Uses

» Building form orientation/massing
» Daylighting optimization study
» Sunshading study
» Solar insolation analysis
» Bioenergy analysis (solar, wind, biomass, hydrogen, geothermal, hydropower)
» Water use – runoff/harvesting/rainfall study and analysis
» Geophysical positioning/weather climate
» Ventilation/infiltration analysis and optimization
» Materials analysis
» Life cycle analysis
» Insulation analysis
» Energy consumption optimization
» Resource consumption analysis
» Green certification analysis such as LEED
» Green code analysis such as IGCC

Construction Uses

» Interference/clash detection
» Quality control
» Change management
» Constructability analysis
» Shop modeling analysis
» 4D schedule development and analysis
» 5D cost/quantity takeoff development and cost control analysis
» Value engineering analysis
» Work sequence simulation/training
» Construction process management/mobilization/work sequencing
» Material/equipment smart tagging, lean delivery
» Shop/design implementation modeling
» Schedule analysis
» Manufacturing/fabrication modeling
» Connection/subassembly analysis
» Delivery schedule analysis
» Assembly analysis
» Punchlisting and project closeout

Facility Management Uses

» Commissioning – systems operations training
» Building systems operations/process controls
» Maintenance planning
» Shop drawings
» Warranty information
» Security monitoring
» FF&E management
» As-built modeling
» Disaster recovery plans
» Future renovation/expansion planning
» Decommissioning