# Transcending the BIM Hype:

DPR CONSTRUCTION

HOW TO MAKE DOLLARS AND "SENSE" FROM BUILDING INFORMATION MODELING

# Introduction

These days it's virtually impossible to make it through an architecture, engineering or construction event without hearing about Building Information Modeling (BIM). Most people tout substantial cost benefits from adopting BIM. Some are even sounding the warning that those who fail to jump aboard the BIM bandwagon will be quickly left in the dust.

BIM, which is often used interchangeably with Virtual Design and Construction (VDC), is the process of creating and managing a dynamic, three-dimensional, computer-generated model for the design, construction and operation of a building or project. The virtual model details the physical and functional characteristics of the building, such as the structure's geometry, spatial relationships, geographic information, and the quantities and properties of components. All of those characteristics can be analyzed, manipulated and corrected digitally before being used to facilitate the construction, fabrication, procurement and other activities necessary to convert the virtual model into the real thing.

When BIM/VDC first emerged in the commercial construction industry in the 1990s, the consensus was it would revolutionize the architecture, engineering and construction (AEC) industry. It offered the promise of substantial cost and time savings on developing projects. The industry and some clients are now starting to see that happen. Project teams are talking about reduced change orders and no MEP conflicts in the field due to BIM coordination. Still, moving BIM from the realm of theory into real-world practice is challenging.

# Learning from History

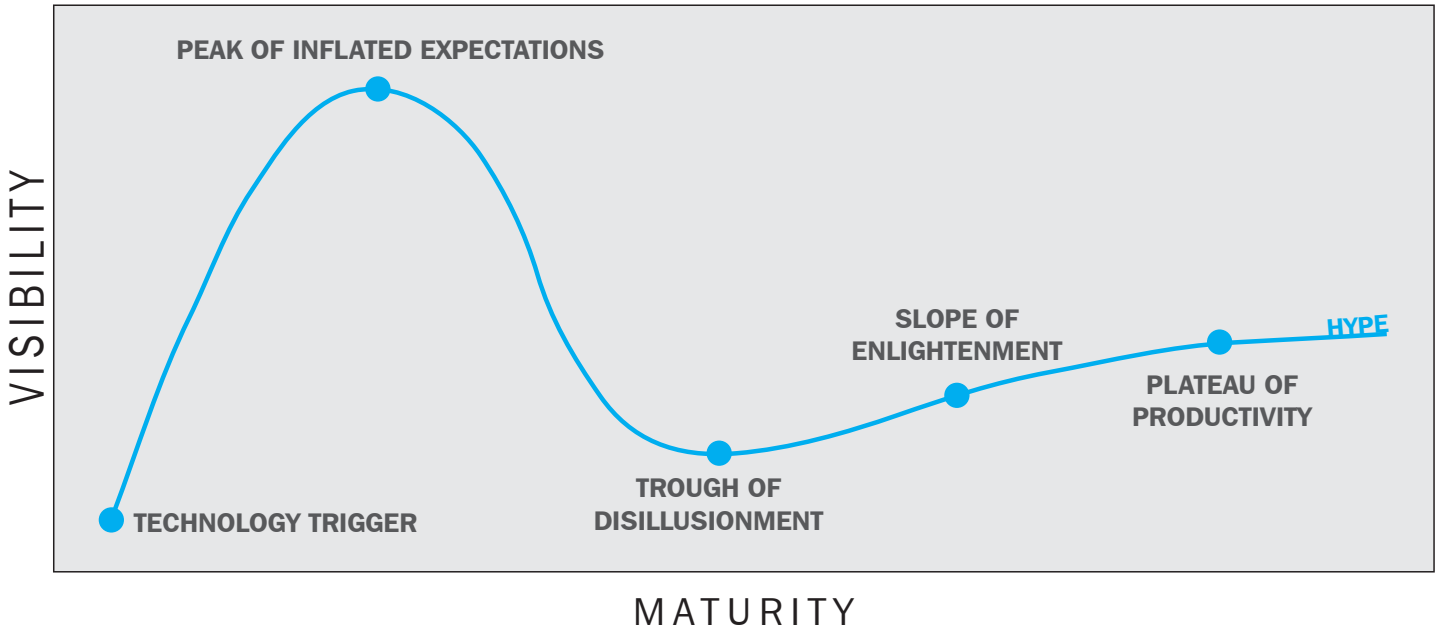
## THE TECHNOLOGY CYCLE

The rapid adoption of BIM technology bears some resemblance to the heady days of the dot-com boom. Back in the late 1990s/early 2000s, a lot of people believed that simply creating an online business by adding an "e-" or ".com" to their company's name and drawing as much traffic as possible to their website would eventually produce vast riches. We all remember what happened.

## Maximizing BIM: Lessons Learned

- Determine the WHY first – Identify the reasons why you want to use BIM and set expectations accordingly.
- WHO creates the BIM is as important as WHAT you want to model – To gain the most value, the trade or contractor responsible for doing the bulk of the physical construction work should create the BIM in collaboration with the design team whenever possible.
- Beware of software interoperability – Test and select software applications that best fulfill the virtual modeling goals set for the project.
- Compensation and contracts should support BIM – All participants should have "skin in the game" to incentivize them to collaborate deeply for project success.
- Even the smallest elements have a big impact – Using BIM to coordinate labor, materials and installations works best if every element that can potentially cause an issue in the field is included in the virtual model.
- Co-location – Yes; Co-creation – Absolutely – To gain the greatest value, it is essential that all project participants co-create the virtual model. Assemble the group to decide how they will work together, what metrics to use to track performance and how success is determined, as well as map and identify the decision making process.
- Model management infrastructure is a key requirement – Determine how a virtual model—or models—will be accessed, managed, shared and updated over wide area networks and the Internet.

FIGURE 1: GARTNER INC.'S HYPE CYCLE




Even before the dot-com boom and subsequent bust, research and consulting firm Gartner Inc. devised what it calls the "Hype Cycle." (see Figure 1). The cycle describes the over-enthusiasm and subsequent disappointment that typically occurs when a new technology is introduced.

Gartner asserts that oftentimes a new technology will generate a significant amount of interest when it's introduced. This leads to hype—or what it refers to as the "Peak of Inflated Expectations." During this phase, a "frenzy of publicity" typically leads to "over-enthusiasm" and "unrealistic expectations" for the new technology.

Once the technology moves beyond the hype, users will continue to experiment and begin to understand the best application of the technology—the "Slope of Enlightenment."

Eventually, users begin to realize practical benefits from the technology, leading to wide acceptance and adoption, the final phase dubbed the "Plateau of Productivity." (Think about the birth and evolution of Amazon, eBay and Google following the trigger of Internet technology.)

## Moving Beyond the Hype of BIM

The potential benefits of adopting BIM are staggering. An online survey of architects, engineers, contractors and owners (total sample size of 302) conducted by McGraw-Hill Construction in 2008 noted that several respondents estimated their return on investment from implementing BIM was a whopping 1,000% or more. More modest, yet nonetheless impressive, return rates for BIM can be found in McGraw-Hill's "SmartMarket Report on Building Information Modeling: Transforming Design and Construction to Achieve Greater Industry Productivity" (released in 2008):

- The surveyed companies, who actively track their return on investment from BIM, say they are getting returns of 300% to 500%.
- 82% of respondents believe BIM is having a positive impact on their company's productivity.
- The use of BIM on construction projects "is growing rapidly." 62% of survey respondents, whose companies are current users of BIM, reported their company will become heavy BIM users (using BIM on more than 30% of their projects) in 2009, up from 45% in 2008. It seems that we have hit the "Peak of Inflated Expectations" in the AEC industry for the use of BIM technology.

Although the reported benefits are achievable, they also require a profound shift in the way projects are delivered.

Simply integrating BIM into an existing workflow will not produce chart-topping returns on investment that the AEC industry and clients are now beginning to expect from BIM. Unless the process for project delivery is fundamentally changed and unnecessary steps eliminated, added costs, delays, and the potential for errors will still exist.

To move beyond the hype of BIM technology and settling for "low hanging fruit" of visualizing design intent and seeing conflicts, we must continue to develop and build upon best practices for deploying BIM on projects. Based on DPR Construction's more than a decade worth of experience in VDC, we have identified the following lessons to help move the industry forward and to assist architects, engineers, contractors and owners in maximizing the rewards of adopting and integrating BIM into their business.

## Determine the Why First!

Project participants need to clearly identify the reasons why they want to use BIM and set their expectations accordingly. This may sound like a no-brainer, but we have seen too many projects where BIM is either implemented as an afterthought or severely underutilized. This means those project teams are missing out on deeper cost and time savings. Using BIM to its full potential would enable project participants to:

- design and analyze the performance of a project and create renderings and documents,
- determine the best sequence for constructing a project,
- ascertain what parts can be prefabricated,
- procure materials,
- estimate the cost of the project throughout its development, and even estimate the cost of operating and maintaining the finished project over its lifetime.

Challenging the project team to answer the question "Why are we using BIM?" will enable the team to decide how the virtual model should be built. Usually, the general answer to the "Why" question is to minimize the overall costs and the time it takes to construct a project. The more specific and detailed the answer to the "Why" question, the greater the likelihood of achieving the cost and time savings.

If you have built a model without answering the "Why" question, you are bound to play catch-up at some point. The benefits you are anticipating will be that much harder to achieve.

For example, on a large-scale hospital project, the design team had already created 2-D documents when DPR joined the project team. Due to the complexity of the project and the customer's overall goals, DPR created a virtual model during preconstruction to coordinate systems and increase the ability for prefabrication on the project. The modeling process is currently ongoing. However, had the virtual model been required from the outset, a substantial amount of time, money and effort could have been saved.

In addition to being implemented as an afterthought, BIM is often underutilized.

We see many projects in which BIM technology was used with the simple aim of conveying design intent. In our view, that's a step in the right direction but only gets us a fraction of the way up the path to the "Plateau of Productivity." In this scenario, if the project team later tries to use that virtual model to determine, for example, what steel components can be prefabricated, the contractor in most cases will be unable to do so. A new virtual model will have to be developed by the contractor for prefabrication, an effort that will cost additional time and money.

In our experience, bringing together the right people to collaborate on creating a virtual model in the first place makes setting the goals—in other words, answering the "Why" question—easier. That's what happened on the Camino Medical Group's 250,000-sq.-ft. outpatient medical center project in Mountain View, Calif. The project team, from the very beginning, agreed to use a BIM-enabled Project Delivery (IPD) or Lean Project Delivery approach and established that they wanted to use BIM to coordinate the installation of mechanical, electrical, plumbing and fire protection systems.

The result: The team estimated that it saved nearly $9 million and six months compared to what would likely have been

achieved with a conventional CM-at-risk approach. What's more, Sutter Health, the owner of the Mountain View campus, has an accurate virtual model of the complex, which its facility management team has been using for two years. The facility management team reports that information is much easier to find compared to the traditional two-dimensional drawings that normally get sent to an owner after the project is completed.

## Who Creates the BIM is as Important as What you want to Model

Once you have identified the WHY, then you need to determine the WHO. There seems to be a big disconnect in the industry on this important issue.

The mechanical, electrical and plumbing systems for technical projects can make up as much as 50% of a project's cost. Using BIM to its full potential during construction to eliminate mis-coordination, as well as identify components that can be prefabricated, is where the most time and money can be saved.

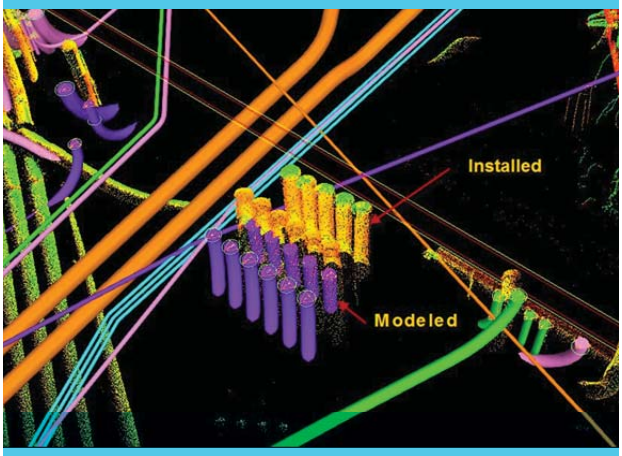
We have seen many instances in which the architecture team is 100% committed to modeling and coordinated its efforts with other team members. Yet, the virtual model that results is not set up, or lacks the detail needed, to take full advantage of the potential cost and time savings downstream, such as scheduling, automated fabrication and model-based estimating. In this case, contractors must create another virtual model of the project, which requires additional resources and effort.

For example, DPR joined a project as the general contractor after the project's design team had already used BIM to create a virtual model. When subcontractors were brought on board, it was discovered that only a small fraction—less than 10%—of the design team's model could be used to coordinate construction. As a result, additional time and money were expended to create another model for fabrication and assembly.

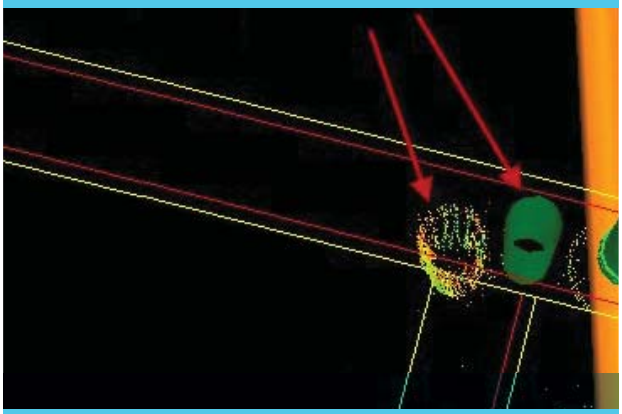
The use of BIM for construction coordination also requires teams to work differently.

The typical "big-batch" detailed design phase does not lend itself to the fast-track nature of virtual building. BIM increases the need for more detailed design information sooner. The entire

DPR is using laser scanning technology in the field to check work in progress against the model. Laser scanning creates a point cloud with details as accurate as 1/16th of an inch.




The laser scan image showing work completed in the field (left) and the model (right) are compared. In this case, underground electrical conduits were not installed as modeled.



The use of laser scanning allows discrepancies between the field and BIM to be resolved much earlier, preventing future issues and rework.


DPR Construction used Navisworks to create 3D and 4D models for the Camino Medical Group facility prior to construction. Including as many details as possible is important because the model may show potential costly problems, such as an MEP clash.

design process speeds up, requiring smaller batches of information to be created and exchanged. For large-scale healthcare projects, this approach will also help the team avoid the need to submit, rework and resubmit to review agencies, such as the Office of Statewide Health Planning and Development (OSPHD) in California, eliminating deferred approvals.

To gain the most value, we recommend that, whenever possible, the trade or contractor responsible for doing the bulk of the physical construction work should create the BIM in collaboration with the design team. The real opportunity for the owner is not just in the automation of drawing production, which is how a majority of teams use BIM now, but in the reduction of risk during construction and the identification of opportunities for increased prefabrication that can result in significant project savings.

## Beware of Software Interoperability

The software applications various project participants use and the degree to which the software can communicate and operate—or interoperate—with one another plays a big role in maximizing the benefits of BIM. Incompatibility between systems often prevents project participants from generating and sharing information rapidly, accurately and completely.

A 2004 National Institute of Standards and Technology (Gallaher et. Al. 2004) study showed that lack of interoperability in our industry accounts for an increase in construction cost by $6.12 per sq. ft. for new construction and an overall impact to the tune of $15.8 billion to the construction industry. That's a staggering number, which is why it is crucial to identify what software the architect, engineer, contractor and subcontractors plan to use before sitting down to create a virtual model.

The key is to test and select the software applications that will best fulfill the virtual modeling goals set for the project. One approach to minimize interoperability issues is to map the workflow required to deliver an entire project, looking for opportunities to eliminate unnecessary steps and hand-offs.

One of the BIM goals for the 130-bed, 230,000-sq.-ft. Sutter Medical Center Castro Valley project is model-based estimating. Shortly after the project participants assembled in early 2008 to lay the groundwork for virtual model creation, DPR discovered that the mechanical, electrical and plumbing subcontractors were planning to use modeling software—CAD-Duct, CAD-Pipe and CAD-Mech—that would not seamlessly interoperate with the Designer of Record's software. To

minimize the waste of duplicate effort, the team, including the owner, determined that the best course would be for the consulting engineers to switch to design software that was more compatible with what the subcontractors were using before any substantial work began on the project.

The upshot is that if BIM is not used collaboratively during design the phase, the project will only receive partial benefits from the use of BIM. For example, on another large-scale healthcare project, DPR came on board about a year after the design team had already started creating the virtual model. This owner also wanted an estimating system put in place to track the ongoing cost of the project. However, DPR's estimating software is not compatible with the architect's modeling software. Now, with the project more than a year into the modeling process, DPR is still working with the team to successfully integrate model-based cost estimating.

Ultimately, the AEC industry needs to look at the interoperability issue beyond just a project or set of projects. Long term, the industry needs to support efforts to make the disparate software applications interoperable.

## Compensation and Contracts should Support BIM

Time and again, we have experienced that the earlier the architects, engineers and builders all come together for the BIM process, the bigger the upside for a project. That means project participants, such as construction superintendents and subcontractor foremen, who normally don't see the drawings of a project until a few weeks before they begin work on it, should to be involved in the BIM process.

This also means that owners can expect to spend more at the onset of a project; although, the overall budget for the project should not increase. In fact, the owner should benefit from a better planned and coordinated project, resulting in an overall lower project cost than a traditional approach.

To support a more collaborative approach to design and construction and realize the greatest benefits of BIM, the traditional compensation and contract structures need to change. Traditionally, the architects, engineers, contractors and subcontractors are treated as separate entities on a project. They are all working together to achieve project goals, but, ultimately, are forced to look out for their own business interests. This needs to change; to borrow a phrase from Warren Buffett, "all participants should have skin in the game" to incentivize them to collaborate deeply for the success of the project.

For example, DPR is part of the design, engineering and construction team that Sutter Health assembled under its own relational contract, the "Integrated Form of Agreement (IFOA)," to design and construct the Sutter Medical Center Castro Valley replacement hospital. The IFOA outlines the use of an integrated Lean project delivery approach to designing and constructing the project. It also calls for all 11 participating companies to share risk and reward to promote making the best decisions for the project as a whole.

Two DPR superintendents, who are in charge of overseeing construction, have been working alongside the architects from very early in the design process on the Castro Valley project. The team has already seen a huge impact due to this early involvement of builders in the process:

- The model has been thoroughly reviewed by the entire team each week in a "Digital Build" session for constructability.
- Problems that normally are only caught during construction have already been addressed. Specifically, superintendents have identified drywall details and installation sequences that would have increased the cost of the project for the owner and replaced them with details that accomplish the same goals, while being much easier to install.
- The design team is also required to share detailed designs in line with the construction sequence, resulting in an overall better coordinated model and project.
- The estimated cost for the project was reduced by more than $20 million during the design process to arrive at the target cost of $320 million.

# Even the Smallest Elements have a Big Impact

Using BIM to coordinate labor, materials and installations works best if every element that can potentially cause an issue in the field is included in the virtual model. The more details included in the model, the better. Any details that are left out may lead to conflicts during construction.

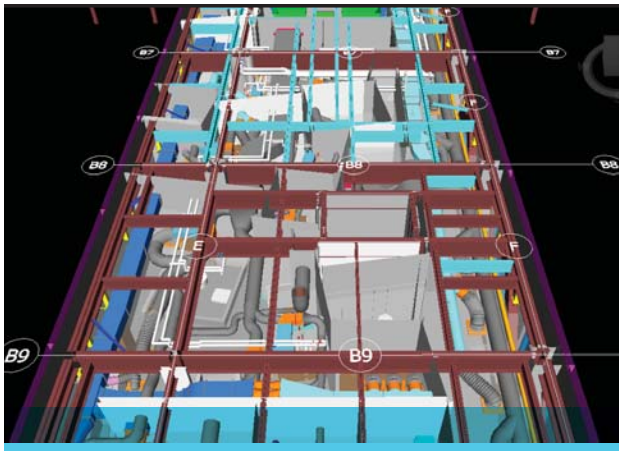
Small items are often overlooked in a model, such as anything with less than a 1-1/2" diameter, miscellaneous steel, hangers, connections to exterior skin systems, bracing, gusset plates, seismic connections, headwall units, and systems, including a pneumatic tube and medical gas. These items, however, must be modeled if a team wants to use BIM to coordinate the mechanical, electrical, plumbing and fire protection system installations or estimate the quantities of materials needed for a project.

For instance, if the project team wants to estimate the quantities of concrete needed by each pour sequence for a slab, the virtual model must include the construction joints in the slab. Or, if the project team wants to estimate the amount of drywall needed, then details, including stud spacing and backing, must be incorporated in the model.

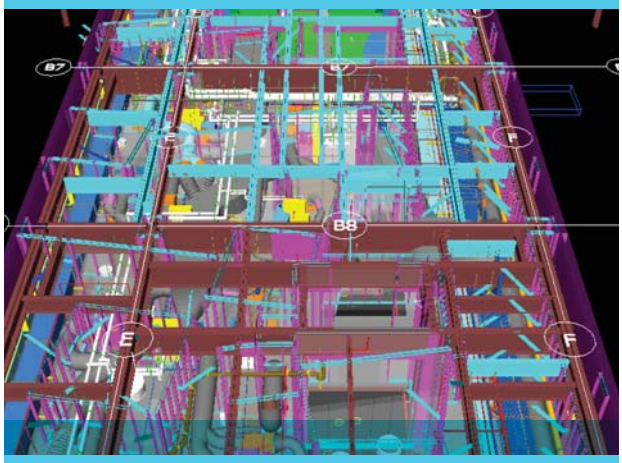
Items not typically modeled include equipment supports. Usually, the team creates "no fly zones" in BIM for equipment supports. Those are the areas that other trades need to avoid and keep open. What DPR has found is that team members often overcompensate for these no-fly zones.

For example, when you have a patient lift, it has a track of three or four feet each that supports it. If you don't know exactly how many lifts or supports you need, you begin to guess. In a project that has very limited interstitial space, such as Sutter Medical Center Castro Valley, we had to incorporate the exact modeling for the supports, patient lifts and radiology.

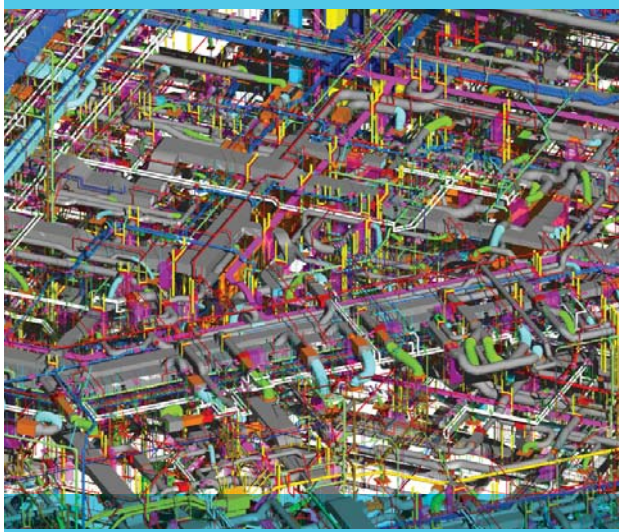
Project participants need to figure out who will model these small components in a timeframe that allows for effective coordination. In addition, no matter how small one of the team




Using BIM works best if every element that can potentially cause an issue in the field is included in the virtual model.




For the UCSF Medical Center at Mission Bay project, the team modeled a higher level of detail, including all studs, hangers, miscellaneous steel and connections to exterior skin systems.



For the 878,000-gross-sq.-ft. medical center, the team modeled a total of 423,866,666 objects and will have resolved an estimated two million clashes.

members perceives a change to be, the snowball effect of that change on the rest of the team can be massive.

Based on Back Check comments from OSHPD, California's health care planning and development review agency, the structural engineers on the Castro Valley project made what normally would be considered a minor change. They changed a steel beam from 21 inches to 27 inches. That change, however, took out six inches of interstitial space. This caused the fire protection system piping, ductwork, medical gas piping and electrical conduit racks to be relocated and all the systems in the area to be modeled a second time. Items were adjusted horizontally to make them all fit into the space, and the structural engineers were able to adjust the size and weight of the beam to get some of the depth back after they understood the overall impact.

## Co-location – Yes; Co-creation – Absolutely

Having the right people available at the right time is crucial for a successful BIM project. Having all project participants working together in the same room—or a "Big Room"—is extremely beneficial. However, it may or may not be necessary depending upon the amount and urgency of the work. What is absolutely essential is that all the project participants co-create the virtual model.

On a practical level, co-locating cuts down on time getting questions answered and issues resolved, with all key project participants working together under one roof. You are reducing the "latency" on the project by bringing together people who ask the questions and who have the answers in the same room.

For one healthcare project in California, where the team is working in a big room, this organic process has been enhanced. Team members have established the practice of addressing simple issues or questions within 30 minutes and more complex ones within one day. Individuals, responding to a survey of what they thought about co-location on this project, reported that actually knowing who is making a request helps them prioritize their work to provide the information.

While fully co-locating an entire team is difficult except on very large projects, it is possible to gather everyone needed on a project together frequently in workshops. The Sutter Medical Center Castro Valley team, for example, meets two, three and, sometimes, four days in succession every other week. The amount and urgency of the work determines the duration of the session. During the off weeks, smaller groups meet virtually through web meetings and teleconferences.

While co-locating has proven to be highly beneficial, it is the co-creation of the model that is vital. Based on the lessons we've learned, we recommend the following to maximize the value of BIM:

- Assemble the group to decide how they will work together, what metrics they will use to track their performance, and how they define success, co-creating the team charter.
- Map and identify the decision-making process to understand when a particular expertise will be needed. Remember, it is not the number of people but the right number of people, who can make decisions and help provide a solution in a rapid fashion that is critical to the process.
- Every member company having a hand in creating a virtual model should be present. We have seen time and again that when everyone works on a BIM project, the process engages colleagues and clients and produces results that are not always quantifiable, but are nonetheless palpable. In his book "Serious Play: How the World's Best Companies Simulate to Innovate," author Michael Schrage argues that the process of prototype—or model—creation inspires team behavior. We can attest to that.

The best example we have seen to date is trade detailers working through conflicts based on a formal or informal agreement that whichever trade can move their component most easily will do that in the virtual model and ultimately in physical space.

## Model Management Infrastructure is a Key Requirement

Given the amount of data generated by a project that uses BIM and the sometimes far-flung locales of team participants, it is extremely important to determine how a virtual model—or models—will be accessed, managed, shared and updated over wide area networks and the Internet.

DPR used File Transfer Protocol (FTP) sites and Web collaboration sites for its work on Sutter Health's Camino Medical Group project, which was completed in 2007. Based on DPR's experience, FTP and Web collaboration sites are just not enough. Extensive download times for models, which average 20 to 30 megabytes, and the inability to access shared drives remotely were some of the issues that helped create the foundation for process improvement.

What's needed is a network of servers where models can be stored locally and will get synchronized at night when bandwidth is available. That enables project participants to access the latest model and information quickly rather than spending precious hours downloading and uploading files.

To date, DPR has experienced the most success using distributed collaboration framework software for infrastructure management. Currently being used on the Sutter Castro Valley project, this collaboration system allows project participants to manage and share virtual models, geospatial content, project data and documents. Some of the benefits include:

- A single location for all project information,
- Time saved finding and accessing project information, and
- Greater efficiency and ability to share models across multiple locations.

## Reaching the "Plateau of Productivity"

All but the simplest facilities should be built virtually before construction begins. However, until BIM-enabled design, construction, and operation and maintenance of buildings becomes second nature, tracking and assessing results are crucial to substantiate the true benefits of BIM. As a result, we at DPR are working hard to learn from our past and present experience, establishing metrics and reporting results.

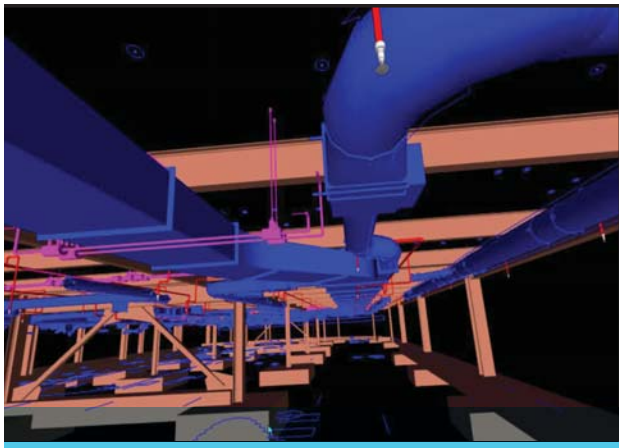
Cost and time savings are the most obvious criteria to measure results. Measuring productivity on a project that used BIM and comparing it to what the industry has seen up to now adds more and richer detail to the discussion of cost and time savings. The same can be said of calculating just how many components were prefabricated and the number of construction changes that were generated on a project that used BIM compared to a similar project that did not.

Following are some specific examples and outcomes:

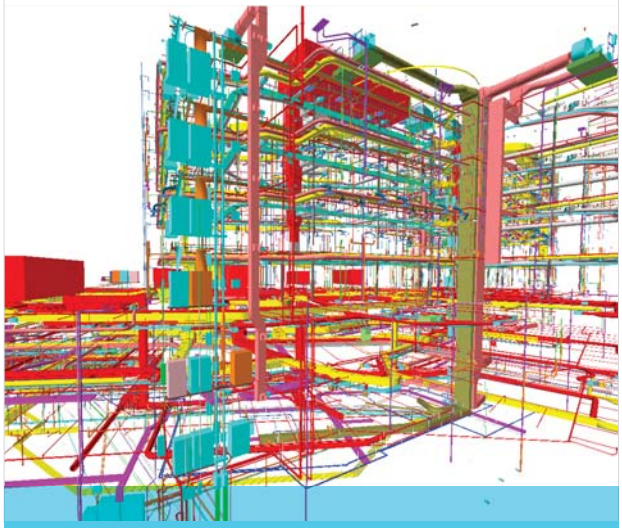
- Camino Medical Group Mountain View campus: Using BIM to build the 250,000-sq.-ft. outpatient medical center resulted in an estimated cost and time savings of at least $9 million and six months over the traditional CM-at-risk approach. The cost of modeling the Camino project was less than 0.5% of its $96.9 million construction price tag. Moreover, the productivity for installing the mechanical and electrical systems was 5% to 30% above industry standards.
- Sutter Medical Center Castro Valley: Currently under construction, the key goal for this $320 million hospital is to design and deliver a facility of the highest quality at least 30% faster and for no more than the target cost. Incorporating both IPD and BIM, the team planned and streamlined the design process. The result: The IPD team delivered complete designs in 15.5 months to meet regulatory deadlines for an on-schedule construction start. (Typical time to design a comparable facility is 24 months.) BIM also is being used to coordinate all elements virtually, maximizing offsite fabrication and pre-assembly. In addition, model-based cost estimating has shortened the traditional two-month estimating cycle to a two to three week cycle, allowing for much quicker and frequent cost feedback.
- Autodesk One Market Office and Customer Briefing Center: For this 45,000-sq.-ft. project, completed

in 22 weeks, DPR coordinated more than 15 different models into one integrated BIM system using Navisworks. The project was also one of the first in the country of its type and size to use IPD. According to Jason Medal-Katz, senior manager of Autodesk, BIM and IPD enabled the team to achieve a LEED Platinum certification on the project and exceed owner quality expectations based on a third-party inspection and evaluation.

These three examples are the tip of the iceberg. As an industry, a great opportunity lies before us. As the software continues to improve and teams change their work processes to a more collaborative, integrated approach, we will experience a breakthrough in facility development—reaching the practical application of BIM and the Plateau of Productivity to deliver greater value.



BIM helped save an estimated $9 million and shaved six months from the schedule compared to a traditional CM-at-risk approach on the Camino Medical Group Mountain View campus.



Model-based cost estimating on Sutter Medical Center Castro Valley has shortened the traditional two-month estimating cycle to two to three weeks, allowing for quicker and frequent cost feedback.

More than 15 different models were integrated into one BIM using Navisworks on this 45,000-sq.-ft. renovation for Autodesk. Completed in 22 weeks, the project achieved LEED Platinum certification.

**TRANSCENDING THE BIM HYPE AUTHORS:**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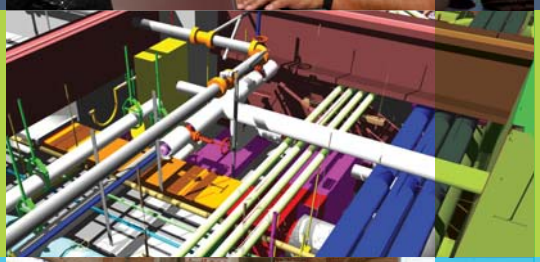
**DPR CONSTRUCTION** is a unique technical builder with a passion for results. Consistently ranked in the top 50 general contractors in the country over the last 14 years, DPR is a national commercial contractor and construction manager specializing in technically challenging and sustainable projects—of all sizes and complexities—for the advanced technology, healthcare, life science and corporate office markets. For more information, visit www.dpr.com

75

Number of DPR projects currently using BIM across the nation.



3M

Square footage of hospital projects being modeled in California.

255

Number of DPR professionals trained in advanced BIM.

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