DPR Drywall Modeling: Ever Forward

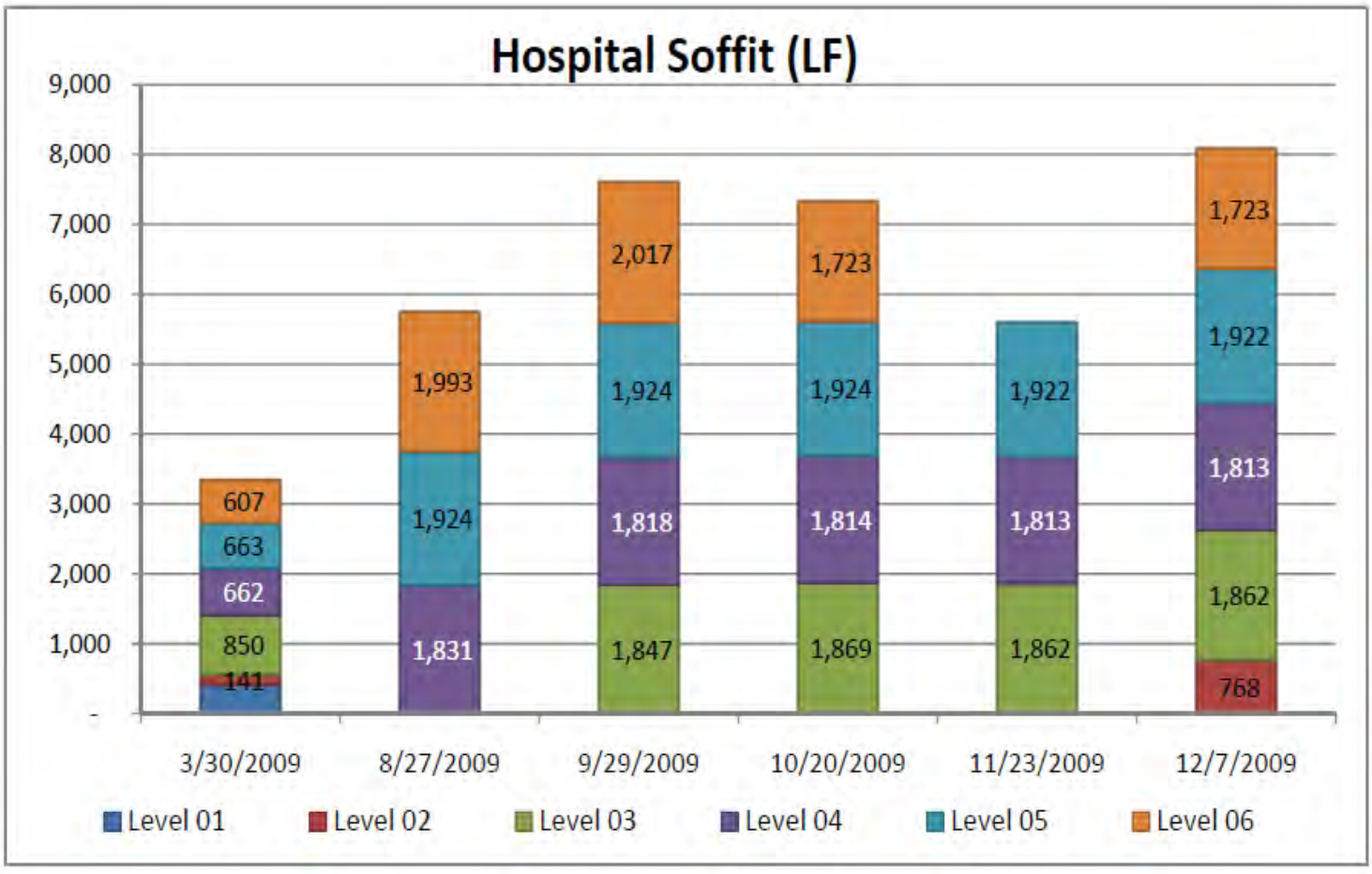
DPR CONSTRUCTION

Introduction

At a time when California's Office of Statewide Health Planning and Development (OSHPD) is reporting more than $20 billion in health facility construction currently under plan review or in construction, strategic builders and architects are turning to building information modeling (BIM) to design and build these complex facilities faster and more accurately. BIM's full potential is starting to be realized as teams apply virtual design and construction tools to aspects of projects not typically modeled in the past, with the intent to minimize unnecessary delays and streamline costs.

For example, DPR Construction is currently modeling metal stud framing on roughly 1.5 million square feet of California OSHPD hospitals in the San Francisco Bay Area alone. Additionally, it has modeled framing at the 750,000-square-foot OSHPD-regulated Palomar Pomerado Health (PPH) Medical Center West hospital in San Diego and a 40,000-square-foot Kaiser Permanente medical office building in Los Angeles, among others. This drywall modeling experience has grown rapidly over the past few years. Early on, metal studs were manually placed in the Autodesk Revit Architecture environment, a process that proved extremely labor intensive. More recently, DPR procured several licenses of an underdeveloped Revit plug-in that advertised an automated metal stud placement function. Over the past year and a half, DPR has been working hand-in-hand with software developers to drive the technology further. As such, when it comes to metal stud framing software and implementation, DPR is cultivating a wealth of technical and field experience that brings tremendous value to DPR projects.

FIGURE 1: QUANTITY TRENDING CHART ILLUSTRATES THE LINEAR FOOTAGE OF SOFFITS IN THE HOSPITAL EXTRACTED FROM THE MODEL BY FLOOR ON A MONTHLY BASIS

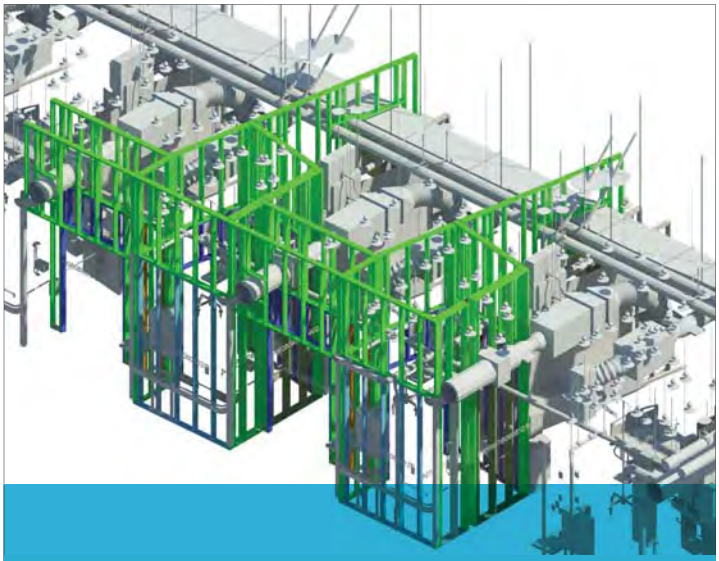


The Benefits of Modeling

Modeling drywall, as with modeling other systems, has multiple benefits:

- Using building information modeling (BIM) tools to create virtual mockups is faster and less expensive than building live mockups.
- Modeling for coordination helps to create an efficient design and resolve potential requests for information (RFIs) during preconstruction.
- Using the model for estimating and quantity trending (**Figure 1**) allows DPR estimators to quickly provide quantity takeoffs and account for hidden conditions.
- Developing the coordination models into construction models aids field personnel during layout and production.
- Eventually, when the construction model is developed into an as-built model for turn over to the owner, which can then be used for building maintenance and future renovations.

These efforts provide short-term and lasting value to the project team, subcontractors and the client.



A composite model with stick built walls, wall panels, and MEP systems. Multiple combinations of heights, lengths and sizes were tested using modeled conditions as a guide prior to erecting a material mockup.

PROTOTYPING IDEAS

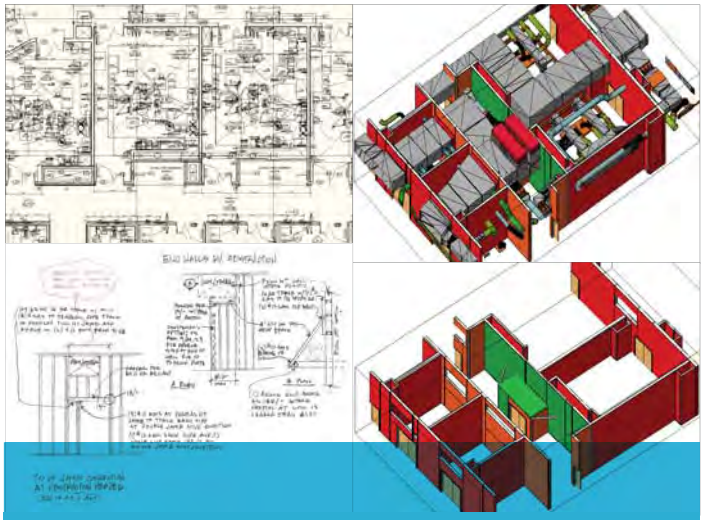
Modeling drywall using virtual mockups allows for the testing of designs and ideas prior to the creation of more expensive live mockups. Partnerships with subcontractors, clients and design professionals have enabled DPR to put prefabricated walls through multiple paces in the virtual world and, eventually, transfer that virtual mockup into a live fabrication. For example, on one large-scale medical center currently underway in the Bay Area, DPR used the virtual mockup to test a variety of designs, sizes, heights and configurations of prefabricated panels for patient rooms before any materials were ordered for a live mockup. The lessons learned from the virtual mockup resulted in a savings of time and money during the project's research-and-development phase. Furthermore, these lessons learned directly impacted the design of the live mockup that eventually was created.

SITUATIONAL AWARENESS

Modeling during preconstruction for coordination improves a project team's ability to anticipate field conditions before the first piece of steel is ever erected. This situational awareness allows DPR to find areas where unique details are required, which can help avoid OSHPD change orders by identifying and incorporating details prior to OSHPD submission.

For architect Tyler Krehlik, an associate principal with Anshen + Allen, the large-scale Bay Area medical center represents his first experience with modeled drywall in his 12 years of practice. According to Krehlik, the level of coordination on this project exceeds the typical level of detail. "Actual stud sizing and orientations at odd conditions are being modeled and coordinated during the construction documents phase, rather than becoming field coordination issues. This should assist the framers later in material quantities, and should make for a quicker install," Krehlik said.

Using the framing model for coordination with mechanical, electrical, plumbing and fire protection (MEP/F) contractors allows DPR to save space for critical studs, corner studs and king studs around doors and large openings. Further



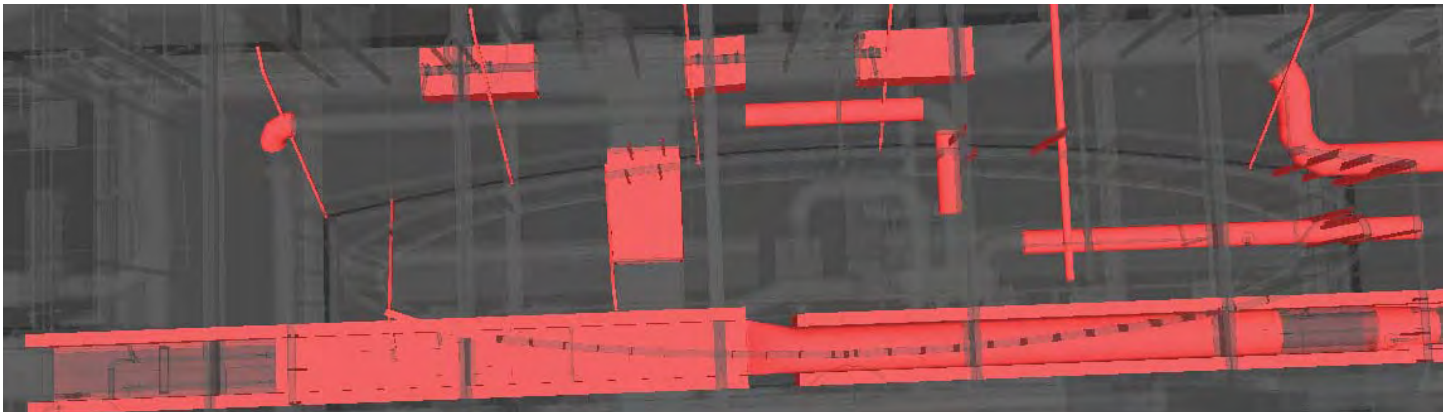
The 2D drawing in the upper left shows a configuration of full-height walls. The image in the upper right shows the mechanical systems in conflict with the walls. The image to the bottom left shows unique details sketched by the engineer of record once she was notified of the situation. The image to the bottom right shows the proposed detail that will be used to brace a rated lid and partial height walls to nearby walls for structural requirements in the model environment. Without drywall modeling and coordination, this issue could have gone undiscovered until the field where an engineering judgment and specialized detail could delay construction.

coordination with overhead kickers, shaft-bottoms, soffits, legovers and backing makes the model more comprehensive, thus providing spatial and visual cues that indicate potential conflicts to anyone viewing the model. This gives the project team a clearer picture of what will be required for construction in the field, allowing the team to decide what makes the most sense for the project – whether it's more efficient to place built-up headers or re-route MEP systems, for example.

According to DPR Drywall Superintendent John Baker, BIM makes it possible to see and plan for things such as legovers or ensure that med gas valve boxes, for instance, will work in a given wall."When all of these potential 'hiccups' can be eliminated before the job starts, the production goes much smoother and should result in increased production rates," Baker said.

Anshen + Allen's Krehlik thinks modeling's potential to eliminate stud/MEP conflicts, therefore reducing RFIs, is significant. "Having the king studs modeled and fully clashing against ductwork and piping should result in fewer framing oddities during construction," Krehlik said.

Although framing has been modeled before, most other contractors are still manually placing studs. Randall Ksenzulak, a project coordinator and mechanical detailer for ACCO Engineered Systems, is working with DPR on the large-scale Bay Area medical center. Previously, Ksenzulak worked on two projects that modeled only king studs. "The level of detail in this project is a very welcome improvement. It helps us layout our systems with fewer unnecessary offsets for studs," he said.

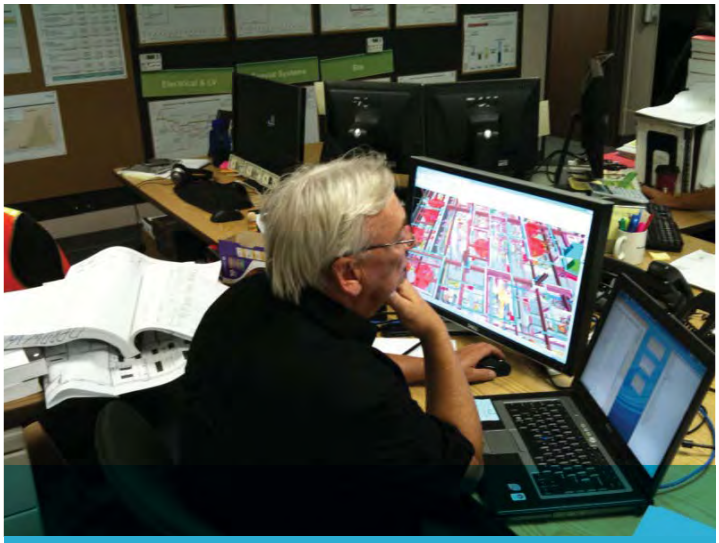


CREATING EFFICIENCIES

By joining ranks with other modeling trades, DPR is able to influence design, making framing and mechanical duct designs and installations more favorable.

"We are able to design a much more efficient system by eliminating unnecessary offsets resulting in pressure loss that come up in the field when king studs are not modeled. We can also get details and options for routings much faster with a [framing] representative available," Ksenzulak said. "The framing model is our base for every room layout. Where the doors and windows are gives us a starting point for the ductwork entering and exiting the rooms. By knowing where the framing is before populating the model, we are able to minimize the number of king studs taken out by large ducts, which leads to a more efficient system."

Increasingly, teams of DPR BIM engineers and superintendents are getting involved on projects early to provide constructability reviews, validate model correctness and influence the design process.



DPR Drywall Foreman Norman Counter analyzing clashes in Navisworks, working closely with BIM engineers to analyze the model and provide constructability comments.

Norman Counter, a DPR drywall foreman with more than 30 years of field experience, sees modeling as having the potential to redefine the coordination process. "Knowing where all of these conflicts occur ahead of time is going to save a lot of 'head scratching.' Knowing where backing is required, what the elevation is and what type it is saves tons of time during layout," Counter said. "Aside from backing, knowing about MEP conflicts and penetrations can only help us do our job better. The more you know ahead of time, the more you can prepare for it."

Dan Casale

Updated: 06/03/2010

	Area(s) Affected	Description	Date Submitted	Response Request	Date Answered	Status	Additonal Comments	Corrected in Prints (04/15/2010	Corrected in DPR Model	Corrected in A+A Model	Documentation	Response
23	4.1	Overlapping Walls Near Gridline M & B.35	######		6/11/2009	Answered		Yes	Yes	Yes	Area 4.1 RFI 4.pdf	Area 4.1 RFI 4.pdf
24	4.1	Non-Continuous Fire Rating in Corridor	######		6/11/2009	Answered		Yes	Yes	Yes	Area 4.1 RFI 1.pdf	Area 4.1 RFI 1.pdf
25	4.1	Non-Continuous Fire Rating in Corridor	6/11/2009		6/11/2009	Answered		Yes	Yes	Yes	Area 4.1 RFI 8.pdf	Area 4.1 RFI 8.pdf
26	5.1	Angled wall at door in handicap bathroom	######		######	No formal response received		No	Yes		Area 5.1 RFI 3.pdf	
27	5.1	Wall Type Confusion	######		######	No formal response received	Extraneous A4-A wall tag needs to be removed	No	Yes	No	Area 5.1 RFI 5.pdf	
28	5.1	Non-Continuous Fire Rating	######		######	No formal response received		Yes	Yes	Yes	Area 5.1 RFI 1.pdf	
29	5.1	Doubly-Rating	######		######	No formal response received		Yes	Yes	Yes	Area 5.1 RFI 2.pdf	
30	5.1	Non-Continous Rating at corridor	######		######	Answered		Yes	Yes	Yes	Area 5.1 RFI 4.pdf	Area 5.1 RFI 4 Answered.pdf
31	5.1	Rated wall and shaft wall conflict	######		######	No formal response received		Yes	Yes	Yes	Area 5.1 RFI 6.pdf	
32	5.1	Rating routing request	######		######	Denied	Drawings and model indicate otherwise	Yes	Yes	Yes	Area 5.1 RFI 7.pdf	
33	4.1	Window Tag Conflict	######		N/A	No formal response received		Yes	Yes	Yes	Area 4.1 RFI 9.pdf	
34	4.1	Ceiling Height Confirmation	######		######	Could not confirm formal response	need A+A to verify ceiling type again	No			Area 4.1 RFI 10.pdf	
35	4.3	A41A or B42A changed to E41A & E42A	######		######	No formal response received		Yes	Yes	Yes	Area 4.3 Shaftwalls.pdf	
36	4.3	A41A or B42A changed to E41A & E42A	######		######	No formal response received		Yes	Yes	Yes	Area 4.3 Shaftwalls2.pdf	
37	4.3	H4-A's changed to D4-A's	######		######	No formal response received		Yes	Yes	Yes	Area 4.3 Single Sided.pdf	
38	4.1	Soffit Heights not Modelled	######			A+A need to verify; not a DPR DW issue					Area 4.1 Soffit Height.pdf	
39	4.3	Window Tag Conflict	######		######	Could not confirm formal response	Window type and sizes have changed in prints				Area 4.3 Window.pdf	
40	3.2	A4+- Changed to D4++	######		######	No formal response received		Yes	Yes	Yes	3.2 Issue 1.pdf	
41	3.4	Issue 2 - wrong partition type	######				One wall remains unconstructable as drawn in prints	Yes	No		Area 3.4 Issue 2.pdf	
42	3.4	Issue 4	######			A+A need to verify	2-hour wall seems misplaced	No	No	No	Area 3.4 Issue 4.pdf	
43	3.4	Issue 13	######			Resolved	1 hr. wall needs to be changed to 2 hr.	No	Yes	No	Area 3.4 Issue 13.pdf	
44	3.4	Issue 16	######			Resolved	Need to clarify constructability of solid surface shelf at braced frame	No	Yes	Yes	Area 3.4 Issue 16.pdf	
45	3.4	Issue 1 - wrong partiton type	######			No formal response received		Yes	Yes	Yes	Area 3.4 Issue 1.pdf	
46	3.4	Issue 3 - wrong partition type	######			No formal response received		Yes	Yes	Yes	Area 3.4 Issue 3.pdf	
47	3.4	Issue 5 - wall alignment	######			No formal response received		Yes	Yes	Yes	Area 3.4 Issue 5.pdf	
48	3.4	Issue 6 - incorrect wall partition	######			No formal response received		Yes	Yes	Yes	Area 3.4 Issue 6.pdf	
49	3.4	Issue 7 - unconstructable condition	######			No formal response received		Yes	Yes	Yes	Area 3.4 Issue 7.pdf	
50	3.4	Issue 8	######			No formal response received	Wall changed to A41A (rated now)	Yes	Yes	Yes	Area 3.4 Issue 8.pdf	
51	3.4	Issue 9	######			No formal response received	Assume wall has changed; wall not tagged though	Yes	Yes	Yes	Area 3.4 Issue 9.pdf	
52	3.4	Issue 11	######			No formal response received		Yes	Yes	Yes	Area 3.4 Issue 11.pdf	
53	3.4	Issue 12	######			No formal response received		Yes	Yes	Yes	Area 3.4 Issue 12.pdf	
54	3.4	Issue 14	######			No formal response received	Wall is ok as drawn -- chase vs. shaft	Yes	Yes	Yes	Area 3.4 Issue 14.pdf	
55	3.4	Issue 10	######			Could not confirm formal response	wall should be drawn as D4++	No	Yes	No	Area 3.4 Issue 10.pdf	
56	3.4	Issue 15	######			Could not confirm formal response					Area 3.4 Issue 15.pdf	

With buy-in from seasoned veterans, DPR can identify what's truly helpful, and development can be tailored toward making field crews more efficient. "Normally, we don't get backing details until we're laying out. Now, BIM is really forcing the issue, and getting people to think of these things ahead of time – before it's too late and impacts production," said DPR Drywall Executive Skip Miyamoto.

Framing and drywall are huge components of any building and are almost always on the critical path. Being involved early to influence the design creates a team environment and allows DPR's experts to analyze and enhance project design efficiency and constructability. According to ACCO's Ksenzulak, the more coordination that can go on before construction starts will lead to fewer clashes in the field and increased productivity by all trades.

ENHANCING THE REVIEW PROCESS

Quality assurance and quality control (QAQC) efforts also are greatly enhanced through the use of drywall modeling. During the coordination phase, DPR has continuously worked with a project's architect to proactively solve problems, often identifying hundreds of unfavorable or unconstructible design situations. In this process, the DPR team develops a feedback loop using Bentley ProjectWise, BIM tools and Microsoft Excel to relay its comments to the architect. The end product has a list of all DPR feedback and hyperlinks to screenshots for each comment. The design team then has an opportunity to review DPR's input and incorporate comments they agree with before a permit set is issued.

Herb Moussa is an associate principal with Anshen + Allen and a 27 year veteran in the field. The importance of having drywall partners on board is significant, according to Moussa. "This experience has solidified our opinion that partition framing should be modeled due to the numerous advantages. The use of drywall modeling has led to the discovery of problems that would have been discovered in the field during construction. Thus, the QC process has been improved," Moussa said.

Some examples of feedback provided include situations in which the designed walls cannot be built, situations rendered unconstructible by MEP configurations, and locations where unique details must be developed that would not have been discovered until construction was under way. All of this feedback during the design and coordination phase creates a powerful partnership with a project's design team.

A detailed wall drawing generated directly from the DPR Drywall model. Drawing has a bill of materials, relevant dimensions and assembly data.

"The benefit of using BIM for partition framing, as well as having the framing/drywall contractor and modelers available to answer questions and provide constructability reviews, has been very valuable," Moussa said. "Frequently, engineers and architects use details that are either generic or based on experience from a recent job. By having direct feedback from the modelers/tradespersons on preferred methods and components, more cost-effective solutions can be developed for standard details, as well as custom details required for unique conditions or clashes."

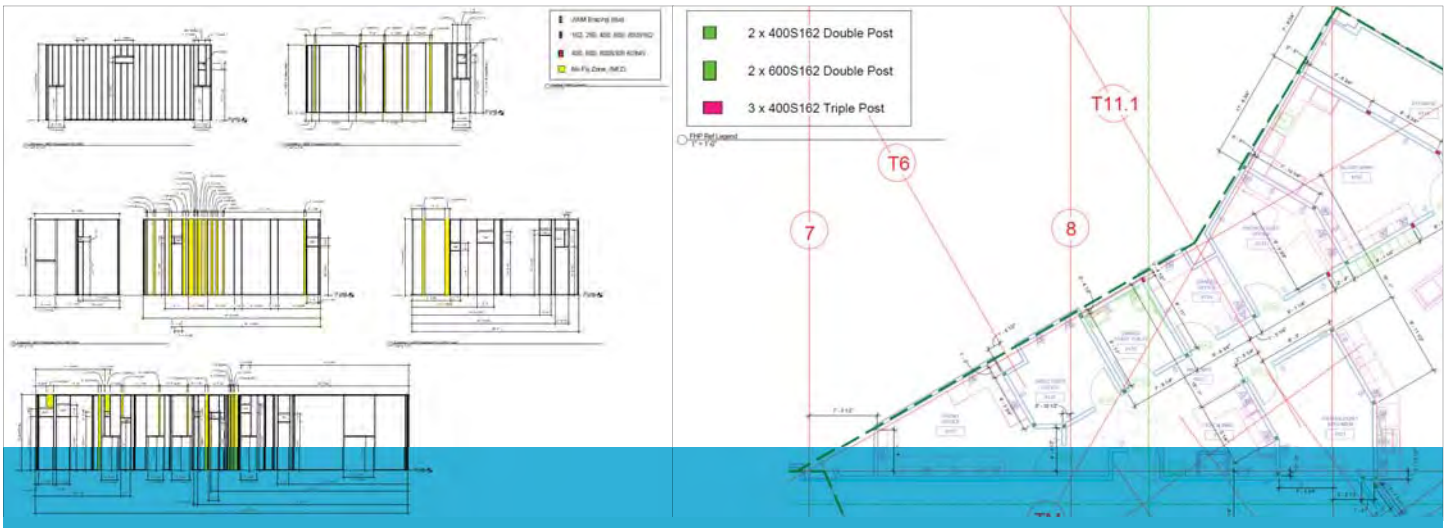
COMPREHENSIVE ESTIMATING

Modeling drywall lends itself to quantity trending and enhancement of estimating practices. Model quantities of walls, shaft bottoms and built-up headers can be extracted from the model to ensure estimates are comprehensive. "Possibly the greatest benefit to modeling drywall and framing is having accurate take-off quantities," Krehlik said.

But the value isn't just in the quantity takeoff; many times it's the things you can't see on a wall takeoff that compromise an estimate. According to DPR Drywall Senior Drywall Estimator/Project Manager Casey Conner, being able to identify more than what's on the drawings allows for a more accurate depiction of what is going to be required. "Even without directly extracting quantities, our BIM team keeps me in the loop on developing changes, and I can keep a comprehensive estimate with these updates – without having to seek out what's changing. Communication and flow of information is enhanced, which is good for everyone involved," Conner said. DPR is also using this quantity tracking and trending for doors, frames and hardware.

DECREASED FIELD COSTS

The preconstruction modeling and coordination effort is important to setup the project for success. Although modeling has primarily been done for coordination to this point, the preconstruction efforts are starting to make it to the field. The goal is to use the DPR model that has been created for coordination and enhance full-scale metal stud layout and production. Layout drawings showing locations of full-height framing members in reference to gridlines are currently being created. These full-height posts occur at handrails, doors and corners. The drawings depict and color code the type of post and their use. The management team is able to get an accurate take off of materials per floor, and the field crews know exactly where the posts go and the correct orientation from looking at just one drawing. DPR expects that the use of the framing model as an intelligent database will decrease field costs, enhance material



Examples of wall elevation drawing and full-height post layout drawing. These drawings take the research and guess work out of placing opening and full-height framing members.

procurement and floor-loading practices, aid in prefabrication and ordering of built-up headers, and create detailed wall drawings for use during layout with elevations, type identifiers and lateral dimensions for backing plates and openings. The tools are available, and DPR is identifying the best way to use them.

Drywall modeling allows the field personnel to stay on schedule by creating an efficient design and making sure that design reaches the field. MEP penetrations and critical studs are placed in the model and coordinated with systems. Then, the information in the model environment is converted to project-specific plan, section and elevation drawings. These drawings include wall system details, color-coded members, and only dimensions relevant to framing placement. Color coding of members can be used to differentiate priority walls, posts, opening framing and a variety of other members. This gives the contractor the added advantage of not having to search through drawing sets to locate MEP penetrations and relevant dimensions. Instead, DPR creates a drywall specific drawing set with all MEP openings and critical studs located. By supplying the field with coordinated layout drawings, the result is an exact layout of future systems based on the model. If openings are framed based on location of penetrations in the model, then MEP systems must penetrate those pre-framed openings. This process ensures model accuracy is duplicated in the field by all trades. Preparing the field personnel a roadmap in the form of layout drawings enhances quality control while saving time and money.

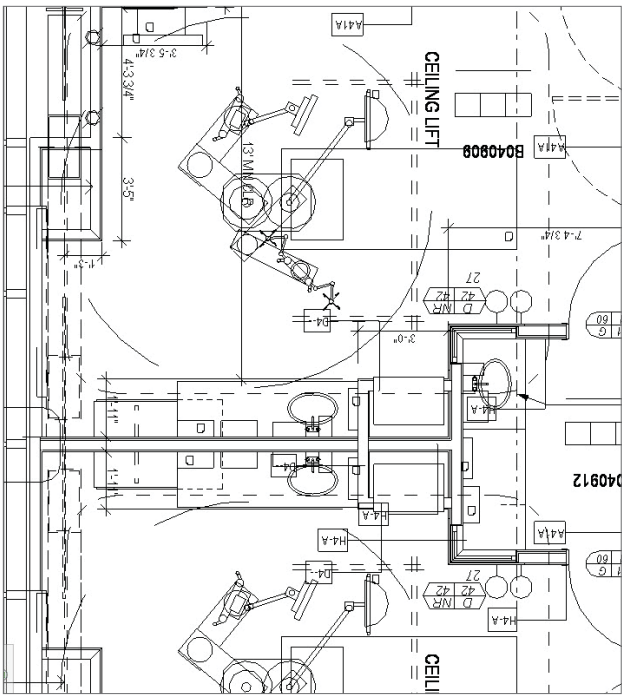
"Although we won't know actual costs and savings until some of these projects are complete, the current cost to create a drywall model is roughly 1.5 percent of the drywall contract value. I anticipate savings to recover that cost coming directly from modeling and coordinating," Conner said. "For example, we expect a savings of 35 to 40 percent for each mechanical duct/king stud conflict that gets resolved. These savings are based on material, field coordination, production rates and 'head-scratching' time. I am also confident that our wall layout production will increase because we should have detailed wall drawings and already know locations of legovers and unique conditions. For a minimal upfront cost, we're figuring out problems in the virtual world, and that is going to save time and money on installation in the real world."

PLANNING FOR RENOVATIONS

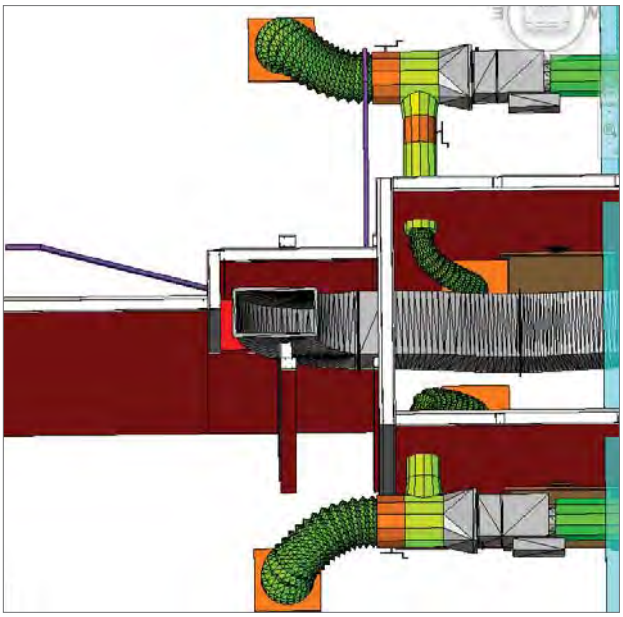
From coordination during preconstruction to detailed drawings and situational awareness during construction, and even evolving into an as-built model to turn over to an owner for use in building maintenance and future renovations, the drywall model can be used for the lifetime of the building. Actual construction above ceiling level often varies from the floor plan design. This is well illustrated in **Figures 2A and 2B**. The 2D background provided by an architect shows a room layout. However, there is a duct in conflict with a wall, and that requires a legover. The legover will not be visible after construction is complete, and it will be a surprise to anyone performing future renovations. With an accurate model, future renovators will be aware of this legover and can plan accordingly. DPR is currently putting together a plan to create and turn over an as-built model to an owner who is interested in future renovations. The elements needed for an as-built are already modeled, so simply tracking production and tweaking elements that vary from the coordination model will create a valuable product for the owner.

TRADESPERSON ENGAGEMENT

Modeling framing is ultimately a team effort that requires a symbiotic relationship between tech-savvy BIM engineers or project engineers (PEs) and experience-laden tradespersons. Given the rapidly evolving nature of BIM, and the experience required to fully understand all framing conditions and fixes, it is difficult to find anyone who is an expert in both fields. DPR is experimenting with teaching BIM/PE personnel framing knowledge, as well as teaching field personnel computer skills, but the most effective recipe so far has been collaboration. The computer-savvy engineers are the mouse-clickers and technical troubleshooters, as well as the group identifying many unique conditions in the model. The more experienced tradespersons review the model for correctness and provide valuable input for constructability and detail



FIGURES 2A & 2B: THE VALUE OF MODELING FOR AS-BUILT PURPOSES: IMAGE ABOVE SHOWS ARCHITECTURAL FLOOR PLAN OF THE FINISHED SPACE BELOW CEILING LEVEL. IMAGE BELOW SHOWS MECHANICAL SYSTEMS CONFLICTING WITH A WALL ASSEMBLY THAT WILL REQUIRE A "LEGOVER" AND "KICKERS" ABOVE THE CEILING. WITHOUT AN ACCURATE MODEL, FUTURE RENOVATORS WOULD HAVE NO IDEA THAT THE WALLS ABOVE CEILING DIFFERED FROM THE LAYOUT BELOW CEILING.



review/development. This relationship benefits both parties: BIM/PEs get the opportunity to pick the brains of experienced craftsmen and learn the trade and details, while the craftsmen are learning computer skills and extending their working value beyond the age where they can no longer perform labor intensive field functions.

Taking BIM to the Next Level

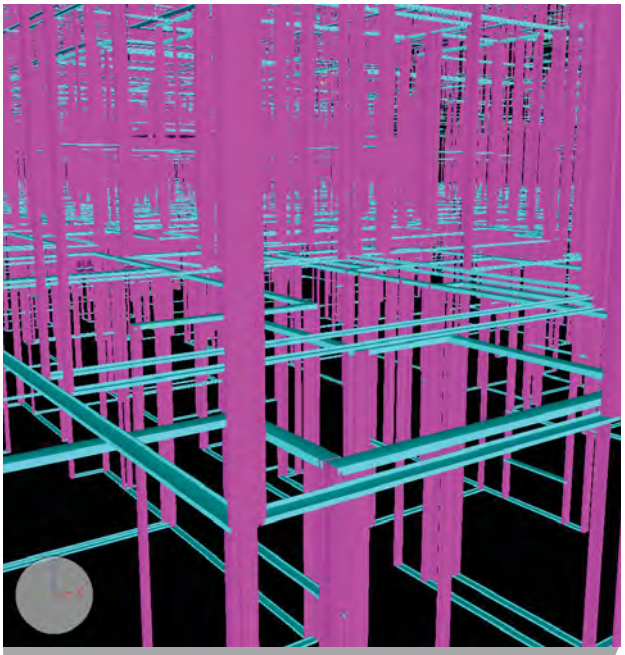
SOFTWARE DEVELOPMENT

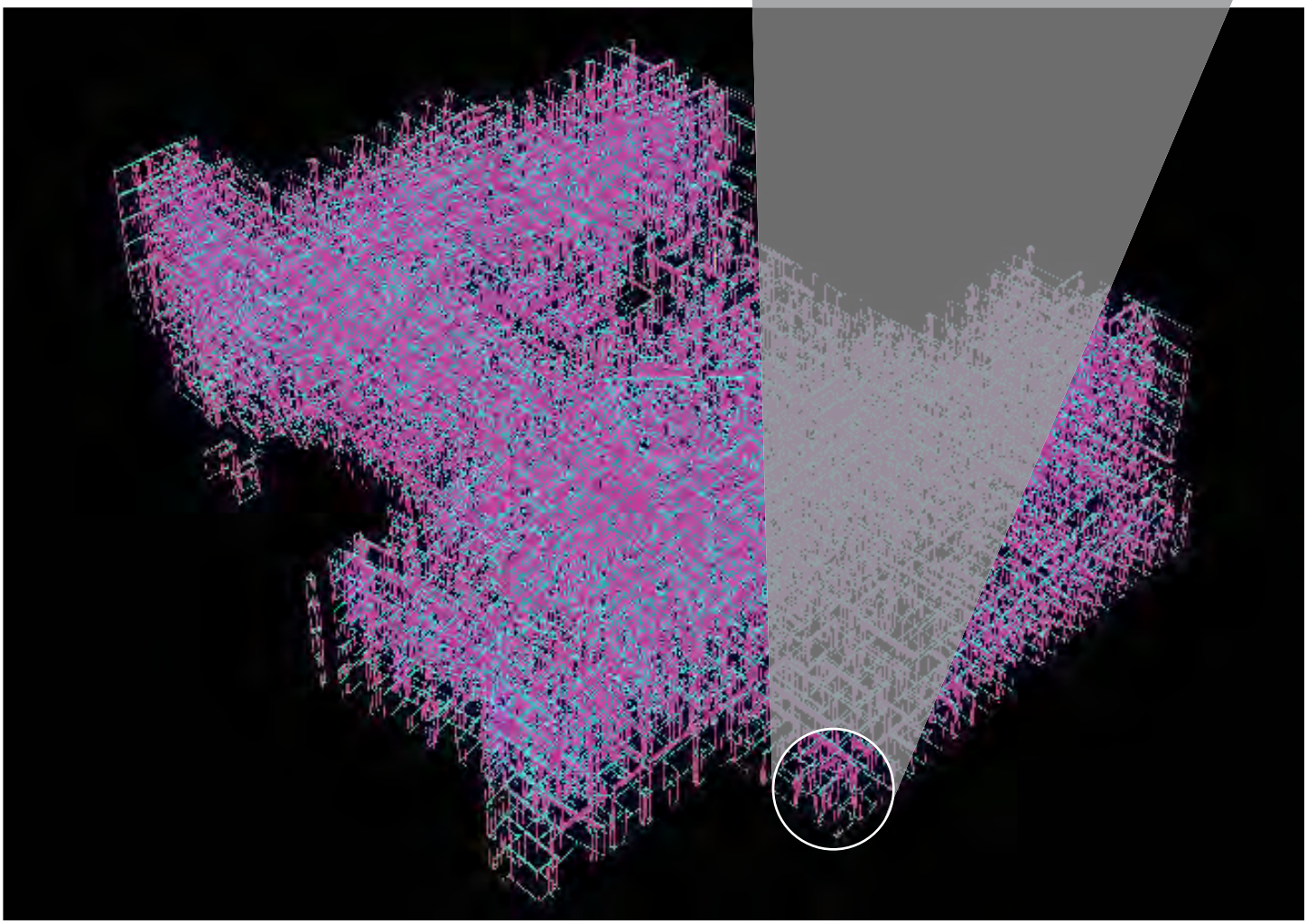
The initial build of StrucSoft Metal Wood Framer (MWF), a wall framing extension running on Autodesk Revit Platform for wood and light-gauge metal construction, was developed as a residential framing platform with limited tools. These tools included basic shop drawing creation and king and corner placement based on templates. Outside of these functions, the majority of work had to be manually manipulated. DPR initiated and drove the development of automated clash detection and resolution, backing template generation and framing, and enhanced corner join logic.

Pushing modeling technology even further, DPR is collaborating with Hilti, STI and StrucSoft to develop a utility that will enable placement of firestopping data into the BIM environment. Firestopping quantity takeoff and installation traditionally has been a complex and cumbersome field of work, which often leads to missed details that can turn into engineering judgments (EJs). EJs can cause delays and cost increases. Accurate and cost-effective data can be extracted from a model and implemented to enhance preconstruction and full-scale production similar to metal stud placement. This will be a valuable tool for estimating and installation, which in turn will provide a value to customers.

Challenges and Lessons Learned

Because modeling framing is relatively new to the industry, many contractors are not accustomed to coordinating with these model elements. If framing is not populated prior to MEP design and coordination, the framing model is rendered essentially useless. Once all systems are designed, trade contractors have exhibited pushback to ex-post facto coordination, as was the case with one medical center project. Conversely, once framing was ahead of MEP trades modeling, it was requested that additional elements be modeled to aid in coordination. Therefore, timing of modeling emerged as a fundamental factor in the decision to coordinate framing.





About the Author

DAN CASALE is a BIM Engineer at DPR Construction. As the lead detailer for DPR's self-perform drywall modeling efforts, Dan spearheaded technical initiatives in the drywall scope. A key player in the testing and development of Metal Wood Framer software, Dan led the virtual prototyping efforts to prefabricate drywall panels on the UCSF Medical Center at Mission Bay project.

Acknowledgements

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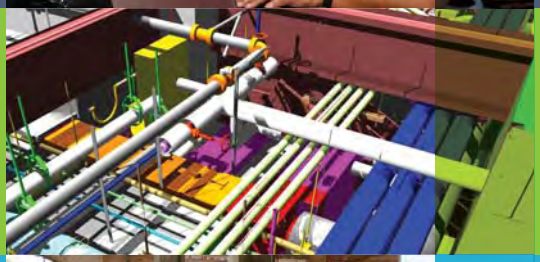
75

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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