MSC
MODERN **STEEL** CONSTRUCTION

November 2008

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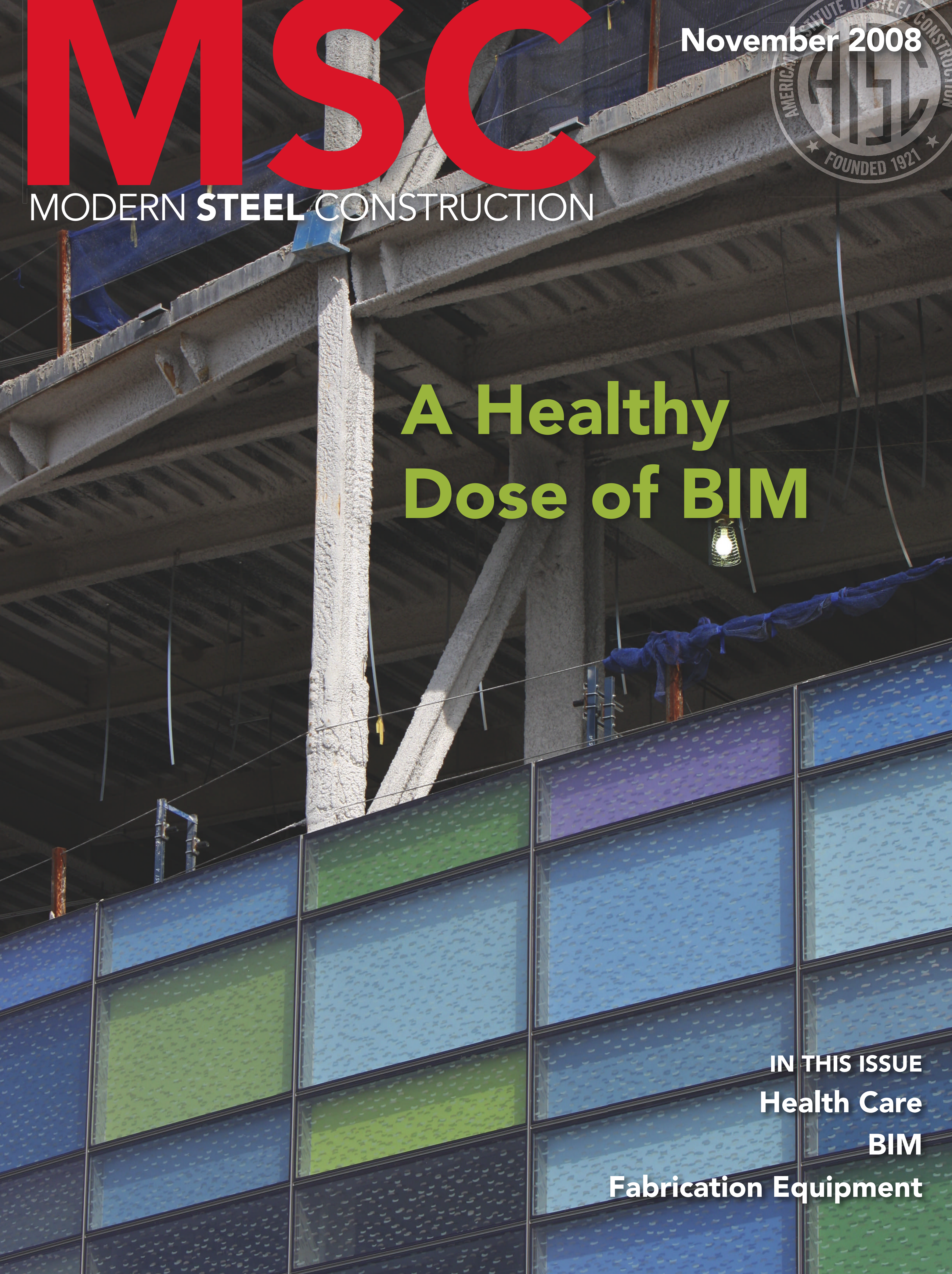

A Healthy Dose of BIM

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ON THE COVER: Johns Hopkins Hospital New Clinical Building. Photo: Wayne Stocks/Thornton Tomasetti, Inc.

MODERN STEEL CONSTRUCTION (Volume 48, Number 11). ISSN 0026-8445. Published monthly by the American Institute of Steel Construction (AISC), One E. Wacker Dr., Suite 700, Chicago, IL 60601. Subscriptions: Within the U.S.—single issues $6.00; 1 year, $44; 3 years $120. Outside the U.S.—single issues $9.00; 1 year $88; 3 years $216. Periodicals postage paid at Chicago, IL and at additional mailing offices. Postmaster: Please send address changes to MODERN STEEL CONSTRUCTION, One East Wacker Dr., Suite 700, Chicago, IL 60601.

editor's note

I GUESS I'M SORT OF A PACK RAT. I have a terrible tendency to keep a lot of clutter—especially electronic clutter. And every once in a while, I'll go back and re-read some of the 13 or 14,000 emails in my inbox. Recently I was reading an email from MSC's former managing editor (and now an AISC regional engineer), Keith Grubb, who sent me a note summarizing some of the things he had learned about career development and leadership from reading some recent issues and listening to speakers at some conferences.

It was all great advice, but what really made me smile was how much of it was applicable to everyone—engineers, fabricators, and even my 12-year-old daughter.

In Keith's memo, he summarized Richard Weingardt's "Six-Pack Plan for Career Development." He recommended the following: participate in continuing education (my daughter takes accelerated classes and participates in study groups before school!); develop your communication skills (she has a major role in the upcoming school play); become an expert in something besides your profession—it broadens your perspective (Julia takes dance classes six days a week); get involved in community affairs (she's recently become a volunteer soccer referee); get involved in politics (in the past, Julia's been on student council); and find a mentor/role model to emulate (my daughter admires and looks up to her very accomplished cousin Beth Ann).

Keith also presented a summary of Anne Scarlett's advice (plus some of his own) on "10 things every entry-level engineer should know." And again I had to smile, because a lot of Anne's advice was dead-on for how we do things at AISC:

1. Compensation is more than just salary; recognize the worth of the benefits you have, including working conditions.
2. Be aware of alternate career paths.
3. Having a personal life is a great thing.
4. Look for a mentor.
5. Raise your hand; volunteer to be in charge of events, projects, etc.
6. No question is too dumb to ask.
7. Get involved with local professional groups.
8. Develop your interpersonal skills.
9. Make it a point to learn the business of engineering.
10. Learn to manage your time; everything is not a priority.

Anne, one of my favorite business consultants, also offers solid advice on the traits of leaders. According to Anne, leaders have:

- Honesty and sincerity
- Courage
- Pride
- Adaptability
- Influence
- Competence

She also stresses that leaders know how to delegate, and offers specific guidance on how to do so:

- Determine the task
- Match the task to the designated doer
- Clearly define measurable expectations
- Communicate authority, responsibility, and deadlines
- Monitor periodically—and give feedback!
- Reward performance

Finally, Anne reminds us that it's okay to single out employees who exhibit leadership traits by "grooming" them for leadership roles with extra training. Remember, you're investing in your firm's future. Or in the case of my daughter, I'm simply investing in the future.

SCOTT MELNICK
EDITOR

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Editorial Offices
1 E. Wacker Dr., Suite 700
Chicago, IL 60601
312.670.2400 tel
312.896.9022 fax

Editorial Contacts
EDITOR & PUBLISHER
Scott L. Melnick
312.670.8314
melnick@modernsteel.com

SENIOR EDITOR
Geoff Weisenberger
312.670.8316
weisenberger@modernsteel.com

DIRECTOR OF PUBLICATIONS
Areti Carter
312.670.5427
areti@modernsteel.com

GRAPHIC DESIGNER
Kristin Egan
312.670.8313
egan@modernsteel.com

AISC Officers
CHAIRMAN
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Advertising Contact
Account Manager
Louis Gurthet
231.228.2274 tel
231.228.7759 fax
gurthet@modernsteel.com

For advertising information, contact Louis Gurthet or visit **www.modernsteel.com**

Address Changes and Subscription Concerns
312.670.5444 tel
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IF YOU'VE EVER ASKED YOURSELF "WHY?" about something related to structural steel design or construction, *Modern Steel Construction*'s monthly Steel Interchange column is for you! Send your questions or comments to solutions@aisc.org.

Effective Length of Vertical Braces

We are having a discussion in our office about the design of a compression diagonal angle in an "X" braced frame. Some engineers believe the unbraced length for compression design is reduced based on the fact the other member in the brace is in tension and will prevent the compression angle from buckling. Is this a valid assumption? Is there any information that would support this design assumption?

It is possible that the tension brace can brace the compression brace at its midpoint. The answer depends on how much lateral stiffness is provided by the tension brace. Among other things this depends on which member is continuous and what assumptions are made about "catenary" stiffness contributions. Appendix 6 of the 2005 AISC *Specification* provides strength and stiffness requirements for column braces, which may be a starting point.

Energy methods are often used for evaluating such problems. An excellent AISC *Engineering Journal* paper by R. Shankar Nair can be found in the 4th Quarter 1997 journal at **www.aisc.org/epubs** and addresses this exact problem.

Amanuel Gebremeskel, P.E.

Specifying End Reactions

Non-composite beam end shear connections for wide-flange beams to columns are typically specified based on 50% of the total uniform load table capacity of the beam. These requirements are given to the steel detailer to develop/detail the connections. Is there a similar table for HSS beam end connection design; or a way to specify end connections for the steel detailer to detail, etc.? The AISC 13th edition *Steel Construction Manual* has Table 3-12 "available flexural strength, kip-ft" for rectangular HSS. Can end beam reactions be tabulated from this table?

I would not agree that specifying end connections at 50% of the total uniform load capacity of the beam is the "typical" method of relaying connection design parameters to the fabricator. It may be used in some cases where the EOR does not want to provide accurate reaction forces, but it is certainly not the preferred method to get the most economical bid. Providing the actual reactions is much more common, and appropriate, today.

HSS shapes are not commonly used as beams, and thus there are no uniform load tables for such in the AISC 13th edition *Steel Construction Manual*. The EOR can employ any method they wish to communicate design information, but it should be based on engineering logic and is most efficient if developed in a useful manner. One could develop a method of equating the available flexural strength back to a reaction value, but it would seem to be more straightforward to simply list the reactions.

Kurt Gustafson S.E., P.E

Beam/Column Connection with Axial Compression

I have a beam connected to a column flange using clip angles. The beam has quite a big compression load. Do I need to check column flange bending or anything else? The AISC *Manual* states that a flange local bending check is required for tensile forces only, but one of my coworkers told me I'd need to check column flange bending for the connection. Could you give me some advice?

There is no need to check flange bending for a compression load on a column flange. The compression load will not transfer through the bolts. Instead, it will transfer through the much stiffer load path provided by direct bearing between the angle legs connected to the supported beam and the column itself. Since it is likely that the column web (plus the k1 distance) is close to the same width as, if not wider than, the distance between the angles, no bending in the column flange will occur.

This said, I would be inclined to use an end plate rather than the double-angle connection for the condition you describe. The end plate will provide more bearing area. Additionally, if the beam end is cut and fitted so that it bears on the end plate, the welds between the end plate and the beam need not resist the compression load. It would likely be a more cost-effective connection.

Larry S. Muir, P.E.

Single Angle in Flexure

The 2005 AISC *Specification* has new single-angle bending equations. I have also looked at the design example provided by AISC on CD. When do you use geometric bending without lateral support as opposed to principal-axis bending? It seems to me that if there is no lateral support, you should use principal-axis bending, but that is not how AISC arranges the section. In the example, the single angle supporting a uniform load is only supported at the ends. This would allow the angle to deflect laterally and vertically, which would indicate bending about the principal axis. Should I use the geometric axis for design or should I use the principal axis for design?

The AISC *Specification* provides a simplified alternative where you can use modified geometric properties when analyzing an unrestrained equal-leg angle that is loaded in bending about the geometric axis. This is provided in section F10.2(i). In F10.2(ii), another simplified case is covered with restraint at the ends and the point of maximum moment. For all other cases the more general solution based upon principal-axis properties must be used. The general solution and simplified special cases all address the unsymmetrical behavior that single angles exhibit when subjected to bending.

Amanuel Gebremeskel, P.E.

steel interchange

Extended Single-Plate Shear Connections

In the procedure for the extended configuration of the single-plate shear connection, the bolts are designed for the eccentricity of the connection, and it says that the column does not need to be designed for a bending moment for the eccentricity. The first question I have is, according to these assumptions, the weld to the column will be only in shear. Why then is it taken as $\frac{5}{8} * t_p$, instead of designing it for the shear at the support? This produces some huge welds for the plates that are necessary for bending in some cases. The second question is, how is the rotation of a simple shear connection achieved when the eccentricity is in the bolts and the weld is only in shear? I am thinking of a 7- or 8-row connection where it is obvious that no rotation will be allowed at the weld.

Extended and conventional single-plate connections are designed in a significantly different way than other shear connections. In most other shear connections (single and double angles, end plates, seats) the inherent flexibility of the connecting elements (angles or plates) is relied upon to accommodate the simple beam end rotation. However, there are still limits related to bolt size, weld size, and plate or angle thickness to ensure ductility.

Obviously, the single-plate connections are much stiffer than the other connection types and require a different design philosophy. You state correctly that the bolts are designed for the full eccentricity between the bolts and the welds. You also state correctly that the welds are sized to be ⅝ of the plate thickness to develop the strength of the plate. Furthermore, the *Manual* states that the column need not be designed for an additional eccentricity. This seems to be a contradiction in that if the full eccentricity is present at the bolts, then none will exist at the weld and vice-versa.

The problem is that we do not know either the location or the magnitude of the moments within the connection. If the plate is welded to a very stiff column, then certainly the connection to the column will draw most of the moment to it. However, if we connect to a very flexible support—let's say a torsionally weak girder—then most of the moment will be drawn towards the much stiffer bolted connection. There is an infinite variation between these extremes. What we have tried to do with the extended tab procedure is accommodate all of the variations with a universally applicable model. The plate between the weld and the bolts is used as a fuse. Under extreme loads, which could develop with a very stiff support (approaching the fixed-end beam condition), the plate is allowed to yield and shed load. In order to accomplish this, the bolts and welds cannot be allowed to fracture prior to the plate yielding. This is the reason for the $\frac{5}{8} t_p$ requirement for the welds and the maximum plate thickness check related to the bolts.

This mechanism is also how the simple beam end rotation is accommodated. The plate can yield prior to rupture of either the bolts or the welds. There is an additional provision that allows the rotation and ductility to be met by plowing of the bolts through the material.

The column is not required to be designed for an additional moment for two reasons. The first is strictly based on precedence. Typically, in other shear connections the eccentricity from the face of the support to the center of the support is neglected. This has never been a problem to my knowledge, and it is allowed for single-plate connections as well.

The second reason is that though the single plate connection may add additional moment to the column due to its rotational stiffness, this same stiffness also adds restraint, which is usually not accounted for in the analysis.

Larry S. Muir, P.E.

Bracing for Cantilever Beams

Must braces be added to the bottom flange (compression) of cantilevered steel beams? After reading the 1999 *LRFD Specification*, Section C4a, it seems like I should brace the tension flange of the cantilevered portion instead. Is this correct?

It is true that adding tension (top) flange bracing on a cantilever is more effective than bracing the bottom flange. This is because it is the top flange that deforms more in the deflected shape. There is a good discussion on this subject in the *Guide to Stability Design Criteria for Metal Structures* by Ted Galambos. You will also find a table therein that defines effective-length factors for cantilevers based on the restraint provided at the base and tip of the cantilever.

Kurt Gustafson, S.E., P.E.

The complete collection of Steel Interchange questions and answers is available online. Find questions and answers related to just about any topic by using our full-text search capability. Visit Steel Interchange online at **www.modernsteel.com**.

Kurt Gustafson is the director of technical assistance and Amanuel Gebremeskel is a senior engineer in AISC's Steel Solutions Center. Charlie Carter is an AISC vice president and the chief structural engineer.

If you have a question or problem that your fellow readers might help you solve, please forward it to us. At the same time, feel free to respond to any of the questions that you have read here. Contact Steel Interchange via AISC's Steel Solutions Center:

Steel Solutions Center
One East Wacker Dr., Suite 700
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steel quiz

LOOKING FOR A CHALLENGE? *Modern Steel Construction*'s monthly Steel Quiz tests your knowledge of steel design and construction. Most answers can be found in the 2005 *Specification for Structural Steel Buildings*, available as a free download from AISC's web site, **www.aisc.org/2005spec**. Where appropriate, other industry standards are also referenced.

This month's Steel Quiz was developed by AISC's Steel Solutions Center. Sharpen your pencils and go!

1 Does the 2005 AISC *Specification* (a free download at **www.aisc.org/2005spec**) prescribe the loads for which steel structures must be designed?

2 True/False: Service-level seismic loading and design criteria in the IBC and ASCE 7 are based on preventing damage and keeping the building functional after the maximum considered seismic event.

3 Does the 2005 AISC *Seismic Provision* (a free download at **www.aisc.org/2005seismic**) address the design of composite lateral force resisting systems for seismic applications?

4 True/False: A design engineer has to use the prequalified moment connections in AISC 358 (a free download at **www.aisc.org/aisc358**) for Special Moment Frames in Seismic applications.

5 When using the Direct Analysis Method, is it necessary to reduce *E*, the modulus of elasticity of members in the lateral force resisting system, when evaluating drift after checking for stability?

6 What AISC document provides guidance on the design and detailing of Steel Plate Shear Walls?

7 True/False: AWS publishes a document that specifically addresses seismic welding requirements.

8 True/False: All bolted connections in the Seismic Lateral Force Resisting System must be designed as slip-critical connections.

9 In sustainability, what is an LCA?

10 I recently saw a chart indicating that the carbon footprint of a ton of concrete was less than the carbon footprint of a ton of steel. Is the carbon footprint of steel then greater than that for concrete?

TURN TO PAGE 14 FOR ANSWERS

steel quiz

ANSWERS

1 No. The AISC *Specification* does not prescribe loads on structures. Loading criteria is contained in governing building codes or the referenced standards, such as ASCE 7.

2 False. The IBC/ASCE 7 seismic loading and design criteria are meant to prevent structural collapse but do not necessarily prevent damage to the structure. The provisions generally reduce the probability of collapse for buildings of higher importance categories by incorporating an importance factor, thus amplifying the design loads; system selection requirements have a similar impact.

3 Yes. The 2005 AISC *Seismic Provision* provides requirements for the design of composite lateral force resisting systems for seismic applications in Part II of the document.

4 False. An engineer can use any feasible moment connection as long as it is qualified as per the requirements of Appendix P or tested as per the protocols in Appendix S in the 2005 *Seismic Provisions*. However, it is common for engineers to select prequalified connections covered in AISC 358, due to the expediency of doing so.

5 No. The Direct Analysis Method contained in Appendix 7 of the 2005 AISC *Specification* does not require that the stiffness of the lateral force resisting system be reduced for serviceability checks. It only requires such reduction to be made when checking for stability. Please see the commentary to Appendix 7.3 for more information on this.

6 AISC *Design Guide 20* provides in-depth discussions and procedures on how to design and detail Steel Plate Shear Walls in both low-seismic and high-seismic applications.

7 True. The new AWS D1.8 works with AWS D1.1 to provide for additional welding requirements that apply to high-seismic projects.

8 False, but this is a bit of a trick question. All bolted connections in Seismic LFRS that have to comply with AISC 341 must be prepared and installed as slip-critical, but the design can consider the connection as "bearing type" for strength calculations.

9 An LCA is a Life-Cycle Analysis. The current draft of the 2009 edition of USGBC's LEED program for new construction does not include an LCA methodology. However, LCA is on the horizon and might appear in LEED v3.0 sometime in 2010. This approach looks at the actual impact of a structure on the environment from an analytical perspective. Rather than specifying a minimum recycled content or a radius for transportation of products to the project site, an LCA will assess the energy, carbon, and resources used in the construction of the building, as well as its operation, maintenance, and eventual deconstruction.

10 No. What a statistic like that doesn't take into account is the equivalent weights of structural steel and concrete in a typical building frame. In a building-to-building comparison (the only realistic way to make a comparison), the carbon footprint of structural steel is typically 10% to 30% lower than the carbon footprint of concrete.

Anyone is welcome to submit questions and answers for Steel Quiz. If you are interested in submitting one question or an entire quiz, contact AISC's Steel Solutions Center at 866.ASK.AISC or at **solutions@aisc.org**.

Steel Solutions Center

STANDARDS NEWS

A Year of ConsensusDOCS

September 28 marked the one-year anniversary of ConsensusDOCS. Today, more than 3,000 unique office locations with upwards of 50 people per location are currently using ConsensusDOCS on projects. Moreover, there is a steady steam of 75 to 100 users joining the program each month, according to ConsensusDOCS organizers.

In addition to producing a comprehensive library of contracts that address all project delivery methods, ConsensusDOCS introduced the first standard tri-party or integrated project delivery contract. In addition, this past summer it added the ConsensusDOCS 301 BIM Addendum, the first and only standard document to comprehensively address the legal ramifications of using building information modeling (BIM).

Originally drafted and endorsed by 20 leading construction organizations, ConsensusDOCS has added the American Wall and Ceiling Institute (AWCI) and the National Association of Electrical Distributors (NAED), as well as the endorsement of the Construction Management Association of America (CMAA), for the ConsensusDOCS 301 BIM Addendum. In addition, AISC and the National Institute of Building Sciences (NIBS) actively contributed to the addendum.

The industry has conducted hundreds of educational seminars and sessions on the documents, including more than 70 in-person education seminars and courses throughout the country and 10 national webinars.

"Interest and usage in ConsensusDOCS has exceeded our expectations, and we project that the rate of adoption will accelerate during the next 12 months," commented Brian Perlberg, executive director and senior counsel of ConsensusDOCS.

In celebration of its first anniversary, ConsensusDOCS has issued a Reference Kit CD available at the limited-time price of $92.87, which includes complete samples of 80+ documents and commentary. For more information, please visit www.ConsensusDOCS.org.

People and Firms

The **American Society of Civil Engineers** recently named 11 exemplary civil engineers as distinguished members. The active roster of distinguished members is comprised of only 193 of ASCE's more than 140,000 members worldwide. The new members are:

- Retired Maj. Gen. Joseph A. Ahearn, P.E., Dist.M.ASCE, NAC, senior executive with CH2M HILL in Denver.
- George W. Black Jr., P.E., Dist.M.ASCE, senior civil engineer and national resource specialist with the National Transportation Safety Board (NTSB).
- Izzat M. Idriss, Ph.D., P.E., Dist.M.ASCE, NAE, professor emeritus at the University of California, Davis.
- Raymond E. Levitt, Ph.D., Dist.M.ASCE, professor of civil and environmental engineering at Stanford University.
- Jon Magnusson, P.E., S.E., (AISC Member), Dist.M.ASCE, chairman and CEO of Magnusson and Klemencic Associates (MKA) in Seattle and Chicago.
- James D. Murff, Ph.D., P.E., Dist.M.ASCE, industry consultant and visiting professor at Texas A&M University in College Station, Texas.
- Craig N. Musselman, P.E., Dist.M.ASCE, president of Portsmouth, N.H.-based CMA Engineers.
- Henry Petroski, Ph.D., P.E., Dist.M.ASCE, NAE, professor at Duke University.
- Cranston R. "Chan" Rogers, P.E., Dist.M.ASCE, a U.S. Army Engineer Reserve colonel.
- Jerry R. Rogers, Ph.D., P.E., D.WRE, Dist.M.ASCE, a professor at the University of Houston.
- C. Michael Walton, Ph.D., P.E., Dist.M.ASCE, NAE, professor of civil engineering at the University of Texas at Austin.

Thornton Tomasetti has opened its third West Coast office, in San Francisco. The new location is headed by principal John Abruzzo.

In other Thornton Tomasetti news, the National Building Museum presented the 2008 Henry C. Turner Prize for Innovation in Construction Technology to Charles H. Thornton, Ph.D., P.E., the firm's co-founder, for his work in founding the ACE Mentor Program, which introduces high school students to careers in the building arts and sciences.

SUSTAINABILITY NEWS

Wanted: Green Building Experts and Educators

The U.S. Green Building Council has issued an ongoing call for USGBC members interested in joining the team that provides peer review of the courses and content that make up the Education Provider Program. Green building subject matter experts and educators are sought for this team.

Given the exponential growth in the green building market, there is a proportionate demand for top-quality education opportunities to support that growth. USGBC facilitates access to this education through Greenbuild365 (**www.greenbuild365.org**), a new online education portal, which includes a catalog of courses offered by USGBC and education providers. In addition to courses, the program has launched a review process for conferences and one-time events, along with a new fee structure.

Professionals seeking to go beyond LEED and enrich their knowledge of green building theories, techniques, and business trends want to know that the content is accurate, timely, and worth their time—and reviewers provide this important oversight.

Not only do reviewers add value to the program, they also receive benefits that enhance their own professional expertise. They are trained in the basics of adult education, the review process, and criteria, and this training can be used to enhance their own courses. In addition, reviewers are eligible for a free review of one of their own courses annually after completing 12 course reviews. A current list of reviewers is listed on the program's web page.

For more information about the Education Provider Program, visit **www.usgbc.org/epp**. And to learn about specific reviewer qualifications, visit **www.usgbc.org/DisplayPage.aspx?CMSPageID=1659**.

SAFETY NEWS

New Crane Rules Coming

The Occupational Health and Safety Administration (OSHA) plans to publish proposed rules for Cranes and Derricks in Construction; publication was anticipated in October 2008 as of press time, and will be followed by a 60-day public comment period.

These first new regulations since 1971 will require crane operators to pass written and practical tests in all 50 states and will also require operators to undergo more training. Several deadly U.S. crane accidents during the past year have underscored the need for changes.

The new standards also seek to toughen requirements on inspecting ground conditions, crane assembly and disassembly, operating cranes near power lines, using safety devices, and crane inspection. Crane operators would have four options for certification under the new requirements: through an accredited third-party testing organization, an audited employer testing program, a state or local licensing authority, or a U.S. military-issued qualification. Currently, just 15 states and six cities require the tests.

FABRICATOR NEWS/EVENTS

FMA Announces New Certification Program

The Fabricators and Manufacturers Association, International (FMA) has announced a new certification program for precision sheet metal operators for testing and validating their skills in sheet metal forming and fabricating. While welders in the industry have had certification programs available to them for proving their knowledge and expertise, the new Precision Sheet Metal Operator (PSMO) Level I Certification is the first to provide a comprehensive exam in the areas of shearing, sawing, press brake, turret punch press, laser cutting, and mechanical finishing.

The exam fee is $245 for FMA members and $345 for nonmembers. As a bonus, those who pass the exam will receive a one-year Basic (individual) membership in FMA. A special student rate of $95 is available, which includes a free one-year FMA Student membership. The certification is valid for three years. For more information, visit **www.fmanet.org**.

MEMBER NEWS

SDI's New Mill Gets Rolling

Structural steel producer Steel Dynamics, Inc. (SDI), based in Ft. Wayne, Ind., has added a new wide-flange beam mill to its Columbia City, Ind. location. The new mill has been running since late August, producing 10×5¾ beams on a five-day, around-the-clock schedule.

"Many service centers expressed a need for a wider product capability or range of products from us, and thus we made the decision to add a second rolling mill," said Michael Busse, sales and marketing manager for SDI's Columbia City Structural and Rail Division. The mill's first shipment was approximately 20 tons of wide-flange, to Chicago-area service center Sugar Steel.

The mill is still in the commissioning stage, and its range of capability will be 3- to 14-in. wide-flange. "We're fine-tuning each size," Busse said. He also noted that the capacity of the new mill will depend on SDI's product mix, and the market demand will determine what and how much the mill will produce.

MARKET NEWS

No Money, No Project

In its Nonresidential Construction Index (NRCI) for third quarter 2008, construction management consulting firm FMI reported that contractors were experiencing increasing project delays and cancellations due to owner financing difficulties. Sixty-five percent of construction industry executives serving as panelists for the survey said they were already seeing these problems. Panelists estimated project delays were running at 17% on average or an average of 2.2 times what they would consider a normal rate; cancellations due to owner financing problems were running at 9.9% on average, 2.5 times what panelists estimated as a normal rate.

In the end it is simple, explained one panelist. If owners don't have a way to finance the projects they plan to build, contractors don't have work. Those with backlogs made up of mostly public work have yet to experience serious delays and cancellations due to financing issues. Some contractors work with owners who can finance projects without going to the financial markets for funds. However, those are becoming the exception. Most contractors are working with owners who rely on financing assistance from the banking sector. Owners may be delaying projects because their customers are delaying purchasing decisions.

While contractors are waiting on the economic traffic to clear, FMI expects there will be some challenging consequences. For instance, there will be greater competition looking for new markets. More competition leads to lower profit margins or worse, taking projects at a projected loss just to keep backlogs full and crews working. Project delays can also mean delayed payments and a higher risk of bankruptcies.

According to another panelist, "While financing and credit issues are not affecting our business today, we anticipate that these issues will impact our business over the next 12 to 18 months. Credit and financing issues will slow the overall economy, and this slowing will adversely impact our education and not-for-profit work, especially as fundraising efforts are curtailed for some period of time."

Correction

The steel detailer for the Shared Parking Facility in Las Vegas ("Ample Parking," p. 27, 8/2008) was accidentally omitted from the article. Action Steel Detailing, Inc., Mesa, Ariz., an AISC Member, was the detailer for the project.


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A new addition to Johns Hopkins Hospital, consisting of two interconnected towers, houses several medical disciplines—and all of the heavy, specialized equipment that comes with them.

The Two Towers

BY ZACHARY KATES, P.E., MATTHEW HORNE, P.E., AND R. WAYNE STOCKS, P.E.

Zachary Kates/Thornton Tomasetti, Inc.

The Johns Hopkins Hospital New Clinical Building will use nearly 13,000 tons of structural steel.

Courtesy of Perkins+Will

The new building will encompass 1.6 million sq. ft.

IF THERE IS ONE STAPLE IN HEALTH-CARE DESIGN, IT IS THAT PROGRAM TAKES PRIORITY. The functionality of the building to serve its doctors and patients is the primary design goal.

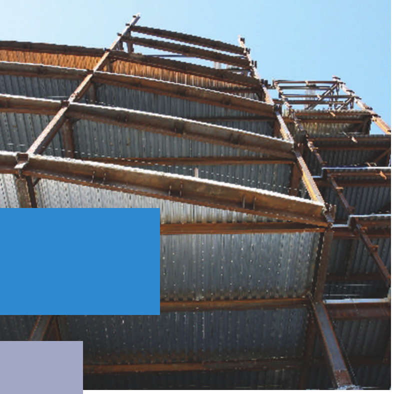
This idea is resonant in the structural design for the Johns Hopkins Hospital New Clinical Building. At 1.6 million sq. ft and almost 13,000 tons of structural steel, the facility, located in Baltimore, is one of the nation's largest health-care projects currently under construction. The New Clinical Building (NCB), consisting of two interconnected clinical towers—a cardiovascular and critical care tower, and a children's and maternal care tower—is intended to replace existing, outdated facilities with a flexible, state-of-the-art hospital that fosters collaboration between researchers and those treating patients.

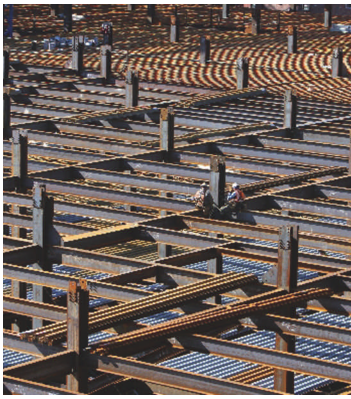
Why Steel?

The main reason structural steel was chosen for the NCB's framing was that it offered flexibility for future modifications while at the same time provided the most cost-effective structural system. Technology changes quickly within the health-care field and modifications to the structure are inevitable. Steel can be readily adapted to accommodate such changes and can be added to form new mechanical openings and accommodate future floor penetrations. Framing members can be easily cover-plated and strengthened for future heavier loads due to constantly evolving medical equipment.

There were a number of site constraints that also guided the project team toward a steel solution. The site is bounded by busy Orleans Street to the south and the existing Jefferson and MRI buildings to the north. In order to meet the hospital's square footage requirements and counter the tight site, diagnostic and patient room areas were cantilevered over the existing structures using a system of full-depth trusses, plate girders, and diagonal tension members.

R. Wayne Stocks/Thornton Tomasetti, Inc.





To meet square footage requirements and counter the tight construction site, some areas of the new building were cantilevered over existing structures. For example, one eight-floor section cantilevers over the MRI building.

The southwest corner of the existing, low-rise MRI building actually projects into the footprint of the NCB, interrupting almost 120 ft of the building's perimeter support system. Full-depth W14 trusses in combination with built-up plate girders are used to cantilever eight floors of building structure over the MRI building.

The tight East Baltimore site also required that the ambulance entrance be located underneath the building structure. This was accomplished with a series of 60-ft-long, 6-ft-deep built-up plate girders resulting in a column-free, sheltered ambulance parking and turn-around area.

The architectural design gained precious patient room area by using half-bay projections to cantilever over the existing Jefferson Building and over the Orleans Street right-of-way. These half-bay cantilevers were accomplished using tension diagonals that tie into the building diaphragm and ultimately rely on the lateral braced framing system for support. Diagonals were coordinated with patient room walls, resulting in cost-effective square footage and dramatic architectural features. The self-supporting design allowed erection without temporary shoring towers, saving both time and dollars.

Typical Framing

The typical bay size, 28 ft 8 in. by 28 ft 8 in., was configured to fit two back-to-back patient rooms within one structural bay, optimized by the space planners to minimize overall building area and control overall costs. The typical framing consisted of W21 girders, cambered W16 beams, and 3-in. composite metal deck. Early in the design process the design team chose shallower non-optimized girder depths to gain precious plenum space above the ceiling for added flexibility to the building systems, thus reducing floor-to-floor heights and minimizing building skin area.

The Pecking Order

The idea of the structural system responding to the programmatic requirements is most apparent in the layout of the lateral braced frame system. The multiple departments and functions that occupy the NCB each have a unique layout and circulation requirements, so stacking of the programs around a simple or consistent braced frame configuration was not practical. Bracing work points were adjusted and coordinated with the architectural design team as needed around doors, hallways, elevators, and building system infrastructure. The resulting layouts included chevron, V-type, single diagonal, and open-bay braces, as well as multiple frames that shift location in plan. Most importantly, the resulting layouts satisfied the programmatic requirements, accommodating the various floor plan requirements of each department.

The complexity of the bracing system required a code lateral system that would allow combinations of bracing types. The system that best fit the design constraints for the NCB was the "Steel System Not Specifically Detailed for Seismic Resistance," or more commonly, the $R = 3$ steel lateral system. This system type is only allowed for buildings with a Seismic Design Category of C or less, which can be difficult to achieve for buildings classified as essential facilities. Due to the low seismicity of the site—confirmed by shear wave velocity testing—the NCB qualified for the $R = 3$ lateral system. In addition to accommodating combinations of bracing configurations, this lateral system type does not require seismic detailing of connections. Standard braced frame connection details saved material, fabrication time, and erection time.

The Flying MRI

One challenging aspect of the structural coordination was determining the medical equipment design requirements and required plan configuration. Medical equipment has a significant impact on the structural framing because of its heavy loads and strict vibration criteria. Because the steel frame design is one of the earliest items requiring coordination, even before finalization of the user group layouts, Thornton Tomasetti had to work closely with the design team to determine a flexible solution that would incorporate possible design changes in the building layout and equipment selection. This required detailed collaboration with the hospital, medical equipment planners, and architectural team, and clear definition and documentation of the design criteria.

The solution employed at the NCB included categorizing areas into room types, which included MRI rooms, CT scanner rooms, designated operating rooms, and operating rooms that could be upgraded to future interventional suites. The structural loads were determined for each room type, including anticipated ceiling and floor-mounted equipment weight, RF or magnetic shielding, and floor fill requirements. The floor slabs were often depressed to allow flexibility to run conduit, install shielding, and set equipment mounting plates. In addition, floor framing was sized to support thickened floor slabs used to reduce sound transmission into areas above and below the equipment, and was coordinated for heavy moving loads within the installation pathways of the equipment.

Vibration within the building structure is caused by foot traffic and sources such as mechanical equipment and street traffic. The floor framing was designed to control floor vibrations perceptible to the building occupants but also, more importantly, to control vibrations that could affect the image quality of the sensitive equipment such as MRI machines and CT scanners. The design team worked with the owner's vibration consultant to determine appropriate vibration limits for each area of the building. Similar to the equipment loads, many areas were designed to a more strict vibration limit in anticipation of future equipment requirements. The vibration design criteria are clearly documented on the structural documents for use in evaluating future modifications. The combination of load diagrams and clearly stated design criteria within the construction documents has been an invaluable asset to rapidly evaluate user-driven proposed modifications and equipment changes without having to recreate the original design.

The medical field has seen an explosion of technological advances in the past few years. One such development is the intra-operative MRI. While typical MRI machines are floor-mounted, this 24,000-lb MRI is track-mounted to the ceiling, allowing patient scans during surgical operations as well as the flexibility to move between two operating rooms. A steel frame, with strict erection tolerances and slope-deflection requirements, was provided to support the track system. To meet the established vibration criteria and to avoid impact from activity on the floor above, the track beams are supported from supplemental column-to-column beams rather than the floor beams above.

Success in Collaboration

In order to get a jump-start on construction, the project was separated into two phases. Phase 1 consisted of the below-grade construction including foundations, below-grade steel floor framing, and at-grade steel floor framing. Phase 2 consisted of the superstructure for the common base and two towers. Separate steel fabricators and erectors were assigned to each phase. In order to meet the schedule constraints, the structural team was asked to produce Phase 1 steel construction documents and Phase 2 documents used for steel mill order approximately six months prior to the issuance of architectural construction documents. This required early coordination with the design team to determine medical equipment loads, installation pathways, floor depressions, vibration design requirements, heavy mechanical and piping loads, and mechanical shaft requirements.

A challenging aspect of the project involved post-bid modifications and enhancements to the building. This resulted in modifications to the entry lobbies at both towers, the addition of a wing-shaped, 28-ft cantilevered canopy, and upgrades to the exterior curtain wall system. Frequent and direct communication between Thornton Tomasetti and the steel detailer and fabricator was a key factor in facilitating efficient solutions to these design modifications and helped to minimize the disruption to ongoing shop drawing review and fabrication. True collaboration and the flexibility of the design and construction team allowed the enhancements to be incorporated with minimal impact on the overall steel delivery and erection sequencing. Steel was scheduled to top out in October 2008. MSC

Zachary Kates is an associate, Matthew Horne is a senior engineer, and R. Wayne Stocks is a principal, all with Thornton Tomasetti, Inc.

Owner
The Johns Hopkins Hospital-Facilities, Design, and Construction, Baltimore

Architect
Perkins+Will, Los Angeles, Chicago, New York

Structural Engineer
Thornton Tomasetti, Inc., Washington, D.C.

Construction Manager
Clark/Banks, A Joint Venture

Steel Fabricator
SteelFab, Inc., Charlotte, N.C. (AISC Member) – Phase 2
Helmark Steel, Inc., Wilmington, Del. (AISC Member) – Phase 1

Steel Detailer
Prodraft, Inc., Chesapeake, Va. (AISC Member) – Phase 2

Second Nature

BIM has been part of the relationship between a Michigan structural engineer and steel fabricator for several years, and their projects reap the benefits.

BY JIM CORSIGLIA, P.E., S.E.

Douglas Steel

WE CONSTANTLY HEAR—AND SAY—THAT BUILDINGS are being designed at a more accelerated rate than ever before, and that fast-track projects are no longer an option but the norm. And that's true. But it's been true for years now.

As we all know, the daily design routine has constantly evolved—from hand-drawn documents to analytical tools and CAD programs, for example—to keep up with this ever-increasing pace. One of the newer tools, of course, is building information modeling (BIM) technology. While not everyone is using BIM, most in the design industry have at least a basic understanding of what it is.

To some, BIM means only "3D modeling," while to others it invokes a complete building model shared between construction team members, with "smart" parametric attributes that hold all of a building's components' information—structural, M/E/P, etc. This latter interpretation is more beneficial. While a 3D model is useful for coordination and space allocation, a BIM model holds this information *plus* all of the structural parametric information for a building. These parametrics, when shared among the various building team members, can result in significant time savings.

BIM and Hospitals

Perhaps nowhere is BIM more important than with hospital projects. An example: Beaumont Hospital, Troy, located in southeast Michigan, is currently undergoing an expansion that encompasses five new buildings as well as additions to four existing buildings. Some of the new work includes a 575-ft-long pedestrian bridge, a vertical bed tower

Beaumont Hospital, Troy's campus is currently undergoing an expansion that will house a total of nine new buildings or additions to existing buildings.

New construction on the campus comprises approximately 1,000,000 sq. ft—all designed using BIM technology.

expansion, an emergency center expansion, a critical-care tower addition, a powerhouse expansion, and a new ambulatory care center (ACC). Altogether, new construction on the campus comprises approximately 1,000,000 sq. ft—all designed using BIM technology.

While this expansion project encompasses several facilities, we'll focus on one: the ACC. This slab-on-grade, three-story, 130,000-sq.-ft building is connected to an adjacent medical office building (also part of the expansion) and the pedestrian bridge via a large atrium. The east wall of the ACC has a rolling spline façade with irregular column spacing in one direction; continuous ribbon windows wrap the building's exterior. Total steel for the job is 1,100 tons.

We evaluated concrete and steel structural framing systems early in the design stage. The main criteria were to maintain program flexibility for future renovations using a 32-ft by 32-ft grid and within vibration restrictions of 8,000 micro in./sec. While a design using both steel and concrete would have met these requirements, cost and schedule were the deciding factors in our eventual selection of a steel frame for the ACC; the steel was able to be released prior to the interiors being designed and signed off on.

The building's framing system is constructed with composite steel beams, and lateral resistance is provided by moment frames in the longitudinal direction and braces in the transverse direction. The braced frames were located strategically near shafts and configured around doorways and corridors. To maintain schedule—and even accelerate it in some cases—BIM played a major role in the project.

Phases

We modeled the building in phases. The first phase was primarily beams, columns, and foundations. We leveraged available technology, electronically transferring our Revit Structure model into our analytical program, RAM Structural System. After completing our engineering of the gravity and lateral members, we round-tripped the design. The interoperability between the two programs allowed the engineers to transfer all of the beam and column design information back and forth with the push of a button. Specifically, Douglas Steel translated the RAM files to CIS/2 then imported the CIS/2 file into SDS/2. In the end, we were able to import all of the beam reactions, camber, shear studs, bracing, and sizes without marking up a single drawing.

Once phase one was engineered and documented, we handed the model over to the project's steel fabricator, who was able to use our model for two important purposes: creating an advance bill of material order for the mill and starting the fabricator's model. The BIM process, executed properly, eliminates concerns over potential discrepancies between the model and printed dimensions since the documents *and* the analytical model were both created from the BIM model; thus the coordination was automatic.

As BIM allowed the shop drawing process to start sooner, the steel was ordered earlier, fabricated earlier, and available for delivery earlier. While the fabricator was detailing the main structural members and preparing to receive steel from the mill, phase two of the modeling was started. This phase comprised all exterior framing components—namely the kickers, struts, vertical supports, and horizontal headers—and miscellaneous interior steel framing members. Thanks to the BIM process, when coordinating with the mechanical engineers, we were able to visually inspect the model to ensure that the kickers did not interrupt the duct runs or other building systems.

Once the building was well under construction, final mechanical equipment selections were made. To facilitate the installation of the equipment and coordinate with the trades that had already been installed, the design team modeled the Unitstrut or open-slotted channel framing and equipment drops.

Douglas Steel

Beaumont Hospital's framing system is constructed with composite steel beams, and lateral resistance is provided by moment frames in the longitudinal direction and braces in the transverse direction.

The structural connection information from the fabricator's model also proved beneficial. When reviewing the building system equipment drawings—specifically, all of the hanging loads—we verified that the beams and their connections had adequate capacity to support the equipment. This readily available information from the fabricator proved to be an immense time-saver. The engineer did not need to go to the field and count bolts or measure a welded connection. Rather, the information was already available and only a few clicks away.

During a post-evaluation of the project and its design process, it was clear why BIM was such a crucial element. We were able to leverage the model to expedite the shop drawing and detailing processes, reduce some of the fabricator's set-up time, and minimize coordination time. MSC

Jim Corsiglia is a structural engineer and principal with Harley Ellis Devereaux. He can be reached at jacorsiglia@hedev.com.

Architect and Structural Engineer
Harley Ellis Devereaux, Detroit

Steel Fabricator/Erector/Detailer
Douglas Steel Fabricating Corporation
(AISC Member)

BIM the Norm

Douglas Steel and Harley Ellis Devereaux have been operating as a team on projects for more than three decades. In fact, one of our first projects together using model transfer and BIM technology was a previous expansion to William Beaumont Hospital in 1995.

During almost all of our projects, we share our ideas and preliminary designs with Douglas for feedback on cost and constructability. We validate this effort when our documents go out to bid and the structural proposals come in within budget.

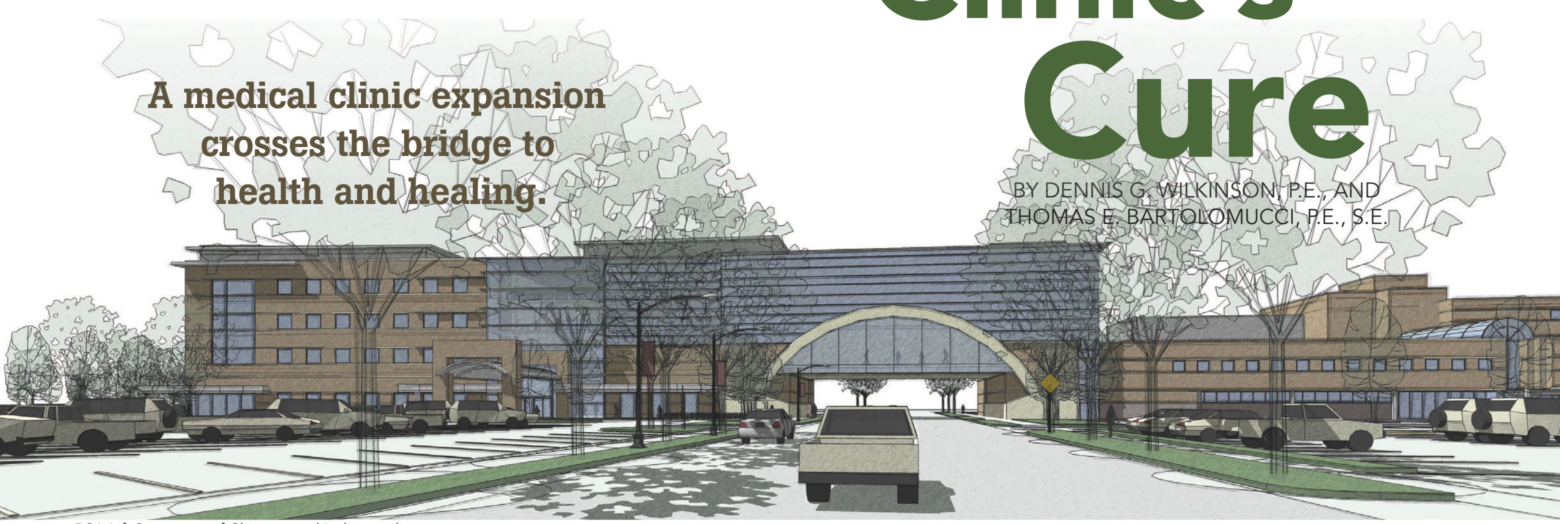
Douglas Steel was instrumental in developing the electronic shop drawing process between our companies. Their staff came to our office for "real" training. (Anyone who implements a new system or program knows what I mean by "real" training.) This is a sign of true partnering, rather than a design team and a separate fabrication team.

BIM technology has come a long way since our first BIM project together. The BIM environment is no longer a buzz word or an additional service. Rather—for us, at least—it has become the normal way of doing business and forming efficient teams between design and fabrication.

Clinic's Cure

A medical clinic expansion crosses the bridge to health and healing.

BY DENNIS G. WILKINSON, P.E., AND
THOMAS E. BARTOLOMUCCI, P.E., S.E.



BSA LifeStructures of Chicago and Indianapolis

The design for the Springfield Clinic medical complex made use of limited real estate by incorporating offices, exam rooms, and patient waiting areas into a three-story, 15,000-sq.-ft air-rights bridge.

IN RECENT YEARS, AS demand for its medical services has increased and its number of physicians has tripled, Springfield Clinic LLP realized that an expansion to its current facilities was needed to better serve its patients and staff. As one of the 10 largest employers in Springfield, the clinic has 195 physicians and 70 nurse practitioners/physician assistants offering care in 40 medical specialty fields. It also has 20 offices located throughout Springfield and the surrounding communities.

With no additional room to expand on its site in downtown Springfield, the clinic purchased a site located to the west of the existing facility for its proposed 117,000-sq.-ft expansion. However, this site was by no means a blank canvas for the clinic's expansion and challenged both the clinic's and the design team's vision for the project.

The project team faced numerous challenges as the project unfolded, including demolishing several existing structures on the acquisition site, accommodating existing utilities, and minimizing disturbances to a privately-owned chiropractic clinic located in the shadow of the construction area—a mere 20 ft to the north.

Complicating the project further was a major city thoroughfare that split the new building site from the existing facility. This four-lane artery transports tens of thousands of motorists to Springfield's downtown and north end daily. Additionally, the design and construction team was charged with minimizing disruptions to the clinic's patients and staff, since the clinic continued to provide essential medical services, including operating its MRI and nuclear medicine facility, as construction progressed.

Design

While the clinic had purchased a site located one block west of its original facility, it envisioned connecting its current medical facility with its new building via an air-rights bridge. While structurally feasible, the project team first had to clear several hurdles, including obtaining approval from the city of Springfield to build over a major roadway, securing air rights for the bridge, and meeting city zoning requirements.

Working with a $30.6 million construction budget, the structural engineers developed the structural framework for the expansion—a 117,000-sq.-ft, four-story structural-steel-framed building with a partial basement. The centerpiece of the facility's design is a 15,000-sq.-ft, three-story air-rights office area that spans Springfield's busy four-lane Sixth Street and connects the new expansion to the clinic's original facility.

The structural design was driven by an aggressive 21-month design and construction schedule. By incorporating structural steel into the facility's framework, the project team could forge ahead with design, fabrication, and construction and meet the client's required time frame for opening its new complex in August 2008.

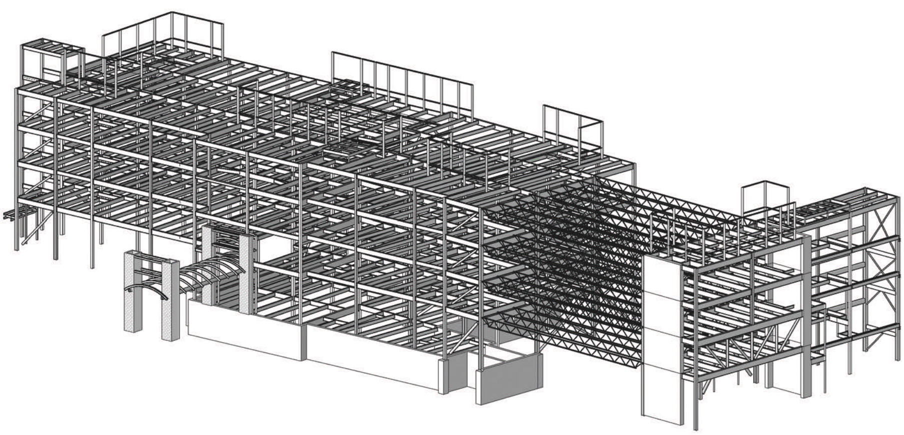
The structural engineers used Autodesk's Revit Structure to design and draft the steel mill order construction documents, and also used RISA Building System to perform structural analysis. Engineers quickly accomplished the design and placed a steel mill order only six weeks after the structural design began. This quick turnaround was followed by the completion of foundation construction documents in three months and completion of the final structural construction documents in five months.

Choosing a Structural System

Several systems were considered for the bridge structure before the project team selected long-span composite bar joists. The composite bar joists provided a redundant structural system to protect against disproportionate collapse if a vehicle impact occurred. They also offered a relatively simple erection sequence that minimized the disruption to motorists traveling through the construction zone into downtown Springfield. Engineers designed the long-span structure to minimize the vibration frequency and amplitude, taking into consideration the impact on the clinic's exam and waiting rooms located on the bridge structure. Floor vibrations were analyzed using Structural Engineers, Inc.'s FLOORVIBE.

Additionally, the engineers analyzed the lateral framing system using Revit and RISA to quickly model several different

Hanging the curtain wall from the roof structure minimized the vertical movement under applied live loading and eliminated the need for expansion joints between levels.



This structural model, produced in Revit, shows a southeast view of the clinic's proposed new facility.

Images: Hanson Professional Services, Inc.

The structural design for this expansion project was driven by an aggressive 21-month design and construction schedule.

framing and bracing scenarios before they selected the final arrangement of lateral bracing and composite-floor framing. Lateral bracing for the facility included steel tube struts, x-bracing, and chevron bracing on the western portion of the facility, combined with two large concrete shear walls, diagonal steel x-bracing, and chevron bracing on the eastern portion of the facility. Bracing connections were designed using Omnitech Associates' Descon Brace software.

The engineers were also challenged with arranging the structural steel members, including the facility's stairwells and elevators, around an existing magnetic resonance imaging (MRI) machine to avoid Gauss field interference.

Collectively, the project team regularly monitored steel pricing and availability to help select readily available and cost-effective steel members. The final structural system consisted of 1,193 structural steel elements, including beams, columns, and bracing, with a total weight of approximately 810 tons.

Reckoning with Magnetic Forces

The clinic's existing MRI facility required that the structure at the east end of the expansion support three floors, the roof, and an air handler while providing a clear span of 60 ft over the MRI. The initial design included steel plate girders at each floor level. Engineers and the steel fabricator then determined that a 14-ft-deep truss could provide a more efficient design. The story truss optimized the use of structural steel framing over the MRI, minimizing the potential effects of Gauss field interference, and provided an estimated cost savings of $200,000 over the steel plate girder design option.

Planning the Façade

The building's exterior façade used brick with punched windows, curtain walls, and deep rib metal panels. Lateral attachment for the curtain walls was provided at slab edges using continuous ⅜-in. bent plate attached to the top flange of the spandrel beams and welded rebar dowels, which developed the plate into the concrete slab. The continuous bent plate reduced the need for coordination with the curtain wall manufacturer, allowing the erection of steel and casting of floor slabs prior to a final architectural layout of curtain wall mullions.

For the air-rights bridge, the exterior façade consisted of a curtain wall with an integral limestone arch supported from three-story-tall structural mullions. A non-continuous bent plate system, similar to the building curtain wall support plates, was used to support the curtain wall mullions from the bridge's perimeter roof joists. Hanging the curtain wall from the roof structure minimized the vertical movement under applied live loading and eliminated the need for expansion joints between levels. The use of continuous curtain wall mullions allowed the limestone arch to be supported from the mullions. Limestone veneer panels were used to create the arch within the bridge façade because of their light weight and identical final appearance when compared to traditional limestone masonry.

Structuring Success

The strengthening of an already strong working relationship between the design and construction team was instrumental in the successful completion of this project. Having past working experience with all parties involved provided a positive work environment and was conducive to providing efficient, well-coordinated designs. The use of technology also played an important role by providing the flexibility to handle modifications to the project, with integrated analysis and drawing production, within project deadlines.

Structural steel shop drawing review was streamlined using Design Data's SDS/2 Global Review Station. Global Review allowed the steel fabricator to share the steel detailing model with the design team. The model acted as a powerful communication tool between the fabricator and the design team, and it also eliminated the need for the standard transfer of hard copy shop drawings.

After enduring an intensive schedule, vertical and horizontal design challenges, and site considerations, the Springfield Clinic project team persevered, completing a major medical complex for Springfield Clinic on schedule. In Illinois' capital city, a place where history blends with modern-day life, a substantial new medical complex graces the skyline, serving as a gateway to health, healing, and vitality. MSC

Dennis Wilkinson is a project engineer and Thomas Bartolomucci is a vice president, both with Hanson Professional Services Inc.

Owner
Springfield Clinic LLP, Springfield, Ill.

Architect
BSA LifeStructures of Chicago and Indianapolis

Structural Engineer
Hanson Professional Services Inc., Springfield

Steel Fabricator
Selvaggio Steel, Springfield (AISC Member)

Construction Manager/General Contractor
Harold O'Shea Builders, Springfield

Engineering Software
Revit Structure
RISA Building System
AutoCAD
FLOORVIBE
Descon Brace

Best Laid Expansion Plans

BY STEVE WYLIE

WKHS Marketing and Public Relations Dept.

A Louisiana hospital grows one story taller—and more seismically stable—and stays fully operational during the process.

THE BUILDING CONSTRUCTION INDUSTRY PRESENTS THE MOST WIDE-RANGING and abundant illustrations of the phrase, "The best laid plans of mice and men often go awry." However, it is the work done to find a way through the challenges of unforeseen problems that drives innovation and makes for a high degree of satisfaction at the end of a project.

An industry example of "best laid plans" is the preparation and effort that goes into designing a structure for future vertical expansion. Columns are typically up-sized to prepare for future splicing of columns not yet designed. Girders and rigid frames are bulked up far in excess of the requirements of the current building in anticipation of more floors being added later. And though the engineer may design a structure that incorporates a vast and authoritative range of considerations for the future expansion, the reality is that no one can prepare in advance now for everything that may happen in the future.

Hospitals represent one of the most active building types in terms of expansion activity. Willis-Knighton Health System (WKHS), for example, began serving the Shreveport, La. community in 1925. Since then, it has grown to become the largest health-care organization in the state and one of the top 100 hospitals in the country. In 1983, Willis-Knighton South opened as South Park Hospital and became the first satellite hospital in Louisiana. By 1989 it had extended its focus on women's services, carrying out a major renovation and expansion to open the Center for Women's Health.

Planning and design of this three-story, 69,540-sq.-ft wing of the hospital had been undertaken in 1987 by architect R. Wayne Estopinal during his tenure as vice-president at VHA Health Facilities Group in Irving, Texas, with additional design services performed by the Dallas firm of Page Southerland Page (PSP). Constructed in steel, the wing included what was then considered a state-of-the-art neonatal intensive care unit (NICU). Anticipating later growth of the NICU, PSP developed the design to accept a future fourth-floor vertical expansion, with seismic requirements based on the most recent regulations at the time, the 1984 Uniform Building Code (UBC).

By 2005, Shreveport had experienced a great deal of growth and therefore WKHS was ready to embark on fulfillment of their "best laid plans" for the NICU. Anything but a whim—or a capital surplus in need of a project—construction of the vertical expansion would be a critical and necessary venture, fulfilling a recog-

Parts of this article were published in the January 2008 issue of HEALTHCARE DESIGN under the title, "An 'Off The Wall' Solution for a NICU Expansion" and are reproduced here with permission.

nized need for a timely upgrade and greater capacity for neonatal care in the community.

Since completing the 1987 wing, Estopinal had gone on to found his own firm, the Estopinal Group (TEG), based in Jeffersonville, Ind. and with an office in Shreveport. The relationship with WKHS had continued during that time, and they again turned to Estopinal for the new expansion. TEG in turn used TRC Worldwide Engineering of Brentwood, Tenn. to provide the structural design.

WKHS Marketing and Public Relations Dept.

The NICU addition to Shreveport, La.'s South Park Hospital is a braced seismic tower composed of HSS16×8×3⁄8 for all vertical members and HSS8×8×3⁄8 for all bracing and horizontal members.

Challenges

The initial request by WKHS was to provide a proposal for a two-story addition. Accompanying the design challenge were several other requirements by the hospital that would affect how the project could proceed. The first and most important of these was the need to keep the facility operational while minimizing disruption during construction, not only because of the critical role of the facility in the community, but also because of the necessity of keeping expectant mothers and mothers with newborns as calm and comfortable as possible. Another requirement would be to extend the existing stairs to the new floor and roof while maintaining egress from the other floors during the entire construction process. Minimizing the downtime of rooftop units during construction of new mechanical penthouse facilities was also a crucial consideration. Overall budget and a 365-day construction schedule rounded out the list of principal issues.

Seismic Dilemma

These issues were trumped, however, during preliminary structural analysis. Seismic design for the proposed new addition would be per the requirements of the 2000 International Building Code (IBC). Given that seismic design conditions had increased substantially since the 1989 renovation, project architects and engineers discovered the existing structure could no longer be considered able to support even one additional floor without significant modifications to the building and its foundation. In fact, governing seismic loads had increased approximately 70% from the 1984 UBC requirements to those of the 2000 IBC. Since the level of modifications required would mean shutting down the facility during construction, the project was on the verge of demise.

However, the absolutely vital purpose of the expansion pressed WKHS and the project team to continue to look for a solution. WKHS agreed to scale back their initial request for a two-level addition in favor of a 23,180-sq.-ft single level, with penthouse areas for elevators, stairs, and mechanical units. This would limit the amount of additional seismic forces on the existing structure to the columns and foundation only.

Going forward with this adjusted scope of work, the project team explored the idea of petitioning for a variance to the building code. Specifically, Section 1614.1.1 of the 2000 IBC stated:

"An addition that is not structurally independent from an existing structure shall be designed and constructed such that the entire structure conforms to the seismic force resistance requirements for new structures unless the following conditions are satisfied: 1) The addition conforms with the requirements for new structures, and 2) The addition does not increase the seismic forces in any structural element by more than 5%, unless the element has the capacity to resist the increased forces determined in accordance with Sections 1613 through 1622 [i.e., Earthquake Loads and Seismic Design]. (331)"

In other words, any vertical addition to the facility would require the entire existing structure to meet the latest seismic force requirements. This section of the IBC would have to be waived by local building officials if the expansion was to proceed with limited modification to the existing structural frame.

The arguments for considering a variance request were based on several factors. The first was that seismic consideration for the new addition would be in compliance with the original 1984 UBC, meaning the design strength of the existing structural elements would not be reduced. The new addition also would be detailed and connected to the existing structure as required by the 2000 IBC and include provisions to reinforce existing members to transmit loads to the foundation. The proposed alterations would not create a structural irregularity or increase the severity of any existing irregularities. Finally, the risk of seismic activity in Shreveport was considered relatively low.

However, before active pursuit of a variance request got under way, an assessment by project engineers revealed that even with the variance, any and all seismic strengthening of the building through the existing structure would create an unacceptable level of disruption if not outright shutdown of the facility. The severity of the predicament was clear: Increasing the capacity of neonatal care in the community was vital, yet just as vital was the necessity of continuing uninterrupted care in the existing facility.

The Solution

The first glimpse of a way through the central challenge of designing an addition that would minimize invasive work in the existing facility came about through a closer reading of the 1614.1.1 section of the 2000 IBC. Rather than interpreting the section as a directive to enhance existing members, a different reading will yield the equally valid interpretation that no seismic strengthening of an existing structural frame is required if the shear loads are sufficiently reduced. After reviewing the feasibility of removing shear forces through reinforcement of the stair towers on the north and south elevations, the idea was seized upon to create a central seismic tower off the face of the west elevation.

A design went forward for a braced seismic tower composed of HSS16x8x3/8 for all vertical members and HSS8x8x3/8 for all bracing and horizontal members. The decision to use a steel tube truss for the tower would accomplish several goals. First and foremost, it appeared to solve the fundamental problem of how to bypass any additional seismic shear loads through the existing columns and foundation in favor of structurally draining them down a braced-frame tower located outside the functional footprint of the building. By designing the tower as a vertical tube truss, fabrication could be done in sections either in the shop or on the ground near the site. The sections could then be lifted into place as complete units, with infill members installed and connections to the existing structure being completed in less time, further reducing the impact of construction on the existing facility.

The tower would be clad in new materials to complement vertical and horizontal elements on the structure. A panel system matched the sheathing on the new elevator tower on the north face, while open aluminum frames on the outer face of the tower corresponded to existing vertical glass areas over the front entrance, as well as to window rows along the west elevation. In addition to its structural functionality, the new tower also provided an important aesthetic function in breaking up the otherwise unremarkable horizontal flow of the existing west elevation.

Ground was broken on the project in May 2006. The construction team chose to shop-build truss bents in three sections that were then assembled on site, erected using two 82-ton truck cranes and then braced. The new 42-bed Level III NICU opened one year later. Only the third floor was temporarily vacated during construction of the stair towers and fourth floor. Though some disturbance to facility operations was unavoidable, the overall impact was considerably less than anticipated and construction flowed smoothly.

Results

The innovative seismic tower solution allowed the project to proceed swiftly and efficiently while keeping disruption of a critical facility to a minimum. The steel design proved very straightforward to build and install, allowing the project to make up a significant amount of time during the construction phase. Further, the mobility inherent in the use of steel truss sections proved much more adaptable to meeting shifting facility demands; imagine shutting down concrete pours due to patients in labor versus simply lowering a boomed section and turning off the crane engine. The solution in steel was instrumental in meeting the project requirements, and the effort to adapt to best laid plans gone awry reinforced the confidence in the project team by WKHS. Perhaps most importantly, the continued operation of the facility and the successful opening of the new NICU earned the likely gratitude of many area families and their newest members. MSC

Steve Wylie is vice president of Total Steel Service, a steel consulting division of TRC Worldwide Engineering, Inc. in Brentwood, Tenn. He can be reached at swylie@trcww.com.

Architect
The Estopinal Group, Jeffersonville, Ind.

Structural Engineer
TRC Worldwide Engineering, Inc., Brentwood, Tenn.

Steel Erector
Ranger Steel Erectors, Inc., West Monroe, La. (SEAA Member)

General Contractor
McInnis Brothers Construction, Inc., Minden, La.

WKHS Marketing and Public Relations Dept.

In anticipation of future growth, the original design for the NICU was developed to accept a fourth-floor vertical expansion, which recently came to fruition.

Staying Competitive

BY THOMAS R. BROAD

In today's highly competitive market, health-care facilities are constantly looking to go the extra mile—and so are some of the teams that help build them.

WHEN IT COMES TO HOSPITALS, it's no longer just about good doctors. Facilities themselves need to stand out from the rest.

Responding to the competitive nature of health-care providers today, the University of Michigan Health System is in the process of constructing its new C.S. Mott Children's and Women's Hospital. The 12-story, 1.2-million-sq.-ft state-of-the-art facility will provide the latest in technology and comfort to its guests. The new facility will be versatile, adaptable, and cost-efficient—ready to face a competitive future with a truly patient-friendly and healing environment.

Midwest Steel is managing the entire steel contract for this project using our Structural Steel Design Assist project delivery system. This methodology provides a solid approach that consistently saves owners 12 to 20 weeks on project schedule and 10% to15% on project cost by:

- completing the detailing process early to foresee any value engineering opportunities
- improving communication between the entire team
- avoiding delays and interruptions
- acting as a unique competitive bid process

In the case of Mott Hospital, the first step was to meet early on with the project owner, the University of Michigan, and the construction manager, Barton Malow. This meeting marked the official beginning to the comprehensive pre-construction phase. The design assist process allows us to assist the structural engineer during the design development phase to make constructability recommendations, starting with the end of the project in mind.

During this critical phase, we offered numerous solutions to the construction process, which reduced the project schedule and the project budget considerably. Specifically, the project represented three unique components that required the Midwest Steel team to research, collaborate, and test possibilities for the best solutions and systems to implement for this project.

The first component was lead time. The entire steel industry is facing longer lead times for large steel sections from the mill. An integral part of the planning process with the Mott project was to develop creative sequencing plans. As a result of the time and effort of this preplanning phase, we were also able to save money on equipment rental costs.

The second important component to our pre-planning was to develop a welding system that would save cost and schedule in the field. As of this printing, the welding foreman has reported that eight welders have worked up to the eleventh floor, completing 774 moment welds. This welding requirement equals 17,200 lb of welding. To date, all 774 welds have passed inspection and their quality eliminated the need for extra bracing. When complete, the welders will complete 998 column splices as well. The welding process we created required several weeks at our shop in Detroit, developing innovative welding carts and gang boxes. These portable systems contain everything the welders need to execute their work in an efficient and quality manner.

The third component was erecting the steel on an extremely congested site in downtown Ann Arbor. Perfect sequencing and shipment coordination were required because there was literally

HKS

When completed, the C.S. Mott Children's and Women's Hospital will add 1.2 million sq. ft of space to the University of Michigan Health System.

The hospital uses 13,000 tons of structural steel, including a 150-ft-long, three-story truss. Photos: Midwest Steel

no lay-down area initially. Only when the decking was installed were lay-down areas created on certain floors of the building. The upper floors of one wing of the hospital require a clear span of 150 ft. As such, we were required to develop an erection procedure for the truss to carry the upper column loads to the lower columns. The truss was not initially integrated into the building. It was to be made up of the largest rolled sections available and it created a huge challenge to the erection crew. The sections created a truss that is 150 ft long and three stories deep, and the diagonal pieces in the truss weigh almost 18 tons; one of the lower columns even weighs 19 tons. The truss was set in pieces, on shoring, beyond the first area of erection. Extra leave-outs, joists, and stability bracing were added, and the shoring will be left in place until the concrete floors are poured. The project uses 13,000 tons of structural steel in all.

Let it Snow

A harsh Michigan winter hindered the erection crew's process; out of 45 days we lost 23 to weather. However, the experienced team was able to finesse the sequencing schedule, and in the end they ended up only one day behind schedule. There were also several changes in scope, and through creative and detailed planning the Midwest Steel team worked with Barton Malow to maintain the project schedule and keep costs under budget. We also provided the schedules of our subcontractors to the Barton Malow team for integration into the overall schedule. The project is scheduled to open in January.

Midwest Steel's detailed safety plan for the site has resulted in an excellent safety record for this very challenging project: zero incidents. One of the ways we ensure safety is by planning it into the job. We met with the Barton Malow safety team before erection started and presented our site-specific safety plan with our fall-arrest manual, as well as the horizontal life-line system we've developed and engineered. We implemented a full-time safety representative to ensure that all safety orientations were completed by the relevant team members; we also hold weekly safety meetings and present safety awards.

Certifiably Superior

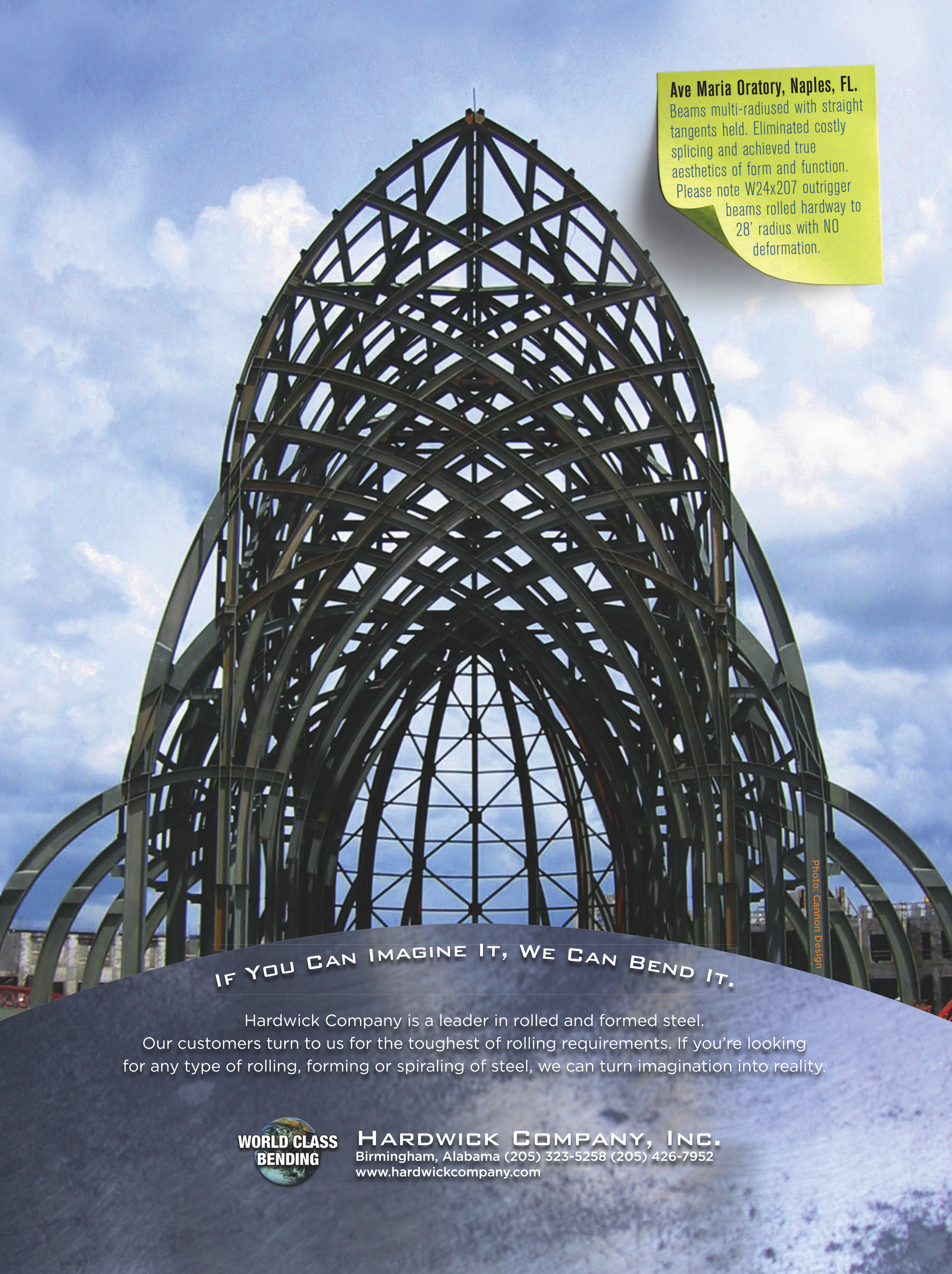
This project served as the jobsite visit for our AISC Certification Audit. During the closing meeting, the auditor reported that the pre-planning, communication, and documentation were second to none—the finest example he had seen. In this respect, we shared something with the project itself: standing out from the rest in a highly competitive environment. MSC

By Thomas R. Broad, Midwest Steel's director of marketing and sales.

Architect and Structural Engineer
HKS, Dallas

Structural Steel Contractor
Midwest Steel, Inc., Detroit (AISC Member)

Construction Manager
Barton Malow, Southfield, Mich.


Ave Maria Oratory, Naples, FL.
Beams multi-radiused with straight tangents held. Eliminated costly splicing and achieved true aesthetics of form and function. Please note W24x207 outrigger beams rolled hardway to 28' radius with NO deformation.
Photo: Cannon Design
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Technical Solutions are Just the Half of It

BY LUKE FAULKNER

The other half of BIM implementation involves true collaboration and the willingness to try a new approach to project design.

IT'S IMPOSSIBLE TO MISS. OVER THE LAST THREE YEARS, there has been a meteoric rise in BIM interest. That which was formerly the domain of a small number of specialists and academics has expanded to be included in the education programs of almost every industry group.

There are myriad guides to BIM for public use, and the A/E/C community has now seen its first BIM-specific contract forms. BIM has very much begun to permeate the mainstream; the terminology, education, and discussion are all commonplace. BIM in practice, though, still remains relatively rare.

To be fair, most surveys, both scientific and non-scientific, indicate that BIM usage and implementation have expanded substantially in the last several years. It hasn't, however, grown at the rate one might expect of a technology with so much promise. How can this be?

Answering that question requires a slightly different perspective on BIM. It's important that BIM be regarded as a combination of technology *and* process. What exists with BIM is not only a more capable technology but also a better, more collaborative—yet new and unfamiliar—process.

Dictating Process Change

The success of BIM hinges in large part on team collaboration. The traditional methods of contracting (design-bid-build and hard bid) do not facilitate the trust and synergy that is required of a build team executing a BIM-based project. A build team that lacks this trust or familiarity will almost certainly not work closely enough to be effective, and therefore will not achieve project goals.

Clash detection serves as a classic example of this collaboration. The sophisticated software required to run effective clash-detection programs has existed for some time. The software to import multiple platforms from a variety of disciplines does a respectable job of detecting interferences between multiple systems in a building. What happens, though, after the clashes have been detected? In a successful execution, such as with Turner Construction's virtual clash room, the build team is physically assembled in one place to review and resolve the clashes in a group setting. In this setting, clashes are noted, a solution is agreed upon and reached, and the model is updated; clashes are eliminated.

That this solution is reached with the help of technology is not the key point. We've always searched for clashes; the medium has just changed, from light table to software. What is remarkable are the subsequent steps taken after clashes are identified. In the days when a light table was used to find clashes, the next step after discovery typically would have consisted of a slew of RFIs and requests for change—likely followed by a period of bickering and finger-pointing. This has been replaced with the aforementioned collaborative methodology. So not only has a better tool—BIM—been developed, but also a better practice is evolving that allows optimized use of that tool.

Creating New Contracts as an Adaptation

One particular role that will require a shift in thinking is the contract arena. For years the A/E/C industry has been using the same standard contract forms that have pushed risk down the line, rather than attempting to shed risk through collaboration.

It's only in the most recent months that standardized, BIM-specific contracts have become widely available to the A/E/C industry. Previously, those wishing to use BIM had to rely on custom documents, contracts written by in-house legal counsel, or traditional standard contract forms that didn't necessarily allocate risk or responsibility properly for the digital environment. People were uneasy about the lack of precedent and case history regarding BIM projects.

For those that were willing to take a chance, were well versed in BIM, or had a lot of trust in their build team, this was something they were willing to overlook. They possessed a comfort level and a familiarity that offset the risk of a less-than-ideal contract. For the great majority, this was an unacceptable risk; not only was too much left to chance, but on a larger project it became increasingly difficult to obtain bonding or insurance, as potential insurers were nervous about the risk of blurred lines in design and intent.

The fact that multiple contract forms evolved from this serves as proof though that the industry is capable of adapting to the change BIM is bringing about.

Luke Faulkner is director of information technology initiatives at AISC. He can be reached at faulkner@aisc.org.

How We Challenge Ourselves

This all begs the question: What is really inhibiting BIM from exploding? What is preventing BIM from becoming the dominant method of contracting and executing construction projects? The answer is largely between our ears. The technology required is widely available. While it is not yet perfected—one could argue that technology rarely ever is—it is certainly widely available to the public should they wish to purchase it. Most potential users feel quite a bit of apprehension in taking on the challenge of launching a BIM program or are intimidated as to how to go about doing so.

In terms of BIM start-up cost, a reasonable approximation is $60,000 per person. This includes:

- $25,000 in software
- $2,000 in new hardware
- $3,000 for outside training
- $30,000 in downtime and learning curve

If a steel fabricator operates at 5% profitability, for example, this requires $1.2 million dollars in new work to generate the profit required to offset the cost of training and implementation for a single seat. In this example, apprehension is certainly warranted, considering the increased revenues a firm would need to support one BIM modeler, let alone a firm-wide BIM program.

So is a small- or medium-sized firm precluded from ever using BIM in day-to-day business? Of course not, but a positive attitude on its own is certainly not enough to offset the increased billing that would have to occur in this scenario.

A well-managed implementation plan is essential. A more attainable approach to BIM implementation might consist of selecting a small number of people (one to three in this example) and naming them the firm's "BIM group," then expanding the program contingent on this group's success. This phased, benchmarked approach requires a much smaller initial investment, allows the remainder of the firm to continue working as usual, and allows the firm to better absorb any bumps that might be encountered.

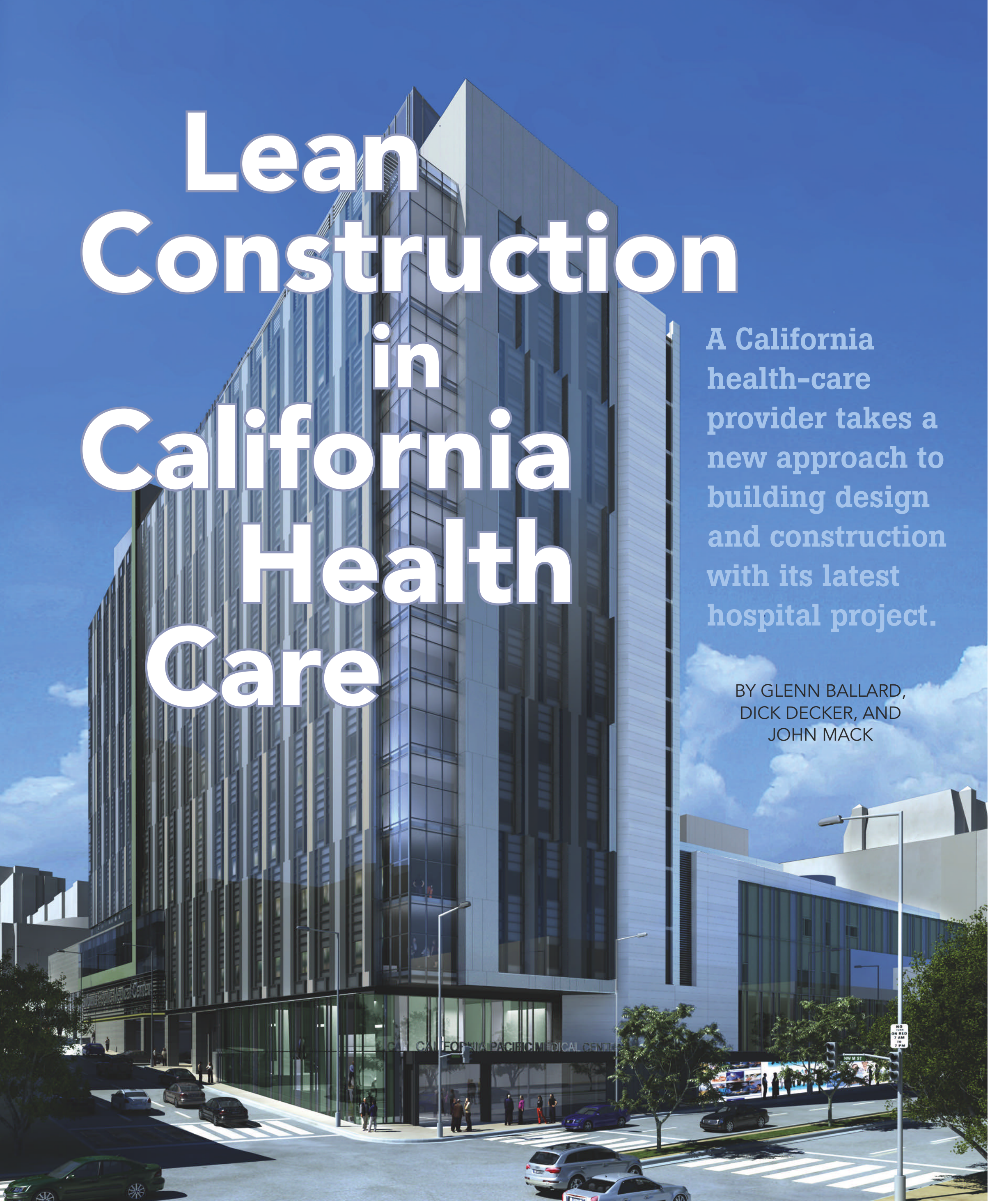
Fostering a Culture of Collaboration

A unique sociological challenge that firms may encounter arises from the amount of internal collaboration practiced within the company. In the past, plan review could be largely compartmentalized, as a set of 2D paper plans could be pulled apart and reviewed separately with little or no coordination within a team. Such is not the case with BIM. Models are not broken apart as easily, and review is not as simple as handing half the contract documents to one person and half to another. The challenge that exists is actually in physically bringing people together to accomplish this. This business model allows reviewers working in separate offices, if not separate cities.

Traditionally, software proficiency has been seen as a critical hurdle to a company's BIM capabilities. However, communication proficiency can be every bit as challenging, if not as important. Says David Ivey of architectural firm HOK, Chicago, "What I can say is that yes, we feel there is a definite learning curve to BIM collaboration methodologies that everyone is still trying to overcome." This underscores the importance of adapting not only the technology but also our working procedures if the A/E/C world is to successfully adapt to virtual construction.

BIM implementation is as much about our willingness to break out of the mold and apply new methodology as it is about software capability. New standard operating procedures will have to be developed and mature, in concert with technical advances, for the industry to use BIM to its full potential. MSC

Lean Construction in California Health Care



A California health-care provider takes a new approach to building design and construction with its latest hospital project.

BY GLENN BALLARD, DICK DECKER, AND JOHN MACK

Cathedral Hill Hospital (CHH), which will take up one complete city block in downtown San Francisco, is being designed in accordance with Lean Construction methods.

SUTTER HEALTH, ONE OF THE LARGEST HEALTH-CARE PROVIDERS in California, has embarked on an aggressive hospital building plan to upgrade their facilities for new seismic standards. In addition to upgrading existing facilities, Sutter will add a new one, Cathedral Hill Hospital (CHH), which will take up one complete city block in downtown San Francisco.

Using Lean Construction methods from the Lean Construction Institute (www.leanconstruction.org), the project team for CHH is assembling sets of tools to improve the efficiency of everyone on the project. Value Stream Mapping, Target Value Design, cluster groups, and building information modeling (BIM) are some of the tools Sutter and the project team have chosen to use in this effort.

A Bit on Lean

Lean Construction is a holistic project delivery approach with the objectives of maximizing value and minimizing waste. The concept is becoming increasingly popular not only in California, but also around the globe. Properly implemented, the following results are achieved:

➜ The facility and its delivery process are designed together to better reveal and support customer purposes. Positive iteration within the process is supported and negative iteration reduced.

➜ Work is structured throughout the process to maximize value and to reduce waste at the project delivery level.

➜ Efforts to manage and improve performance are aimed at improving total project performance, because it is more important than increasing the speed of any activity.

➜ "Control" is redefined from "monitoring results" to "making things happen." The performance of the planning and control systems are measured and improved.

Lean is certainly a major shift in project management philosophy. To make a suc-

Meetings, consisting of a "big room" meeting followed by smaller "cluster" meetings, are integral to the Lean Construction philosophy.

cessful transition to this new way of thinking, the change needs to come from top management. On the CHH project, the owner is 100% behind the Lean delivery method and requires all project participants to attend Lean training classes. The classes are grouped into four categories: Introduction to Lean, Basic Training, Lean Project Delivery, and Lean Management.

The CHH project recently completed a round of "Introduction to Lean" classes for all participants. This three-hour class teaches the history of Lean Construction and its concepts and methods. One of the class exercises is a hands-on construction project to build airplanes out of plastic building blocks. The plane is constructed three different ways to show how Lean methods can increase efficiency with less effort. There will be future classes on Target Value Design, Last Planner System, A3 Reports, Weekly Work Plans, and Plus Delta.

Value Stream Mapping, a powerful lean tool, was employed early on in the set-up of the design-assist process for CHH. Designing the relationships and dependencies between the owner, designers, and constructors was a necessary first step to produce a functional group. What information was needed and when did the designers need to supply it to the constructors for them to continue their work? What information did the constructors need to feed back to the designers to input the constructability factors, and when? Who communicates to whom and by what method? How are conflicts resolved? When do the owner and GC have to approve competed work? These are all very important questions that Value Stream Mapping can help answer in a systematic fashion.

Building Information Modeling

Sutter Health and HerreroBoldt are committed to reducing waste through the use of BIM models and clash-detection software. BIM is another tool to make the project more efficient. Drawing the building in a virtual environment and performing clash detection between architectural, structural, and building systems in the virtual model is more efficient than finding and correcting the issues in the field. This eliminates waste, thus meeting a core requirement of Lean Construction.

Another use of BIM that can help reduce cost and manpower is extracting production plans from the model. The production plans are used for prefabrication, assembly, delivery, and installation of items during the construction of the building. This allows assemblies to be delivered to the field, reducing the amount of people doing the installations. Using this method, efficiency of the workers also increases. Fewer and more efficient people also reduce safety-related incidents. This whole process is a chain reaction of efficiency.

In terms of BIM software, Revit Structural is being used to design CHH. The Revit model is then imported into Navisworks for clash detection and will also be imported into Tekla for detailing, fabrication, and erection planning.

Collaborate, Really Collaborate

Target Value Design (TVD) is a value engineering technique that allows team members from the design and construction side to work together as a group. The TVD group meets once a week for two hours to review and discuss ways to achieve a better building design at less cost. This group has at least one person from each designer and subcontractor. The group designs for what is constructable and uses detailed estimates to help guide the design, thus designing to cost rather than costing design. These methods are in opposition to the "throw it over the fence" design of each company working in its own "silo." All decisions are made in the group environment, not in isolation. This allows for the construction team to be part of the project at a much sooner time than a traditional project, in both definition and design.

On the CHH project, the TVD meeting takes place every Tuesday at 8:30 a.m. The meeting is held in the "big room," a management technique taken from Lean design management philosophy. After the meeting, team members move on to "cluster" team meetings to participate in their various specialties. There is a structural cluster, an architectural design cluster, an external cladding cluster, etc.

At the conclusion of every meeting at CHH, a Lean tool called "plus/delta" is used. The leader asks all the participants what they thought went well at the meeting (plus) and after all the pluses are written on a chart, the meeting leader then asks what changes could be made in the meeting to improve it for next time (delta). This tool has proven to be very powerful in that each meeting becomes part of a continual improvement process.

The Project as a Network of Commitments

The group uses the Last Planner System to track requests made from one team member to another. It is a system of production control that tracks reliable promises made by team members. The success of the method is in tracking percentage of promises completed (PPC) versus promises made. When using Last Planner, a request is made of someone and the request is put into a weekly work plan. Each request is assigned to a person responsible for completion of the action. The weekly work plan is tracked at meeting minutes, and at the following week's meeting all the requests are reviewed for completion.

For a request to be complete it must meet the conditions of satisfaction from the person making the request. If a request is not met then an acceptable reason must be given to the team. The reason for non-completion is selected from predefined answers, and these reasons are also tracked to see if there are patterns to items not being complete, so that action can be taken to prevent reoccurrence.

Interestingly, the Last Planner System can become a game and bring out the competitive nature of the team members. Each week when something is assigned, the people that are responsible for completion of the task strive harder to complete the task so their name is not next to an incomplete item at the end of the promised period.

The A3 process, another lean tool, is a structured report used to solve a problem, report project status, propose a policy change, or make a purchase. The name A3 refers to A3-size paper (11.69 in. by 16.54 in.). The objective is to fit all the necessary criteria on one page of A3 paper to present to for approval. A good A3 report will have a description of the current condition, root cause analysis, target condition, implementation plan, follow-up plan and result report.

At CHH, the core team signs reviews and approves submitted A3 reports prior to anyone taking action on the A3 problem/proposal. The core team has representatives from the owner, architect, and construction management. When the A3 is approved, someone will be assigned to complete the actions describe on it. The person that presented the A3 is usually the primary person assigned to complete the action.

Innovation

In tandem with employing Lean techniques, Sutter also wanted a structural team that could think outside the box in terms of seismic design. Degenkolb Engineering, the project's structural engineer, quickly demonstrated this ability when it recommended the use of viscous wall dampers (VWD) in the seismic load resisting system (SLRS). VWDs are a Japanese seismic invention used in other parts of the world, but this will be the technology's first United States implementation. As the structural design evolved, Degenkolb validated their prediction that the VWDs would produce a very efficient structural system with superior seismic performance, as compared to conventional seismic systems.

Another new tool applied on the CHH project is the Office of Statewide Health Planning and Development phase review process. Hospital construction in California is regulated, approved, and inspected by the OSHPD, and the CHH leadership and project team requested that OSHPD apply their new phased review process to the CHH project. This phased review would change the California design review process from one-step approval at the end of a three-year period to a six-step phased review process, allowing for submission of the gravity load resistance system, then the seismic load resistance system, and so on over six phases. This helped the design team spread the review and revision work load evenly over a three-year period instead of one big approval at the end of three years—a win-win for everyone on the project, including OSHPD, and also another Lean Construction technique (under the Just In Time heading).

Now and for the Future

Participation in the CHH Lean Construction/design assist project has been a powerful experience for all project participants. The teamwork that has developed as a result of the customer, designers, and contractors truly working together will carry through to the construction phase of this project and produce unlimited future gains. Lasting friendships have been formed, professional relationships developed, and many new tools learned. This project has succeeded in producing a profound cultural change in the way health-care construction projects are designed and built. MSC

Glenn Ballard is director of the Project Production Systems Laboratory at the University of California, Berkeley and a consultant to the CHH project, and can be reached at ballard@ce.berkeley.edu. He is also one of the co-founders of the Lean Construction Institute. Dick Decker is design-assist project manager with Herrick and can be reached at dickd@herricksteel.com. John Mack is a VDC integration specialist with Herrero Contractors, Inc. and can be reached at jmack@herrero.com.

Owner
Sutter Health

Architect
SmithGroup, San Francisco

Structural Engineer
Degenkolb, San Francisco

Steel Fabricator
Herrick, Stockton, Calif. (AISC Member)

General Contractor
HerreroBoldt (a joint venture between Herrero Construction and Boldt Construction), San Francisco

Digging Through the Rubble, Part Two

BY MONICA STOCKMANN AND THOMAS J. SCHLAFLY

The discussion on welding for seismic applications continues...

LAST MONTH WE PROVIDED a glimpse of what seismic welding is all about, discussing the historical perspective of seismic welding requirements and the resulting references; the three weld categories (non-seismic, seismic, and demand-critical); the protected zone; and filler metal requirements for seismic and demand-critical welds. This month we build on the previous article (read it online at **www.modernsteel.com**) and continue to highlight seismic weld requirements. Please refer to the following references for more detailed information: AISC *Seismic Provisions for Structural Steel Buildings* (AISC 341-05), AWS D1.8 *Structural Welding Code—Seismic Supplement* (AWS D1.8), AISC *Prequalified Connections for Special and Intermediate Moment Frames for Seismic Applications* (AISC 358-05), and AISC *Design Guide 21 Welded Connections—A Primer for Engineers.*

Steel Backing

Welds joining beam flanges to columns in seismic framing systems specifically detailed for seismic resistance have been the subject of several of the additional seismic provisions by AISC and AWS. In non-seismic applications (buildings designed with $R = 3$ that are not specifically detailed for seismic resistance), steel backing is typically permitted to remain in the finished connection. However, backing bar removal is often required in seismic structures. When steel backing is used in tee joints, typical of beam-to-column connections in special moment frames (SMF), the lateral forces will cause bending moments, which impose tensile stresses on these connections, particularly on the bottom beam flange connection in this case. The notch-like condition created by backing left in place in tee joints can serve as a stress concentrator and crack initiator. To eliminate this condition, for the bottom beam flange to column flange connection, the steel backing is removed and the root pass is gouged to sound weld metal. The welder must then re-weld the gouge and add a contouring fillet weld under the bottom flange. Any remaining gouges must be repaired. Figure 1, located on page 50, illustrates the steel backing removal process, which is typically performed overhead.

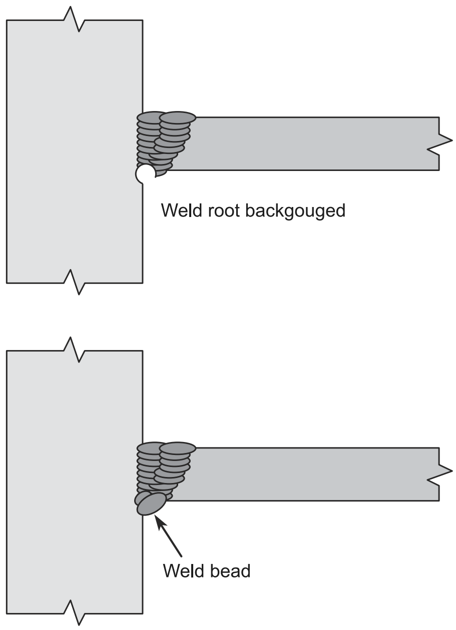
For top beam flange to column flange welds, the backing can be left in place with the addition of a reinforcing fillet weld between the backing and column. As illustrated in Figure 2 (page 50), the backing that is to remain under the top flange must be fillet welded to the column; fillet welds to the beam are not permitted. This procedure will minimize the tension force delivered from the beam into the backing, and also will convert an external "crack-like" interface between the column and backing into an internal interface that won't open up. The overhead fillet weld does add some labor and cost to the connection when compared to standard non-seismic applications, but the top flange requirements are certainly less expensive than the bottom flange requirements.

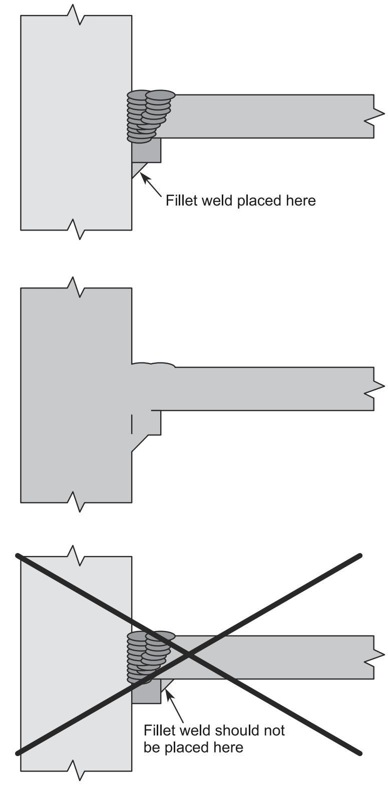
Don't be afraid to pick up the phone and contact a steel fabricator for advice on economical connection design, shop vs. field welding questions, and other constructability issues.

Weld Access Holes

Weld access holes are not used at all with moment end-plate connections. Additionally, special seismic access holes are not typically required with reduced beam section (RBS) connections; rather, AISC 358-05 refers to the requirements of AISC *Specification for Structural Steel Buildings* (AISC 360-05), Section J1.6 for weld access hole geometry requirements. AISC 341-05 does, however, include special requirements for weld access hole geometries for fully restrained (FR) moment connections in ordinary moment frames (OMF). According to the Federal Emergency Management Agency (FEMA) research, FR moment connections with special weld access hole geometries may possibly be qualified as SMF and IMF connections as well. When weld access holes are required, they must


Monica Stockmann (stockmann@aisc.org) is an advisor in AISC's Steel Solutions Center, and Thomas J. Schlafly (schlafly@aisc.org) is AISC's director of research.





Left: Figure 1. Steel Backing Removal (Figure 10-2, page 109 of AISC DG 21)
Right: Figure 2. Backing Treatment for Top Flanges (Figure 10-3, page 109 of AISC DG 21)

be fabricated free of unacceptable notches and gouges that may serve as stress concentrators, in accordance with the fabrication requirements specified in AWS D1.8.

The complete joint penetration (CJP) groove welds between the beam bottom flange and the column flange using weld access holes are sequenced according to Section 6.14 of AWS D1.8. The provision includes that each layer of weld must be completed across the full length of the flange before beginning the next layer.

Weld Tabs

Weld tabs are normally permitted to be left in place for building construction, but for high-seismic applications, weld tab removal is typically required, including for the prequalified connections in AISC 358-05. This eliminates potential harmful effects that discontinuities on the weld tab may cause. AWS D1.8 explains the methods and surface roughness requirements for weld tab removal.

The removal of steel backing is not treated the same as the removal of weld tabs in AWS D1.1; if you direct removal of one, you have not directed removal of both. This is as expected because the removal of backing is a much more costly process.

Making the Grade

Additional testing requirements are placed upon those welders that are required to make demand-critical welds that join the bottom beam flange to column flange by welding through a weld access hole in the beam web. Not only do they need to meet AWS D1.1 testing requirements, the welders performing this task on seismic jobs must also pass the Supplemental Welder Qualification for Restricted Access Welding as prescribed in Annex C in AWS D1.8. This test limits the welders to deposition rates in the shop and field not higher than that for which they qualified in their qualification testing. Requiring welders to demonstrate their skills on the connection mock-up tests, at certain deposition rates, helps to ensure that workmanship on the final structure will meet the special demands of welding on structures subject to high-seismic loading.

Nondestructive Examination

The building codes typically assign the responsibility for developing a Quality Assurance Plan (QAP) to the engineer of record. Nondestructive Examination (NDE) is commonly specified in the QAP. Testing process, extent, techniques, and standards of acceptance should be clearly defined in the QAP. To ease compliance with this responsibility, AISC 341 includes a reference QAP in Appendix Q.

The NDE methods and acceptance criteria for seismic structures are generally the same as those for non-seismic applications defined in AWS D1.1. AWS D1.8 includes supplemental requirements for NDE technician qualifications, inspection techniques, and acceptance criteria. AWS D1.8 also includes provisions for flaw sizing if needed to resolve problems.

What to Include

The resources referenced throughout this article provide lists of information and specifications that the engineer must include in the contract documents. AISC 341-05 Appendix W, Section W2 specifies the necessary information that the engineer must include on the structural design drawings and specifications. This section also lists the items that must be included on the shop drawings and the erection drawings. AWS D1.8, Section 1.2.1 lists 14 items that the engineer must provide in the contract documents.

The Bottom Line

Designers and contractors need to be familiar with the added costs associated with high-seismic applications. Keep in mind that each of the requirements described above has a price tag associated with it. Some of the more costly seismic weld items include column splice CJP groove weld requirements and backing bar requirements. For example, a typical special moment connection beam flange to column flange weld can take a welder an entire day to complete, due to the backing bar removal, back gouging, and re-welding requirements. In addition, applying AISC 341-05 to a structure typically results in thicker stiffener plates, which in turn typically results in larger welds, and often CJP groove welds.

If it's possible to design the building with $R = 3$, then do so. It is true that the use of $R > 3$ may result in a lower base shear. However, the seismic detailing requirements associated with such a design, in particular the seismic welding requirements, will result in higher steel fabrication and erection costs.

Another helpful hint: Don't be afraid to pick up the phone and contact a steel fabricator for advice on economical connection design, shop vs. field welding questions, and other constructability issues. Steel fabricators are an invaluable, often untapped, resource to the design community.

It is important to keep in mind that no matter what building material you choose, a project located in a high-seismic zone will almost always have a higher structural frame cost than the exact same project located in a low-seismic zone. This is the nature of the world in which engineers are designing today. But hopefully we've given you a better idea of the added welding requirements in high-seismic applications and some adequate references for more detailed information. MSC

CPRP Supplement Preview

Currently, there are three prequalified connections: Reduced Beam Section (RBS), Bolted Unstiffened Extended End Plate (BUEEP), and Bolted Stiffened Extended End Plate (BSEEP). The BUEEP and BSEEP connections currently are not prequalified for SMFs if a concrete structural slab is in direct contact with the steel. However, AISC's Connection Prequalification Review Panel (CPRP) will be releasing a supplement to AISC 358-05 in the near future. The supplement will include additional prequalified connections and enhanced criteria to the existing prequalified connections. In particular, for BUEEP and BSEEP connections, it is expected that the "no concrete slab in contact with steel" limitation will be eliminated if the slab is isolated from the column with a compressible material, such as rigid insulation. A new prequalified connection will be included in the supplement as well: Bolted Flange Plate (BFP).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The Auditor Cometh

BY ZANE KENISTON

How to make your next QMC audit a bit less stressful.

AMONG THE MANY ACTIVITIES IN LIFE THAT CAN CAUSE STRESS is being subjected to an audit—specifically, an audit of your company's quality system. But learning more about who auditors are and what they do can help reduce the stress level.

Meet the Auditor

Quality Management Company (QMC) auditors are all independent contractors, not employees of either QMC or AISC. As such, this allows the audit to be independent and objective. This fact alone provides an assurance to the steel construction industry that AISC Certified Fabricators' and Erectors' quality systems are not above scrutiny.

To that end, QMC strives to continually improve the auditor's skill set and understanding of process-based auditing of quality systems. This is accomplished in a variety of ways: semiannual training sessions, regular communication with the auditors, an online forum for the auditors to "calibrate" amongst themselves, and quarterly performance reviews.

The basis for these reviews is generated in part from feedback received from the certified fabricator and erector through a QMC customer survey. QMC's lead auditor discusses with each auditor their identified areas of strength as well as areas needing improvement.

All of this is how the auditors are themselves audited. Anything less would not be fair to the auditors or those they audit.

Putting a face with a name can also reduce the stress related to an audit. After all, auditors are people too! (You can get a look at an auditor's "mug shot" by visiting QMC's website at **www.qmconline.com** and following the "About Us" link to the "Meet Our Auditors" link.)

Auditor Goals (Besides Auditing)

A QMC audit typically lasts one or two days at the fabricator's or erector's facility. (For the erector, an auditor will spend one day at a functioning erection site.) Since the audit is relatively short in relation to the company's working year, what is the goal of the audit and how is that accomplished? There are several quality goals that the QMC auditor wants to achieve during the audit. These are to lead, inspire, and educate.

Lead

The auditor wants to help lead the fabricator and erector forward. Just as people grow and mature at different rates, so do fabricators and erectors. Therefore, the QMC auditor attempts to discover what growth level the company is at and then lead them forward along the growth path. This can be a serious challenge, especially if it is the auditor's first visit to the facility and/or there is some resistance from the employees at the facility.

On that point, although resistance to the auditor does happen from time to time and at various levels of management, for the most part the fabricators and erectors demonstrate themselves to be quite willing to undergo the rigors of the audit. They understand the benefits associated with having constructive observations made of their quality system.

Whatever growth level the fabricator or erector is at, they can always continue to move forward. Standing still in the steel fabrication industry is not healthy in these challenging times. For one thing, although the structural steel fabricators compete amongst themselves on projects, their biggest competitor comes from the concrete industry.

But whether your competition is another fabricator or another building material, it has been said that standing still is actually moving backwards when your competitors are moving forward!

So, one way the auditor measures growth is by identifying the process controls and their features that are functioning within the current quality management system (QMS). Such controls are the practical application of written procedures. These process-related controls are one of the best measurements of a company's QMS level of maturity. These observed controls within the system become part of the audit report as "Identified Strengths."

Zane R. Keniston is the owner of Keniston Technical Services and a Certified Quality Auditor.

Inspire

Now that the tempo is set for the on-site audit, the next goal of the auditor is to inspire. What do we mean by that?

The dictionary definition of inspire is "to stimulate to action" or "motivate." The auditor does not act as a consultant, but

Quality Corner is a monthly feature that covers topics ranging from how to specify a certified company to how long it takes to become a certified company. If you are interested in browsing our electronic archive, please visit **www.aisc.org/QualityCorner**.

instead tries to inspire, stimulate, and motivate the fabricator or erector to action—that is, action in regards to their QMS.

Each auditor is confident that the effective use of an AISC Certified QMS is vital to the overall growth and health of the fabricator and erector. In a much larger way, the growth of the steel industry is affected. Why do we say that?

Well, the end use of the product, structural steel, is ubiquitous, thereby affecting the lives of hundreds of millions, if not billions of people. And all of that steel at some point in its life made its way through a steel fabrication shop of some sort and then into the hands of a steel erector. Once the steel is placed in its service position, that is not the time to question whether or not the fabricator's purchasing control functioned correctly—i.e., that the specified grade of material, bolts, or welding consumables were ordered, received, and incorporated into the product. Neither is it the time to begin wondering if the erector's written bolt procedure was followed or if their welding was performed according to the contract's specified code.

Instead, the auditor inspires the fabricator to examine their existing QMS in such a way that the quality of the product is built in long before the steel even arrives at the fabrication shop. Or, he motivates the erector to discern where improvement needs to be made in their QMS so that not only does production improve, but also costs and exposure are reduced.

Improving productivity and reducing costs and associated risks are fundamental aspects to any company's QMS. Thus, as the audit progresses the auditor is seeking to inspire—to motivate the fabricator and erector to seek ways to improve their QMS.

How does the auditor accomplish this without taking on a consulting role? There are three ways:

Opportunity for Improvement. This is a suggestion that appears in the final report for the company to consider during their next high-level management meeting. If such a control is instituted, it may improve their processes (increase production, reduce costs and risks). Whether or not to implement these suggestions rests with the fabricator or erector, since the QMS belongs to them.

Concerns. Sometimes the controls the fabricator or erector has established are obsolete or for some reason are not being used. In this case, if the auditor finds such a nonconformance within the system, it will quite likely be written into the final report as a "Concern." Such a nonconformance would be relatively minor in nature but still needs attention so that it does not develop into a much larger problem. The management team must address Concerns at their regularly scheduled review meetings and take their own corrective action to bring the process back into control.

Corrective Action. Sometimes the controls set in place have failed for some reason and the fabricator or erector has a "customer-critical" nonconformance on their hands. If this is identified by the auditor, a corrective action request (CAR) is issued. This is an elevated nonconformance in that the company now has to address the matter with the QMC office in Chicago, within a set time frame.

As the name implies, a customer-critical nonconformance needs immediate attention so as to protect not just the customer but also the fabricator or erector.

If the nonconformance has found its way into product, then the fabricator or erector must follow their written nonconformance procedures to remedy the situation. At the same time, the CAR forces them to address the nonconformance at its root cause, find the control within their QMS that is malfunctioning, and correct it. Otherwise, how will they be able to cost-effectively prevent a repeat of that same customer-critical nonconformance?

Educate

Dr. W. Edwards Deming is quoted as saying "Learning is not compulsory...neither is survival." In this nugget of wisdom from his book *Out of the Crisis*, Dr. Deming reminds us that every day we should be making efforts to expand knowledge and develop expertise in our work and in our lives.

One definition of education encompasses both the teaching and learning of knowledge, proper conduct, and technical competency. It thus focuses on the "cultivation of skills, trades, or professions," as well as "mental, moral, and aesthetic development."

So the auditor's third goal is to educate without consulting. In particular, the auditor desires to educate senior management to the benefits of a healthy, active QMS.

Care is needed on the part of the auditor so that management does not feel their years of experience and knowledge in the structural steel industry are being ignored. With that in mind, the auditor endeavors to educate in a manner that management will benefit from the most.

How is this goal achieved? During the course of the audit the auditor will review with senior management the company's internal audit, corrective actions, management review meeting, and the quality goal. This is designed to help the fabricator and erector cultivate skills vital to their quality system. The auditor will not perform these tasks for the company; rather, they will try to bring an understanding or acceptance to these management-related aspects of the QMS.

For instance, is the internal audit effective, revealing areas within the system that may need more attention from management? If the internal audit is promoted as a function of management, it will be used as a quality tool that will help the company realize improved production levels and lower costs and exposure. Just like a tool or piece of equipment purchased for use in the shop or field, the company does not want it used once and then sitting idle indefinitely. Few pieces of equipment realize a return that quickly. Rather, a piece of equipment must be productive to realize a return on that investment. It is similar with the internal audit, management reviews, corrective actions, and the quality goal. These are all quality tools that, used properly by management, will be generous in their returns for the fabricator and erector.

Take a Deep Breath

So as the time for your next audit becomes reality, hopefully any stress it may produce will be alleviated somewhat from this brief discussion. Keep in mind that the auditor is there to lead, inspire, and educate. All of this is for the benefit of the company being audited, as well as for its customers and the steel construction industry as a whole. MSC


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The Right Way to Camber a Beam

BY REIDAR BJORHOVDE

Knowing when to drill holes in cambered members is key to reducing the likelihood of cracking.

HORIZONTALLY AND VERTICALLY CURVED MEMBERS HAVE become a popular choice for building and bridge construction. There are two main reasons: architectural expression and, perhaps more commonly, because of how they carry and distribute loads in the structure. The action of an arch makes it possible to cover significant spans, since the load is carried largely in compression instead of through bending action. For certain arch geometries, support conditions, and load distributions, the effects of the imposed loads translate into uniform compression within the entire arch.

In addition to complete structures such as arches, individual curved structural members are also used. Common to most building applications is the fact that the curving of such members is very often done at ambient (room) temperature.

Possibly the most common curved member is a beam that has been cambered to satisfy certain deflection limitations, to ensure that the beam is near level when the structure is placed in service. Cambering criteria vary but are most often expressed as a certain fraction of the anticipated dead load deflection. The principles are self-explanatory; the actual implementation of cambering varies a great deal from structure to structure, from designer to designer, and from fabricator to fabricator.

How to Bend for Cambering

Straightening, cambering, and curving of structural shapes are all representative of bending that involves local yielding of the steel to varying degrees. Although the principles and basic mechanics of these processes are the same, they are used for significantly different purposes and with very different magnitudes of the bending deformations and the strains that develop in the cross-section.

A certain amount of plastic deformation must take place in the cross-section during the process in order for the curving operation to work. Elastic bending and stress analysis cannot be used, since any deformations taking place under such conditions will revert to zero once the applied force or moment is removed.

Straightening

ASTM Standard Specification A6/A6M gives detailed requirements for bars, plates, shapes, and sheet piling used in construction (ASTM, 2008). Among these, it provides the permitted variations for straightness for rolled shapes. For example, the maximum out-of-straightness, *e*, for wide-flange shapes with a flange width larger than or equal to 6 in. is determined as

$$e = \tfrac{1}{8}\, x\ [(\text{number of feet of total length})/10]$$

with the value of *e* in inches. This translates into approximately $\frac{1}{1{,}000}$ of the length of the shape. The requirement is the same for camber and sweep, which are the ASTM terms for out-of-straightness measured relative to the strong and weak axes, respectively.

Out-of-straightness is measured by the steel mill during the production of the shapes, and straightening is applied to make any non-conforming element meet the ASTM A6 requirements. Depending on the size of the shape, the straightening is either done in continuous fashion, or if the shape is heavy, it is done through point application of loads. The former procedure is referred to as roller or rotary straightening; the latter is known as gag straightening.

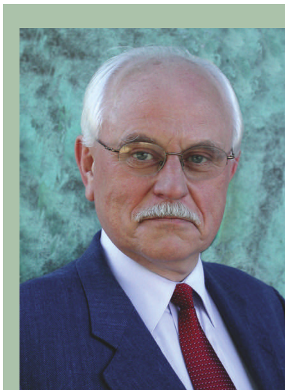
In rotary straightening the local yielding takes place continuously along the length of the shape. Gag straightening causes local yielding in the shape only in short segments along the length of the member, surrounding each of the load application points. Common to both of these methods is the fact that the amount of curving and the accompanying strain demands within the cross section are very small, and the radius of curvature of the bent member is very large.

Straightening of shapes to meet delivery standards is used by all of the world's steel mills. The methods and results are the same, and the equipment that is used operates on the same principles and applications.

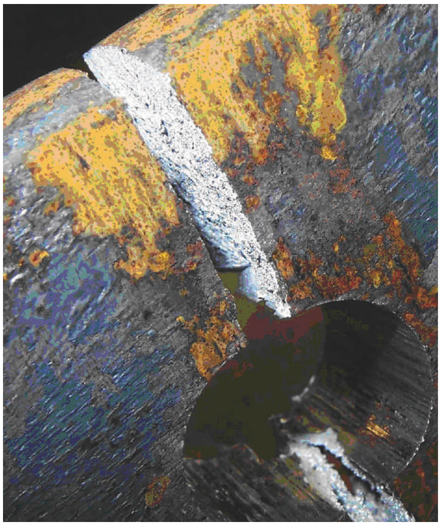
In view of the discussion of cambering that follows, however, it is essential to bear in mind that the shapes that are mill-straightened have no holes or attachments of any kind. The shapes are straightened as they come off the cooling bed in the steel mill.

Cambering

For a structural engineer, cambering a beam means to pre-bend the member in the direction opposite to the deflection that will be developed by the anticipated gravity loads. The aim is to have a structural component that is horizontal or nearly so following the application of the most closely known load component. Since the dead load is generally known more accurately than the live load, for example, cambering is almost always done to an extent that equals a fraction or even all of the dead load deflection.



Reidar Bjorhovde is president of the Bjorhovde Group, Tucson, Ariz.



A close-up of a camber crack through a W-shape flange with a punched bolt hole.

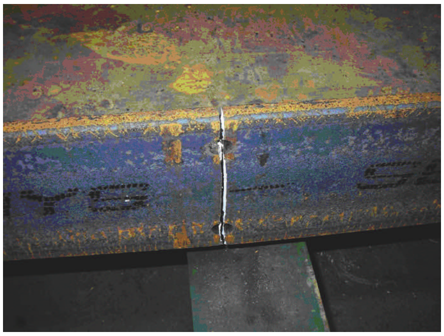
Structural cambering can be accomplished through selective heating of areas of the shape, or, as is most common, through gag pressing at ambient temperature of the member while it is installed in a cambering frame. Cold cambering does involve yielding of small areas of the cross section, similar to gag straightening. The accompanying deformation demands for the steel in the shape are very small, and the force necessary to develop the camber curve tends to be fairly small.

While the deformation and force demands associated with cambering are small, it is important to bear in mind the modifications of the cross-sectional area that will occur as a result of punching or drilling of bolt holes and similar fabrication operations. Some fabricating shops are set up for holes to be made at the beginning of the various operations, running the shape through the beam line with preprogrammed hole sizes and locations. The cambering is then done at a later stage.

The cross-sectional area changes associated with punching or drilling can create a preferred plane for yielding, with the potential for localized failure during the cold cambering process. Further, procedures such as punching have a tendency to leave the inside and the lower edge of the hole fairly rough. Micro-cracks may develop inside or at the edge of the holes, with significant potential for crack propagation and overall failure of the shape during the cambering operation. While sub-punching and reaming the holes and/or grinding the hole edges may help, it will not prevent cracking in many cases. This is particularly important for the holes that are located at or near center span of the beam. Small cracks may even appear near drilled holes that were made before cambering.

Cracking during cambering has been observed on a number of occasions in beams that met all ASTM and structural design requirements. As a result of the potential for cracking, it is strongly recommended that holes and similar features near the location of the maximum cambering deformation should be made after the cambering is completed.

In addition, keep in mind that beams do not necessarily need to be cambered continuously but can be cambered instead as a series of short chords. In this situation, the fabricator can place holes in the center of one of these segments to avoid the problem of cracking.



A full-flange transverse crack of a W21×93 taking place during cambering.

Material Properties

When the steel has been deformed to produce local yielding, it has undergone permanent deformations that are not removed upon unloading of the material. Upon reloading, the steel response appears to indicate a material with a yield stress and elongation properties as defined by the "new" stress-strain curve. If there is only a small or even no yield plateau, which is typical of higher strength materials, the reloading response appears to be for steel with a yield stress that is larger and an elongation at rupture that is smaller than the corresponding properties of the virgin material. If the steel has been strained into the strain hardening range, the change in the apparent mechanical properties can be substantial.

This behavior must be considered when planning the curving operations for structural shapes. Specifically, a part of the cross section must be deformed plastically in order for the curving to work. The extreme fibers in the cross section will be strained well beyond the level of the initial yield of the steel. If there are stress concentrations such as holes in the flange(s) of the beam, the magnitude of the strain that is imposed by the cambering operation may reach the fracture level at the edges of the holes, with subsequent propagation in the cross section.

Delaying Drilling

It is the fabricator's responsibility to prevent cracking during cambering, and they should make every possible effort to do so, including delaying drilling. In many cases, in order for a beam to be properly cambered, it is essential to delay some of the hole punching, drilling, and similar operations until after the bending is done. This will ensure that cracks will not be initiated at the locations of the holes. Specifically, it is recommended that holes at the center of the span should be drilled after the cambering has been completed. (Note that the scheduling of punching/drilling is a fabricator issue and not something that engineers need to add to their specifications or inspection requirements.)

When the beam has been cambered successfully, with no buckling or localized cracking in the steel, the member will experience strains under actual service conditions that are much smaller than those that are associated with the bending operation. MSC

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Build a Winning Team

BY JEFF SCHULZ

Building a team environment, letting people know their roles, and putting them in a position to win all go a long way toward being successful.

MAXIMIZING PRODUCTIVITY. MINIMIZING COSTS. RETAINING KEY EMPLOYEES. Reducing waste. Controlling scope creep. These are some of the major problems affecting nearly every company within the construction industry. Tremendous amounts of time and money are wasted on these issues. Yet, one possible, all-encompassing solution exists within your company: teamwork.

Teams win championships. Having superstars is a tremendous advantage, but the everyday guys who perform their roles and buy into the team-first strategy are the real keys to victory. The Chicago Bulls and Michael Jordan provide a good example. Do you think Jordan won those six titles by himself? Jordan was definitely the best player, but he did not do it by himself. In fact, until he became a team player, he did not win an NBA Championship. Remember the Detroit Pistons and their "Jordan Rules" tactic? Under this strategy, the Pistons fouled Jordan every chance they got. They did this because they knew the Bulls were not a team. If Jordan couldn't beat them, they weren't going to lose. But, Jordan finally brought home the trophies when he had a team around him. By themselves, Jordan's teammates were not superstars, but they did have individual strengths that could be parlayed into team success. When Jordan was double-teamed, Steve Kerr and John Paxson were there to hit the open threes. When a shot was missed, Horace Grant and Dennis Rodman were there to grab the rebounds. And Scottie Pippen was there to back up Jordan and even *be* Jordan when the "big guy" needed a break. That team had its star, and the others were willing to be role-players in order to win and be named champions.

Construction Teams

"It's the team, the team, the team." One of the most successful and respected coaches in the history of college football professed this mantra. The late coach of the Michigan Wolverines football team, Bo Schembechler, knew that if he could get his star players to play as a team, he would win—and he did win. He was the winningest college football coach of the 1970s; he won or tied for 13 Big Ten Championships and never once had a losing record in his 27 seasons as a head football coach. As the athletic director, he emphasized this to all his teams: ice hockey, softball, swimming, you name it. The players bought into his team philosophy and were rewarded by being winning teams and earning the glory for successful tasks, including the 1989 men's basketball NCAA title.

Construction is arguably the industry that most closely resembles the sporting world. Teams are requirements. It is impossible for nearly any project to be completed successfully by one person acting alone. A typical project has several sub-teams working within a big team. The foremen, supervisors, and laborers work internally for the self-performing GC. Then the HVAC, plumbing, steel erector, roofers, and other subcontractors work on the same team as the GC. Don't forget about the office crew or the architect, scheduler, estimator, sales force, admin, P.E., and on and on. Tying this all together is the coach of the project, the project manager.

A football team is a strong analogy for a construction project. In football, you have the head coach, the assistant coaches, and the players who specialize in different positions. The head coach sets the vision for the team. He then tweaks this vision based on input from his assistant coaches. At this point, the coach leaves his assistants so they can go to their individual players whether it is the offensive line or the defensive backfield, and implement a plan based on the overall goal. Goals are set for the long-term and the short-term. Every player knows what his role is every day. Then, after the individual units have their assignments, they put it all together and practice, practice, practice. The saying goes: Amateurs practice until they get it right, but professionals practice until they can't get it wrong.

> Teams are requirements. It is impossible for nearly any project to be completed successfully by one person acting alone.

This mirrors a construction project, or at least how a winning company runs a project. The project manager acts as the coach of his or her team. He has the plan and sets the vision. He then assembles his supervisors and foremen and gets their input and buy-in. If anyone in this group sees something that could be improved or a danger that was previously overlooked, they work together to solve the problem. Then, those leader-supervisors take the ideas back to their groups, and the process repeats itself with each individual calling upon his experience and background to add to the process.

Getting employee input helps employees feel that they provided value and were important to the project. It also encourages employees to put in the extra effort sometimes needed to keep the project on schedule and within budget. These newly educated employees can make informed decisions, reducing waste caused by uncertainty. Uncertainty forces a delay so a situation may be discussed with a supervisor, or worse, it leads to doing something incorrectly and creating expensive re-work.

Subcontractors are the free agents who have the expertise we cannot find within our organization. These agents also need to feel like a part of the team. As free agents, they have their own way of doing things so they need to know how the team operates and what the goals are. Otherwise, they will act individually and prevent the project team from reaching its potential.

Another part of the construction team is the back office. These are the people who facilitate projects and make them run smoothly and efficiently. For example, the administrative staff answers phones and handles paperwork. Taking these tasks off project managers' plates frees up their time to ensure the actual construction work stays on plan. Administrative staff perform many tasks effectively and at a significantly lower cost. Other team members perform necessary roles for a successful project, even though they are not physically out on the playing field. The estimators, human resources coordinator, business developers, and workers in the supply shed, for example, are the scouts, the grounds crew, and the equipment managers of our construction team. If these people do not share the same vision as the rest of the team, they can seriously impair or cripple a job.

Perhaps the most important team member, yet often the most overlooked member, is the client. On too many projects, the client is perceived as the enemy, the opponent on the field. Nothing could be further from the truth. The most successful firms make sure they share a common vision with the client. They work hand-in-hand as a team. This leads to many benefits. If a client trusts you, they are more willing to listen to your suggestions and act on your expert opinion. If a project hits a bump, teammates don't hide the problem; they turn to the client and seek client input or maybe even assistance in order to overcome this obstacle. It also accelerates other processes and minimizes change orders. Team behavior can reduce payment periods. Teamwork leads to long-term relationships. Consider a contractor whose sense of teamwork with a client is so well established that the contractor does not bid a job unless there is a potential long-term relationship with the client.

Preparation

Teamwork is all about the development of your team and your people. It is not about building buildings.

So why don't all construction crews put an emphasis on developing their people?

In the 2005–2006 U.S. Construction Industry Training Report, FMI's survey respondents listed their top five training challenges as:

1. Finding time to train people
2. Obtaining measurable results
3. Training people at multiple or remote sites
4. Delivering comprehensive training
5. Using training to drive organizational change.

While these are all valid issues, there are several ways to overcome them, with some effort. For example, finding time to train means that the individual being trained is not at that moment helping to produce a building. People perceive an employee in training as a cost. Yet, this is very shortsighted. Individuals in training are learning valuable ways to increase productivity, and gains of 10% in margin can be created by something as small as a 1% gain in productivity. Oftentimes, even greater gains can be realized. Beyond productivity improvement, workers are also learning how to improve safety and prevent costly accidents, reducing waste. Furthermore, the training investment made in the employee by the organization builds loyalty. The Craft Labor Supply Outlook states that while there probably will not be a shortage in actual bodies for the construction workforce, the problem will be the quality and the lack of necessary skills and talent. Recruiting will be important, but retention will be essential. Companies will be forced to do whatever they can to keep good team members. Keeping your team for the long run will mean realizing a large return on investment.

The majority of training for baseball takes place during spring training. The team manager sets the season strategy and selects the team that will best help the team achieve its goals. This does not necessarily mean selecting the best players. Even in perceived individual sports such as cycling, the winners are usually those with the best team. Lance Armstrong won seven straight Tours de France, but he readily admits that it was his team who made this possible. It could be argued that his team, the U.S. Postal Service Team (and later the Discovery Channel Team), was not the best team. That honor belonged to Team Telekom. However, Telekom had no leader since its three best riders were out for themselves and would not sacrifice potential individual glory for the team. Why would Lance's teammates subjugate themselves to support roles? Two major reasons exist: to be associated with winning as opposed to simply being an above-average individual and perhaps to be the future leader of the successful, winning team. Individuals become team members, train appropriately, and focus on team success. They develop skills that strengthen the team more than themselves, and their reward is the team's success.

In player development, the company aligns its efforts to build the team's long-term success, not just an individual's win or a short-term project success. Find time or make time. The outcome of increased employee loyalty, reduced costs, and increased efficiency will nearly always more than offset the short-term costs of developing the skills of team members and the teamwork of those members.

Know the Score

In order for the stakeholders in your project to be a winning team, they have to know what qualifies as winning. In baseball, it is easy to know. You look up at the scoreboard and everything is there: runs, innings, pitch count, and the runners on base. You even know the history of the batter. All of this information is up-to-the-moment. Baseball players know exactly where they stand. They know the score, and they know if they are winning or losing.

But, how do you tell what the score is on a job site? And does your team know the score? The project score can be based on many things, but it is usually some combination of client satisfaction, meeting the specs, safety, and, of course, completion on time and within budget. These scores should be reinforced every day on the job. Daily huddles are excellent times to provide the team with updated information, remind everyone of the plays for the day, and inform them of the score and how they can help the team win.

It is easy enough to state, "We are going to be under budget and on time." That is a fair selection, as it is easily quantifiable and normalized. The most successful companies tend to have team development and human measurement involved as well from both the client and the project team.

Forward

There are many needs that must be met to assure a team success. Maximizing productivity. Employee retention. Keeping costs to a minimum. Reducing waste. A highly effective way to achieve all of these is through the building of a strong team. Allow team members to feel that they have the power to contribute to and affect the success of the job. Provide them the opportunity to voice their opinions. Employees, once encouraged, are usually excited to come together and express their views, talking candidly about ways to improve.

Industry analysts have stated that labor is going to be the biggest issue—including how the industry is able to manage that demand in more creative ways—for the construction industry for the next three to five years. Building a team environment, letting people know their roles, and putting them in a position to win goes a long way toward being successful. You already have some of the players, now make them a team. Develop more team members. When you do, you will improve your profits and beat your competitors. MSC

Jeff Schulz is a consultant with construction management consulting firm FMI. He may be reached at 813.482.3765 or via e-mail at jschulz@fminet.com.

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Flynn ON HEALTHCARE

ARCHITECTS "I particularly enjoy working with architects at the beginning of a project because, well, that is when the most creative structural solutions are born. We have to really understand the architect's vision, their goals, to provide world-class structural design for our healthcare projects. For hospitals, that means understanding the relationships between the different departments, the desired design aesthetic, the project goals and challenges, and how best to deliver all of this within an established budget. It's never a cookie-cutter design! We deliver the most value to the project when we participate in the process early."

Lanny J. Flynn, P.E., S.E. Principal. Heads up the Healthcare Specialist Group at Magnusson Klemencic Associates. Harmonizes creativity with structural engineering. Appreciates the flexibility of steel shapes to enhance the vision of today's architects and healthcare facilities.

PATIENT CARE "The primary focus of hospitals is patient care, which demands intense medical, mechanical and electrical systems with very rigid architectural requirements…efficient staff circulation and patient flow, acuity adaptable rooms, patient- and family-friendly spaces, and integration of infrastructure. There are also required levels of transparency, as well as stringent vibration criteria for sensitive equipment and procedures. The structure must support all these demands and be flexible enough to change rapidly. Steel structural systems are great for this type of design. As hospitals bring in new technologies and adjust patient care strategies, steel structures are able to easily morph to make these modifications possible."

SEISMIC "Hospitals need to function after an earthquake, so Codes impose more stringent requirements on their design. Steel is a wise choice, because it is a very ductile and predictable material. One of our recent hospital designs involved a 700,000-square-foot expansion and utilized a unique steel bracing system with a well-defined ductile steel core designed to dissipate the energy imparted by an earthquake. That system actually bettered code requirements and, because of the steel bracing system, actually reduced the structural costs of the foundation system and columns. The hospital not only saved money, but also received a better-performing building."

PERFORMANCE-BASED "MKA has taken a leadership role in the development of performance-based seismic design for new buildings, with over 3 dozen successful projects. A performance-based approach is becoming the trend in seismic design, rather than prescriptive Code-based structural design. Performance-based design involves a very detailed analytical process that identifies anticipated demands on structural elements and sets parameters of acceptable performance for each element. Armed with that knowledge, we proportion and create the structure to support those criteria. In light of the benefits to be gained by the industry, MKA has even sponsored physical testing to verify performance and further advance the technology."

FAST TRACK "Hospitals are about patient care, but the financial part of the operation is equally important. If you are not successful financially, you can't deliver the best patient care. Steel pays the dividends on fast track construction, and for hospitals, fast track is always an issue. The shorter the construction, the faster they can treat patients!"

DESIGN "Twenty years ago, hospitals were more institutional. They had repetitive grids, boring public areas, and drab décor. Today's hospitals incorporate amenities you see in five-star hotels, and the framing is moving away from institutional to the longer spans of steel. In one of our recent hospital designs, a portion of the patient-care wing was cantilevered 120 feet. Steel made it possible."

BIM "Our firm has been doing this for quite some time, even though the transition to BIM (Building Information Modeling) is occurring as we speak. We actually use a BIM delivery system for all of our hospital designs, because of the benefits it provides in coordinating structure with the intense MEP systems and Architectural requirements embedded in modern healthcare design. In one hospital where we used a BIM delivery, all the structural steel framing was developed in 3D object-based design. The mechanical routing of the intense duct work and HVAC systems through the interstitial truss work was shown, and a lot of conflict checking and coordination occurred early on in the design phases avoiding downstream coordination issues. BIM is a real time saver, and steel is leading the way."

TRANSPARENCY "Today's healthcare designs call for openness and controlled transparency. Small, sleek structural members and long spans aid in supporting this concept. Steel systems are an excellent choice to create open and transparent spaces which help to improve the experience of the patient and the patient's family and friends."

STEEL "Owners saving money, saving time, increasing building performance, and lengthening the hospital's service life is what steel is all about. You have more ability to dial-in performance with steel."

In the Shop

EDITED BY GEOFF WEISENBERGER
PHOTOS BY JESSICA SLADEK PHOTOGRAPHY

Manufacturers of fabrication equipment large and small share their thoughts on the fabrication industry and the machinery they're providing to it.

How has the fabrication shop changed in recent years?

Menke: One major change in recent times has been the focus on material handling and shop layout. A fabricator can save incredible amounts of time if they take a closer look at how material flows through their shop. On average a fabricator loses 15 minutes when he handles material with a crane. A fabricator that can minimize the amount of time used to physically handle material will stay competitive now and for years to come.

Additionally, fabricators become more competitive and have the capability to react more quickly to "fast-track" jobs when using BIM detailing software, which seamlessly integrates with shop floor machine tools via a DSTV interface package.

In addition to that, CNC machinery has become a much stronger element in the common shop. Over the years we have seen the overall physical size of structural shops shrink, but the amount of automation, and fabricated tonnage, dramatically increase.

Walsh: Recent developments in structural steel fabrication shops include the increased use of computerized plasma cutting systems. One of the traditional knocks against the use of plasma machines has been the severe bevel created on the edge of the cut part, especially on thicker metal. However, today's high-density plasma power supplies have solved this problem. These systems can accurately pierce and production cut at high speeds with less than 2% bevel.

Morrall: There have been many recent developments, but as far as the fabrication shop itself, it has been the introduction of fully automated systems that can run practically unmanned. Some equipment can now be left to run without the intervention of a machine operator, reducing labor and material

Participants

Ficep Corporation	www.ficepcorp.com	**Tom Boyer**, President
Hougen Manufacturing, Inc.	www.hougen.com	**James Kaiser**, Sales Manager
Ocean Machinery	www.oceanmachinery.com	**Danny Steyn**, Vice President
Peddinghaus Corporation	www.peddinghaus.com	**Lyle Menke**, Vice President of Marketing
Plasma Automation, Inc.	www.plasma-automation.com	**Timothy E. Walsh**, President
Voortman USA Corporation	www.voortmancorp.com	**Adrian Morrall**, President

handling costs. Such equipment will automatically load itself and sort, by contract, the parts produced. We have such a machine in our own fabrication shop that runs up to eight hours a day after normal working hours and will text you on your cell phone should a problem occur. You can even restart the system with a text message back to the control.

Boyer: For years, the machine tool industry has been concentrated on the fabrication of structural steel and plate; it's been fixated on process speed to the point that the amount of time it takes to drill and saw a structural member has never been faster, as the latest in spindle and tooling technology now permits drilling at speeds up to 50 in. per minute. This ability to process structural steel at rates that seemed impossible 5-10 years ago has exposed other challenges that were not apparent previously. Today, a progressive fabricator needs to focus their attention more towards integrated solutions, as the ability to drill and saw structural steel sections efficiently is a given in most cases.

Traditionally, the most expensive operation that a fabricator faces is the one of manual layout. CNC drill lines have always offered the ability to produce layout marks to facilitate manual layout, but it was necessary for a CNC programmer to enter these layout commands and determine the proper location. The laborious nature of this process, when compared to the ability to download the cut length and hole location data automatically with a DSTV interface, meant that the ability to use a CNC drill to generate layout marks was generally not utilized to its fullest extent.

Kaiser: Like virtually every aspect of industry and manufacturing today, fabricating and fabrication shops have had to adapt their fields of expertise and disciplines to become more quality conscious. Gone are the days of doing layouts with pieces of chalk, grease pencils, and rulers on steel plates; CMMs and laser measuring have found equal opportunity in the fabrication atmosphere. With this need for quality has come a need for suppliers of manufacturing equipment to enhance the precision and accuracy of their machines.

Steyn: Going back to our first ventures into CNC automation in 2001, our original feelings were that we would anticipate around 10% of the small to medium fabricators adopting some form of CNC fabrication. Today, the picture is significantly clearer. Except for the smallest of shops, 100% of all fabricators will have to make the transition to CNC fabrication in order to remain in business, just in the same way we had to embrace the fax, cell phone, internet, and email, despite how much we might have resisted at the beginning.

What have been the most significant challenges to the fabrication industry in recent years?

Morrall: Challenges have been many. Finding good reliable labor is [certainly] an issue. This lack of individuals coming into fabrication has driven the fabricators to invest in CNC equipment, and in the last four years we have seen investment like we have never seen before. This has been worldwide. Fabricators are always trying to find a way to reduce material handling and labor. Voortman, with its unmanned systems, is the only company that at this time has achieved that goal.

Menke: The structural steel industry, as well as many other manufacturing industries, must adapt to this era of changing skilled labor availability. There have been many articles written on this subject, but the fact is that the number of individuals who understand and appreciate the opportunities that our industry offers them is shrinking. This is a major influence on the manufacturing world that is forcing many fabricators to rethink the way they run their operations. As always with change, some will adapt and some will not; however, you will never replace the human element.

People are smarter than machines. A well-trained CNC operator is the industry's strongest tool, and working with a machine tool manufacturer that can offer high levels of training and service is crucial to the success of that shop. Peddinghaus currently has 60-plus field service technicians and 20-plus in-house phone service technicians, and offers a thorough training curriculum for customers of all sizes.

Boyer: Over my years in the business, the trend of skilled labor shortage is the one that never changes. In bad times you

may be able to hire a more energized workforce, but the skills required, such as manual layout, more often than not have to be developed within the organization. When times are good, the guy that you have invested significantly in training over the past years may end up leaving you for just a few [more] bucks a week.

Certainly, we have to identify steel prices as the most significant challenge in recent years. The price increases we have experienced recently go hand-in-hand with the unprecedented transfer of wealth from this country to the oil-producing countries of the world and the corresponding decline of the dollar.

This trade imbalance would be one thing if it represented capital goods that added productivity to our economy—in a 10-20 year life cycle—but in this case it literally goes up in smoke in just a few days, only to be faced with the requirement to do it again! As our dollar declines we have to pay more for the portion of steel that we historically imported, and in addition we now have to compete with foreign fabricators to purchase steel, as our domestic steel producers can realize higher prices due to export opportunities that are subsidized by the weak dollar.

I believe that enough has been written about this national energy challenge in the recent months, and as we proceed further, hopefully our politicians will finally establish an energy policy that we can all live with, and the value of the dollar will then rise so that steel prices can decline to make steel construction, once again, more competitive.

Steyn: For the most part, small fabricating shops are either swamped with work or don't have enough, and their owners are always too busy with the day-to-day pressures of satisfying customers, chasing up orders, dealing with uncooperative vendors and employees, and the never-ending administration of running a business that they have built painstakingly from scratch. They seldom have the time to give much thought to how they can be making incremental productivity improvements in their operations. And so for most fabricators, productivity is often a misunderstood term.

But unless the fabricator gets out from under this cycle and starts looking at productivity, there will be a lot of hard work, sweat, and grind and very little profit at the end of the day.

And to complicate matters, here in the U.S. we have always had an "on-off" approach to labor. When we are swamped with work we crew up, and when we are short of work we crew down.

This approach has had long-term negative effects on our understanding of how to make productivity improvements. In other countries where employees are typically very difficult to terminate, owners take a long hard look at all possible options prior to hiring a new employee who might have to be there for the next 20 years! Two of the most commonly considered tactics are outsourcing work or investing in machinery to do the work, as the machine can be paid off in a few years and it will continue to work for free for many more years, while the new employee will require a salary for as long as they are at the company.

What are some solutions to these challenges and/or what are some of your company's latest offerings?

Steyn: Today there are fortunately many affordable solutions on the market and all of them embrace some form of automation, essentially CNC fabrication. In the realm of beam fabrication, the proven solution for the small to medium fabricator is the single-spindle beam line. It is this machine that has transformed fabrication for steel fabricators that would never otherwise be able to afford larger and more expensive multi-spindle beam lines.

And the flexibility of the single-spindle drill to process the entire spectrum of profiles—including angles, base plates, channels, stair stringers, etc.—has made it very attractive to even the smallest of fabricators who do miscellaneous metals and just a hint of structural steel. Moreover, the ability to tackle the heaviest jumbo columns, as well as large-tonnage projects, has allowed the steel fabricator to cast the net to a far wider range of jobs than he had traditionally gone after, and because of this we have seen many small fabricators with exceptional tonnage and revenue figures per employee.

Furthermore, with the advent of the 3D detailing software that has become so prevalent and more affordable, the ability to import data from the detail drawings directly to the CNC machine, essentially eliminating the unnecessary costly and potentially inaccurate step of laying out the steel, has made additional improvements in productivity, speed, and accuracy.

Walsh: Plasma Automation, Inc. has introduced the Vicon Monarch heavy-duty precision plasma cutting system with I-beam construction. The machine was engineered to provide total cutting versatility for structural steel shops. Its capabilities include cutting, via plasma and/or oxyfuel, sheet metal to 4-in.-thick plate, I-beams, angle iron, channel, and fixturing, as well as square and rectangular tubing.

Morrall: The introduction of DSTV ++ in September will now allow real-time feedback to an ERP/MRP system from the fabrication equipment. Voortman has opened its database, and as we use a PC-based control system, this allows the end user to select certain information from the equipment, such as cycle time (to compare to estimates made during the bidding process), tracking information to locate piece parts during fabrication, number of saw cuts made, number of holes drilled, and material used to update inventory.

We also have the first true robotic structural burning/cutting system for coping all structural shapes. The Voortman V806 uses a Panasonic industrial robot integrated with the roller-feed measuring system.

Also, our marking system can obtain layout information from the CAD software and print the part location and part number on the material.

In addition, our high-speed drilling system with carbide tooling employs spindle speeds up to 2,500 rpm and can produce up to three times more than hydraulically fed systems.

Menke: Some of the Peddinghaus' latest offerings include:

- The high-speed FDB-2500 plate-processing system, which includes a rotary tool changer that travels with the spindle throughout its full range of motion and provides drilling, tapping, countersinking, part marking, layout marking, and thermal cutting (both oxy-fuel and plasma) all in one machine.
- The BDL-1250/D three-axis, high-speed carbide drilling with a 1,800-rpm motor.
- The Ring of Fire, which features 400 degrees of plasma cutting motion and is the only plasma machine with this range of motion that comes complete with a dust and particulate collection system.

Boyer: Today, CAD systems permit the ability to download in a seamless fashion from their 3D model to a Ficep interface that not only generates the hole and cut length data, but also generates the data to scribe the main section to facilitate the fitting operation on all four surfaces by indicating layout location; part number of the detail element that is to be welded at this location; and orientation mark on the detail member and the main member to show the orientation for fitting.

The data that flows from this Ficep interface with Tekla to generate the CNC program for the detail lines, such as an angle line or plate fabrication system, also includes the program to scribe the part number on the detail part and orientation mark to match up with the main member.

Even the material-handling systems that we offer today can be fully automated so the stock length material will automatically transfer into the drill/saw entry conveyor, load the program and start the CNC process, remove trim cuts, and convey finished parts to the storage table. All this is now done today without an operator to start each process correctly and without delay.

Kaiser: One recent advancement by Hougen Manufacturing has resulted in providing improved productivity and accuracy for drilling holes in awkward positions, including horizontal or upside-down. The Hougen model HMD904S portable magnetic drill features a swivel base that allows users to first engage its magnet to secure the drill in place in awkward locations, then to pivot and move the cutter point to precise drilling spots, then lock the base/drill in final position. This innovation is helping fabricators speed up hole-making production both in the shop and on-site.

Another recent development from Hougen is the HMD150 model for drilling in hard-to-reach or limited access places. Measuring $7\frac{13}{16}$ in. high, the HMD150 fits in places where even hand-held drills won't fit, yet provides drilling capacity of up $1\frac{3}{8}$-in.-diameter by 1 in. depth of cut. The inclusion of a sturdy quill feed arbor has also added new rigidity and accuracy to this tool.

Hougen also offers the Punch-Pro lineup of electro-hydraulic hole punchers. The self-contained hydraulic system eliminates the need for separate, remote hydraulic power units that leak and are a deterrent to easy usage and portability. The five models of punchers provide from 13.2 tons to 34.1 tons of pressure to punch round (to $\frac{15}{16}$-in.-diameter) or oblong (to $\frac{11}{16}$-in. by $\frac{13}{16}$-in. dimensions) holes through material up to ½ in. thick. MSC

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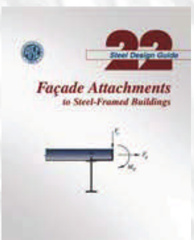
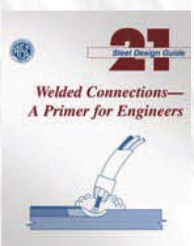


Façade Attachments to Steel Frames

Perhaps the most complicated details in a building occur where the façade and structural frame meet. The details of this interface have a significant impact on the cost of the project. The performance issues that affect the façade attachment details include: proper support of the façade elements, structural anchorage to the frame, relative movements, fire protection, waterproofing, thermal and moisture migration, air infiltration, and sound transmission. Just as these details need to integrate performance issues, the design team needs to coordinate responsibilities between the architect, base building engineer, façade engineer, general contractor, steel fabricator, steel erector, and façade subcontractors.

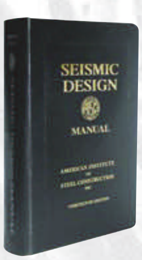


NEW! Listen to Steel: Duane Miller on Welding

Everything you need to know about structural welding applications is discussed in this new one day seminar. Each module gives concise resolutions to steel welding issues and together they represent the full spectrum of welding concerns.

NEW! Intelligent Design: Low-Rise and Mid-Rise Buildings

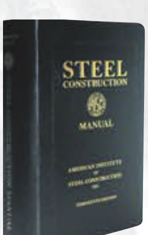
This new seminar focuses on rational and efficient building design methodologies that you can incorporate into your practice as soon as you get back to the office. The lectures cover the philosophy of design, design considerations relative to loads, selection of training systems and their components, preliminary design techniques and much, much more. Don't miss this opportunity to obtain valuable information relevant to design efficiency!



AISC Seismic Provisions/Manual

AISC Seismic Design – Updates and Resources for the 21st Century

Structural engineers across the country have appealed to AISC for good resources and continuing education seminars on seismic design. In response, Thomas Sabol, Ph.D. – referencing AISC's extensive seismic design resources – has developed a seminar to meet those needs. If you are a practicing structural engineer looking to increase your knowledge of seismic design of structural steel – make sure you attend this seminar!



NEW! Seismic Connections/Manual

Practical Applications of the 2005 AISC Seismic Provisions

With recent advances in code requirements and options, it can be a challenge to design cost-effective connections to resist seismic demands. This new seminar demystifies seismic connection design. You will learn how to design connections for moment frames, braced frames, and other seismic load resisting elements.

AISC Fall 2008 Seminar Schedule

NEW Building Design Seminar

- ☐ 9/16 Miami, FL
- ☐ 9/23 Boise, ID
- ☐ 9/23 Cleveland, OH
- ☐ 9/25 Albuquerque, NM
- ☐ 9/25 Chicago, IL
- ☐ 10/7 New Orleans, LA
- ☐ 10/16 Memphis, TN
- ☐ 10/21 San Jose, CA
- ☐ 10/21 Washington DC
- ☐ 10/28 Albany, NY
- ☐ 10/30 Minneapolis, MN
- ☐ 11/5 Oklahoma City, OK
- ☐ 11/6 Dallas, TX
- ☐ 11/12 New Brunswick, NJ
- ☐ 11/13 Pittsburgh, PA
- ☐ 12/3 Charleston, WV
- ☐ 12/4 Columbus, OH

Façade Attachments Seminar

- ☐ 9/25 St. Louis, MO
- ☐ 12/9 Orlando, FL
- ☐ 12/10 Atlanta, GA

NEW Listen to the Steel-Welding Seminar

- ☐ 10/2 Philadelphia, PA
- ☐ 10/23 Honolulu, HI
- ☐ 11/11 Chicago, IL
- ☐ 12/9 New York, NY*
- ☐ 12/11 Boston, MA

NEW Seismic Connections/Manual Seminar

- ☐ 9/16 Seattle, WA
- ☐ 9/17 Denver, CO
- ☐ 9/23 Houston, TX
- ☐ 10/2 Las Vegas, NV
- ☐ 10/7 Boston, MA
- ☐ 10/14 Los Angeles, CA
- ☐ 10/15 San Francisco, CA
- ☐ 11/5 Indianapolis, IN
- ☐ 11/13 Spokane, WA
- ☐ 12/2 Burlington, VT
- ☐ 12/2 Sacramento, CA
- ☐ 12/4 San Diego, CA

Seismic Provisions/Manual Seminar

- ☐ 10/21 Lexington, KY
- ☐ 10/23 Richmond, VA

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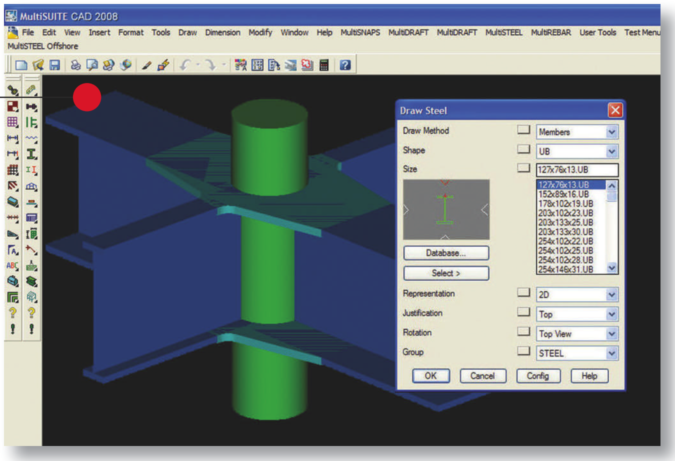
Each month MSC's product section features items from all areas of the steel construction industry. In general, these products have been introduced within the past six months. If you're looking for a specific product, visit MSC's online product directory at **www.modernsteel.com/products**. You can browse by product category or search on any term to help find the products you need, fast.

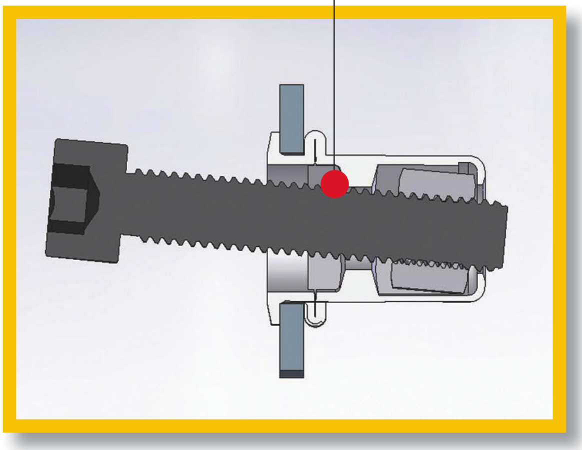
Using CAD to its Fullest



MultiSUITE Software has announced that its structural detailing products have been enhanced to fully utilize the improved drafting environment offered by AutoCAD 2009. Users of the latest applications should see tangible benefits delivered by the main features, with new functionality in MultiSTEEL like steel cloning and simplified bar creation in MultiREBAR, making the software easier to use and increasing detailing efficiency. MultiSUITE CAD 2008 combines MultiSUITE structural tools with AutoCAD OEM Technology, enhancing 3D structural modeling and 2D steel drafting.

For more information, visit info@multisuite.com or call 800.500.4563.

Staying Afloat



Sherex's RIVFLOAT rivet nuts feature internally floating threads, which allow for component attachments in off-center applications and can accommodate for tolerance stack-up in the manufacturing process. The floating nut (.020 in. radial float) aligns to drive the angle of the screw and thus eliminates cross-threading and spin-out. The fastening technology was designed for post installation in applications where cage nuts, clinch nuts, floating nut plates, or weld nuts are typically used.

For more information, visit www.sherex.com or call 866.474.3739.

No Pain in the Neck

To improve operator comfort and access to difficult-to-reach joints, Bernard Welding Equipment has introduced a new MIG gun neck grip and neck coupler. The neck grip shields the operator's hand or forearm from the heat of the neck, and the high temperature silicone rubber provides better control and increased accuracy compared to the metallic neck tube. The coupler allows users to join two or more Q-Gun or S-Gun necks consecutively, thereby avoiding the costs and production delays of ordering a custom neck for applications with difficult-to-access weld joints. The coupler is easily installed in under three minutes and provides joint access that would otherwise be impossible with a traditional MIG gun neck.

For more information, visit www.bernardwelds.com or call 800.946.2281.

All products submitted are considered for publication, and we encourage submittals related to all segments of the steel industry: engineering, detailing, fabrication, and erection. Submit product information via e-mail to Geoff Weisenberger (weisenberger@modernsteel.com). To be included in MSC's online products directory, contact Louis Gurthet (gurthet@modernsteel.com).

Versatile and Portable

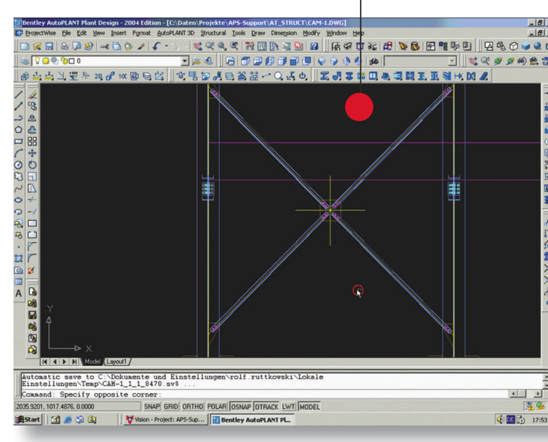
Hypertherm has unveiled its portable Powermax45 ½-in. plasma cutting and gouging system. The Powermax45 is a single-gas system designed for both hand-held and mechanized applications. Featuring patented technology and high power efficiency, the system delivers consistent performance even with low-line conditions or when connected to a motor generator. This feature—along with its light weight—provides additional versatility, as it allows the system to be easily used in various locations. In addition, it is designed with a built-in CNC interface and 50:1 voltage divider, making it a suitable choice for mechanized cutting of ductwork and other materials up to 3/8 in.

For more information, visit www.powerfulplasma.com.

Modeling Like a Pro

Bentley's ProSteel v18 is a 3D modeling environment for structural steel and metal work, supporting construction and planning tasks. Available for both MicroStation and AutoCAD platforms, this intuitive and integrated multi-material package is well suited to lay out complex structures, produce shop drawings, assemble all connections, and manage the bill of materials. ProSteel offers an array of easy-to-master tools to create and modify structural steel objects. It also includes a number of routines to automatically complete tasks—such as the creation of standard connections, shop and overview drawings, parts lists, and CNC data—that would normally consume significant time.

For more information, visit www.Bentley.com/ProSteel.



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Arnold ON STEEL

STARTING OUT "I wanted to be an architect. I started working in an engineer's office and enjoyed the speed at which projects went through my office. There were 10 projects on and off my desk in a week, or sometimes in a day. Engineering is very exciting. Architects make a building beautiful and interesting, but engineers are the people who make them stand up."

Barry Arnold. Principal. Vice President. ARW Engineers, Ogden, Utah. Started his career with ARW in 1985 as a drafter. Received master's degree in engineering in 1991. Received the 2007 Engineer of the Year award from Utah Engineers Council. Loves nature for its structures. Uses steel to create what he sees.

FLEXIBILITY "ARW works on a large variety of projects, but my greatest interest and affection is in steel design. Every designer finds that, despite their best efforts, no project can be perfect; problems happen. Steel provides the simplest and easiest solutions to fix any problem. With steel there's always an easy solution to any problem. If a beam's a little short, you can weld something on. If you need to move a column 10 feet, with steel, it's easy. If your concrete beam is short or a column needs to be moved – you've got a big problem with no easy solution. Steel keeps the projects flowing and going, no matter what type of building it is. I'm happiest when I'm designing in steel… Steel is not nearly as frustrating as other materials – there's always an economical solution in steel."

GREEN "My love of steel wasn't a huge epiphany, it was a growing appreciation of its characteristics and qualities, you know, the nature thing. It only takes working on one or two projects in other materials to make you wish you were designing in steel. You know the design would have been so much easier with steel; it's just so much more predictable. Steel allows for expression in combination with simplicity of design. If an owner is thinking long-term about the environment and building flexibility, steel's the only answer. With everything going green, steel is a natural choice because it's revered as a recyclable material. LEED® is making an impact now, and in years to come, it will be a significant driving factor. With steel, it's easy to make LEED points and points with your clients."

LEARNING "The inspiration I get personally comes from when I attend AISC seminars or go to AISC conferences. There's a plethora of new ideas and innovation available through AISC. Information is presented in a neat, orderly format. You can come back to your office and use the ideas and information immediately. It's always applicable to the projects you're working on today. AISC gives you all the backup and support you need. If you ask a question, AISC responds very quickly."

TEAMWORK "Teamwork is very important… Engineers can be very opinionated. If you ask 20 engineers how to solve a problem, you'll get 20 different answers and that's a good thing. They're all slightly different answers, but they're all correct. You have to keep options open. We tend to gravitate toward what we've done before and many times, that turns out to be a solution that includes steel.

Everyone has that 'manual' in their head of how to do things and that's okay. The young engineers like to test the old engineers as much as the old engineers like to test them, but one thing we all seem to end up having in common is a deep appreciation for what steel can do that other materials can't. We review lessons learned on projects weekly in our office. Everybody has a say. We talk freely and openly without egos getting in the way. We're one unified company, with 20 different people thinking about the options. You get to pick one answer. And most of the time the answer you pick will center around steel and its seemingly unlimited capabilities."

PRIDE "I have no dreams about a special project that I'd like to do one day. I've devoted myself to being proud of every single job I worked on – regardless of whether it's big or small, or designing the whole building or a few connections. I do what needs to be done every day. I don't put my professional ego on display and say, 'look at all these buildings we've done.'"

INSPIRATION "I have a huge appreciation for the environment. In fact, I can see the Wasatch Mountain Range from my office. Being outdoors helps me appreciate my responsibility and obligation to future generations. Engineers have an ethical obligation to protect our natural resources; it's your way of contributing to all of mankind. My work directly affects the environment – I'm humbled by that fact. I find inspiration when I'm in our National Parks and take in the grandeur and majesty of it all, and understand that we all have an obligation to preserve these spaces and our resources for future generations. You get a much bigger perspective out there."

STEEL "If you look at modern steel construction, you will see some exciting innovation going on. I've seen a lot in my career but I know the best is yet to come. Steel is like a good friend – reliable, strong, tested and trustworthy – that has supported me, as I interpreted the architects' concepts to make their dream a reality. That's what young engineers really need to know. That's the power of steel."

BIM and Beyond

BY CARL PUGH, P.E.

Catching the BIM wave requires an understanding of the forces behind it.

SOONER OR LATER, informed owners and developers will put the wrecking ball to poorly orchestrated building design and construction practices. They will come to recognize inflated contingency fees for what they are, and they will reward those of us who showed them a better way.

BIM is a technological response to a people problem. At its core, BIM is a communication solution that requires multiple trade disciplines to play well together in the same sandbox. So to the extent this new tool can make communication easier, BIM or some variation of the concept will one day be added to every trade's business-building toolset.

Retool the Office—and the Shop

Retooling is inevitable, once a sense of urgency compels us to gather the knowledge needed for BIM implementation. So where does this sense of urgency come from?

Our company recently asked dozens of building design and construction professionals about their views on process improvement. A key finding was that 80% ranked communication as very important. Yet only 24% said they were extremely satisfied with the quality of current communication.

We also interviewed dozens of fabricators to learn their views. The majority of respondents complained about incomplete structural drawings and the resulting need for constant and often contentious RFIs. Many expressed a tone of resignation on this issue, as though the "process" is now one of documentation—not for the purpose of communication and project advocacy but more often as self-defense against predictable problems and attempts at payment deductions.

Carl Pugh is an engineering manager with New Millennium Building Systems, supplier of steel joists and decking.

This is one of the important differences between BIM and e-mail. Building information modeling is not just a computerized way to reactively document our miscommunication; it is a proactive tool for enforcing effective communication.

The General Services Administration recognized this fact two years ago when it mandated that new buildings designed through its Public Buildings Service use BIM in the design stage. GSA has further announced that all of its contracts will be completely BIM-based by 2012.

Meanwhile, the U.S. Army Corps of Engineers is leading the way on BIM adoption, noting in its presentations that BIM requires a change in the design process—which requires a change in the way we do business.

Speak Now or Forever Hold your Drafting Pencil

Organizational change can be complicated for a small business. Fabricators can learn how from their adoption of AutoCAD and other computer-based efforts to simplify business tasks, increase accuracy, reduce costs, and increase workflow.

BIM promises similar outcomes, and yet it will take time for a company, let alone an industry, to lock in what is a technological approach to marrying multiple design and construction disciplines. This is all the more reason why steel fabricators need to have a say in the matter, before they are handed a "solution" that does not take into account their ideas for making BIM truly work.

Once fully informed of the challenges around BIM implementation, fabricators can make sure their employees know what procedural changes are required, and that employees feel the same level of urgency to make these changes happen.

Steel Resolve

Steel fabricators should especially feel a sense of urgency and opportunity as they come to know the business implications of BIM. On any steel project, it is the steel package that sets the framework for that project's success. When the steel package is efficiently designed, engineered, and erected, the owner's buying power is maximized. You eliminate a chain reaction of costs ranging from field delays to unnecessary added fuel costs, as all subsequent trade participation is integrated into the steel package.

It all comes down to this: Fabricators are the steel package design and engineering experts. They must take their seats at the architectural and engineering table, fully prepared on BIM. But more importantly, they must do so with an understanding of the forces that are bringing them together. They must show architects the new design possibilities of steel, advise structural engineers on ways to minimize material and fabrication costs, and work with erectors to see a project through to its successful completion.

Fabricators are about to partake in a new kind of business conversation—either initially facilitated by BIM or by their own decisions to change and grow. MSC

Have an opinion you'd like to share in "Topping Out"? Send your feedback to Geoff Weisenberger, senior editor, at weisenberger@modernsteel.com.

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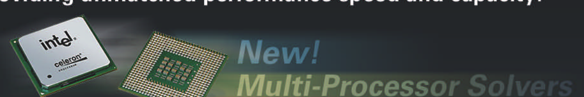

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