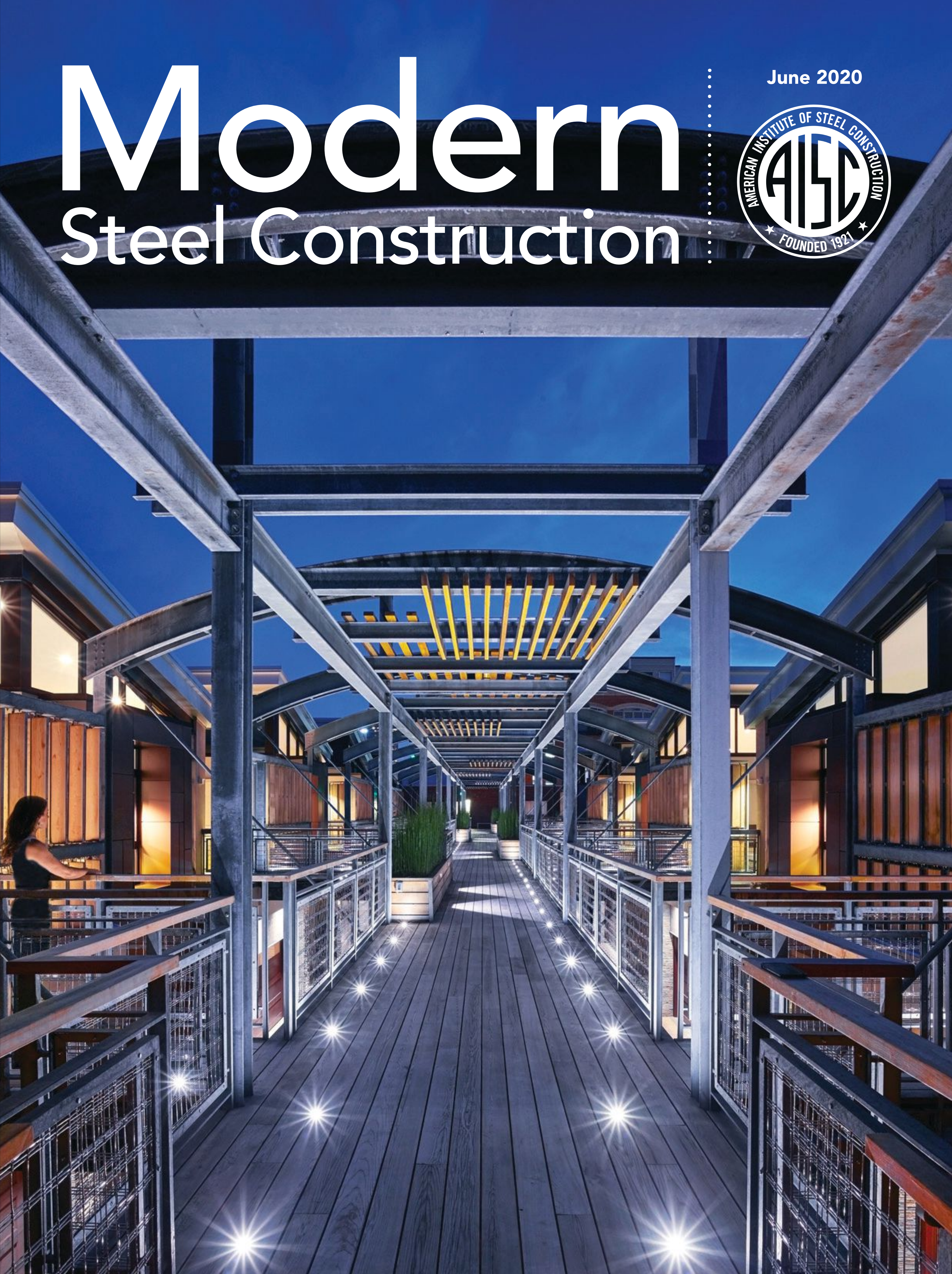
Modern Steel Construction

June 2020




Tekla PowerFab
Steel Fabricator's
Competitive
Advantage

Modern Steel Construction

June 2020

Sterling Stevens

columns

features

ON THE COVER: Take a walk on the steel side, er, boardwalk at a warehouse-turned-residential complex in Pittsburgh, p. 24. (Photo: Ed Massery)

MODERN STEEL CONSTRUCTION (Volume 60, Number 6) ISSN (print) 0026-8445: ISSN (online) 1945-0737. Published monthly by the American Institute of Steel Construction (AISC), 130 E Randolph Street, Suite 2000, Chicago, IL 60601. Subscriptions: Within the U.S.—single issues $6.00; 1 year, $44. Outside the U.S. (Canada and Mexico)—single issues $9.00; 1 year $88. Periodicals postage paid at Chicago, IL and at additional mailing offices. Postmaster: Please send address changes to MODERN STEEL CONSTRUCTION, 130 E Randolph Street, Suite 2000, Chicago, IL 60601.

editor's note

The world is a very different place than it was just a few months ago. Social distancing, Zoom, face masks, and more. While the country is beginning to reopen for business, it's still not business as usual.

Throughout this crisis, designers, steel fabricators, and erectors have continued their work. On the fabrication side, new safety measures are being implemented to promote social distancing and to monitor health. And on the design side, we're seeing new ways to work emerge.

But just as important as finding new ways to work, we need to find new ways to think. At last year's NASCC: The Steel Conference, Ozan Varol, a former rocket scientist turned law professor and bestselling author, discussed the need for contrarian thinking. And more recently, he told this story:

To send or not to send?

That was the question swirling through my mind as I sat in front of my computer as a 17-year-old high school senior in Istanbul.

The cursor was blinking at the end of an email I had just typed up to a professor at Cornell, where I had recently been admitted to pursue my lifelong dream of studying astronomy. I had discovered that the professor was the principal investigator for a planned mission to Mars. What's more, back in the day, he had worked as a graduate student for Carl Sagan, a childhood hero of mine. This was too good to be true.

I drafted an email sharing my burning desire to work for him on the mission and attached my resume.

But when I thought about hitting send, a chorus of voices filled my head.

There's no job posting. Why would you apply for a job that doesn't exist?

You're a skinny kid with a funny name from a foreign country halfway around the world. What could YOU possibly contribute?

If you send this email, you'll make a fool of yourself.

I had grown up in a society that reinforced these beliefs. We were seduced into believing that flying lower is safer than flying higher, that coasting is better than soaring, and that small dreams are wiser than moonshots (sound familiar?).

Then I asked myself two questions.

What's the worst that can happen? Nothing. I'd never hear back from him, and that would be the end of that.

What's the best that can happen? I'd land a pinch-me-now job working on a Mars mission.

I took a deep breath and clicked send.

Less than a week later, I got a response. The professor invited me in for an interview upon my arrival at Cornell. Thanks in part to the coding skills I had picked up in high school (which did me no favors when it came to my dating life) I landed a job on the operations team for the 2003 Mars Exploration Rovers mission. I triple-checked the name on my offer letter to make sure it wasn't some terrible clerical mix-up.

What a great way to think!

Scott Melnick
Editor

Modern Steel Construction

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If you've ever asked yourself "Why?" about something related to structural steel design or construction, *Modern Steel*'s monthly Steel Interchange is for you! Send your questions or comments to **solutions@aisc.org**.

steel interchange

All mentioned AISC publications, unless noted otherwise, refer to the current version and are available at ***aisc.org/publications****.* Engineering Journal *articles can be found at* ***aisc.org/ej****.*

Multistory Structures Taller than 125 ft

Section J1.10 of the 2010 AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360) listed four conditions where pretensioned bolts were required. This entire section was removed in the 2016 AISC *Specification*. Were these requirements removed or relocated within the 2016 *Specification*?

Section J1.10 of the 2010 AISC *Specification* contained the following requirements:

"Joints with *pretensioned bolts* or welds shall be used for the following connections:

1. *Column splices* in all multi-story structures over 125 ft (38 m) in height
2. Connections of all *beams* and *girders* to columns and any other beams and girders on which the bracing of columns is dependent in structures over 125 ft (38 m) in height
3. In all structures carrying cranes of over 5 ton (50 kN) capacity: roof truss splices and connections of trusses to columns; column splices; column bracing; knee braces; and crane supports
4. Connections for the support of machinery and other live *loads* that produce impact or reversal of load"

Items 1 and 2 were not included as requirements in the 2016 AISC *Specification*. The task committee that develops and maintains the provisions in Chapter J investigated when these requirements were added to the *Specification*. It turns out they were added in 1942 with no explanation as to why they were added. The task committee believes that these requirements were arbitrary and cannot be supported by technical rationale.

Items 3 and 4 are also no longer addressed explicitly in the 2016 AISC *Specification*. Section J3.1 of the 2016 *Specification* states:

"Bolts in the following connections shall be pretensioned:

1. As required by the RCSC *Specification*
2. Connections subjected to vibratory loads where bolt loosening is a consideration
3. End connections of built-up members composed of two shapes either interconnected by bolts, or with at least one open side interconnected by perforated cover plates or lacing with tie plates, as required in Section E6.1."

Section 4.2 of the 2014 *RCSC Specification* states:

"*Pretensioned joints* are required in the following applications:

1. *Joints* in which fastener pretension is required in the specification or code that invokes this *Specification*
2. *Joints* that are subject to significant load reversal
3. *Joints* that are subject to fatigue load with no reversal of the loading direction
4. *Joints* with ASTM A325 or F1852 bolts that are subject to tensile fatigue
5. *Joints* with ASTM A490 or F2280 bolts that are subject to tension or combined shear and tension, with or without fatigue"

The AISC and RCSC specifications more generally addresses pretension requirements for connections subjected to vibration and load reversal. A specific requirement for structures carrying cranes or connections supporting machines was viewed as an unnecessary duplication of these requirements. It was therefore was removed from the 2016 *Specification*.

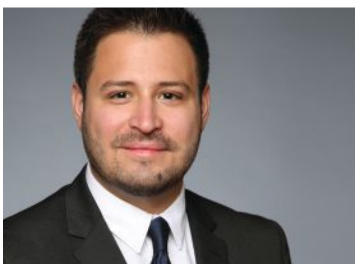
Carlo Lini, PE

Width-to-Thickness Ratios for Beam-Columns

I am uncertain how to apply the limiting width-thickness ratios in Table B4.1a and B4.1b of the AISC *Specification* when trying to determine if the web of a built-up plate girder is slender when the plate girder is subjected to varying degrees of combined compression and flexure. In almost every case, we will have some combination of compression and flexure. Still, it seems illogical that with just the addition of a very small percentage of bending, the limiting width-thickness ration of the web can jump from $1.49(E/F_y)^{0.5}$ to $5.70(E/F_y)^{0.5}$. Can you give some guidelines regarding the application of this table to combined axial and flexure?

The local buckling classification is dependent on the load (axial or flexural). The member strength, including local buckling, is calculated for each load acting independently. The member is then analyzed with the interaction equations in AISC *Specification* Chapter H. For beam-columns, the limiting width-to-thickness ratio is calculated for both axial compression and flexural compression. It is common for members to be in different classifications for axial and flexural compression. For example, a W14×90 with F_y = 50 ksi is non-slender for compression and non-compact for flexure.

Bo Dowswell, PE, PhD



Carlo Lini (**lini@aisc.org**) is AISC's director of technical assistance and **Jonathan Tavarez** (**tavarez@aisc.org**) is a staff engineer with AISC's Steel Solutions Center. **Bo Dowswell**, principal with ARC International, LLC, and **Larry Muir** are both consultants to AISC.

Prying at Stiffened Beam Flange Bolted Connections

Part 9 of the AISC *Steel Construction Manual* provides guidance on checking prying action. I am designing a bolted beam to girder connection where the beam is underhung from the girder (see Figure 1). If I add stiffeners, would I still need to consider prying action?

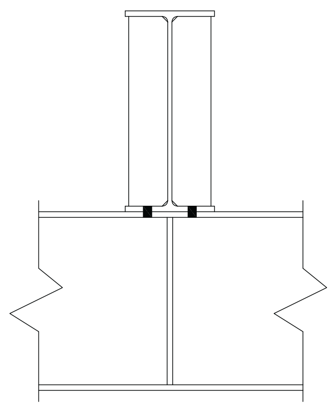


Fig. 1.

Yes, prying action could still be a design consideration even if stiffeners are provided depending on the number of stiffeners and spacing of stiffeners provided. In fact, when checking prying action, you may determine that stiffeners are not required. This will reduce the cost of the connection. The guidance provided in Part 9 of the *Manual* does not explicitly address this type of connection configuration. However, I believe the AISC *Engineering Journal* paper "A Yield Line Component Method for Bolted Flange Connections" (Second Quarter 2011) would be helpful. It provides a method for evaluating the tension strength of bolted flange plate connections, including those that use stiffeners.

Jonathan Tavarez, PE

OCBF Design Clarification for V-Braced and Inverted V-Braced Frames

The requirements for load effects on the beam due to tension in the braces appear to have changed from the 2010 and 2016 AISC *Seismic Provisions for Structural Steel Buildings* (ANSI/AISC 341). This section used to permit the engineer to consider a brace tension force equal to the expected yield strength of the brace in tension, $R_yF_yA_g$. Was this requirement removed and if so, why?

Section F1.4a.(1)(i) in the 2010 *Seismic Provisions* stated:

"The forces in braces in tension shall be assumed to be the least of the following:
(a) The expected yield strength of the brace in tension, $R_yF_yA_g$
(b) The load effect based upon the amplified seismic load
(c) The maximum force that can be developed by the system"

In the 2016 *Seismic Provisions*, this was revised to the text shown below:

1. The forces in braces in tension shall be assumed to be the least of the following:
   (i) The load effect based upon the over-strength seismic load
   (ii) The maximum force that can be developed by the system

While it appears that the provision regarding $R_yF_yA_g$ was removed, this is not the case. Section B2 of the 2016 *Seismic Provisions* states: "Where the required strength refers to the over-strength seismic load, it is permitted to use the capacity-limited seismic load instead." Per Section B2, you are still permitted to limit the load effect based on the capacity of the brace, $R_yF_yA_g$.

Larry Muir, PE

STEEL SOLUTIONS CENTER

Steel Interchange is a forum to exchange useful and practical professional ideas and information on all phases of steel building and bridge construction. Contact Steel Interchange with questions or responses via AISC's Steel Solutions Center: 866.ASK.AISC | **solutions@aisc.org**

The complete collection of Steel Interchange questions and answers is available online at **www.modernsteel.com**.

steel quiz

This month's Steel Quiz tests your knowledge of connections, cellular beams, and more.

1 **True or False:** All structural analysis software programs are capable of accurately and directly modeling the *P*-Δ and *P*-δ (second-order) effects.

2 In a seismic prequalified bolted flange plate (BFP) moment connection, what is the beam plastic hinge location, S_h, as dimensioned from the face of the column? (Write down the formula.)

3 Which of the following seismic prequalified connections for special moment frame (SMF) and intermediate moment frame (IMF) systems allows the use of hollow structural sections (HSS)?
a. ConXL
b. SidePlate Moment Connection
c. Reduced Beam Section
d. a and b

4 When the number of cycles of application of live load exceeds 20,000, the maximum permitted stress due to peak cyclic loads is _____.

5 **True or False:** Castellated and cellular beams are not economically attractive alternatives for spans greater than 30 ft.

6 **True or False:** A BIM execution plan clarifies the schedule and responsibilities of all the parties associated with the project.

All questions and answers were created by Bhavnoor Dhaliwal, a graduate student at the University of Illinois at Chicago and an AISC intern. (Thanks, Bhavnoor!)

TURN TO PAGE 14 FOR THE ANSWERS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Everyone is welcome to submit questions and answers for the 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 **solutions@aisc.org**.

1 **False.** Many, but not all, modern commercial structural analysis programs are capable of accurately and directly modeling all significant P-Δ and P-δ second-order effects. Programs that accurately estimate second-order effects typically solve the differential equations using a geometric stiffness approach or the use of stability functions. More information can be found in Section C2.1 of the Commentary to the AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360-16, **aisc.org/specifications**).

2 From Eq. 7.6-5 in AISC's *Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications* (ANSI/AISC 358-16, **aisc.org/specifications**):

$$S_h = S_1 + s\left(\frac{n}{2} - 1\right)$$

Where

S_1 = distance from face of column to nearest row of bolts, in. (mm)

n = number of bolts

s = spacing of bolt rows, in. (mm)

3 **d. a and b.** From AISC 358 Section 2.3.3, only ConXL and SidePlate connections allow the use of HSS.

4 **0.66 F_y.** (See AISC *Specification* Appendix 3 Fatigue, Section 3.1.)

5 **False.** As a result of expanding the web and introducing web openings, castellated and cellular beams have an increased depth-to-weight ratio, an increased section modulus, and increased strong-axis moment of inertia. These increase efficiency and make longer spans possible. More information can be found in AISC Design Guide 31: *Castellated and Cellular Beam Design* (**aisc.org/dg**).

6 **True.** It also specifies the delivery strategy. For more details on BIM execution plans, see AISC's *BIM & VDC for Structural Steel*, available at **aisc.org/bimvdc**.

STEEL SOLUTIONS CENTER

steelwise

HIGH BRACING STANDARDS FOR LOW-RISE BUILDINGS

BY MICHAEL A. WEST, PE

A revised AISC publication provides updated erection bracing guidance for big-box stores, warehouses, office buildings, and other sprawling low-rise structures.

Michael A. West, vice president emeritus of CSD Engineers, is a member of the AISC Committee on Manuals, AISC Code of Standard Practice Committee, and AISC Committee on Specifications Task Committee 12 on Quality Control and Assurance. He is also the chairman of the AISC Certification Standards Committee.

The second edition of AISC Design Guide 10: *Erection Bracing of Low-Rise Structural Steel Buildings*—as well as all AISC Design Guides—is available at **aisc.org/dg**.

BRACE YOURSELF: The second edition of AISC's Design Guide 10: *Erection Bracing of Low-Rise Structural Steel Buildings* is now available.

The first edition authors—me (Michael A. West) and James M. Fisher—return for this second edition. Although the scope and organization of the guide have not changed, the new edition reflects the current provisions of the referenced standards, which serve as the foundation upon which this guide was developed. In addition, the authors have attempted to clarify areas in which there have been questions from readers of the first edition, which was released in 1997.

The focus of the guide, the stability of one- and two-story structures during erection, is a framing scenario frequently found in "big box" retail structures, low-rise office buildings, light manufacturing facilities, and warehouses. The lateral stability for these low-rise facilities is often provided by building elements other than the frame itself, such as shear walls.

For example, requirements for framing stability are provided in both the AISC *Specification for Structural Steel Buildings* (AISC/ANSI 360) and the AISC *Code of Standard Practice* (AISC/ANSI 303); you can find both at **aisc.org/specifications**. *Specification* Section M4.2 states: "The frame of structural steel buildings shall be carried up true and plumb within the limits defined in the *Code of Standard Practice* Chapter 7. As erection progresses, the structure shall be secured to support dead, erection, and other loads anticipated to occur during the period of erection. Temporary bracing shall be provided, in accordance with the requirements of the *Code of Standard Practice*, wherever necessary to support the loads to which the structure may be subjected, including equipment and the operation of the same. Such bracing shall be left in place as long as required for safety."

Likewise, Section 7.10.3 of the *Code* states: "Based upon the information provided in accordance with Sections 7.10.1 and 7.10.2, the *erector* shall determine, furnish and install all temporary supports, such as temporary guys, beams, falsework, cribbing, or other elements required for the erection operation. These temporary supports shall be sufficient to secure the bare *structural steel* framing or any portion thereof against loads that are likely to be encountered during erection, including those due to wind and those that result from erection operations."

What's New?

Let's take a look at how the new edition is organized and what new information it includes. The scope of the second edition is much the same as the first edition and, like the first edition, it is organized into five chapters and an appendix:

Chapter 1 Introduction
Chapter 2 Load for Temporary Supports during Construction
Chapter 3 Resistance to Loads by the Permanent Structure during Construction
Chapter 4 Resistance to Loads Using Temporary Supports during Construction
Chapter 5 Determination of Bracing Requirements Using Prescriptive Requirements

Chapter 1 illustrates the need for Design Guide 10 and its utility to the steel construction industry. After all, the whole reason for erection bracing is to ensure that a structure stays standing while it's being built. While this may seem like a no-brainer, erection bracing isn't always properly designed and implemented—and sometimes isn't used at all—and, unfortunately, collapses do happen (see Figure 1).

Chapter 2 presents loads imposed on structures during erection based on ASCE/SEI 37-19, ASCE 7-10, and other national and international standards such as *Actions on Structures—Part 4: Wind Loads*, German Industrial Standard 1055-4:2005-03, published by the German Institute for Standards.

As was the case in the original edition, the effect of wind on the partially complete structure is significant. First, the surface areas that are exposed to the wind may be greater than in the completed building. This greater area is partially mitigated by shielding of some elements by others. The effect of shielding is addressed in both ASCE/SEI 37-19 and German Industrial Standard 1055-4. The effect of shielding was initially studied in trussed bridges in which the windward truss partially shielded the leeward truss. The wind exposure period is less than it is for the completed building, and this effect—and how it can be taken into consideration in the design—are discussed. Likewise, in hurricane-prone regions, wind load reductions are permitted when construction takes place outside of the hurricane season.

Chapters 3 and 4 present an engineered design basis to determine the available strength of elements of the structure itself (Chapter 3) and elements of the temporary bracing (Chapter 4.) The primary applicable standard for calculations presented in these chapters is the AISC *Specification*.

Much of Chapter 3 is devoted to the various limit states that are applicable to the strength of the column bases, anchor rods, and foundation. Ten conditions are considered from the welds between the column shaft and the base plate down to the overturning of the footing, as shown in Figures 2 through 11. As a frame is erected, in almost every case the individual columns stand as cantilevers until they are incorporated into the frame. As cantilevers, the columns and

Fig. 1. An erection collapse due to the footing overturning and a lack of bracing.

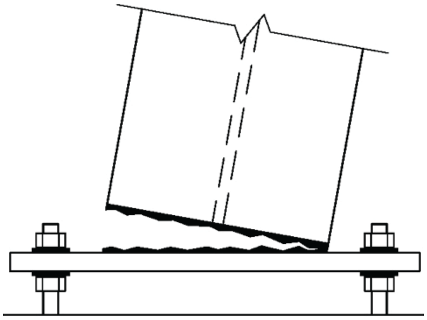


Fig. 2. Failure mode 1: fracture of weld.

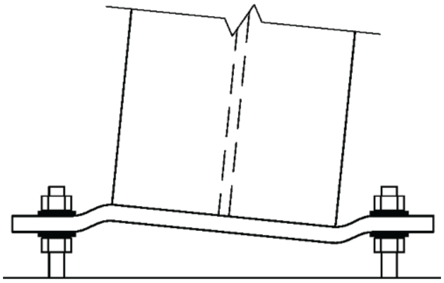


Fig. 3. Failure mode 2: bending failure of base plate.

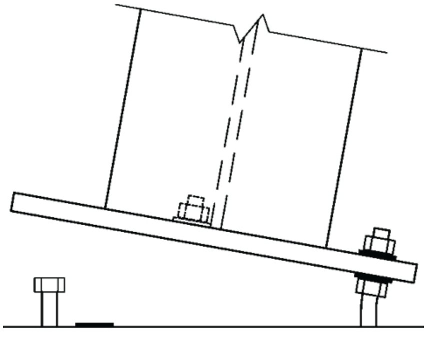


Fig. 4. Failure mode 3: tensile rupture of anchor rods.

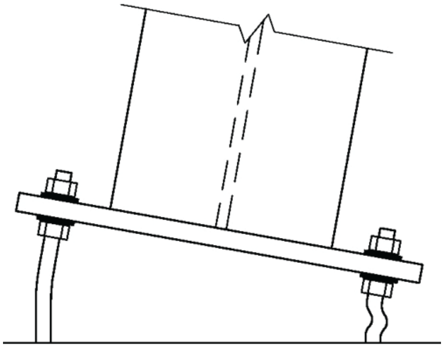


Fig. 5. Failure mode 4: anchor rod buckling.

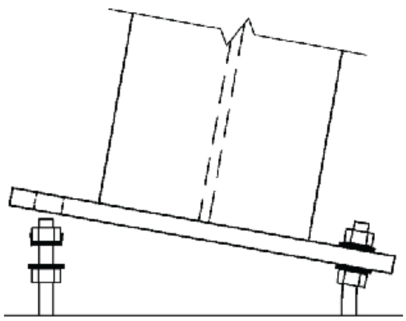


Fig. 6. Failure mode 5: anchor rod nut pullthrough.

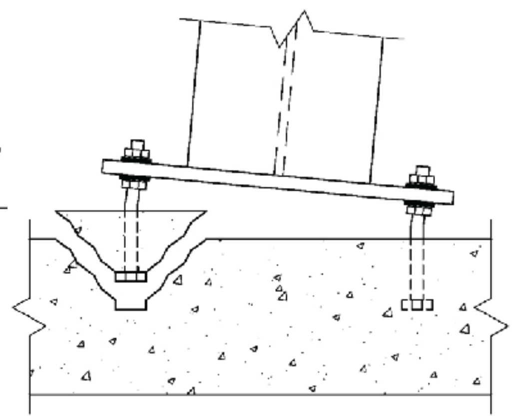


Fig. 7. Failure mode 6: anchor rod breakout.

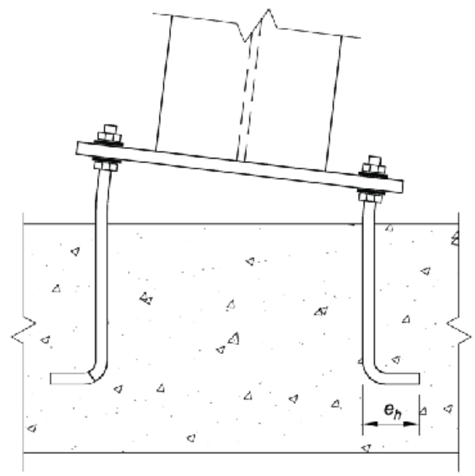


Fig. 8. Failure mode 7: anchor rod pullout.

their bases are likely subjected to conditions of loading that exceed and differ from the loads imposed on the completed structure. Multiple design examples illustrating the consideration of the various limit states are included.

Chapter 4, which covers the resistance of temporary elements, focuses on design considerations for wire rope, suggested fittings to terminate the wire rope, securing the wire rope diagonals, and consideration of the effects of the temporary elements to the permanent structure, such as anchor rods and foundations. This chapter also features multiple design examples.

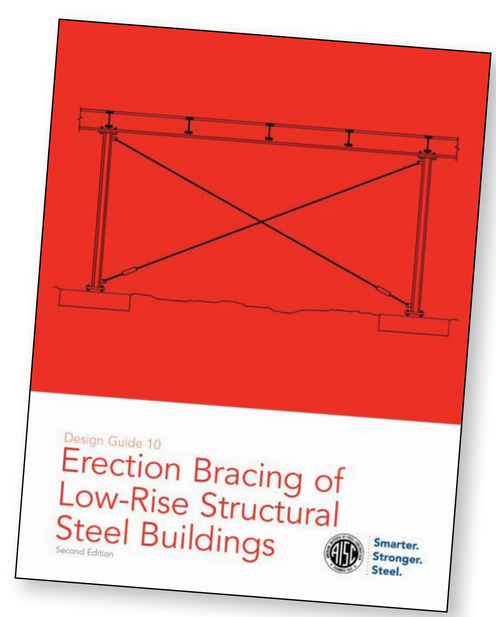
The design basis of the guide is LRFD using factored loads and the ϕ-factors appropriate to the nominal strength in question. Unlike other AISC publications, design examples in ASD format are not included because the ASD stability provisions result in P-Δ forces that are needlessly conservative. Thus, for continuity and ease of use, only LRFD is used in the guide.

Chapter 5 presents prescriptive bracing schemes for specific boundary conditions that, when satisfied, can eliminate the need for the engineering calculations described in Chapters 3, 4, and 5. These prescriptive requirements were a feature of the original design guide that were specifically requested by AISC reviewers to simplify the determination of temporary bracing if erectors

A Brief History of Design Guide 10

How did Design Guide 10 come about in the first place? When developing the first edition, the authors were motivated by an observed absence of comprehensive guidance, from an engineering perspective, for the temporary bracing of low-rise structures. The closest thing to a design guide at the time was provided in a publication called *Wind Force on Building and Other Structures*, Loss Prevention Data, published by Factory Mutual Engineering Corporation, which provided useful but limited prescriptive guidance with respect to low-rise steel frames during erection. The Design Guide 10 authors' original work on this topic was presented in a paper titled *Erection Bracing of Structural Steel Frames* that was presented at the 1993 Conference of the Structural Stability Research Council.

A significant contribution to the original guide was the publication of ASCE/SEI 37 *Design Loads on Structures during Construction* in 2002; as a member of this ASCE/SEI committee since 1997, West actively participated in the development of the standard. ASCE/SEI 37 was revised in 2014 and reaffirmed in 2019. ASCE/SEI 37 is based on the provisions of ASCE 7-10 *Minimum Design Loads for Buildings and Other Structures*. The revision of ASCE/SEI 37 in 2014 is what prompted the development of a second edition of Design Guide 10. Additionally, the second edition is based on the 2016 AISC *Specification* and the 15th Edition AISC *Steel Construction Manual*.



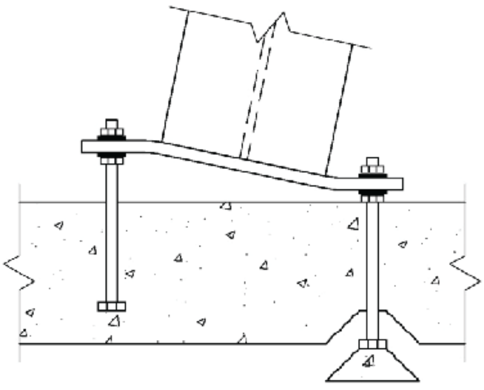


Fig. 9. Failure mode 8: anchor rod pushout.

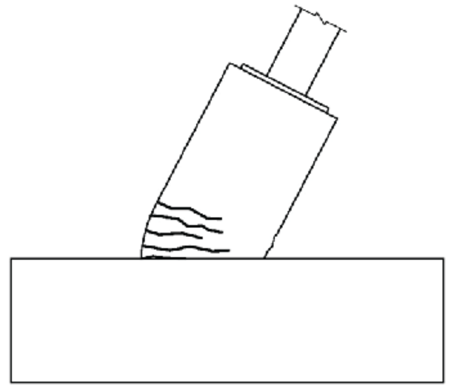


Fig. 10. Failure mode 9: pier bending failure.

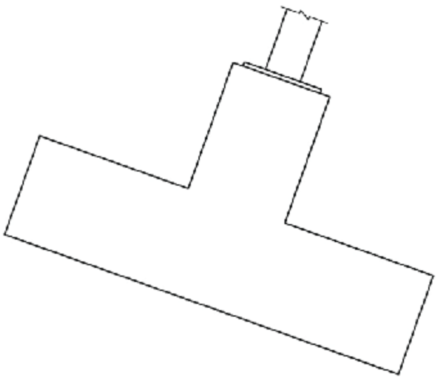


Fig. 11. Failure mode 10: footing overturning.

elected to follow these prescriptive requirements in lieu of preparing an "engineered" solution.

Finally, an extensive appendix is provided, with tabulated strengths for embedded anchor rods, base plates, and related items, and is great design aid for the practicing engineer.

As low-rise buildings continue to proliferate, the need for updated erection bracing guidance became apparent. And now that it's available in the form of this revised Design Guide, engineers have a focused tool for designing safe, efficient erection bracing for these facilities. ■

field notes

MAKING CONNECTIONS

INTERVIEW BY
GEOFF WEISENBERGER

Carol Drucker is an expert on connection design as well as what makes the Windy City wonderful.

Geoff Weisenberger (**weisenberger@aisc.org**) is senior editor of *Modern Steel Construction*.

To hear more from Carol, visit **www.modernsteel.com**, where you can listen to the interview podcast in its entirety.

WELCOME TO FIELD NOTES, *Modern Steel Construction*'s podcast series, where we interview people from all corners of the structural steel industry with interesting stories to tell.

Our subject this time is **Carol Drucker**, cofounder of Drucker Zajdel Structural Engineers in Chicago, which has been involved in countless steel connection projects throughout the country. Carol currently serves on AISC's Committee on Specifications as well as several task committees, and is being honored as one of this year's AISC Lifetime Achievement Award winners for her many contributions to the steel industry—particularly thanks to her expertise in connection design but also due to her extensive involvement with AISC. Here, Carol discusses how bridges pulled her into engineering, how she fell into connection design, and why she was drawn to Chicago.

One of the first things I like to ask anybody in structural design is: What got you interested in buildings in the first place?

Well, really it was bridges that got me into engineering in the first place. I grew up in Louisville, and I always wanted to know how the bridges that cross the Ohio River were designed, the bridges that connect Louisville to Indiana. That, along with my love of math, made it a natural fit for me to go into civil engineering. Many years later, when I was a summer intern at the Army Corps of Engineers, I asked the head of structural engineering in the Louisville division of the Corps how those bridges are designed, and he simply turned around and pulled a book off the bookcase, flipped a few pages, and said it's pretty much just this one. Fast-forward decades later and I now know it really isn't just that easy.

How did you find your way into connection design?

Connection design was really never my intent. I was a practicing EOR, a typical structural engineer designing buildings, but then I had a set of twins. So I was on maternity leave and a local detailer asked me to do connection design while I was home. I really didn't have time to do connection design with a two-year-old and newborn twins, but when things started to calm down I started doing connection design for various companies, and one thing led to the next and here we are today.

Tell me a little bit about your company. How long has DZSE been in business?

This August, it will be 17 years. I'm very excited about that! Ten years in Naperville and then almost seven years in Chicago. Before DZSE, both MaryLynn [Zajdel] and I each had our own one-man shop businesses, but we wanted to lose that one-man shop label. So we decided to combine. She did more of EOR-type work, I did more of the connection-type work for contractors, and it worked really well. Business really did boom overnight.

So what was the tipping point for moving the company from Naperville to Chicago?

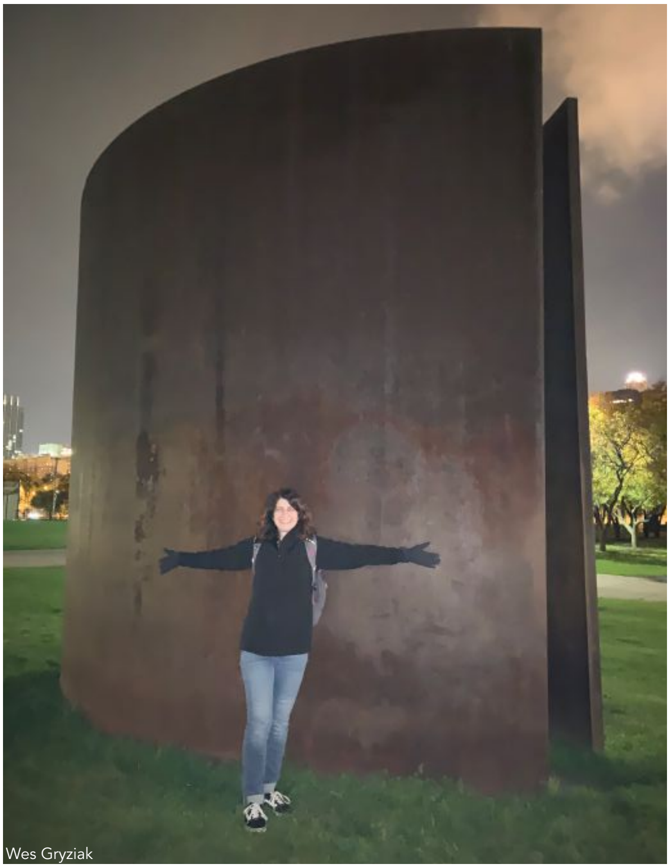
Well, I think we knew all along that we would probably have to move the company from Naperville to Chicago, but we both lived in the Naperville area and we wanted to be close to home; we had kids in school here. But we needed to grow the company and attract more staff, and we had internal pressure to move the office to Chicago. So I finally agreed that we'd move when the kids graduated high school, and that's exactly what happened. We still have some stragglers in Naperville who didn't really want to make the move with us, and that's fine; they work remotely. And last year, we opened up a Milwaukee office, very close to the Milwaukee School of Engineering.

How you ended up in Chicagoland in the first place?

From Kentucky, I went to Purdue then off to California [Berkeley], but it's really no surprise that I ended up in Chicago because both my parents were from here and I knew all along, even as a kid, that I wanted to live here. When I walk from Union Station to my office every day, which is right by Willis Tower, I honestly smile just looking at the amazing engineering along the way.

What do you enjoy most about the city?

Besides buildings, what I really enjoy about Chicago is the diverse culture. There's no shortage of things to do. I love the opera, the symphony, the Art Institute, Lake Michigan, the Riverwalk, but probably my absolute favorite thing to do is to go on the architectural boat tour. We had our office summer outing every year on the tour until one summer, when they kept telling us that we were being too rowdy. So the next summer we rented our own boat and made our architectural boat tour!



Wes Gryziak

Drucker in front of Richard Serra's *Reading Cones* in Chicago.

Do you have any personal "best kept secrets" for the city?

I like the Richard Serra sculpture, right in the middle of Grant Park, not too far from AISC's office. It really is a spectacular sculpture, and the reason it's so cool is because it's made out of weathering steel plate. It's, I don't know, maybe 15 ft tall and it's called *Reading Cones*. It really is a wonderful piece of work.

Can you talk about one of your most memorable projects or one that you're particularly proud of? I mean, I'm sure you're proud of them all, but is there one that stands above all others?

In general, I really like the projects where there's good collaboration between the different team members, with the end goal of producing a fabulous product. But it's really hard to choose one particular project. They all have a kind of special place in my heart. It's almost like picking your favorite child. You really just don't want to do that. Having said that, if I had to choose one, it would be the Blue Cross Blue Shield building vertical expansion in Chicago—also close to AISC—where we put 30-something additional floors on top of the original building. That was a fabulous project. We were able to do a lot of innovative things with a vertical bracing, and there was no shortage of problems for the team to solve together.

So obviously we're in the midst of an unprecedented situation with COVID-19. How have you and your staff been adapting to working in this environment?

We did see the global crisis coming. It truly is a horrible thing right now that we're going through, but we saw it happening in Europe and we saw what was happening in Seattle. We were in a little bit of denial but nonetheless we made sure everybody could work remotely and tested the VPN. We start every day with a quick 15-minute meeting to go over what each person did the day before and then review what they are doing that day, and if there are any barriers or things preventing them from getting anything done or if they need to talk to anybody or anything like that. And at first I thought it might have been overkill, but it turns out everybody likes it. It keeps us together and keeps us communicating. The trick is that you don't want to get hung up on project specifics because the next thing you know, 30 minutes goes by and you really want to keep these types of calls as short as possible. At this point, I think we've adapted pretty well. We were busy before this happened and luckily, no jobs have been canceled. But like any engineer, I'm very concerned about what's to come and I'm very much looking forward to the economy returning and getting back to work in the Loop! ■

Be sure to check out Carol's session "Solving the Puzzle of Delegated Connection Design," which was presented as part of NASCC: The Virtual Steel Conference: ***aisc.org/2020nascconline****. You can also read about it in the April 2020 article "Solving the Puzzle."*

business issues

GOOD DATA, BAD DATA

BY ALEX PATTON

Stats and graphs aren't always honest or accurate. Here are some tips on how to avoid falling prey to bad information—and also how to avoid spreading it.

Alex Patton, owner of Meer Research, seeks to understand clients' operating environments by offering confidential, accurate research and structured analysis. Alex has conducted quantitative and qualitative research across the U.S. for corporate, nonprofit, and political clients and has appeared in national publications such as *Time*, *The Wall Street Journal*, and *Politico*. For more information, visit **www.meerresearch.com**.

YOU MAY HAVE EXPERIENCED something like this before: A coworker walks into a meeting and, trying to impress, announces something along the lines of: "If the U.S. would only reduce oil imports from Norway, we could literally reduce the number of deaths of drivers colliding with railway trains by [insert number] per capita. I got the data from the Department of [insert department] website and the monthly [insert scholarly journal] journal of research."

This employee was likely met with blank stares, blinking eyes, and banishment to reread statistics 101. Why? Because they fell prey to "lies, damn lies, and statistics" (a phrase popularized by none other than Mark Twain). And while this story is an exaggeration, being misled—intentionally or incompetently—based on speculative, manipulative, incomplete, or just plain inaccurate statistics and graphs is all too common in work and other aspects of life.

Does this mean that we shouldn't trust statistics? Absolutely not. Evidence in the form of good data is invaluable in conquering bias, prejudice, misunderstanding, and preconceived notions, and can sometimes (accurately) turn "conventional wisdom" on its head. In addition, simply casting aside statistics that you don't agree with or that don't validate what you already believe is irresponsible. But there are plenty of statistics out there that aren't properly vetted and don't hold up, and it's a matter of keeping an eye out for them. Some of the biggest offenders are as follows. Not only should you be wary of them when it comes to citing them, but also when you look to compile your own statistics.

Bad polling and surveys. Academics spend an inordinate amount of time and resources testing questions, question order, and question effects in surveys. For example, one of the largest political science studies, housed at a major Midwestern university, constantly welcomes and publishes pilot studies to explore "new methods and new substantive instrumentation" against its own survey questions, and it has been conducting political surveys continuously since 1948. However, survey questions can go astray for multiple reasons: leading with biased questions, poorly worded questions, forced-choice questions, and questions that force participants to look "good" or "bad" with no in-between and no context, to name a few. Survey questions should strive for neutrality and always offer an "I don't know" option. Great care should be taken when approaching any controversial topics to avoid respondents being pushed toward the socially desirable answer.

Not communicating polling uncertainty. All research, especially survey research, contains uncertainty, and this uncertainty is almost never communicated correctly. A poll should be released with a margin of error and a confidence level—e.g., "This poll has a margin of error of +/- 5% with a 95% level of confidence." This means if this exact poll is repeated 100 times, the overall results would be expected to match 95 times, meaning that on average, the results will be an outlier the other five times. So if a survey has a margin of error of +/- 5% and the question result indicates that 42% of the people, say, like a specific product, you would accept results of 37% to 47% as valid. Adding in the confidence level, we would accept a result of 37% to 47% at a rate of 95% of the time. This uncertainty is the inherent danger of relying on a single poll result.

Bad actors. There are parties, sometimes easy to spot and sometimes not so easy, who will intentionally commission a survey with a predetermined result in mind. In addition, there are bad actors that hack away at data without a hypothesis.

Not telling the entire story. There are countless examples like the following, especially in advertising. "More than 80% of veterinarians recommend [insert brand] dog food." What they aren't reporting is that the survey allowed veterinarians to pick multiple brands. While this may be acceptable (if not honest) in advertising, it is not acceptable to manipulate or wordsmith when conducting credible research.

Faulty correlations. Repeat this to yourself, over and over: "Correlation is not causation, correlation is not causation, correlation is not causation…." In other words, a mutual relationship or connection between two things does not necessarily mean that one thing causes the other. It is all too easy to make this mistake. Human brains are hardwired to take shortcuts, react to group information cues, and seek out patterns. This "skill" allowed us to understand that a rustling in the jungle brush could be a hungry tiger, and we needed to run. The tendency to use heuristics and jump to conclusions is what caused our employee at the beginning of the article to blame Norwegian oil imports for train collisions. Human behavior is messy, and proving what comes first and causes the other is extremely difficult.

Improper presentation of results. One of the most common ways to manipulate an audience, intentionally or not, is manipulation of the *visual* presentation of results. A vast majority of people are visual learners, and one easy manipulation of a report or a board room is the manipulation of axis or scales. The most common *x*-axis manipulation is the changing of time periods. Need to downplay a downward trend in this quarter's sales? Simply display 40 quarters of sales information. The most common *y*-axis manipulation is the changing of scales. As seen in Figure 1, the two graphs show the exact same data but with different scales tell two different tales. Are sales increasing or flat? It depends on which tale you believe.

When it comes to your own company, it's important to push yourself and others to conduct research and surveys with good intentions, an open mind, and as comprehensively and honestly as possible. How open is your senior executive team to hearing something like the following? "I know we spent significant time, energy, and money on this research, but we found the results to be inconclusive. The results indicate additional research needs to be done." The answer might be one of the most telling statistics of all.

Repeat this to yourself, over and over: "Correlation is not causation."

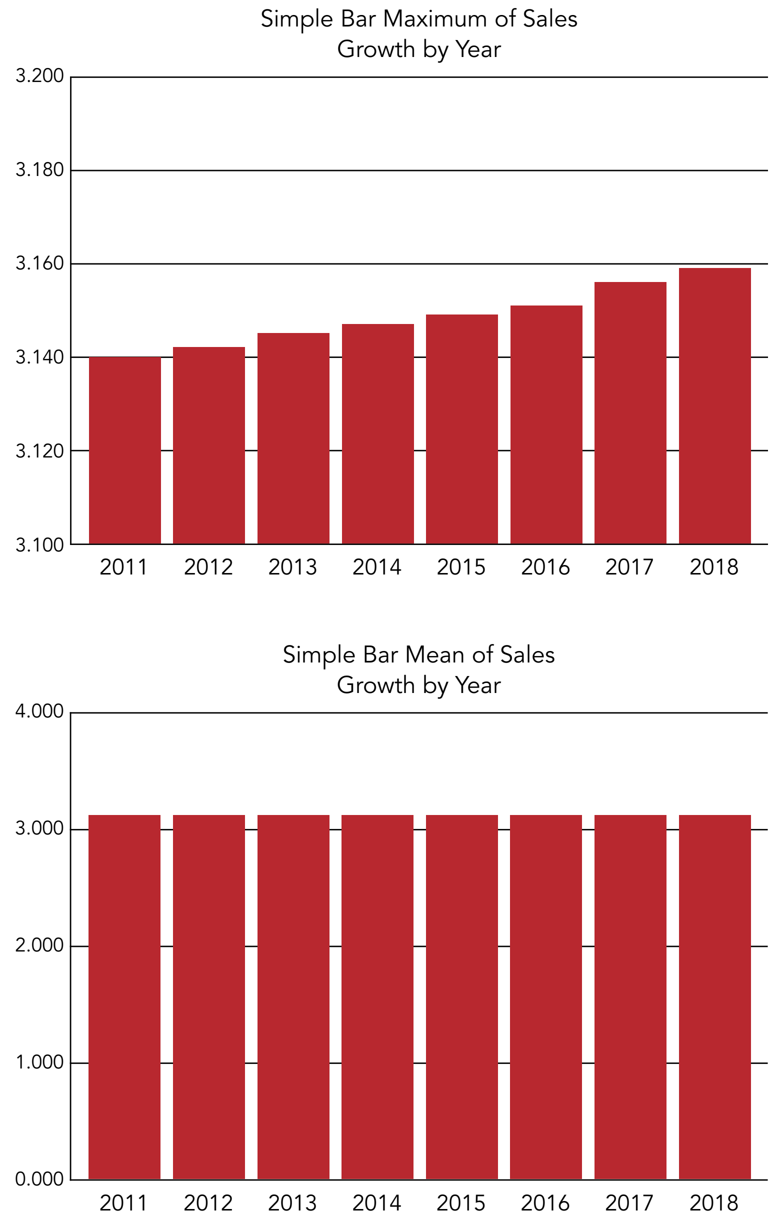
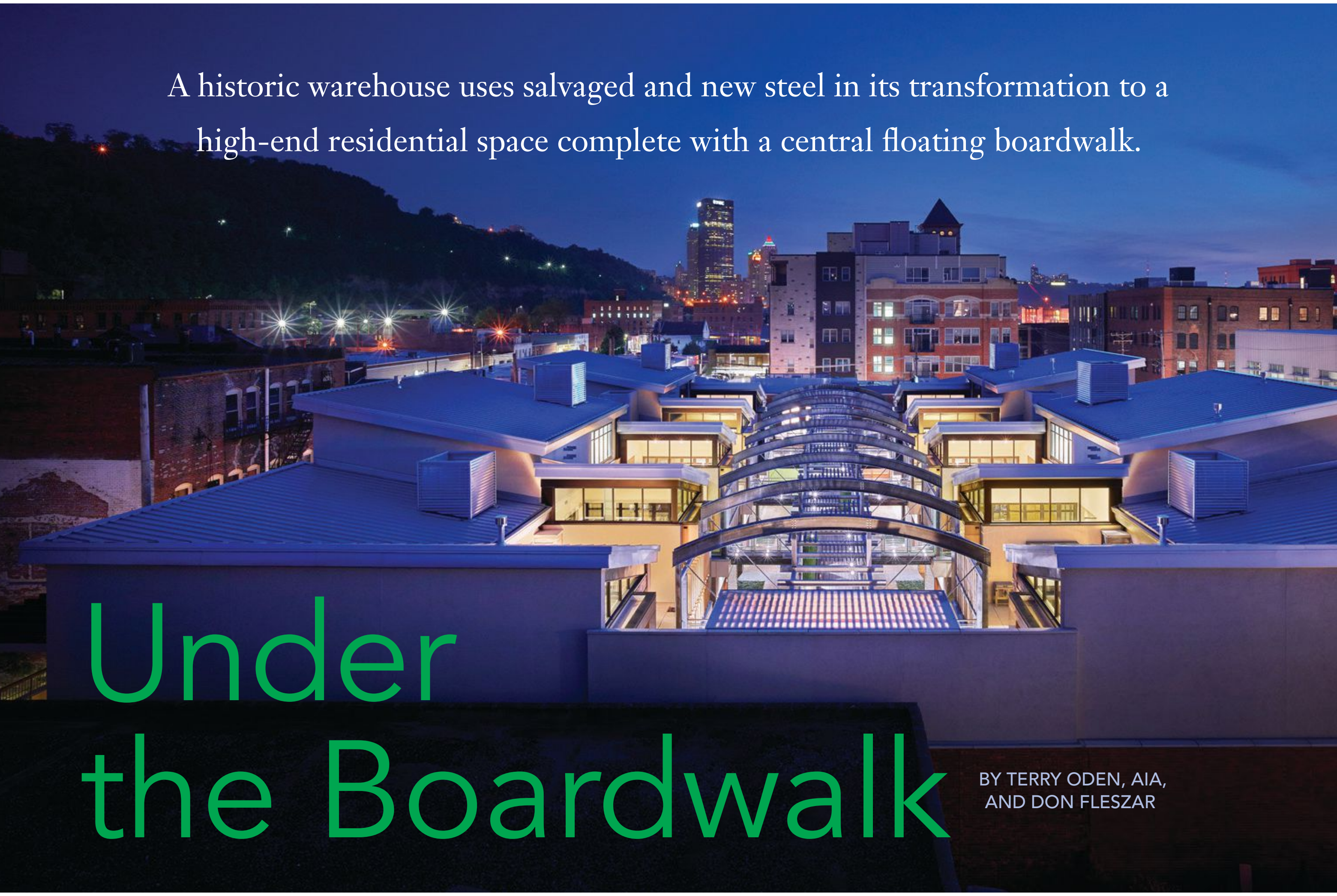


Fig. 1. Same data, different narratives.

The prevalence of online tools has made surveying and the presentation of results incredibly easy to the point that anyone can sign up and conduct "research." While most research is conducted ethically, part of the scientific and research process is healthy skepticism. A good manager will make any marketing or data team explicitly state their underlying assumptions about their research. But a great manager understands there are few "conclusive results" and is continuously asking their team, "Where may your research may be incorrect or incomplete?"



A historic warehouse uses salvaged and new steel in its transformation to a high-end residential space complete with a central floating boardwalk.

Under the Boardwalk

BY TERRY ODEN, AIA, AND DON FLESZAR

Terry Oden (**toden@desmone.com**) is an associate with Desmone Architects in Pittsburgh and **Don Fleszar** (**dfleszar@maccabeeind.net**) is with Maccabee Industrial, Inc., in Belle Vernon, Pa.

THE BUILDING KNOWN AS 2500 Smallman resulted from a big transformation.

The project vision was to redevelop a former 1950s warehouse facility into an 11-unit residential property, with each spacious residence loaded with amenities and collectively forming a communal courtyard. Private patios and terraces allow a connection to the outdoors, encouraging a sense of community while also maintaining personal space.

The building is nestled in the heart of Pittsburgh's Strip District, a vibrant mix of small and large businesses, sidewalk vendors, and restaurants. The neighborhood is creative and eclectic with a distinctive nature, ample history, and a wealth of opportunities—a place where industrial and wholesale businesses merge with entrepreneurial, retail, and high-tech companies.

In the planning stages, the zoning code permitted for greater density and a taller building, but the developer insisted on a high-quality urban project that captured the spatial benefits of the suburbs while also realizing the amenities of urban living, thus the project was right-sized to its two-story scale, with bays set at 21 ft, 4 in. The project uses 420 tons of structural steel—typically W10×15, W18×40, HSS8×4×3⁄8, and HSS12×6×3⁄8—and some existing steel members were repurposed in other areas.

Early in the process, the structural engineering team adopted a 3D modeling approach, creating a structural model that was instrumental in helping the architectural team deliver the best possible result and set the direction for future projects. Steelwork evaluation and project development were documented through drone video footage, which in turn was used by the property's realtor to market the building. The design team discussed the project concept and flight pattern with the drone specialist, starting with the central boardwalk "spine." The drone footage helped the team quickly evaluate the construction progress without having to be on-site, as well as see gaps in the construction and visualize where next activities were needed.


Ed Massery

left and below: The building is nestled in the heart of Pittsburgh's Strip District, a vibrant mix of small and large businesses, sidewalk vendors, and restaurants. In the planning stages, the zoning code permitted for greater density and a taller building, but the developer insisted on a high-quality urban project that captured the spatial benefits of the suburbs as well as the amenities of urban living.


Ed Massery

The suspended boardwalk, which serves as a required means of egress, was necessary for creating a column-free motor court, and the east staircase, constructed of heavy steel, became an efficient terminus to the boardwalk. The boardwalk carries a transparent railing system and supports an overhead trellis system providing shading and visual privacy. Curved steel elements create a series of MC18×58 arches over the walkways, and the boardwalk's overall steel framing, which was assembled with stainless-steel bolts—the project used more than 13,000—became the focal point of the community court and a showpiece for the development as a whole.

Existing steel beams were evaluated for possible salvage and reuse, and some members from the motor court area—approximately 16 tons worth—were salvaged and used to support a portion of the second floor, essentially changing a roof load to a floor load. To create the central, open courtyard, the existing motor court was removed and beams supporting the

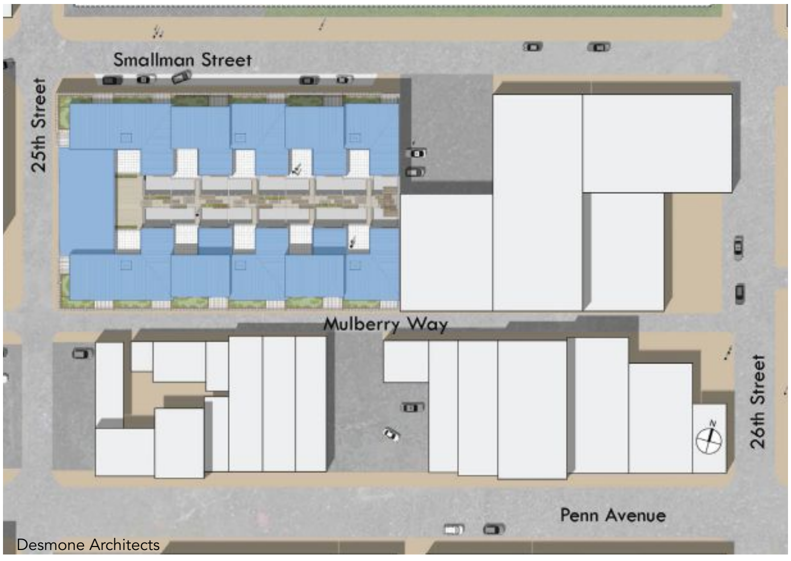
Steelwork evaluation and project development were documented through drone video footage, which in turn was used by the property's realtor to market the building.

Studious One Digital Film Arts

First Floor Plan

Second Floor Plan

Desmone Architects



Desmone Architects

above and left: The 11 two-story units line either side of a central courtyard. Private patios and terraces allow a connection to the outdoors, encouraging a sense of community while also maintaining personal space.

roof deck load were taken out and set aside. When new steel framing was erected for the boardwalk and two-story residential units, the beams were reintroduced to become floor supports for the second stories of the residential units—essentially cutting the deck span in half by piggybacking the reused beams in a new place.

The lobby celebrates steel with its off-center open steel-framed staircase and steel trim accent as a precursor to the central boardwalk. This steel aesthetic continued with steel interior finish elements like fireplaces, railings, and staircases within each residential unit. On top of the units, HSS4×4×3⁄8 framing hides the

The project uses 420 tons of structural steel—typically W10×15, W18×40, HSS8×4×3⁄8, and HSS12×6×3⁄8—and some existing steel members were repurposed in other areas.

Studious One Digital Film Arts

residential mechanical equipment on an elevated platform that allows for proper airflow.

One challenge with erecting the steel was that the motor court drive and ramp concrete, which run under the original second-story portion of the building, couldn't be added until the steel was erected in order to ensure that the crane had enough clearance to get into the middle of the development. The entire work area was limited to the motor court—the crane was also located there—and the team had to erect its way out the building. The original building included a ground-floor slab that was 4 ft above exterior street grade, so the area under the second story was excavated and paved to provide a driveway with at least 13 ft of clearance. The existing warehouse was a single-story building with a second-story mezzanine on the 25th Street end of the building. This second story remained, so the only access was through the future entrance garage door under the mezzanine into what would become the courtyard with the boardwalk above. When the last piece of steel was hung, the erection team drove right out the main garage door.

All of the exterior exposed steel for the boardwalk, a feature louver system, and east stair tower went through a two-minute acid-etch process, creating an

Ed Massery

right: Exposed steel is apparent throughtout the development, especially on the upper-level boardwalk.

below: The entire work area was limited to the original motor court, shown here in its transformed state.

Ed Massery

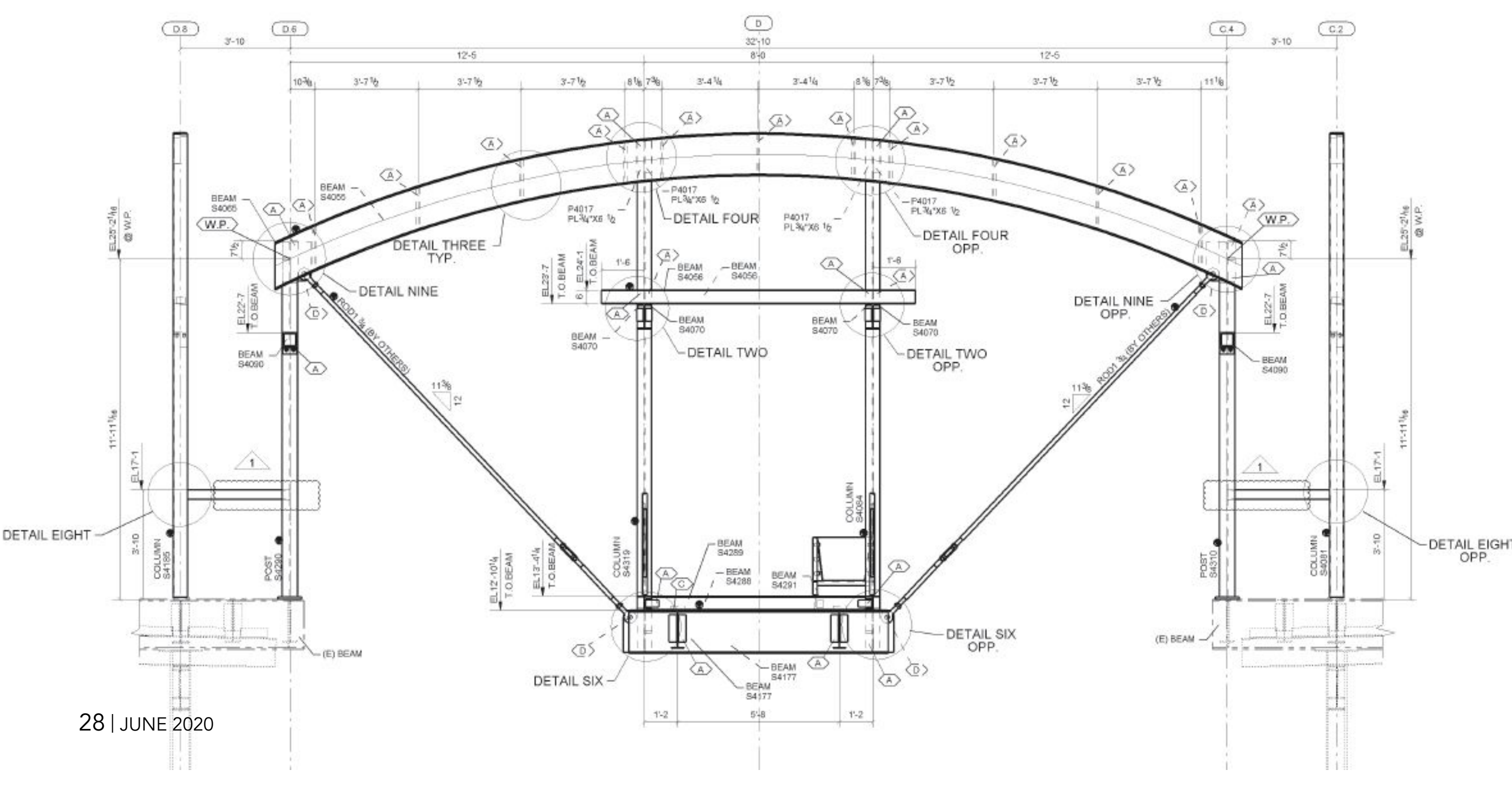
Terence Oden

above and below: When new steel framing was erected for the courtyard boardwalk and two-story residential units, the beams were reintroduced to become floor supports for the second stories of the residential units.

Terence Oden

Ed Massery

above and below: Curved steel provides a crown of sorts to the second-story boardwalk that connects the units above the central coutyard. All of the exterior exposed steel for the boardwalk, louver system, and east stair tower went through a two-minute acid-etch process, creating an aged galvanized appearance.

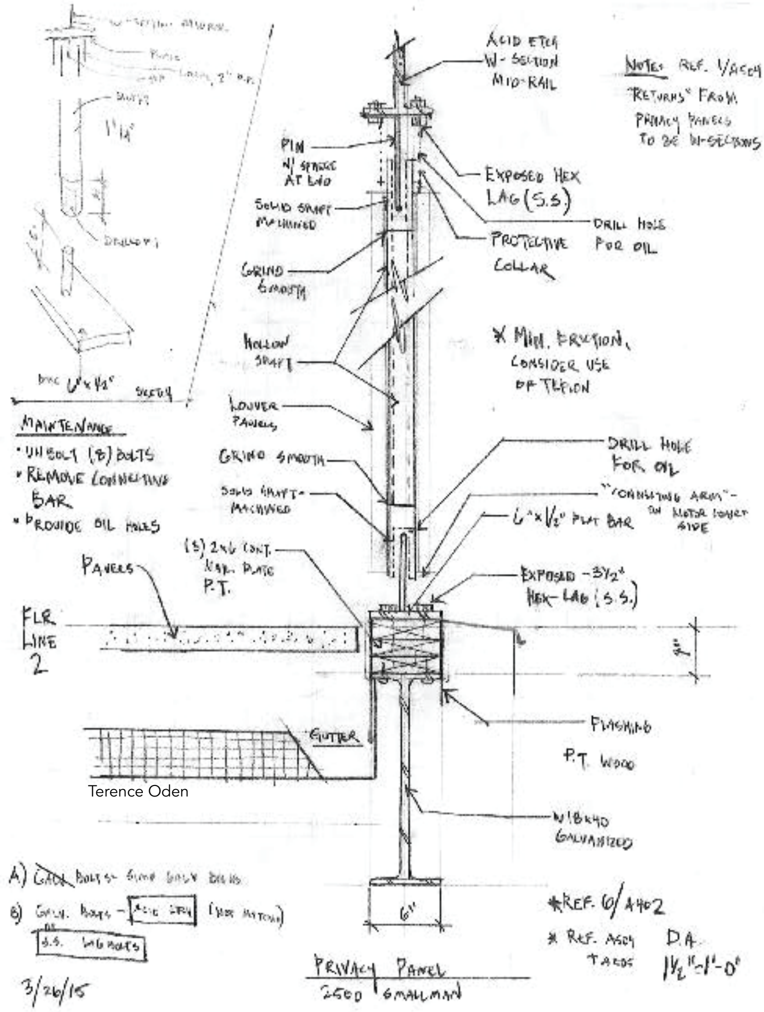


Terence Oden

above: The project features a series of louver panels, each fabricated from L1¼×1¼×⅛ members and mounted in a structural steel frame. The panels were connected by ¾-in. round bar and function horizontally.

below: 2500 Smallman's location at the edge of downtown Pittsburgh gives residents easy access to the city's amenities.

Terence Oden



Terence Oden

aged galvanized appearance that recalls the city's industrial history. HSS6×6×½ was used to frame the private courtyards, and HSS12×6×⅜ members facilitated large triangular clerestories on top of six of the units, allowing light to flood into the living spaces without sacrificing privacy between immediate neighbors.

Now open, 2500 Smallman demonstrates and reinforces the possibilities of steel construction and reuse for its practical and aesthetic solutions. The building, especially the central courtyard, serves as a gallery of sorts for exposed steel assemblies that stand out and blend in at the same time. ■

For some brief drone footage of the 2500 Smallman construction site, see the Project Extras section at ***www.modernsteel.com****.*

Owner
Pitt Ohio, Pittsburgh

General Contractor
Guardian Construction Management, East Pittsburgh, Pa.

Architect
Desmone Architects, Pittsburgh

Structural Engineer
Whitney Bailey Cox and Magnani, Pittsburgh

Steel Team

Fabricator and Erector
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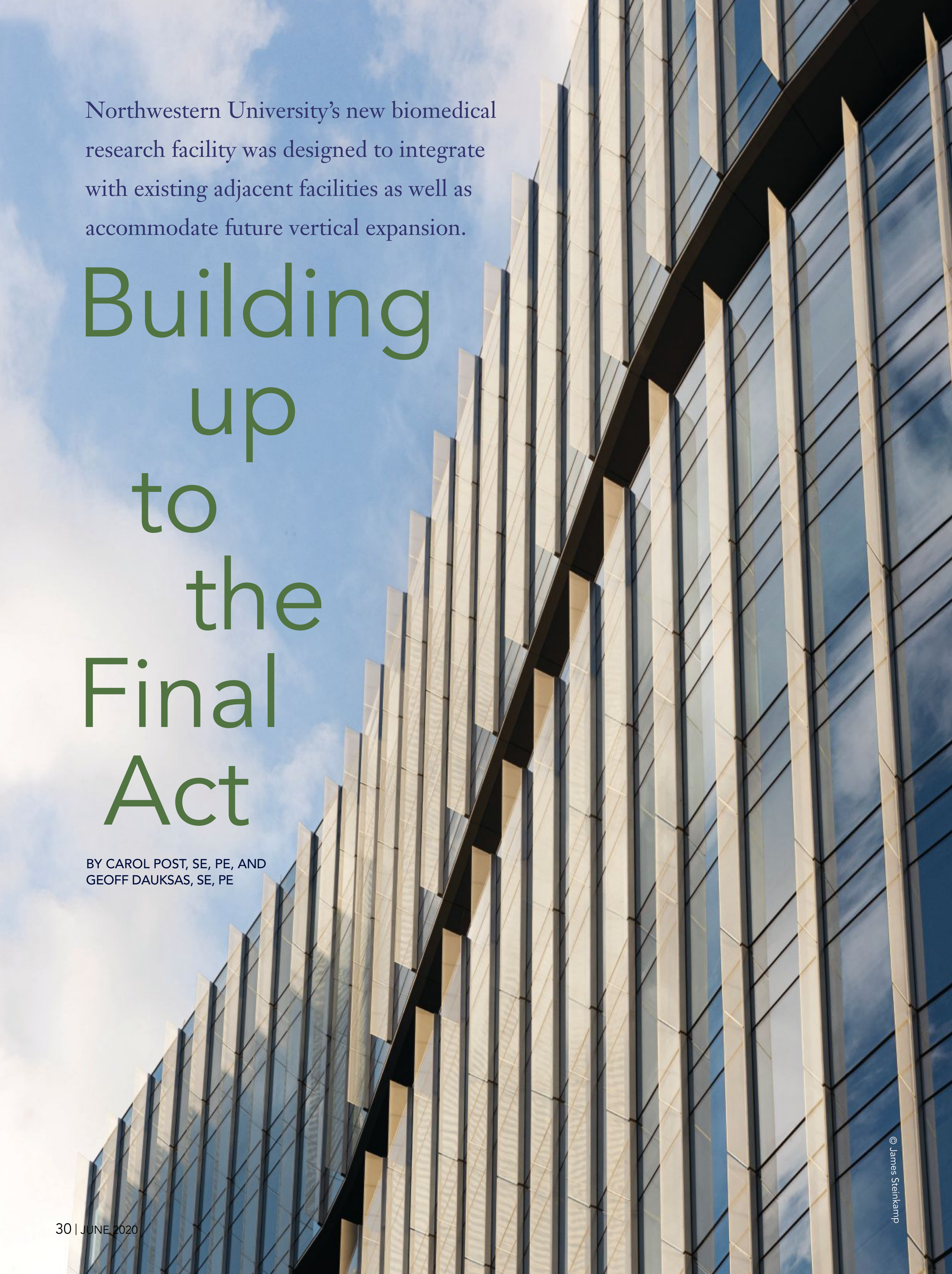
Detailer
Anatomic Iron, North Vancouver, British Columbia, Canada AISC DETAILER

Bender-Roller
Greiner Industries, Mount Joy, Pa. AISC ASSOCIATE



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Northwestern University's new biomedical research facility was designed to integrate with existing adjacent facilities as well as accommodate future vertical expansion.

Building up to the Final Act

BY CAROL POST, SE, PE, AND GEOFF DAUKSAS, SE, PE

opposite page and below: From the beginning, the Louis A. Simpson and Kimberly K. Querrey Biomedical Research Center (SQBRC) was designed with expansion in mind. Phase 2 (which currently has no set time frame) will eventually take the 320-ft-tall tower to 600 ft.


© James Steinkamp

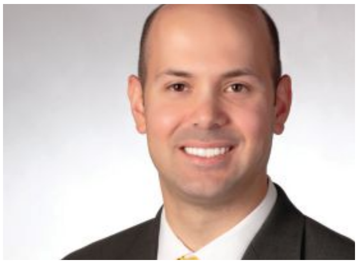
NORTHWESTERN UNIVERSITY is boosting its research profile higher than ever.

Its new 14-story, 320-ft-tall Louis A. Simpson and Kimberly K. Querrey Biomedical Research Center (SQBRC) was designed to serve as a hub for the university's downtown Chicago medical-academic district and is sculpted to fit seamlessly within the existing research campus.

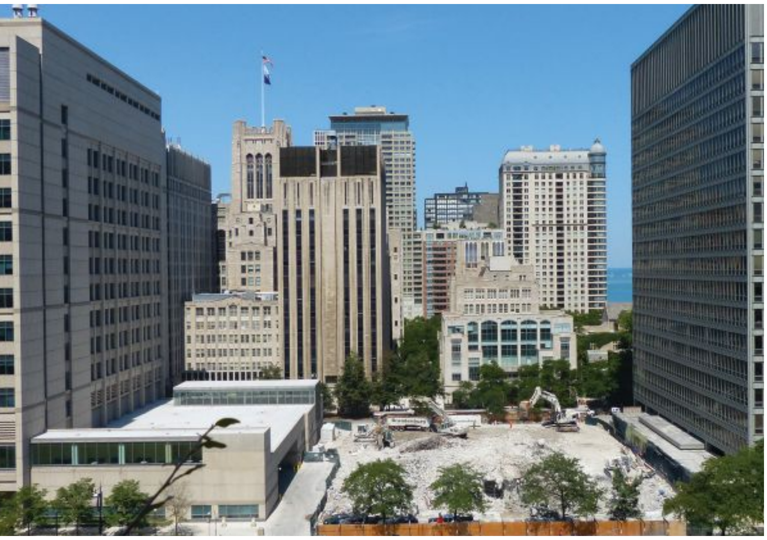
From the beginning, it was planned with future expansion in mind. The 14-story building, consisting of 624,000 sq. ft of space, is phase one, which opened last year. Phase two will eventually take the building 280 ft higher to 600 ft tall, adding 600,000 sq. ft and making it one of the tallest laboratory buildings in the world. And it was obvious that only steel could accomplish this future flexibility.

The new building is located on a site previously occupied by a large hospital and partially above the adjacent Ann and Robert H. Lurie Biomedical Research Building (Lurie), an existing lab building. The original design of Lurie included a planned vertical expansion above the level 2 podium, and SQBRC takes advantage of the structural capacity that was built into Lurie. However, the portion of SQBRC built above Lurie, comprising 100,000 sq. ft, is significantly different from the planned design. The new research center has a different architectural module, column grid, and a curved northern profile to avoid blocking light into the existing Lurie labs. As a result of these modifications, the new column locations did not align with the existing columns or deep foundations. These offsets drove the need for column transfers to allow for the new lab above with the existing column locations.

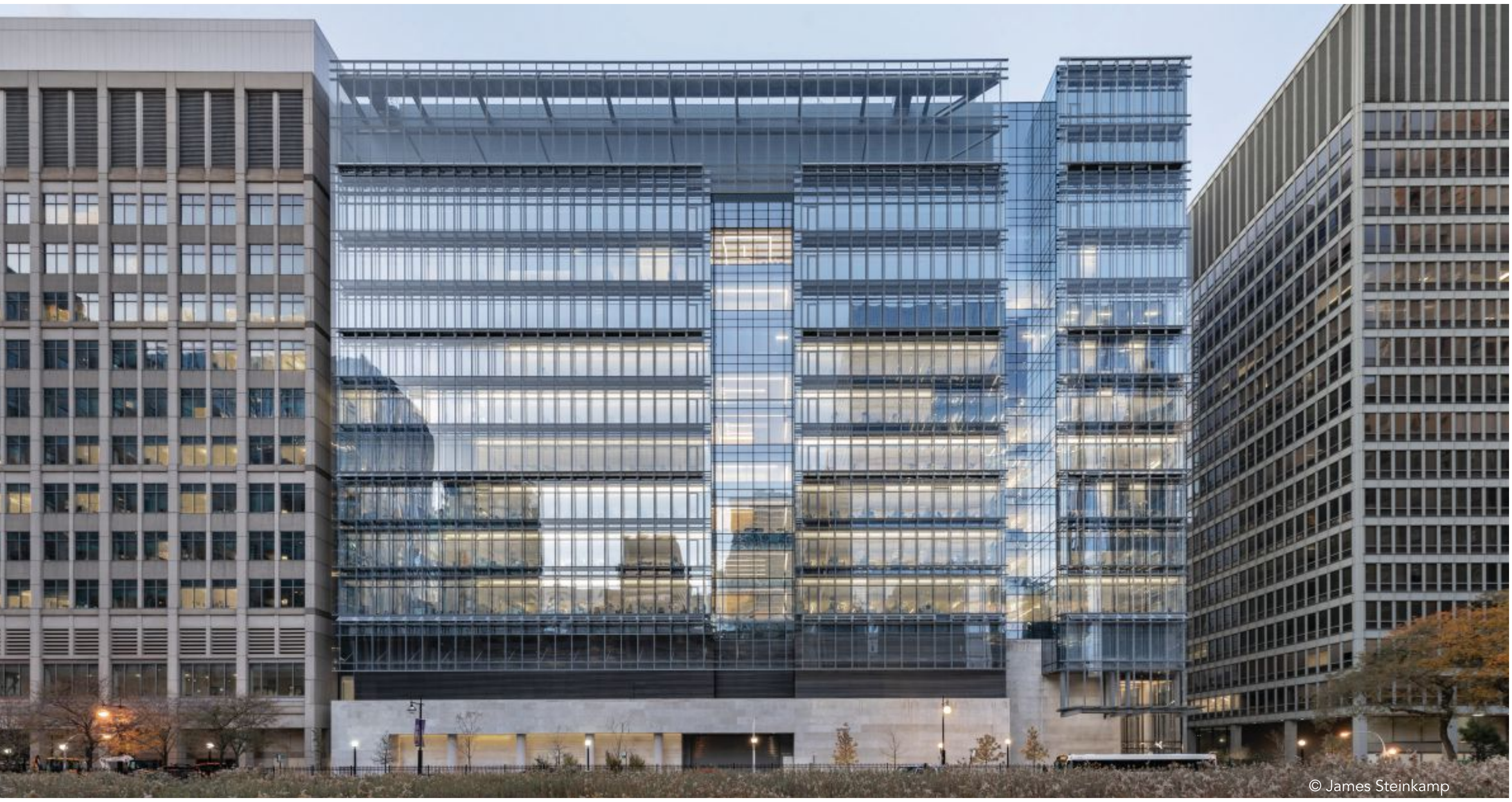
Structural engineer Thornton Tomasetti designed a series of steel plate girders and transfer trusses, weighing approximately 365 tons, to accommodate the desired laboratory layouts. Several of the transfers occur at the newly constructed third level. However, due to the existing column and braced frame layout, not all of the transfers could take place above the existing building, so areas of the second level had to be



Carol Post (cpost@thorntontomasetti.com) is chief quality assurance officer and **Geoff Dauksas** (gdauksas@thorntontomasetti.com) is a senior associate, both with Thornton Tomasetti in Chicago.



Construction progress from start of construction to near completion of the steel framing to the completed and open tower. The new building is located on a site previously occupied by a large hospital and partially above the adjacent Ann and Robert H. Lurie Biomedical Research Building, an existing lab facility.



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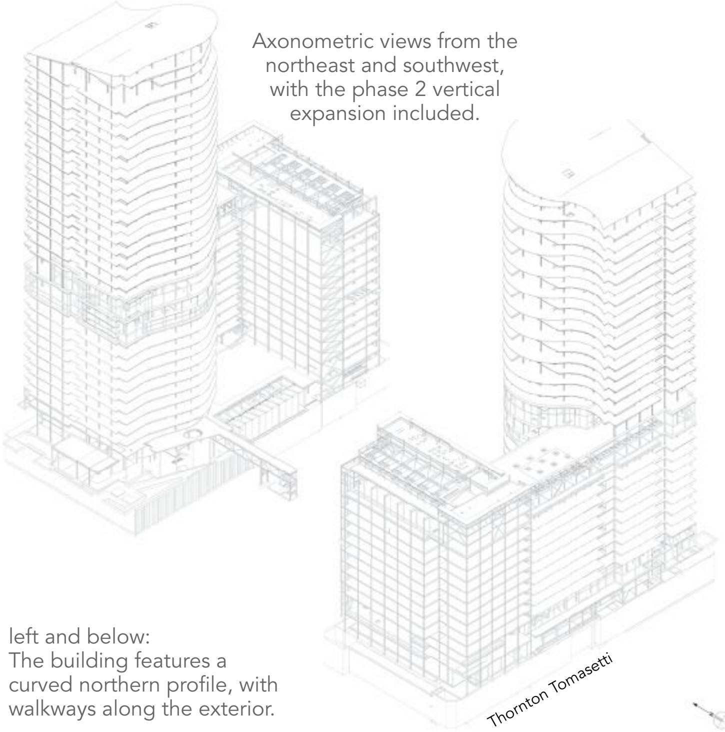
removed to allow for the new transfers at level 2. Extensive coordination between Thornton Tomasetti, general contractor Power Construction, steel fabricator Zalk Josephs Fabricators, and erector Chicago Steel was necessary to accommodate the existing conditions at the roof of the existing building. Surveys of the existing Lurie columns were performed to accurately locate them so that the transfer girders and columns splices could account for any as-built variations from the previous construction documents.

Approximately 500,000 sq. ft of SQBRC phase 1 is located adjacent to Lurie on a site that was previously occupied by a large hospital. The hospital was demolished above grade, but the basement and deep foundations remained. As a result of this existing condition, new deep foundation elements had to be strategically located to avoid the existing belled caissons. This forced new caisson locations that did not align with the column grid, making it necessary to use deep grade beams to transfer the vertical load to new caissons. The new building has a two-story, 38-ft-deep basement with levels that are purposely aligned with the existing floor levels of the Lurie building, so that eight doorways could be cut through the existing foundation wall to combine the two basements into one unified space.

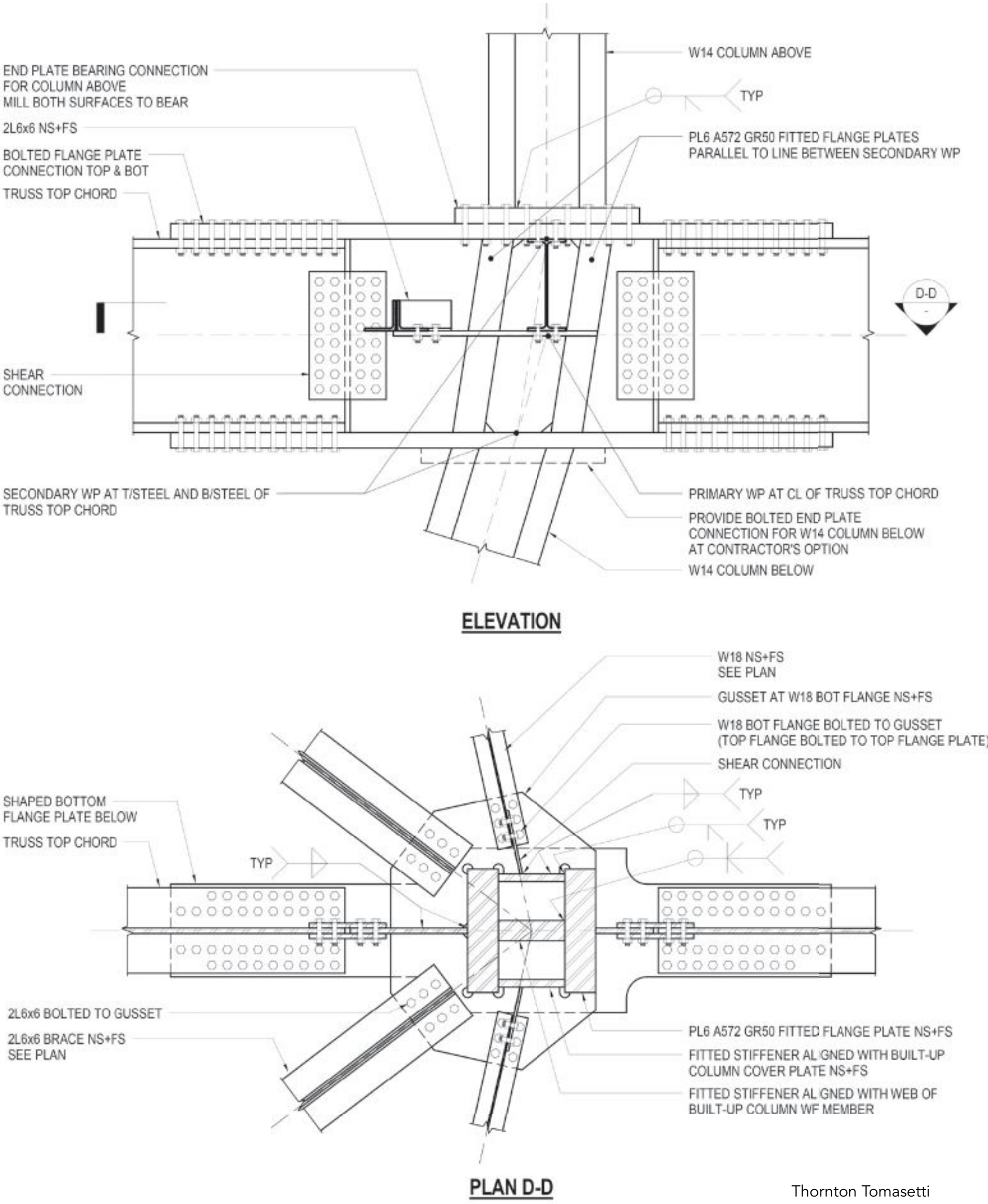


Axonometric views from the northeast and southwest, with the phase 2 vertical expansion included.

left and below:
The building features a curved northern profile, with walkways along the exterior.

© James Steinkamp

The tower consists of 14 stories of steel framing. Steel columns range from cover-plated W14×873 at the base to W14×68 for columns that do not extend into phase 2. Cantilevers are typically W30 or W36 for the larger conditions, internal girders are typically W24 or W27, and beams range in size depending on the vibration criteria. Like the basement levels, these new levels also align with the levels of the existing Lurie building to allow for a connection at each floor. Two concrete cores provide the lateral stiffness for the new tower, and high-strength, 65-ksi steel columns were implemented to minimize the column dimensions and reduce the need for cover plating. Between the ground level and the first labs at level 3, three one-story deep steel trusses (made up of shapes ranging from W14×159 to W14×426) were needed to transfer the columns from their locations at the lab levels to locations required by the lobby and loading dock functions. In anticipation of the second phase, multiple "future-use" details were designed—particularly at the top of the columns and shear walls just above the first phase roof—for future crane foundations and anticipated crane tie-in locations to minimize interruptions of the occupants when the second phase is constructed.

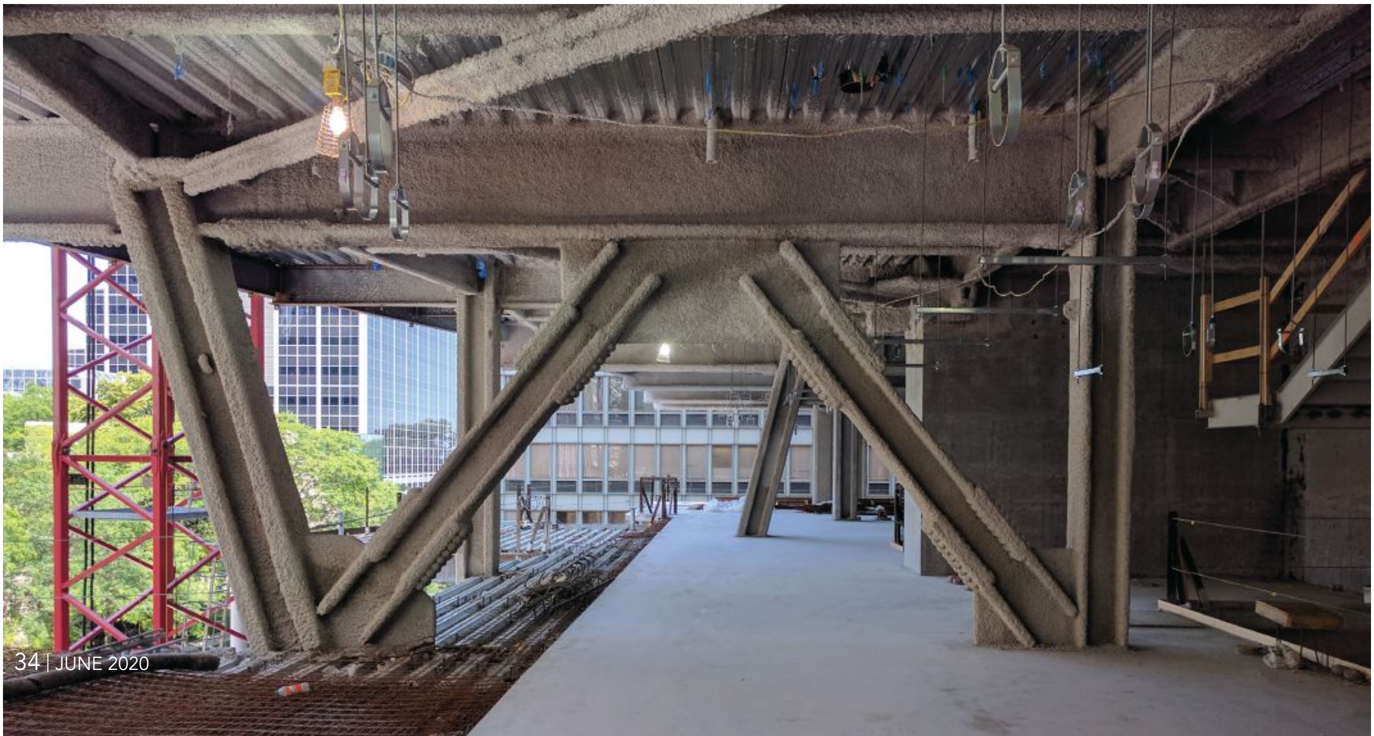


Thornton Tomasetti

above and below: Thornton Tomasetti designed a series of steel plate girders and transfer trusses, weighing approximately 365 tons, to accommodate the desired laboratory layouts.

The architectural vision for the south elevation consisted of a column-free space with a double-skin glass façade to let in natural light and provide a glimpse of the research that is going on inside. The typical framing along the south façade consisted of 14-ft cantilevers to the south to support the façade, while the northern façade incorporates cantilevers ranging from 10 ft to 21 ft. To help with field erection of these large cantilevers, Zalk Josephs proposed interrupting the steel columns and running the beams through the beam-column joint at each level, which also helped to reduce the number of field moment connections. The exterior wall weight, anticipated vertical movement, and slab connection detailing were coordinated and documented prior to bid to allow for efficient framing sizes, and the impacts on the ceiling heights and structural profile at the slab edge were also minimized thanks to the team detailing the cantilevered framing with coped ends.

In addition to the planned vertical expansion, considerations for the expansion joints between SQBRC and Lurie also needed to be addressed. Thornton Tomasetti collaborated with wind tunnel consultant RWDI to minimize the expansion joint size by carefully reviewing wind tunnel



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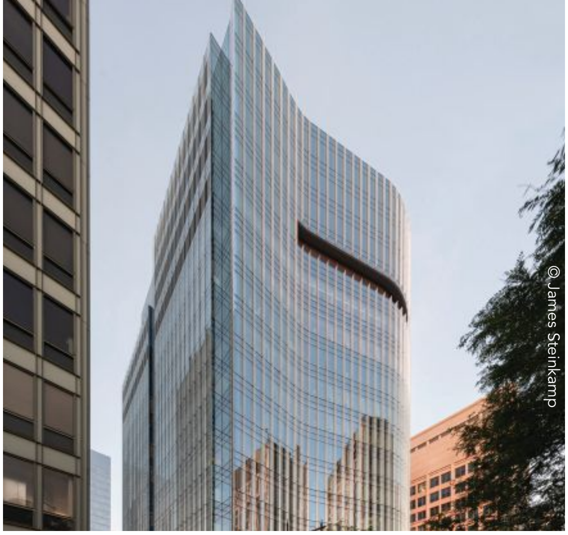
recommendations and comparing them with the results from the analytical models. Equally important was the collaboration between Thornton Tomasetti and architect Perkins+Will, which resulted in revising an expansion joint location so as to minimize its impact on the building's architecture.

As with most higher education research facilities, vibration considerations needed to be addressed, particularly in the laboratory spaces. Steel framing was analyzed using methods from AISC Design Guide 11: *Vibrations of Steel-Framed Structural Systems Due to Human Activity* (available at **aisc.org/dg**) as well as finite element models, with RWDI performing vibration analysis and Thornton Tomasetti verifying and fine-tuning the results.

While steel provided the best solution for both phase 1 and the anticipated phase 2, it also added artistic value. Prominent exposed steel spaces, designated as architecturally exposed structural steel (AESS), include a pedestrian bridge, multiple monumental staircases, and a glass "fly-by" parapet. The long-span pedestrian bridge is formed by two steel trusses extending north from SQBRC over Superior Avenue to provide a direct connection to the existing Searle Medical Research Building. To avoid affecting the Searle Building's foundations, the bridge incorporates a 53-ft cantilever at its northern tip. In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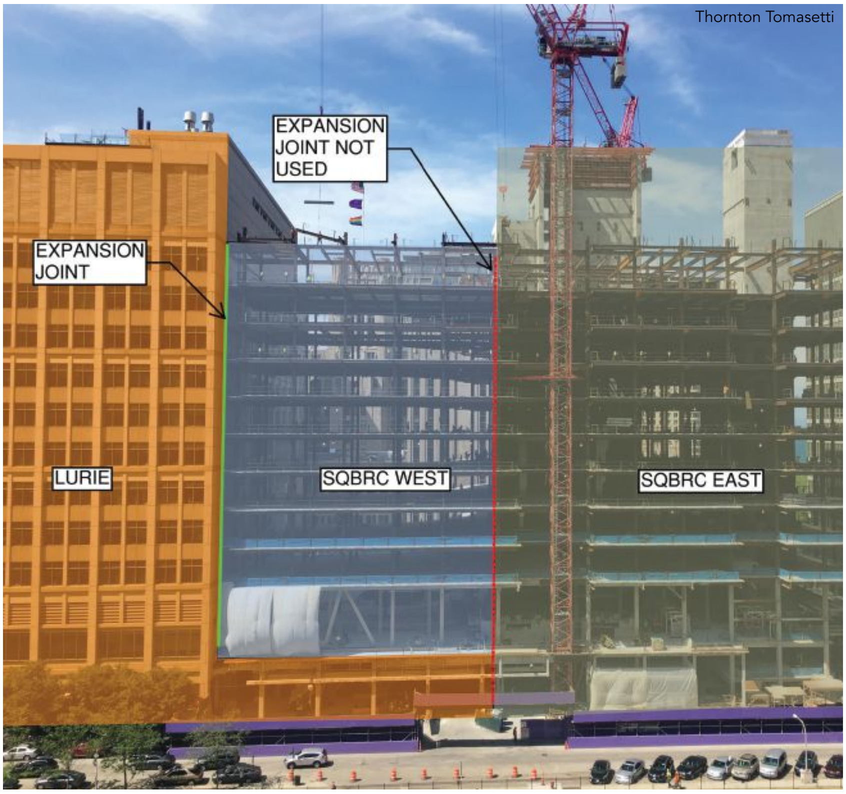
above: The project used approximately 7,500 tons of structural steel.

below: Assembling kinked columns at Zalk Josephs' fabrication shop.


Zalk Josephs

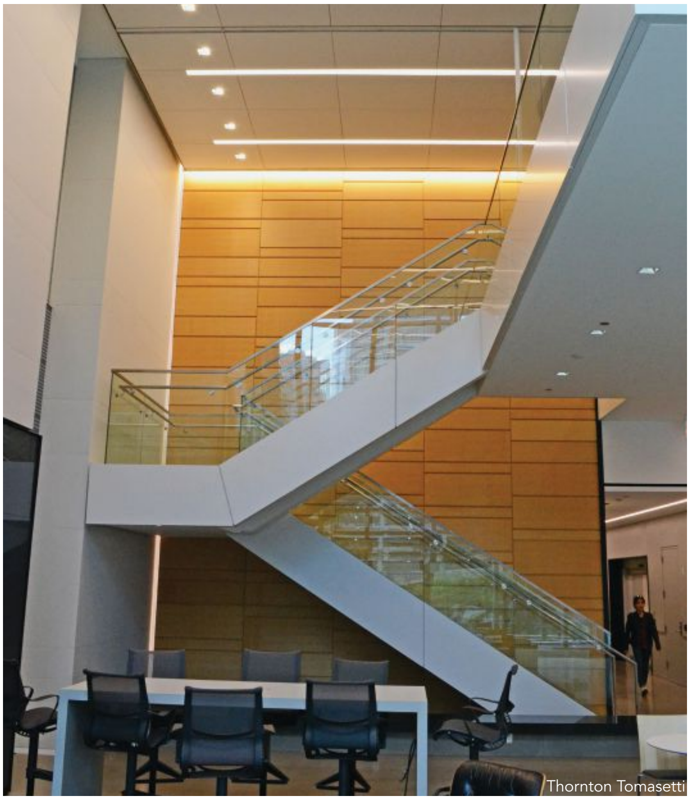


Thornton Tomasetti

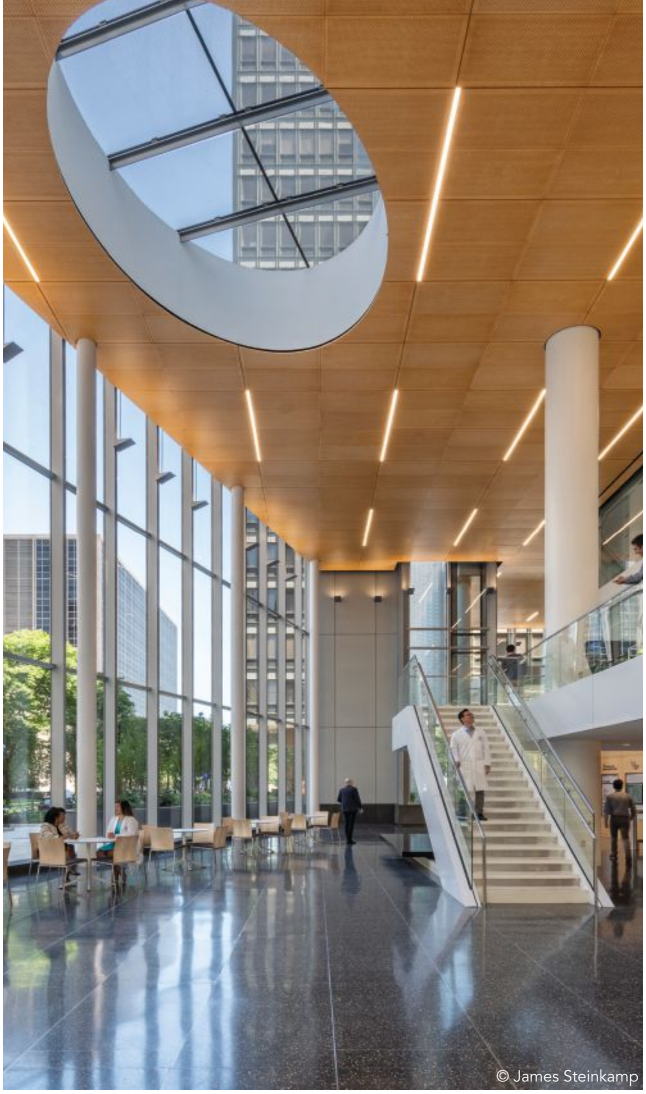
Expanded Possibility

Perkins+Will's vision for SQBRC was to seamlessly connect the 12-story vertical expansion (SQBRC West) above the existing level 2 podium of Lurie to a new neighboring 14-story building (SQBRC East). Traditionally, engineers would advocate for an expansion joint separating the two buildings to allow for differential movements. In this case, it was a nonstarter since it would add a joint through the exterior façade and require braced frames within the open lab plan. Thornton Tomasetti went beyond the obvious solution and proposed one that would give P+W and Northwestern the façade and lab plan that they wanted. A hard connection ties the SQBRC East lateral system to the existing Lurie building at and below level 2. Above level 2, concrete cores within SQBRC East laterally support SQBRC West. An expansion joint at the preferred architectural location is much less noticeable due to a change in the façade type and allowed the new double-skin curtain wall façade to be joint-free. This also reduced the wind load on the existing Lurie building, as the wind load on SQBRC West is redirected to SQBRC East.

above: The long-span pedestrian bridge provides a direct connection from the new facility to an existing research building.



Thornton Tomasetti



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above and left: The facility features multiple steel stair designs, including lobby stairs (above) and interaction stairs (left). The latter design occurs four times throughout the building, connecting the odd and even lab levels (3-4, 5-6, 7-8, and 9-10).

below: Existing steel was reframed to accommodate a new glass winter garden that ties the existing Lurie lobby into SQBRC.

© James Steinkamp

addition, several sets of steel stairs provide connections between public spaces; the northern lobby features three sets of stairs that connect the entry portal to the common spaces on the lower levels, and another set links a pair of collaboration spaces on the lab levels.

The northern entrance, which connects the building to Superior Street with a pedestrian plaza, winter garden, and lobby galleria, also showcases steel framing. The existing steel structure was reframed to accommodate a new glass winter garden that ties the existing Lurie Lobby into SQBRC. Within the new design, large columns have been relocated to create a more spacious northern lobby. The southern façade follows suit with exposed steel, featuring the vertical glass fly-by parapet extending the curtain wall 35 ft above the 12th level mechanical level slab. The fly-by is supported at three levels by steel members that cantilever horizontally from the southernmost columns to support the vertical and lateral loads.

Approximately 7,500 tons of steel were used in the construction of phase one. While this number is higher than what typically might be anticipated for a building of this size and usage, this forward-thinking steel package was sized to support the future addition, which will virtually double the tower's size and take an already impressive lab facility to new heights. ■

*For more images of Northwestern University's Louis A. Simpson and Kimberly K. Querrey Biomedical Research Center, see the Project Extras section at **www.modernsteel.com**.*

Owner
Northwestern University, Evanston, Ill.

General Contractor
Power Construction, Chicago

Architect
Perkins+Will, Chicago

Structural Engineer
Thornton Tomasetti, Chicago

Connection Designer
CSD Structural Engineers, Milwaukee

Steel Team

Fabricator
Zalk Josephs Fabricators, LLC, Stoughton, Wis. (AISC Certified Fabricator)

Erector
Chicago Steel Construction, LLC, Merrillville, Ind. (AISC Associate)

Detailer
LTC, Inc., Onalaska, Wis. (AISC Detailer)

Long-span steel trusses were the winning structural solution for a high school sports facility in El Paso with a transparent, wide-open design.

Clear Winner

BY MICHAEL STUBBS, SE, PE, ADAM SANCHEZ, AND ISAAC HARDER

SCHOOL EXPANSIONS are typically driven by overcrowding and the need for more academic space.

But for Bel Air High School in El Paso, Texas, a recent expansion was completed to address the school's desperate need for additional space to accommodate its successful basketball, volleyball, wrestling, and dance programs.

The problem was where to put it. The school was out of space for new facilities, having built out its entire parcel of land between four bordering roads, including a state highway.

The solution came in the form of a 98,000-sq.-ft, two-story replacement gymnasium on the site of the existing, smaller gym. The intent, according to David Alvidrez of Alvidrez Architecture, was to create "a facility that celebrates sports in a visible, connected manner to the community," with transparency as the foremost design goal.

And the new gym is certainly transparent. The lower level of the 40-ft-tall building starts approximately 12 ft below the existing grade and houses the primary competition court with bleachers,

Bel Air High School's recent expansion provides additional space to accommodate its successful basketball, volleyball, wrestling, and dance programs.

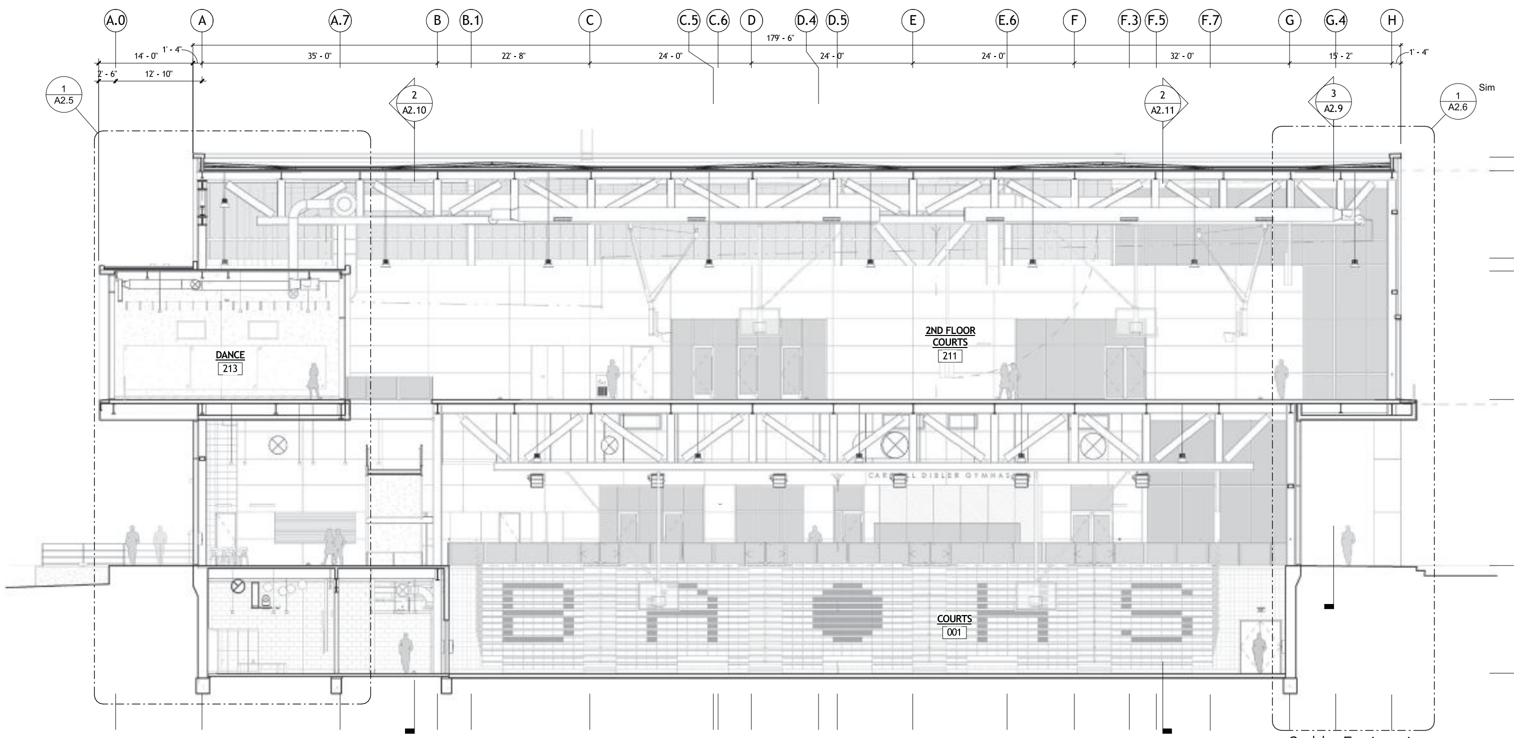
Manny Madole Photography

locker rooms, coaching staff offices, and storage space. And at grade level, it is wrapped with floor-to-ceiling windows, providing viewing and walking areas on three sides, along with lobby, concession, and restroom spaces. The upper level supports practice courts, a dance studio, and gymnastics and wrestling practice areas.

From an architectural standpoint, the challenge was taking spaces allocated to different sports with different needs and getting them to coexist in the facility while also optimizing circulation. The intent was to create multiple large, column-free, high-bay spaces that could accommodate both athletes and spectators. Structural engineer Stubbs Engineering rose to the challenge with a framing plan driven by exposed long-span structural steel

Michael Stubbs (**mstubbs@stubbseng.com**) is president and **Adam Sanchez** and **Isaac Harder** are engineering interns, all with Stubbs Engineering, Inc., in El Paso.

Be sure to check out Stubbs' session "Strategies for Managing Projects with Delegated Design," which was presented as part of NASCC: The Virtual Steel Conference: **aisc.org/2020nascconline**.



Stubbs Engineering

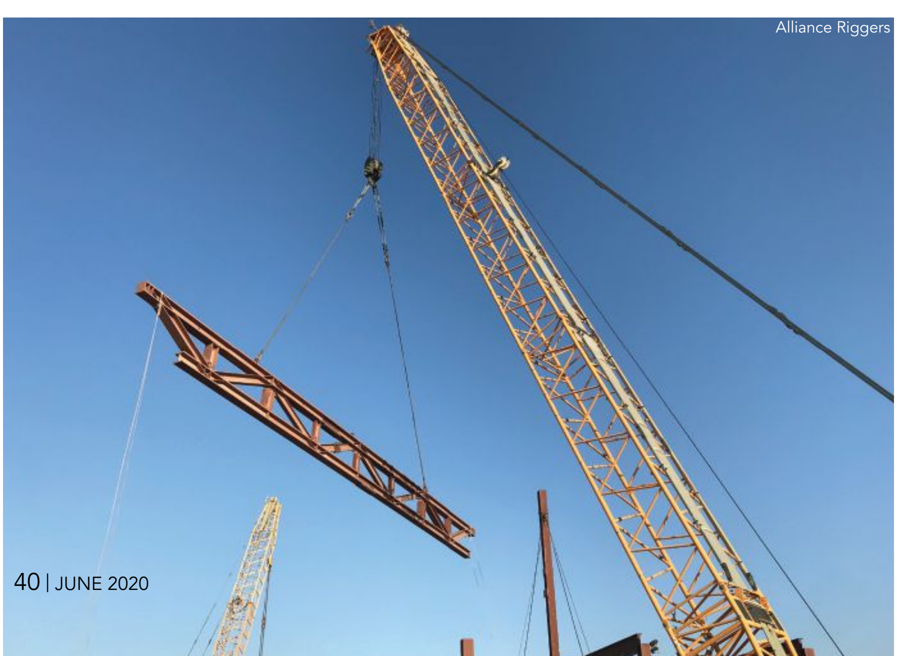

Stubbs Engineering

above: The lower level of the 40-ft-tall building starts approximately 20 ft below the existing grade.

left: The facility is supported by 127- and 177-ft-long trusses.

trusses and a "stacked" approach as opposed to a sprawling layout. The second-floor trusses, which are 9 ft, 11 in. deep, span approximately 127 ft and are composed of W14×342s for the top chords, W14×311s for the bottom chords, and predominantly W14×90s for the web members. Due to the building's athletic program and the need to prevent movement in the suspended lights and scoreboards, vibration in the trusses was of great concern during design. To address damping, the team designed a floor system comprising 4 in. of concrete over a 3-in. metal deck. While this system helped with vibration, it also created deflection concerns, so camber design for the trusses also became a critical part of the analysis.

The roof was also framed with long-span trusses—even longer than the main-floor trusses, at 177 ft—that are 7 ft, 10 in. deep and use W14×257s for the top chords, W14×233s for the bottom chords, and W14×90s for the web members. For both economical and aesthetic reasons, the roof slopes were kept very shallow, highlighting the need for detailed deflection and camber design for these trusses as well.


Alliance Riggers

Lifting a long-span truss into place.

The trusses were shipped on special dunnage (manufactured specifically for this project) in 32 escort loads from Houston to El Paso.

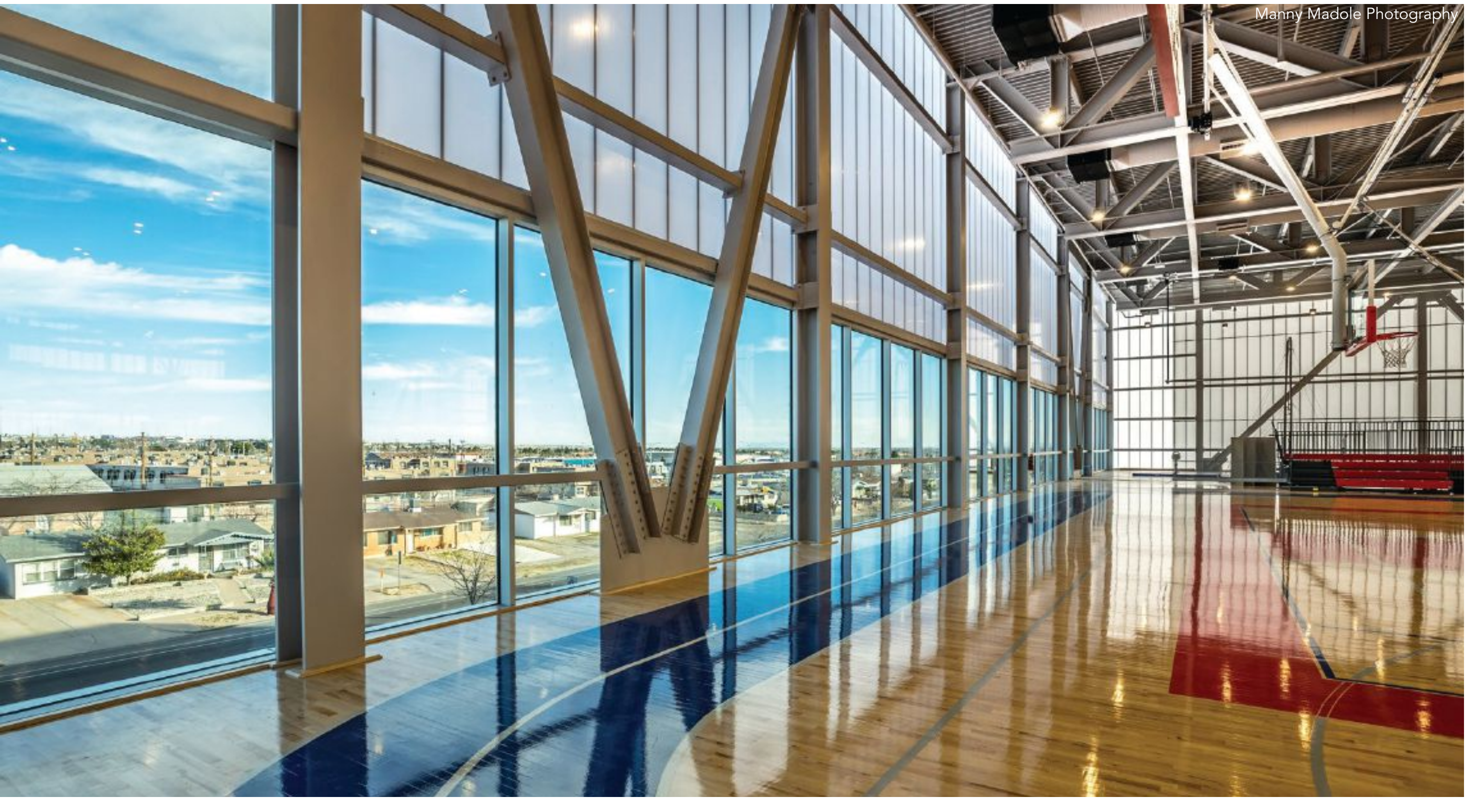
El Paso is in a region of moderate seismic risk, and the new gym was classified as a Seismic Design Category C. In response, the building incorporates a lateral system comprised of a combination of cast-in-place shear walls and steel braced frames. Despite the moderate seismic loads that needed to be designed for, the structural design team decided to use a Response Modification Factor (R) of 3, allowing maximum flexibility when designing the exposed braced frame connections to meet the architectural intent. The design team was able to get the braced frames to work within the code provisions for a structural steel system not specifically designed for seismic and as such, no supplemental damping products were needed. The braced frame connections consisted of gusset plates with bolted angle connections to the brace flanges and bolted plates to the brace webs. To accommodate the necessary long column-free spaces, the braced frames and shear walls were located at the perimeter of the building. Like the trusses, the braced frames were also left exposed.


Stubbs Engineering


Banes Construction

right: For both economical and aesthetic reasons, the roof slopes were kept very shallow.

below: Steel braced frames at the perimeter.


Manny Madole Photography

The building is wrapped with floor-to-ceiling windows, providing viewing and walking areas on three sides.

Of course, trusses of such a large scale created fabrication challenges. Weighing approximately 27 tons each, the trusses exceeded project fabricator Basden Steel's crane capacity, so the shop developed custom jacking systems to maneuver each one. Basden also test-assembled each truss at its Houston plant prior to shipping to verify fit-up and camber. The trusses were shipped on special dunnage manufactured for this project in 32 escort loads from Houston to El Paso. In addition, the truss web connections were welded to the chord members with stiffener plates in the chords, and the design team created bolted splice connections for the chords to facilitate shipment of the trusses.

When it came to erection, there was limited ability to connect to the primary lateral system. The floor and roof decks were also difficult to place do to their size and weight and were therefore not always in place while steel was being erected. Additional piers were placed around the site with W14 columns embedded in them to act as tie-off points for bracing cables. Where adding piers was not feasible, 17.5-ton concrete deadman anchors were used. The bracing cables were attached to trusses prior to installing hoisting cables to serve as both temporary lateral bracing and to brace against lateral-torsional buckling until the deck could be installed. The erection plan also included post shores to act as temporary lateral braces until the diaphragm could be fully connected to the brace frames and shear walls. The trusses—six at the lower level, six at the main level, and one at the roof—were erected in pairs, resulting in several unique bracing/rigging configurations throughout the erection phase.

The finished structure is a necessary, efficient, and attractive addition to Bel Air High School. Thanks to its stacked nature, it makes the most of limited available space on campus. And thanks to its long-span steel trusses, it makes the most of the space inside the building, providing a high-performing venue for the school's high-performing teams. ■

Owner
Ysleta Independent School District, El Paso

General Contractor
Banes General Contractors, Inc., El Paso

Architect
Alvidrez Architecture, Inc., El Paso

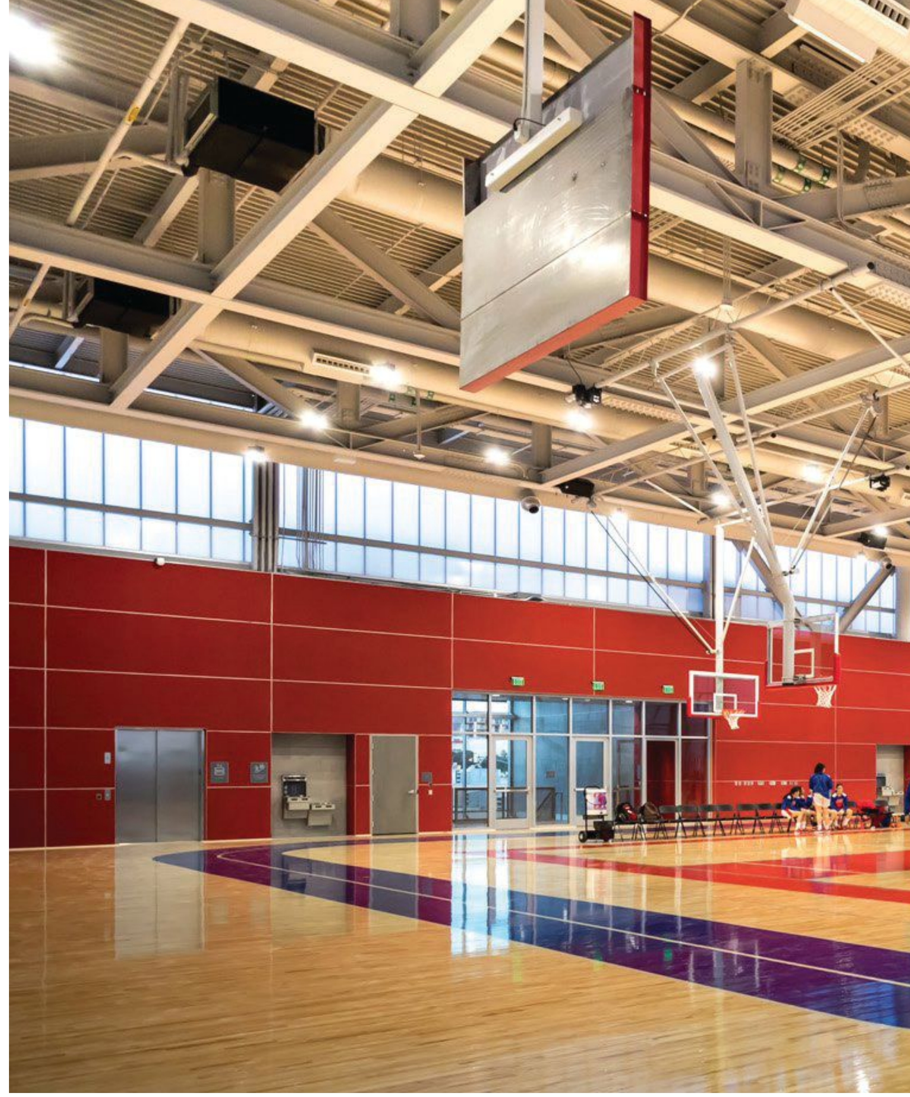
Structural Engineer
Stubbs Engineering, Inc., El Paso

Steel Team

Fabricator
Basden Steel Corporation, AISC CERTIFIED FABRICATOR
Brookshire, Texas

Erector
Alliance Riggers and Constructors, Ltd., AISC ASSOCIATE AISC CERTIFIED ERECTOR
El Paso

Detailer
Steelweb, Inc., Coral Springs, Fla. AISC DETAILER



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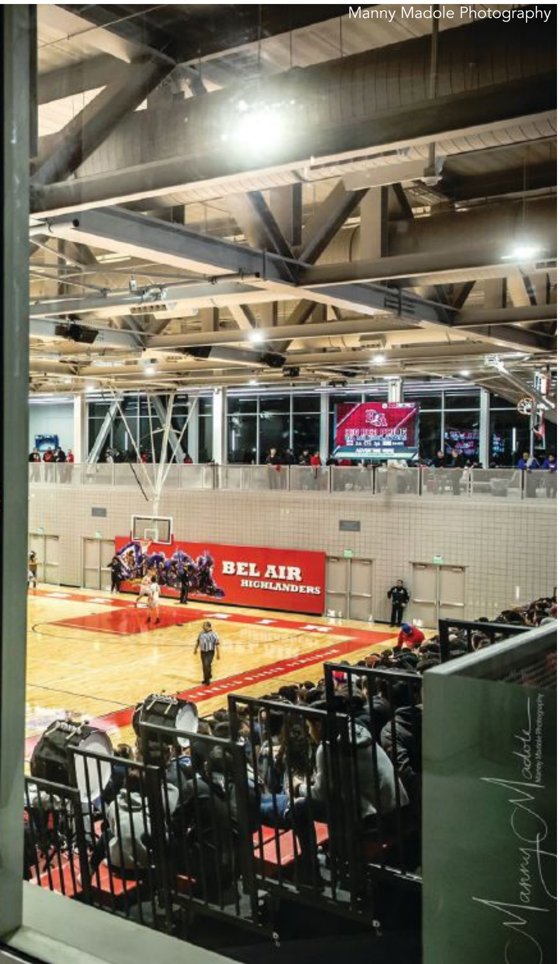


Manny Madole Photography

Alliance Riggers

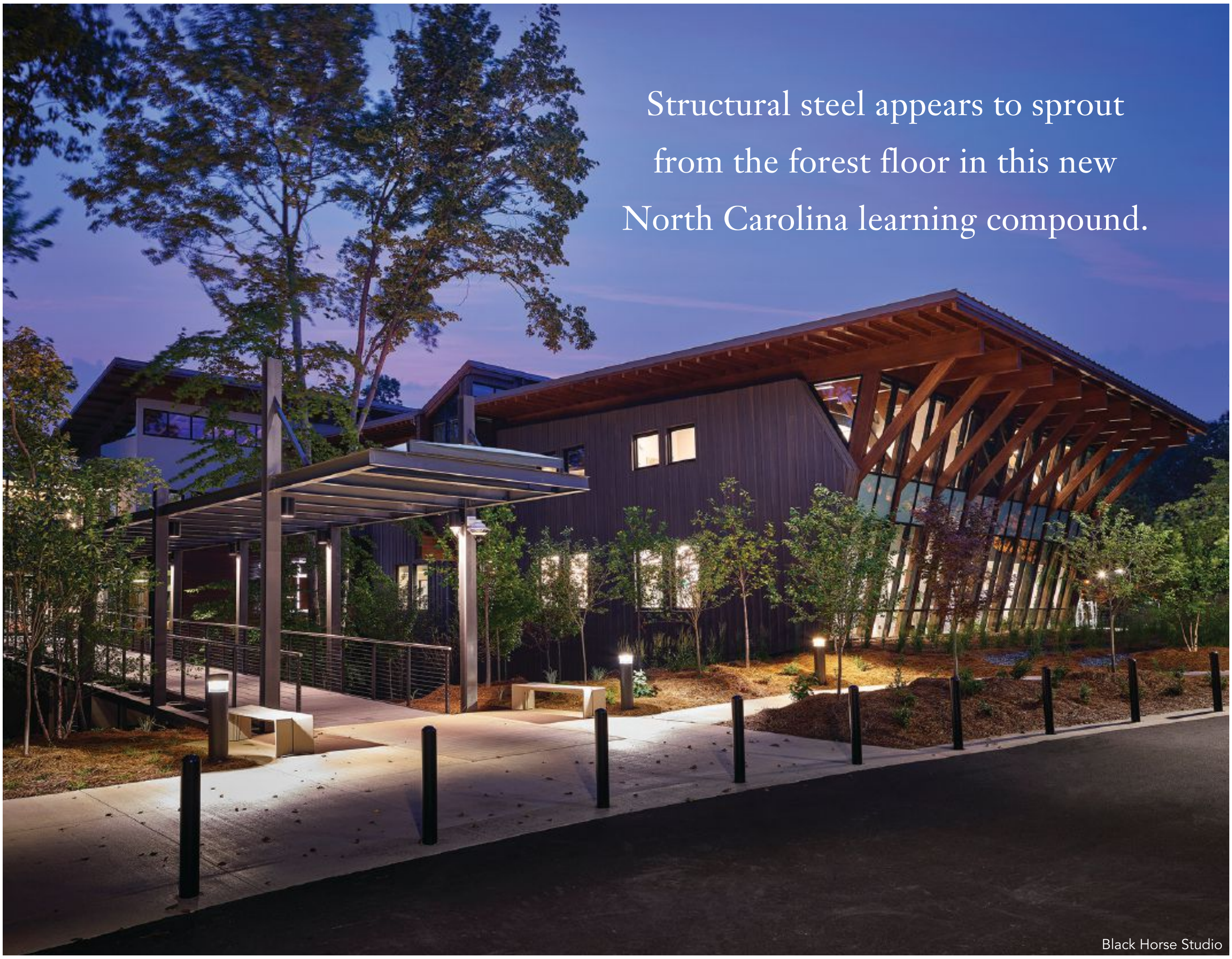
above and below: The trusses exceeded project fabricator Basden Steel's crane capacity of 27 tons, so the shop developed custom jacking systems to maneuver each truss.

Basden Steel

Seeing the Forest for the Trees

BY BANNING REED, PE, AND MICHAEL MCDONALD, PE

Tom Holdsworth



Black Horse Studio

THE BB&T LEADERSHIP INSTITUTE helps businesses and community organizations develop better leaders.

Unfortunately, its home in a nondescript office park had become a barrier to its mission. Space constraints limited the number of courses that could be delivered, it was tough to insulate students from distractions during multiday programs, and staff members worked in a "rabbit warren" of hallways and private offices. As such, the executives determined it was time for a new home that would be as unique and transformative as the courses the Institute delivered.

Taming a Wild Site

BB&T selected a heavily wooded site for the new facility, adjacent to its Greensboro, N.C., corporate headquarters and the Piedmont Triad International Airport. The Institute wanted to nestle the new structure into the trees to preserve the natural surroundings. But it wouldn't be easy, as the 11-acre property is long and narrow and sits on a 30° slope.

After studying the terrain and natural features of the site, designers at CJMW Architecture found an answer. They could use structural steel to integrate the Institute's new home into the site with a soft footprint, blurring the boundary between the natural world and the built environment. The trees themselves became the inspiration for a retreat-like campus featuring five buildings that stretch 565 ft along the natural spine of the property, all connected by broad, steel-supported floating walkways.

The design includes two three-story corporate training and conference facilities and two 24-person guest wings for overnight accommodations. Floor-to-ceiling glass, open stairs, and wide decks blend the inside and outside and provide sweeping views of the woods and a nearby lake. The buildings feature an elevated first floor extending from existing grade contours, and seem to float above the ground. The steel framing also mini-

Banning Reed (bjreed@fluhrerreed.com) is a principal and **Michael McDonald** (mmcdonald@fluhrerreed.com) is a professional engineering team member, both with Fluhrer Reed in Raleigh, N.C.

Steel interacts with glulam beams throughout the facility, and steel framing alignment was coordinated to provide clean and effective bearing conditions for exposed connections to roof timbers.

Cameron Triggs

mizes site disruption by limiting the need for significant regrading and site modifications.

The fifth and most unique building on the campus is a multipurpose "treehouse" floating some 20 ft high among three large oaks. With floor-to-ceiling glass on all four sides, the space delivers panoramic, treetop views. The structure is supported by a single, central column with steel braces, with the forest floor below remaining exposed and undisturbed. The braces are made from HSS10×10 members that connect into a custom-fabricated steel collar on the central concrete column with stiffeners and headed studs to transfer brace forces into column. The collar tie was supported on a W8 column for erection that was eventually encased in the larger concrete column.

Projecting Warmth

In addition to taming a challenging building site, exposed steel inside and outside the buildings, coated with a zinc primer, also serves as an architectural element and important design aesthetic.

"Sometimes people think of steel as cold and hard," said Jeffrey Sowers, senior architect at CJMW. "But in this project, it's just the opposite. Steel helped us make the BB&T campus warm, fuzzy, and inviting."

Sowers wanted the vertical steel structural columns to feel like tree trunks, which are married to heavy timber-frame roof trusses acting as branches. Both the steel and timbers are exposed to view.

Because of the importance of steel to both the structure and feel of the project, CJMW began working early on with engineers from Fluhrer Reed and steel fabricator SteelFab. Together, they developed two custom AESS finish categories that would balance aesthetic desires with budget realities. A more refined finish was used in areas where the steel would be most visible, with a less refined finish used elsewhere. Both custom finishes used a mix of AESS Category 1, 2, and 3 elements, which allowed for columns throughout project to meet many of the standard AESS Category 3 requirements where they would be visible at eye level, without the unnecessary cost of some of the weld and connection requirements that would primarily be concealed or elevated out of view. (For details on the various AESS levels, see "Maximum Exposure" in the November 2017 issue, available at **www.modernsteel.com**.) With these early decisions made, the steel mill order was placed several months before construction documents were issued, helping to truncate timelines.

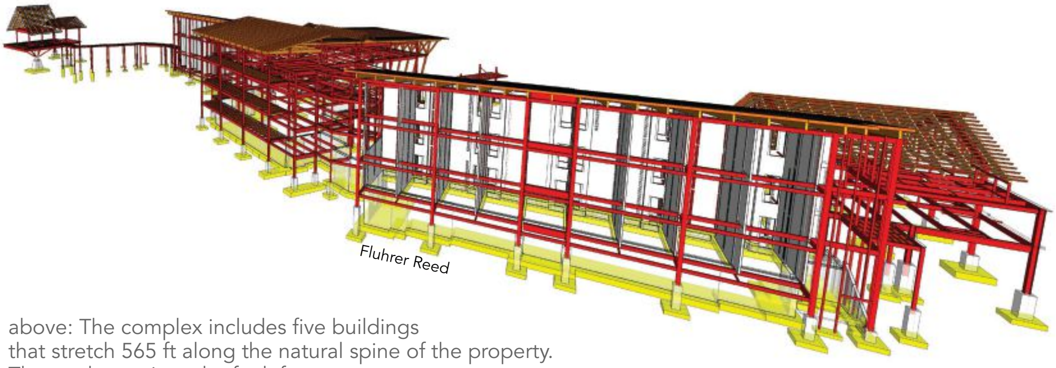
Navigating—and Saving—the Forest

The project team knew that engineering and building the new facility would require a deft hand. Before work began, designers had walked the site with an arborist and landscape architect, marking specific trees to be saved. To double-down on that tree-saving effort, a robotic total station (RTS) was used to map the locations of all the trees on the 11-acre site, making it possible to position each structure and the connecting bridges while minimizing disruption and retain as much forest as possible. Engineers used the same data to position footings, anchor rods, and columns. Instead of imposing its will on nature, the building respects it—and even blends in.

Black Horse Studio

Floor-to-ceiling glass, open stairs, and wide decks blend the inside and outside and provide sweeping views of the woods and a nearby lake.

above: The support system for the treehouse is a single, central concrete column with steel braces that cantilever to the edges, allowing the forest floor below to remain exposed and undisturbed.



Fluhrer Reed

above: The complex includes five buildings that stretch 565 ft along the natural spine of the property. The treehouse is at the far left.

below: The wooded setting and steep grade made it impossible to use standard cranes and other heavy equipment. A 200-ton crane with 280 ft of boom and jib was used to lift steel beams, heavy timbers, and other building materials over the treetops to on-site crews.

Fluhrer Reed

Tom Holdsworth

The treehouse and the rest of the buildings are connected by broad, steel-supported walkways that "float" above the forest floor.

It took careful planning to marry steel with the large glulam beams used throughout the facility, and steel framing alignment was coordinated to provide clean and effective bearing conditions for exposed connections to the roof timbers. In the guest wings, the challenge was even more complex, involving alignment of vertical steel columns with both roof timbers and load-bearing metal studs. The use of moment connections eliminated the need for braced frames and contributed to the openness of each building.

To guide the construction team, the engineers used a RAM Structural System and RAM Elements to create an analytical model of the new campus. They then transferred their work into Revit and created a 3D model of the skeleton of the building. The architectural "skin" and building systems were then created and applied, making it easier to plan around steel beams and heavy timbers. Once again, the team looked to RTS technology to ensure precise layout of structural elements, and a 3D laser scanner was used to produce "as-builts" and coordinate the placement of plumbing, cabinetry, and other components for a precise fit. The 3D modeling software also included virtual reality tools, with "fly-throughs" showing the owner what the project would look like before it was built, room by room, inside and out.

Construction carried its own set of challenges. The wooded setting and steep grade made it impossible to use standard cranes and other heavy equipment. A 200-ton crane with 280 ft of boom and jib was used to lift steel beams, heavy timbers, and other building materials over the treetops to on-site crews. The Federal Aviation Administration (FAA) even had to authorize use of the crane since the site abutted the Piedmont Triad International Airport.

"The project required a new level of coordination and communication," said Joshua Cook of general contractor Blum Construction. "We were working with new methods, new equipment, and new vendors. It sometimes took us two weeks to plan for just four to five hours of work."

A robotic total station (RTS) was used to map all the trees on the site, making it possible to position each structure and the connecting bridges so as to minimize disruption to the forest. The engineers used the same data to position footings, anchor rods, and columns.

Connecting the steel columns with metal studs and wooden timbers was a special challenge, noted Cook. So was managing the sheer scale and quantity of moment welds.

"We knew we had to have a lot of highly trained ironworkers on the project," he said. "Many of the welds involved a multi-step process and took about two hours each to complete. But it was worth it. The steel elements are a part of the beauty of the building."

Impactful Outcomes

The multibuilding campus took just 19 months to bring to life, from initial design to occupancy. And it has received rave reviews both from the Institute and the leaders it trains. The organization reports that revenue is up by 41%, which it attributes in large part to the new facility, and it can run multiple programs and events simultaneously. Guests say the building makes them feel good and allows them to focus more clearly on the content of the programs they are attending. Seating nooks, wrap-around decks, a fire pit, and other casual spaces encourage connection and sharing. And staff members now work in light-filled spaces, with exposed framing, that encourage collaboration and creativity.

"I truly look forward to coming here every day," one staff member said. "I've been with BB&T for 30-plus years, and I've never felt this attached to any other facility." ■

Owner
BB&T Leadership Institute, Greensboro, N.C.

Architect
CJMW Architecture, Winston-Salem, N.C.

Structural Engineer
Fluhrer Reed, Raleigh, N.C.

General Contractor
Frank L. Blum Construction, Winston-Salem, N.C.

Steel Fabricator
SteelFab, Raleigh, N.C. AISC CERTIFIED FABRICATOR

A new manufacturing arts teaching facility builds a theme of roundness into its structural system to practical, aesthetic, and illustrative ends.

Rounding Up

BY DAVE BLANKFARD, SE, PE, AND SARAH MUSSER, PE

Sterling Stevens

Dave Blankfard (**david.blankfard@littleonline.com**) is the Durham engineering studio principal and Sarah Musser (**sarah.musser@littleonline.com**) is lead structural engineer, both with Little Diversified Architectural Consulting, Inc.

ALAMANCE COMMUNITY COLLEGE'S Advanced Applied Technology Center packs quite the punch under one roof.

The new single-story, open-bay, 53,000-sq.-ft structure houses five industrial programs: mechatronics engineering, computer-integrated machining, welding, automotive systems, and air conditioning/heating/refrigeration.

The old facilities that housed these programs were outdated, too small, and not centrally located on the school's Graham, N.C., campus. A new building provided an opportunity to create state-of-the-art facilities for growing technology programs, construct a model of sustainability and energy efficiency, expand and strengthen the campus experience, and provide a new generation of students with the skills they need to succeed. In the new building, each program has its own classroom with accompanying high-bay lab space. The center showcases technical education and training, maximizing the learning experience and preparing students for highly-skilled fields.

The building's design philosophy was to reinforce the function of the space as a learning and working environment for students. Every building detail was used to extend this philosophy. Exposed ducts and mechanical systems were to enhance the learning for the air conditioning/heating/refrigeration program. Conduit is left exposed to demonstrate the proper layout runs, and accessible welded joints exhibit proper welding. And all of the building's structural steel framing system, highlighted by long-span cellular beams, is open to view.

The center's programs require wide-open spaces—the longest is an 80-ft span in the auto tech lab—with few columns and easy access to building systems for upgrades and modifications. In addition, many of the program functions require the use of round shapes, from the pistons in automotive systems to the rods and washers used in HVAC work. This fundamental shape actually influenced the selection of the structural steel framing, with the beams, columns, and lateral system being sculpted to reinforce the functions that are

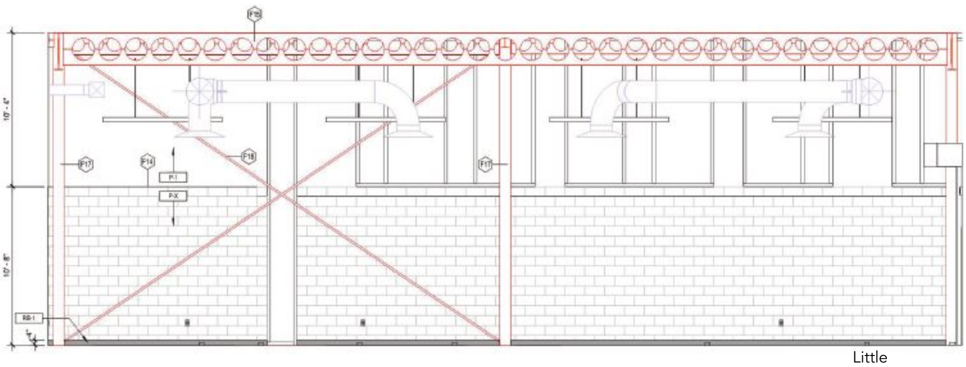
above and opposite page: The building's design philosophy was to reinforce the function of the space as a learning and working environment for students. Ductwork, conduit, and steel framing are all left exposed to view for aesthetic, practical, and educational purposes.

right: Cellular beams are prominent throughout the building. The initial direction of these beams was intentionally changed to cross internal corridors widthwise as opposed to lengthwise in order to highlight the holes to students, faculty, and visitors walking through the building.

performed in the spaces. The steel framing totaled roughly 230 tons, and approximately 140 tons of that total is comprised of cellular beams—i.e., beams with circles in the webs—mimicking the round shapes of the various crafts. The project was sequenced into three phases, with steel erection taking approximately five weeks in all.

"One of the major challenges on this project was getting drawings out for approval quickly," noted Bryan Chamberlain, project manager with fabricator North State Steel. "[Castellated and cellular beam fabricator] Metals USA had a 10- to 12-week lead time on cellular beams from the time they got approved drawings returned with all information provided. To try to keep the project schedule, we really had to hit the ground running and work together to get all of our drawings submitted. We had only done a couple cellular beam projects before, but the fabrication and detailing teams did a great job communicating and working together from the start, and we had minimal connection issues in the field."

LB36×62s were used for the 80-ft spans, LB27×40s for the 60-ft spans, and LB15×12 for the short spans over corridors, and beam depths were selected based on loading requirements and span. The design team intentionally changed the initial direction of the framing in the corridors to cross them widthwise as opposed to lengthwise to highlight the holes. In addition to displaying the circular concept and their ability to achieve long spans, the cellular beams use less material, require fewer members, and subsequently shorten erection time thanks to fewer picks being needed. Cellular beams are standard shapes that are split and shifted to create circular holes, and then re-welded together, creating a deeper, stronger section. The holes allow natural daylight to flood the space and provide an accent backdrop to the clerestory window conditions. This beam type also lets building utilities pass



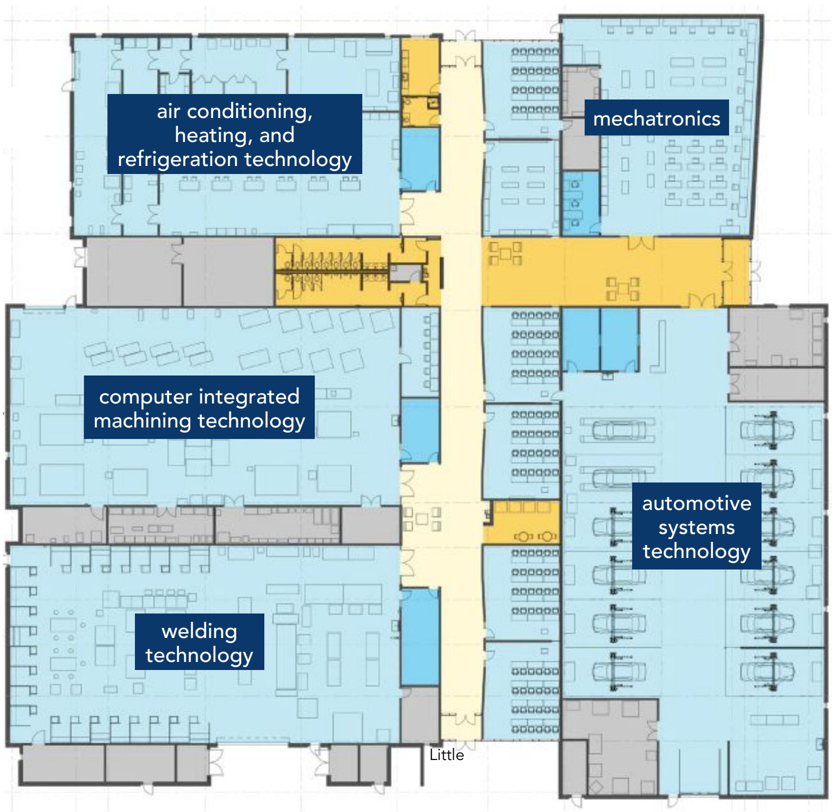
Little

An interior elevation view of the computer-integrated machining area.

through the beams instead of being routed around them.

Roundness was also incorporated into the columns, with HSS8.625×0.375 being used for the gravity columns and HSS10.75×0.375 for the lateral columns. Rod X-bracing, round column isolation joints, and circular connection plates were all used to reinforce the round/cylinder design concept. The exposed structural members were painted international orange to keep the structure engaged as a design component of the room rather than fading into the background—and no fireproofing was required on the steel based on the space heights and the building's construction type.

These round elements required some modifications from more traditional design when it came to the lateral rod X-bracing frames. The bottom connections of the brace needed to be raised to reveal the detailing, and the footing and column were designed for the eccentric loading. The rod intersection was connected using a circular gusset plate looking similar to a circular washer plate, as the plate was designed for bending and tensile forces. At the connection of the cellular beams and rods, the end transfer of loads was resolved by



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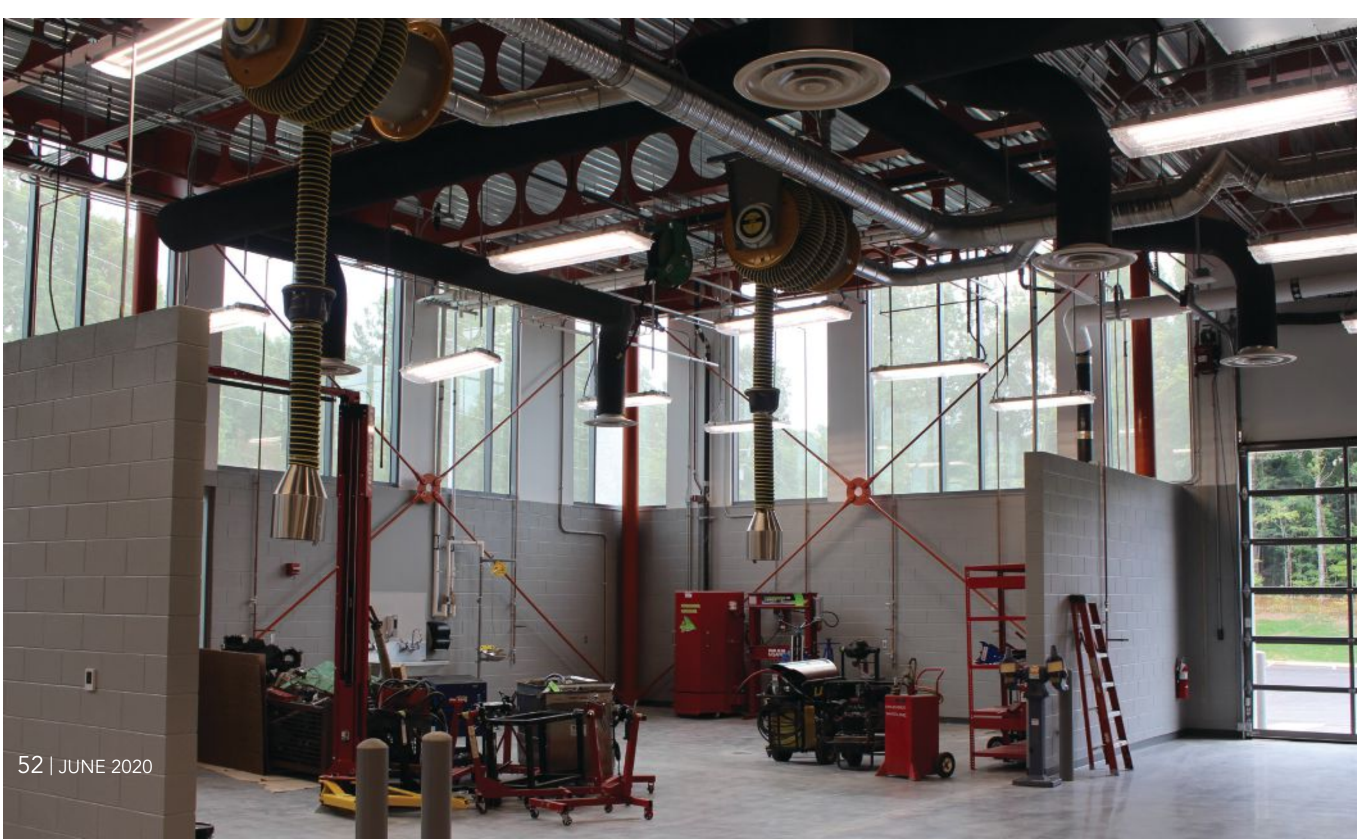
left: The building houses five industrial programs.

below: Rod X-bracing, round column isolation joints, and circular connection plates are all used to reinforce a round/cylinder design concept.



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infilling the last few holes; transferring the end reaction around openings would have required the beam to be upsized. Cellular beam layout and supporting beam connections did cause some irregularity in the form of half-moon conditions—i.e., where a cellular beam ends at a wall or column and a full circle (moon) gets cut off. Thankfully, it was only noticeable during construction, and the layout ultimately worked well, with placement of a solid wall versus windows in these areas.

This thoughtful design has been successful not only in creating a functional, attractive space, but also in terms of recruitment. In its first year of operation, the programs in the center have seen an enrollment increase of nearly 25%.

"The impression upon walking into the building is impressive, as one is immediately aware of it being a beautiful state-of-the-art facility," said Algie Gatewood, Alamance's president. "It is inviting, from the artwork to the functionality of the space." ■

For more images of Alamance Community College's Advanced Applied Technology Center, see the Project Extras section at www.modernsteel.com.

Owner
Alamance Community College

General Contractor
Rodgers Builders, Inc.

Architect and Structural Engineer
Little Diversified Architectural Consulting, Inc., Durham, N.C.

Connection Designer
Greeson Engineering, Inc. (Braced Frames)

Steel Fabricators
North State Steel, Inc., Louisburg, N.C.
Metals USA, Ambridge, Pa. (Cellular Beams)

Cellular Source

While Metals USA fabricated the cellular beams for this project, the company no longer provides this product type. However, C-BEAMS (**www.c-beams.com**) currently manufactures cellular (round) and castellated (hexagonal) beams for structural steel projects. For technical guidance on designing steel buildings using castellated and cellular beams, check out AISC Design Guide 31: *Castellated and Cellular Beam Design* at **aisc.org/dg**.

Managing BIM

BY ANDREW D. MENDELSON, FAIA

BIM is more than just a tool.
It's a process. And knowing how to navigate the process
will help you get the most out of the tool.

Andrew D. Mendelson (**amendelson@berkleydp.com**) is senior vice president and chief risk management officer with Berkley Design Professional.

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BUILDING INFORMATION MODELING, known widely by its acronym, BIM, continues to have a significant impact on the building and design industry. When properly implemented, BIM not only allows for greater productivity and efficiency of the design process, but it can also facilitate higher-quality project delivery through improved identification and resolution of conflicts during the design and documentation phase, thereby reducing rework during construction.

From a risk management point of view, there are a number of practice, technology, staff, and legal issues that design firms should consider when entering the world of BIM. Here, we'll discuss several of these key issues.

Practice Considerations

BIM is a design technology that requires process change for improved effectiveness. Implementation of BIM can have meaningful impact on and even disrupt a traditional CAD-oriented project delivery process. Design process in the BIM environment requires careful planning and integration amongst design disciplines and other participants in the project team to maximize its benefits.

BIM in project delivery is most effective when implemented in a collaborative and integrated project team environment that includes architects, engineers, general contractors, major trade contractors, and manufacturers' representatives who are facile and experienced in the 3D modeling of systems, materials, and components of the construction project. The project team should operate under a *BIM execution plan* with clear intent for the use and reliance of the BIM, as well as the process protocols and management responsibilities established. It is recommended that the lead design firm identify and empower a BIM leader for the entire project team. (When team members do not have equivalent levels of skill and dexterity with BIM, inefficiencies of productivity are to be expected.) The need for enhanced collaboration between architectural, engineering, other design disciplines, and construction team members will likely require a significant culture change in your firm and with your consultants and contractor team members. While individuals may be used to working in isolation, model development is most successful when data is shared and coordinated regularly between design and construction disciplines according to the BIM execution plan.

Efficiency is improved when decision-making on key design, building system, and other technical matters is moved forward in the process (see Figure 1), enabling integrated development of the model in part due to the data-rich nature of BIM. This process shift requires the project design leaders and the client to be more facile and timely in reaching design decisions. An accelerated client decision-making process can be a challenge for

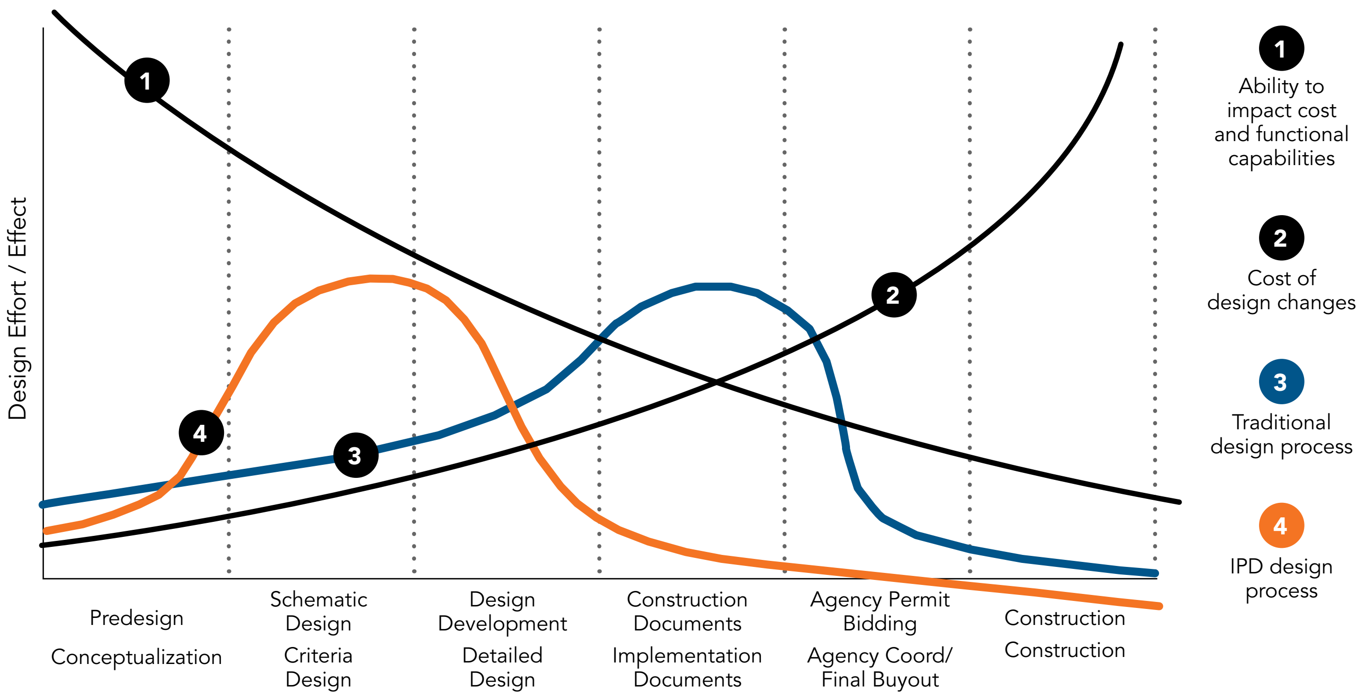


Fig. 1.

Graphic content originated by Patrick MacLeamy, FAIA

owners with extended internal approval processes involving certain institutional and corporate owners. The ability for the design professional to provide advanced 3D images in BIM enables owners to better visualize the project design intent and thus facilitate accelerated decision-making.

BIM process change requires a firm-wide commitment to understand and realize the benefits and challenges, as the transition usually involves short- to medium-term productivity inefficiencies in converting from traditional CAD design and production. In many ways, BIM is like learning a foreign language with a whole host of new terms, such as "families," "components," "shared parameters," etc. Some practices that will aid that transition include the following:

- Establish BIM process and protocol guidelines and standards and maximize consistent use throughout the firm.
- Recreate CAD libraries to BIM. This requires careful thought and planning, but is a necessary and worthwhile investment for the firm's productivity, effectiveness, and quality management.
- Have skilled BIM personnel work closely with senior staff to enable quality assurance of the BIM content and stronger adoption of the new standards and processes.
- Adhere to established firm standards and protocol on every BIM project. "Workarounds" should be discouraged as they counteract consistent practice and compromise productivity and quality.
- Use a BIM execution plan, including a Model Element Table—see AIA Document G202-2013—to establish the level of development (LOD) and author of each model element, developed collaboratively with the project team and initiated by the lead design firm (the architect or engineer under direct contract with the client). Establish a template to facilitate the creation of the BIM execution plan to enhance the efficiency of the BIM planning process. The productivity, efficiency, and coordination for the entire design and project team can best be effectuated through the use, monitoring, and adjustment of this important planning tool.

Refer to the following resources for further information: Guide, Instructions, and Commentary to the 2013 AIA *Digital Practice Documents* (**tinyurl.com/digpracdoc**) and the Penn State University *BIM Project Execution Planning Guide* (**bim.psu.edu/bim_pep_guide**).

Technology and Training Considerations

Like any new technology, BIM requires a meaningful and often significant investment in time and overhead expense for IT infrastructure, hardware, software, and training. BIM involves the storage and exchange of data-rich files that are much larger than CAD files and can stress IT networks (LAN, WAN, and servers) of design firms that have insufficient capacity.

Employee training should be intense and thorough, enabling firm-wide commitment and consistency. A process of ongoing feedback and input from BIM users will help update and maintain the BIM library and the evolution of BIM process in your firm. Implementation should include the creation of a content library management system where the firm's BIM standards are stored and easily accessible. The content library may require separate software and a dedicated server(s). Hosting the model for use by other project participants may expose additional cyber risks that need to be mitigated through enhanced network security features and protocols.

Legal Considerations

Clients and contractors often have expectations for a higher level of coordination and quality with BIM design services and documents. It is important to manage these expectations and maintain the normal "standard of care" in the design services agreement with the client. Do not allow the standard of care to be elevated with the use of BIM.

Project team operational protocols including file and data exchange procedures on BIM projects must occur by established agreement amongst all of the project team members. AIA documents

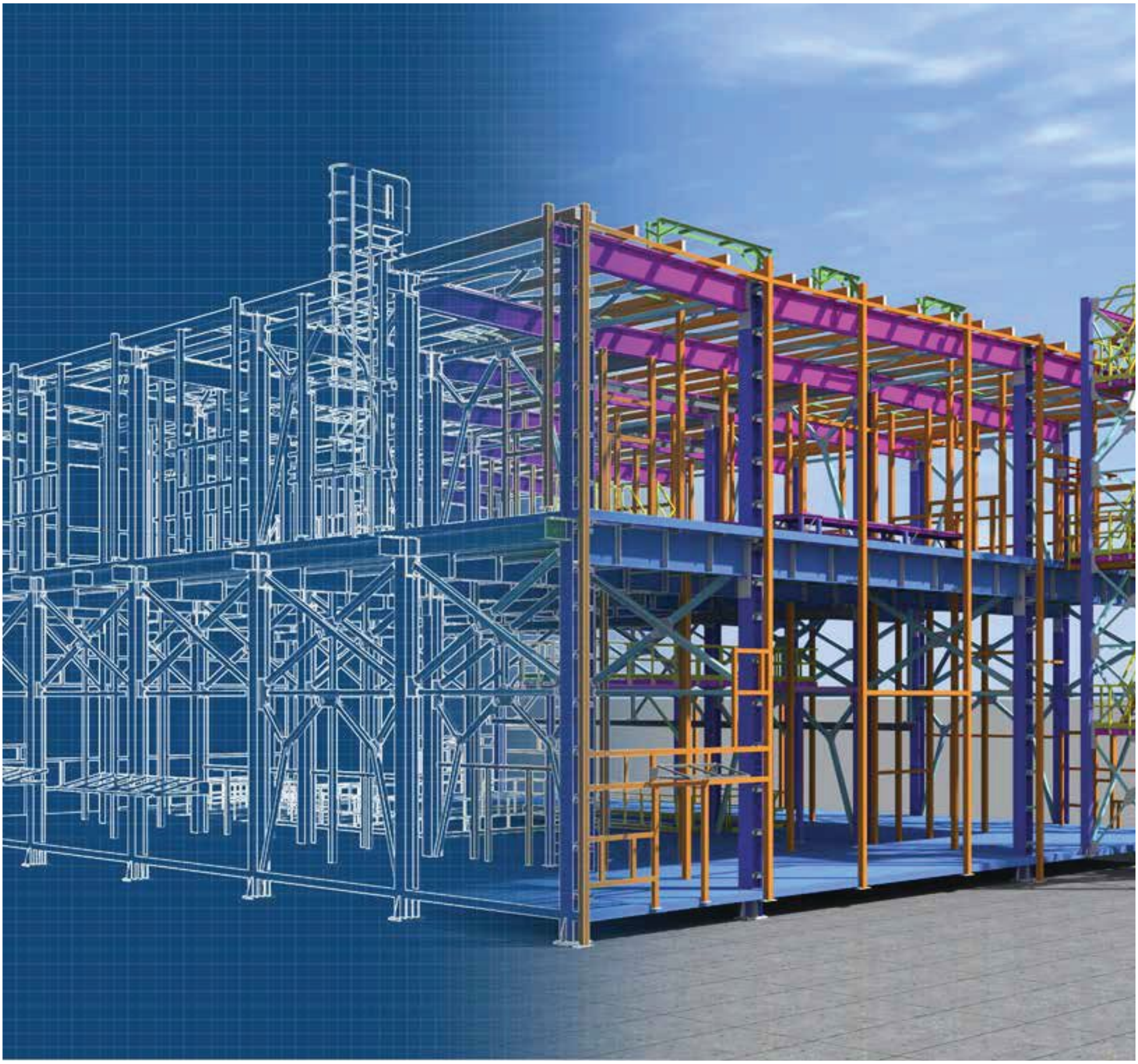
E203-2013 and G202-2013 provide thorough definitions of allowable use of BIM on the project and understanding of the project team roles and expectations (**tinyurl.com/bimdigdataex**). Another good resource for definitions of use and reliance is the *Level of Development (LOD) Specification* published by the BIMForum (**bimforum.agc.org/lod**).

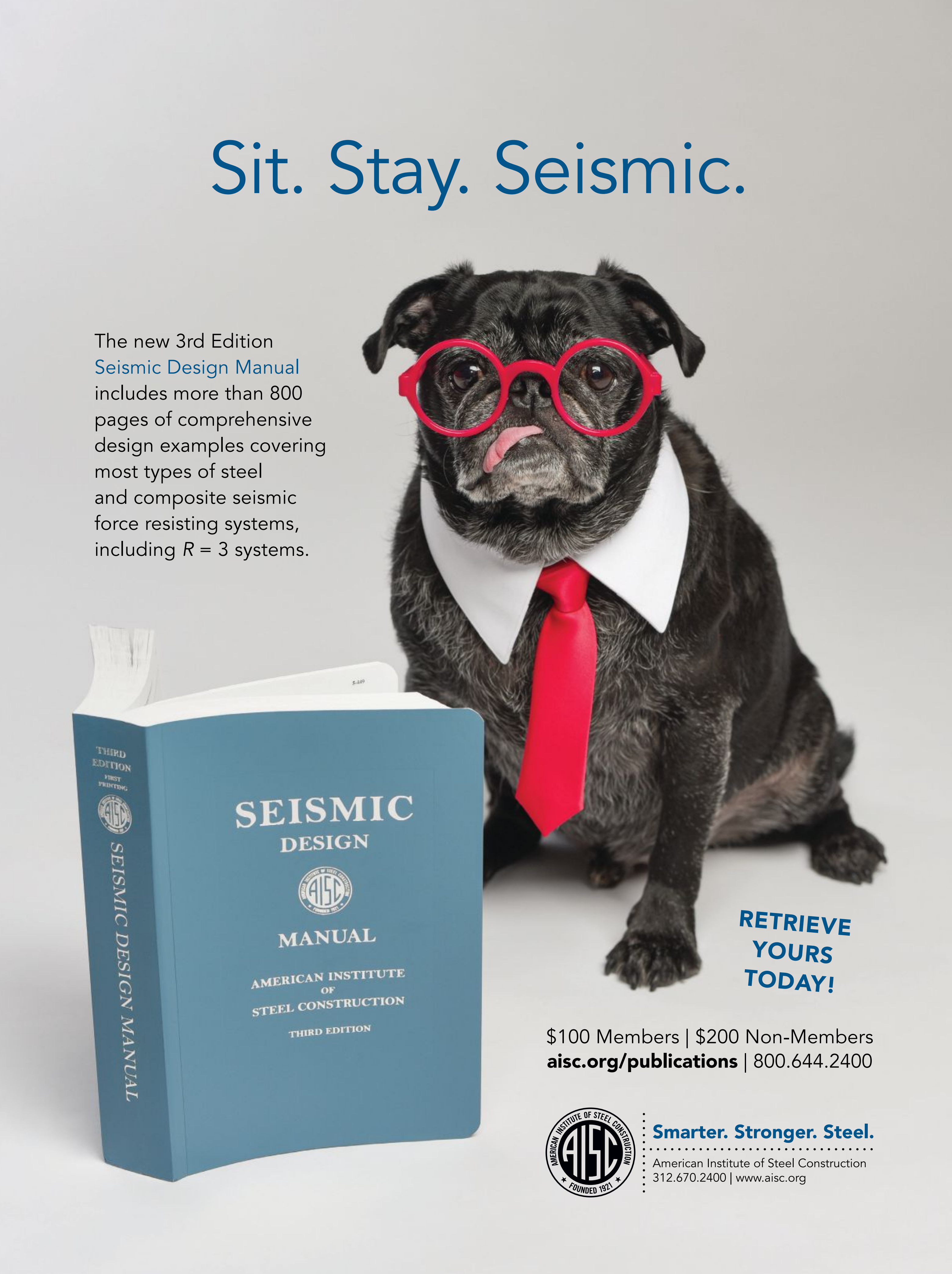
BIM project delivery is most effective when implemented in a collaborative and integrated project team environment.

The intended use of BIM by the project team, including the "right to rely" on the 3D model, is a critical element in client-consultant and client-contractor agreements. However, it is recommended that unless the entire project team is committed and equally skilled in working in BIM, the model should be considered as a "tool of convenience," with reliance for construction based on the stamped and sealed drawings and specs.

BIM is an exceedingly useful tool, and it's being used more and more every day. But it's not just a plug-and-play solution. Knowing what to expect and preparing for it will help avoid legal, technical, training, and process challenges as you develop skills and efficiencies in the implementation of this powerful design technology. ■

Want to learn more about best practices and legal issues related to BIM? Check out Mendelson's session "Managing the Legal and Practice Issues of Building Information Modeling (BIM)," which was presented as part of NASCC: The Virtual Steel Conference: ***aisc.org/2020nascconline****.*

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Mind the Gap

BY LUKE FAULKNER

To close the productivity gap, the construction industry will have to use one of its strongest tools: technology

Luke Faulkner (**faulkner@aisc.org**) is AISC's director of technology initiatives.

CONSTRUCTION TRAILS VIRTUALLY EVERY OTHER INDUSTRY in terms of productivity growth.

Fragmentation is the main culprit and has long been a barrier to improving the productivity of the construction workforce. Technology in particular has been a struggle for the industry to get a handle on.

One of the keys to successfully implementing new technology is scalability and, to put it bluntly, this fragmentation does nothing to facilitate scalability. To be sure, there are external factors at play that are largely out of control of individual firms. The regulatory environment, for example, or industry-wide tendencies to use contract frameworks that foster inefficient and often adversarial project teams are, for the most part, out of an individual firm's control. The need for institutional change is clear but because this often happens at a glacial pace, much of the responsibility for closing the productivity gap ends up flowing (by default) to individual firms and project participants.

One of the better guides to understanding the various aspects of the productivity gap is a report by the McKinsey Global Institute, *Reinventing Construction through Productivity* (you can view it at **tinyurl.com/mckprodrev**). Here, we will unpack some of the findings of that report and discuss what technologies are ready to be immediately deployed (particularly as they apply to steel construction) and are actionable at a firm level, what technologies are coming, some of the factors that are beyond immediate control of a company, and actionable items that can be undertaken at a firm level.

What Is out of Your Hands

Keep in mind that there will be some factors that just can't be controlled on an anything approaching an individual level. While frustrating, a little perspective can help you focus on what you can and cannot control, and save heaps of frustration.

Industry standards. As identified by the McKinsey report, a critical factor in closing the technology gap in the AEC industry will be the implementation of clear standards by the respective industry groups and trade associations. Without clear standards, the burden of navigating new technology lands on individual companies, and this in turn falls disproportionately on sub and specialty contractors. AISC is in the fortunate position to be able to offer standards and technical guidance in the areas of building information modeling (BIM) or 3D modeling (see *BIM & VDC for Structural Steel* at **aisc.org/bimvdc**), steelXML (which supports electronic transactions—**aisc.org/steelxml**), and software standards for automated fabrication.

Owner attitudes. Better owner awareness of technology is a key driver in its implementation. This can vary widely from owner to owner. Naturally, some owners will be more progressive in what they ask out of their project teams and the value that they perceive from technology. This doesn't fall entirely into the category of "things you can't control"—i.e., it's not a binary situation in which an owner is either pro or con. There may be options for suggestion or implementing various levels of technology.

AGT

Automated fabrication has grown significantly in the last ten years.

Unlocking workflows that will allow technology to flex its muscles. Though it may be some of the lowest hanging fruit, technology isn't the only avenue through which productivity can be improved. Traditional contract structures that evolved from a world where data wasn't widely collected and digital models didn't exist can't necessarily be expected to support a highly digitized process—at least not as effectively as a one that emphasizes integration and collaboration.

What You Can Leverage

So how do individual firms do their part to help themselves and the industry improve productivity? According to the McKinsey report, there are three big levers at the firm level that can be manipulated: on-site execution, technology, and capability-building. By far the one with the highest-percentage impact is technology. Of the 50% to 60% total improvement in productivity the industry could find by leveraging every possible advantage, 15% of that overall improvement could come from technology alone. There are areas that could conceivably have a bigger impact, but all of those require major sociological changes, whereas technology is much easier to move at the individual level.

Below are some technologies that can be and already have been useful in closing the productivity gap. It's fair to say that some of them aren't exactly "emerging" in a general sense; other industries have been leveraging them for years (you don't have to look far to see how other industries have used robots for decades, though in their case it was done for tasks that can be repeated hundreds of thousands, even millions, of times).

Implement BIM. BIM/3D modeling, not surprisingly, tops the list of technologies that can be implemented at the firm level. The report recommended universal, firm-wide implementation of 3D BIM. Companies that want to be at the cutting edge should consider implementing 4D and 5D BIM. This means going beyond the typical 3D geometric model and implementing model-based estimating (4D) and model simulations (5D)

Identify a technology champion. Be it BIM or any other technology innovation, it will need someone to further the technology cause and see its implementation through. Just make sure not to sugarcoat things; the implementation process for new technology can be long, painful, and frustrating—thought, fortunately, worth it in the end. And keep in mind that the champion doesn't have to be president or CEO. Rather, an empowered project manager, a CTO, or another qualified, eager, and open-minded employee should be tapped.

Developing the internal ability to manage and evaluate technology is critical for firm-level success. Beyond having a champion, it's also critical to have internal processes in place to assess the value and ROI of a given technology. It's simply not enough to eyeball a new modeling software package or fabrication process and assume it will save you time and money.

Robotics and automation. Robotic, automated fabrication has progressed rapidly in the steel construction industry in the past decade and is already one of the most effective avenues to closing the technology gap. Robotics and automation are not entirely new, but previously their domain was highly repeatable tasks such as in the automotive industry. But in the last ten years, automated fabrication has grown by leaps and bounds as the ability to process unique pieces has improved. (For more on robotics in fabrication shops, see "Robot Ready" in the January 2020 issue and "Robotic Revalations" in the January 2019 issue, both available at **www.modernsteel.com**.)

Digital collaboration and mobility. The industry is steadily moving away from a paper-based process, and while it may take time to filter down, digital collaboration is coming to the construction industry. These programs and apps (PlanGrid, Autodesk BIM360, Procore, Tekla EPM, StruMIS, SDS/2, Advance Steel, and Fabtrol to name a few) offer real-time and digital methods to track productivity (through wearables/sensors such as smart boots, smart glasses, and even smart hard hats), manage documents, plan site logistics, etc.

Drones. Unmanned aerial vehicles (UAVs), better known as drones, have become a useful tool for general contractors and construction managers for site survey, site logistics, inspection, and overlaying field progress to the 3D model—and they're cool. But while they seem to have a fairly low financial barrier to entry, once professional-grade hardware, software, and operator training are factored in, the costs of using drones can be considerable. It's for this reason that it's better to employ a specialty drone operator rather than implement drones on your own. A good place to start with a GC that has successful experience with drones.

AR/VR. Augmented and virtual reality (AR and VR) are high-upside technologies that are still somewhat new in the construction world. VR has moved past being purely a marketing tool to being a practical collaboration tool for design and construction. For now, it probably belongs firmly in the "things you should be aware of" camp rather than the "you should implement this tomorrow" camp. Expect to see a much wider adoption of these technologies for training and coordination in the relatively near future.

Technology has a large role to play in improving construction productivity, but it alone cannot revolutionize the industry. It's not as simple as flipping a switch and in a highly fragmented industry, most individual stakeholders lack the leverage or size to make an impact entirely on their own. To improve the flat productivity curve in construction, there are myriad factors that need to be addressed beyond technology alone. But it is the most powerful and actionable—not to mention fun—route to improving design and construction. And it should be appropriately championed by someone at your company. ■

With VR and AR technology, walking a virtual beam can feel like the real thing.

DWP©

Virtual Conference, Real Success

BY GEOFF WEISENBERGER

COVID-19 kept us apart for the 2020 NASCC: The Steel Conference, but it brought us together in new ways—and in large numbers.

Geoff Weisenberger (**weisenberger@aisc.org**) is senior editor of *Modern Steel Construction*.

WHEN I WAS A SOPHOMORE at the University of Iowa, I took an elective class in the religious studies department called, I kid you not, "Quest for Human Destiny." (How can you resist a class called Quest for Human Destiny?)

It wasn't just the title that made it one of the most popular classes on campus. It was the professor, Jay Holstein. He was mesmerizing, a master lecturer and storyteller. Every week for his lecture, he filled the 900-seat lecture theater in Macbride Hall, one of the school's oldest edifices. I took multiple courses in that room, and let's just say that with a lot of other ones, there was always plenty of prime seating available. Not so with a Holstein class. If you didn't get there early, you sat in the last few rows of the balcony—or worse, in one of the stairwells (I sat on the stairs a lot).

This was in the 90s, long before online and distance learning opportunities were common. (As a Gen X-er, you Millennials don't know how good you've got it. And as for your Boomers and the Greatest Generation, yes, I am fully aware you walked to and from school uphill both ways in the snow.) It's 2020 now, and thank goodness we have these opportunities—especially this spring, when NASCC: The Steel Conference was originally scheduled to take place in Atlanta but was forced to go online due to COVID-19/Coronavirus.

While the pandemic kept us away from the Big Peach, kept us from shaking hands with or hugging colleagues we see only once a year, kept us from physically packing the exhibit hall and session rooms, and kept us from letting some steam off at the always-festive networking events, it couldn't keep us from convening to learn from the best and brightest in our field. NASCC went online, where it featured more than 50 sessions as well as an online exhibit hall with nearly 250 exhibitors. Every cloud has a silver lining, and in the case of Virtual NASCC, many sessions drew large, engaged audiences—in some cases much, much larger than a typical convention center meeting room can accommodate, and a few even large enough to fill Macbride Hall twice over and then some—and no one had to sit in the stairwell.

"The attendance numbers were the big story of the week, and most speakers were interested in knowing how many attended their sessions," said moderator Nate Gonner, a senior engineer with AISC's education department. "When we told them how many, the reactions ranged from excitement to bewilderment. Many speakers asked us to repeat ourselves. They could not believe their ears when they heard the number the first time."

"I think we delivered a high-quality conference for both the attendees and speakers," said Brent Leu, AISC's manager of continuing education. "It was an adjustment for everyone not to be in Atlanta, but the willingness of the speakers to present in the virtual format and the appreciation of the attendees to still have a Steel Conference to attend made for a great week."

The virtual format also allowed for real fun.

"Occasionally, friends of the speaker would make themselves known through the Q&A, where the audience could submit questions," said Gonner. "Duane Miller asked Lou Geschwindner if he was wearing one of his colorful bow ties, and a large number of employees from Nucor-Vulcraft asked Bruce Brotherson if the rumors were true that he was known as "Captain Joist Girder."

All of the 2020 Virtual NASCC sessions can be viewed at **aisc.org/2020nascconline**. There were plenty of highlights and takeaways from the sessions, and AISC staff moderators shared some of their own. Here are 14. (Special thanks to **Jacinda Collins**, **Nate Gonner**, **Christina Harber**, **Brent Leu**, **Dennis Pilarczyk**, and **Kristi Sattler** for providing their feedback!)

A3: Sustained in Steel

Many people feel that the energy usage in recycling steel can be viewed as a bad thing. However, the extra energy is offset by other advantages—e.g., less landfill waste and the harm that waste can do to the environment. Also consider that the vast majority of steel's carbon footprint is tied to electricity use. If the grid becomes greener, so does steel production and fabrication.

A4: Performance-Based Structural Fire Engineering for Steel Buildings

The speaker provided an enlightening overview of the differences between prescriptive fire design and performance-based structural fire engineering and discussed a performance-based design case study that resulted in a reduction in fire protection on some of the steel members.

A5: Architecturally EXPOSED! From High-Tech Architecture to Today's Best Practices in Architecturally Exposed Structural Steel

The presentation mostly explained how we got to our current category system) with architecturally exposed structural steel (AESS) and how a majority of projects can benefit from simple geometry with the use of AESS Categories 1-3 (for details on the various categories, see "Maximum Exposure" in the November 2017 issue). In addition, speaker Terri Meyer Boake is working on a new book!

A6: Working With New Materials and New Techniques

This presentation followed the prototyping process for four unusual projects, including two art installations that used mushrooms (you heard that right) as the building material.

A11: Innovations in Steel for Architects

One question that arose is how to achieve large or small floor penetrations when using hollow-core plank. Small penetrations can be cored through the plank itself, and hangers (or seats) are available for larger penetrations.

E3: Designing Built-Up Flexural Members

Speaker Lou Geschwindner has the rare ability to present highly complex topics in a way that even an entry-level engineer can understand and relate to. (Find out more about Lou in the March 2020 Field Notes article, "Long-Time Lion.") This session topped out at more than 2,000 attendees.

E4: Fast and Efficient Design for Stability

Presented by Larry Griffis and Rafael Sabelli, this was a "full-house" presentation. It was also a practical, effective one, with feedback ranging from "Informative and a great find for future design/analysis for tall structures" to "A very interesting and efficient application. I will definitely follow up in learning this methodology."

E13: Resistance and Resilience of Composite Floor Systems to Fire: Experiments, Modeling, and Design

Experimental testing at Lehigh University, as part of an AISC Milek Fellowship, looked at the behavior of composite floor systems in fire scenarios. The findings will be used to develop performance-based fire engineering design methods that can leverage standard fire tests.

Q1: Answers to your AISC Certification Questions

A great overview on how COVID-19 has affected AISC's Certification Program and how AISC/QMC is adapting to accommodate participants, including remote assessments.

R4: Advances in Erection Engineering for High-Rise Steel Structures

181 Fremont in San Francisco is an amazing project! (And you can read about it in "Braced for the Future" in the April 2016 issue as well as our May 2019 coverage of AISC's IDEAS^2 Award winners.)

T10: New Technology, Existing Spaces

Going into this session, presenter Thad Wester knew that there would be a lot of audience questions related to digital scanning and point cloud technology, so he kept his presentation short to allow for a lengthy Q&A period. He was spot on with that assessment as we had more than 100 questions! (To read more about this session, see "A Real Look at Your Job Site" in the April 2020 issue.)

Y7: Is This Floor Moving? Vibration Analysis of Steel Joist Concrete Slab Floors

Only an hour into the presentation, speaker Brad Davis, one of the world's foremost experts on vibration of steel-framed structures, received nearly 50 questions!

Y11: Design and Detail Issues that Add Cost to Structural Steel Projects—and How to Avoid Them

This was hosted by Brian Volpe of Cives Steel Company. Once we informed Brian of the attendance—2,585!—he said that this was by far the largest crowd he has ever presented "in front of!" (To read more about this session, see "Streamlined Design" in the March 2020 issue.)

Z6: Understand Your Assets as a Manager

Engineers tend to be people that are technically proficient, building technical skills as they work on larger and more varied projects—and they tend to mentor and train new engineers in these technical skills. Management responsibilities, however, often tend to be thrust upon engineers without much training or guidance. Speaker Dan Coughlin challenged the audience to think about how to use their talents and personality qualities to motivate their staff. (Dan presented multiple sessions via the Virtual Steel Conference and has authored several *Modern Steel* articles. His most recent is "Thoughts on Excellence" in the March 2020 issue.) ■

All referenced Modern Steel Construction *articles can be found in the Archives section at* ***www.modernsteel.com****.*

AWARDS

Nominations Sought for 2021 AISC Higgins Lectureship Award

Nominations are being accepted through July 15, 2020, for AISC's T.R. Higgins Lectureship Award, which includes a $15,000 cash prize. Presented annually by AISC, the award recognizes a lecturer-author whose technical paper(s) are considered an outstanding contribution to engineering literature on fabricated structural steel. The winner will be recognized at the 2021 NASCC: The Steel Conference, April 14–16, 2021 in Louisville, Ky., and will also present their lecture, upon request, at various professional association events throughout the year.

Nominations should be emailed to AISC's Rachel Jordan at **jordan@aisc.org**. Or if you'd prefer to mail your nomination, contact Rachel for mailing information. Nominations must include the following information:

- Name and affiliation of the individual nominated (past winners are not eligible to be nominated again)
- Title of the paper(s) for which the individual is nominated, including publication citation
- If the paper has multiple authors, identify the principal author
- Reasons for nomination
- A copy of the paper(s), as well as any published discussion

The author must be a permanent resident of the U.S. and available to fulfill the commitments of the award. The paper(s) must have been published in a professional journal between January 1, 2015 and January 1, 2020. In addition, the winner is required to attend and present at the 2021 Steel Conference and also give a minimum of six presentations of their lecture on selected occasions during the year.

The award will be given to a nominated individual based on their reputation as a lecturer and the jury's evaluation of the paper(s) named in the nomination. Papers will be judged for originality, clarity of presentation, contribution to engineering knowledge, future significance and value to the fabricated structural steel industry.

The current T.R. Higgins Lecturer is Bo Dowswell, PE, PhD, principal at ARC International, LLC, who received the award for his paper "Design of Wrap-Around Gusset Plates," as well as for his outstanding reputation as an engineer and lecturer. If your organization is interested in hosting a T.R. Higgins lecture, please contact Christina Harber, AISC's director of education, at **harber@aisc.org**.

The award is named for Theodore R. Higgins, former AISC director of engineering and research, who was widely acclaimed for his many contributions to the advancement of engineering technology related to fabricated structural steel. The award honors Higgins for his innovative engineering, timely technical papers and distinguished lectures. For more information about the award, visit **aisc.org/higgins**.

Bo Dowswell, current AISC T.R. Higgins lecturer.

PUBLICATIONS

Stainless Steel Spec Open to Public Review

The new AISC *Specification for Structural Stainless Steel Buildings* will be open to public review from June 8 to July 10 and, along with the review form, will be available for free download at **aisc.org/publicreview** during this period. Copies are also available (for a $35 charge) by calling 312.670.5411. Please submit comments using the form provided online to Cynthia J. Duncan, AISC's director of engineering (**duncan@aisc.org**), by July 10 for consideration.

People and Companies

The **American Galvanizers Association (AGA)** Board of Directors has appointed **Melissa Lindsley** to the position of executive director. She will be transitioning into the position over the next several months with the full support of the current executive director, **Philip Rahrig**, who is retiring in later this year.

Lindsley has been with the AGA since 2005 and for the past 13 years has served as marketing director. In that time, she has become the driving force in the galvanizing industry's digital marketing and communications strategy and developed a broad network and collaborative experience within key influential organizations such as AISC, NSBA, the American Iron and Steel Institute (AISI), the American Institute of Architects (AIA), and many others.

In addition to developing a keen technical acumen on the galvanizing process and its products, Lindsley has a deep understanding of architects, engineers, and specifiers in the markets served by the hot-dip galvanizing industry. She has also been instrumental is working with key experts to define and quantify the industry's position on sustainable development, and create and distribute this important messaging to all those as concerned with the environment, future society, and economic frugality as the galvanizing industry.

"Ms. Lindsley is a passionate advocate for all things hot-dip galvanized and is committed to the continued growth and success of our great industry," said AGA president Daniel Bever.

Welcome to Safety Matters, which highlights various safety-related items. This month's topics include grinding and National Safety Month.

Grinding

Grinding steel to remove corrosion and other elements is an integral part of structural steel fabrication. And like any industrial process, it comes with its own set of hazards. Some of the major ones to look out for and mitigate include:

- Bursting. A major injury risk in the use of grinding wheels is that the wheel may burst during grinding.
- Eye injuries. Dust, abrasives, dirt and mill scale are a common hazards to the eyes in all dry-grinding operations.
- Fire. Combustibles left in the vicinity of grinding can be ignited by sparks. Combustibles such as combustible dust should be kept away from grinding and the path of sparks.
- Vibration. Working with handheld grinders and holding pieces while using a bench grinder transmits vibration to your hands. Hand-arm vibration exposure (HAV), besides being a known contributing factor to carpal tunnel syndrome and other ergonomic-related injuries, causes direct injury to the fingers and hands, affecting feeling, dexterity, and grip. Proper gloves can reduce vibration and its effects.
- Respiratory issues. Grinding puts respirable dusts in the air around the person doing the work. Masks and other PPE should be worn.
- Kickback. Catching a grinding wheel on a protrusion or putting the grinder down before it has stopped can both cause the grinder to jump in unintended directions, potentially causing injury.

A safety checklist for abrasive wheel equipment grinders is available at **tinyurl.com/newgrindcheck** and a checklist for portable grinders is at **tinyurl.com/portcutoff**. When it comes to grinder training, periodic refresher training should follow initial training. OSHA requirements for grinder training in construction are in OSHA 1926.21.

National Safety Month

June is the National Safety Month, and each year it motivates thousands of organizations work to reduce and eliminate the leading causes of injuries and deaths at work. This nationwide event was created in 1996 by the National Safety Council and since then, has focused on worker safety by offering resources like targeted weekly safety topics throughout the month. Accidents are preventable and it is the duty of employers and employees to work together to help create safe working environments.

One effective idea to get management and workers interested in safety is to take the "SafetAtWork Pledge." This pledge challenges management to provide the financial backing, training, tools, and oversight to create a healthy and safe work environment. For workers, it is a commitment to not compromise personal safety and coworker safety, be actively engaged in looking for workplace hazards, and report those hazards is the focus. For more information, visit **safety.nsc.org/safeatworkpledge**.

Dates to Note

- National Safety Month. Month of June, **www.nsc.org**
- World Environment Day. June 5, **www.worldenvironmentday.global**
- SteelDay Safety Event. September 25, **aisc.org/steelday**. Information was sent out this spring to participate in a SteelDay Safety Event and receive a banner to display at your facility. If you missed it, let us know via the email address below.

Given the current COVID-19 situation, these dates are subject to change. Check the related websites periodically for updates. Also, visit **www.osha.gov**, which includes information concerning COVID-19 safety in the workplace.

AISC has established its own resource page with information on employment, contract, and safety issues regarding COVID-19. It's at **aisc.org/covid19**.

We are always on the lookout for ideas for safety-related articles and webinars that are of interest to AISC member companies. If you have safety-related questions or suggestions, we would love to hear them. Contact us at **schlafly@aisc.org**. And visit AISC's Safety page at **aisc.org/safety** for various safety resources.

news & events

Letters to the Editor

You're Welcome

The December 2019 news item "Federal Appeals Court Turns to AISC *Code of Standard Practice*" contained some interesting information that highlights the value QMC adds to our audits in at least three areas: contract review, purchasing, and training.

Contract review. The *Code*'s Commentary states: "Such evidence should indicate consideration of pertinent Sections of this Standard and *other critical project requirements* that, if missed, will have a major impact on project quality." In the item, the fabricator missed incorporating "critical project requirements" and "failed to incorporate (the contractor's) bid package into the purchase order, which required the subcontractor to follow" the *Code*. Then, when it went to court, the fabricator unsuccessfully argued that the *Code* governed. However, since the purchase order didn't mention the *Code*, nor did it incorporate the *contractor's bid package requirements* (which did include the *Code*), the court ruled against the fabricator's argument that the purchase order governed.

Purchasing. Section 1.10.1 of the *Code* specifies the purchase order (PO) data. Although the fabricator didn't write the PO, they failed to identify that the contractor's PO did not carry over the project specifications into the PO. This legal case highlights that an executed purchase order can be used in the courts; the fabricator's argument was prefaced on the contractor's PO. Since POs have such legal force, how often have you seen POs that fail to meet the *Code*'s minimum requirements? It never ceases to amaze how often fabricators/erectors haven't written "Terms and Conditions" in the POs in order to protect them. The difference between a PO that has the bare minimum data (and no terms and conditions) and a PO that is a few pages long (and does include terms and conditions) is significant. A well-written PO can save you if things ever go to court!

Training. The AISC *Certification Standard for Structural Steel Fabrication and Erection and Manufacture of Metal Components* states: "Personnel responsible for functions that affect quality... shall receive appropriate initial and periodic documented training." Think about it, what percentage of participants would you say are effectively training *management* personnel on subjects like contract review, purchasing, etc.? A large percentage of training records focus on *shop* personnel who have no impact whatsoever on what appears in a purchase order or are ever invited to sit in on contract reviews. Another area where QMC adds value to the audits.

Thank you for publishing that news item. And to all the applicants to/participants in AISC's Certification program: You're welcome!

Zane Keniston
QMC Auditing

Old-Fashioned Engineering

Thank you for finally including a good article on practical, everyday, old-fashioned engineering ("Engineering the Building of Buildings," April 2020). Mr. Twarek did a good job discussing practical engineering problems one might face in the real world.

I had almost lost interest in your magazine with all your super modern, way-out steel designs. It presents what may be of interest to an architect but not normal civil engineers.

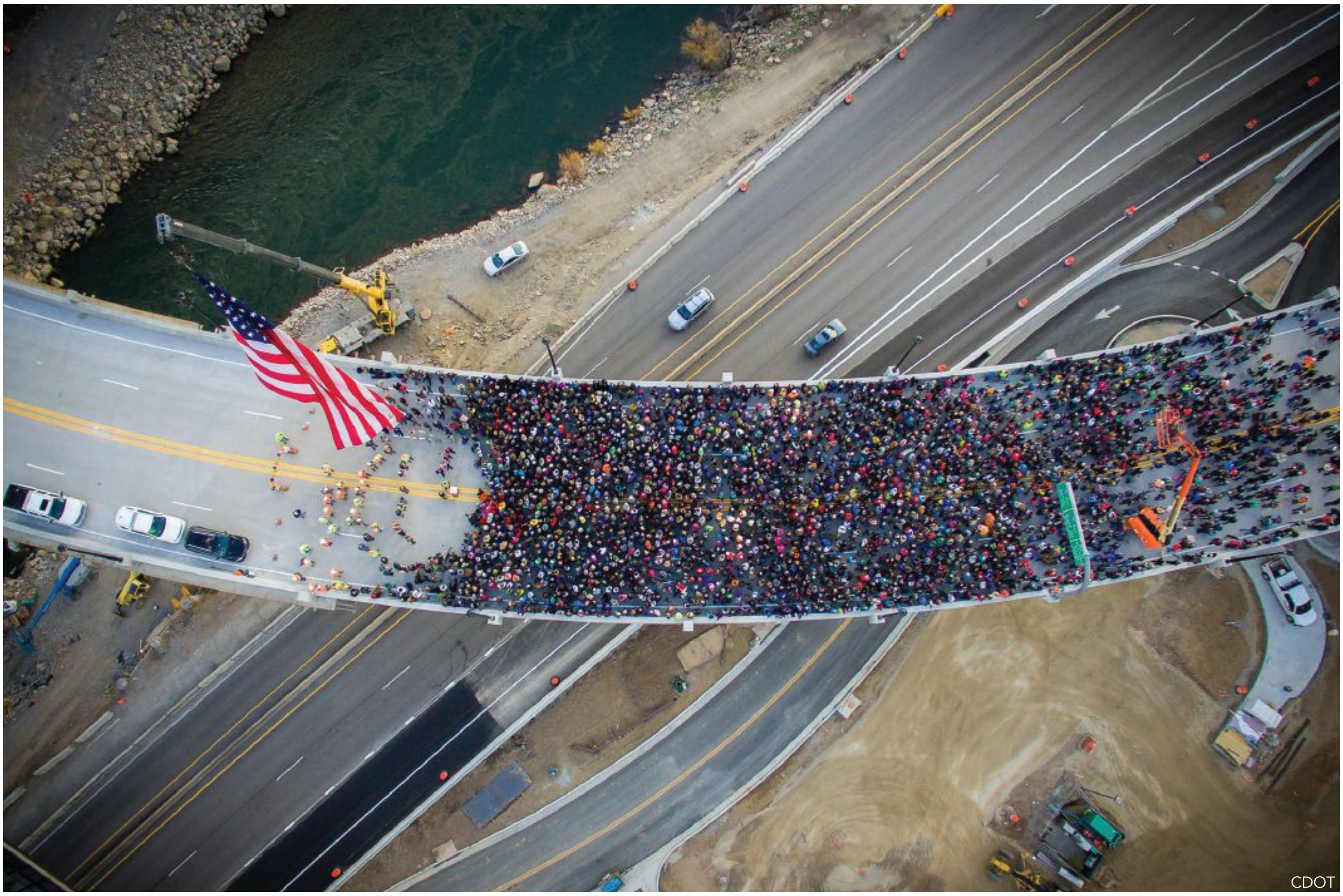
William H. Sewell, Jr., PE
Sewell Engineering, LLC

Response from Andrew Twarek:

Thanks for the kind words! I would agree that construction engineering (CE) isn't the flashiest type of structural engineering, but it is certainly a vital part of helping a project come together in the field. I enjoy that every CE project is unique and challenging.

Andrew Twarek, SE, PE
Ruby+Associates, Inc.

advertiser index



CDOT

HOT SPRINGS, COLD RIVER

PEOPLE FLOCK TO GLENWOOD SPRINGS, Colo., for its soothing hot springs. But they must cross a cold, rumbling river to get there from the town's historic downtown business district.

Up until recently, that crossing came in the form of a 676-ft-long steel plate girder bridge over the Colorado River, built in 1953. But after more than a half-century of service, the bridge had become a traffic bottleneck whose structural capacity didn't meet current codes. Its replacement, the new Grand Avenue Bridge, carries State Highway 82 over Interstate 70, the Colorado River, and UPRR lines before descending into downtown Glenwood Springs.

Designed by engineering firm RS&H and fabricated by AISC member W&W/AFCO Steel–Hirschfeld Division, the project scope changed the SH82 alignment over the bridge from straight to curved with a 625-ft radius. The new alignment and proposed intersections at the north end improved traffic flow at the SH82/I-70 interchange but made the new bridge geometrically challenging, with the bridge crossing I-70, the river, and the railroad at varying degrees of skew. Built as two units—one steel and one concrete—the steel portion is a curved, variable-width, constant-depth, five-span continuous steel trapezoidal tub girder bridge. Not only does this new crossing span several obstacles, but it also showcases how steel tub girder design can serve as an efficient solution to complex bridge geometry.

The Grand Avenue Bridge is a 2020 NSBA Prize Bridge Award winner. You can read more about it and all of this year's winners in the July issue. ■

PYTHONX® STRUCTURAL

SUCCESS STORY: M&G Steel

Retains a competitive edge with 14-year-old PythonX Technology

Based in Oakville, Ontario, M&G Steel Ltd. has grown into one of the leading structural steel fabrication and erection contractors in Canada.

CHALLENGE

M&G Steel is not your typical structural steel fabricator; they do more customized structural steel. Their niche is working on and through very complex projects that present challenges in engineering, site access, tight timelines and coordination. Their customers expect a quality product that is on time and as cost-effective as possible in the market and sometimes that can be a challenge. So they needed to think outside the box to find a way to provide a good quality product to their customers at a competitive price.

SOLUTION

Since they performed all fab shop operations manually, they quickly needed to get up-to-date with technology. M&G realized that adding a traditional drill line and saw only brought their capabilities to that of their competitors. What they were looking for was something that gave them a distinct advantage over others within their market.

BRIAN THOMPSON
Vice President, Operations

PRODUCT

Coincidentally, they received a CD from PythonX in the mail, and once they viewed the CD, they were impressed with this new technology. PythonX STRUCTURAL was completely different from any of the other machines that they were considering. So they took a leap of faith and purchased it a week later. After 14 years, the PythonX STRUCTURAL is better than ever and has proven to be the most profitable piece of equipment they have ever owned.

RESULTS

INCREASED THROUGHPUT
Production more than doubled

PERFORMANCE
14 YEARS
IN OPERATION

MINIMAL WEAR & TEAR
Virtually maintenance-free

For more information on this revolutionary technology: Call +1 833 PYTHONX

Watch the Video: www.pythonx.com/mg-steel

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