Modern Steel Construction

November 2022

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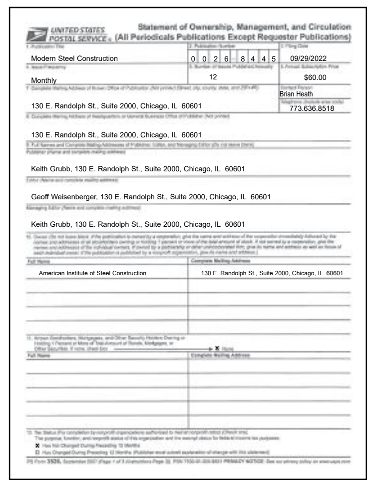

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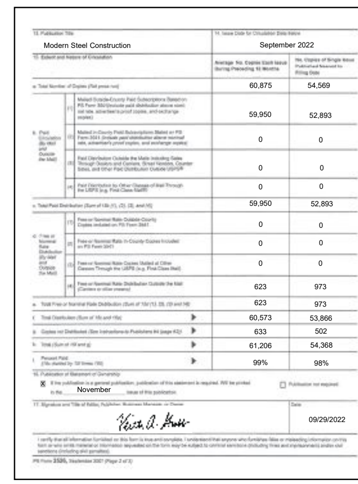

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a.	60,875	54,569
b. (1)	59,950	52,893
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b. (4)	0	0
c.	59,950	52,893
d. (1)	0	0
d. (2)	0	0
d. (3)	0	0
d. (4)	623	973
e.	623	973
f.	60,573	53,866
g.	633	502
h.	61,206	54,368
i.	99%	98%

X ... in the November issue of this publication.

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ON THE COVER: Carson's new Omaha headquarters building looks to enhance the employee and customer experience, p. 30. (Photo: AJ Brown Imaging/courtesy of LEO A DALY)

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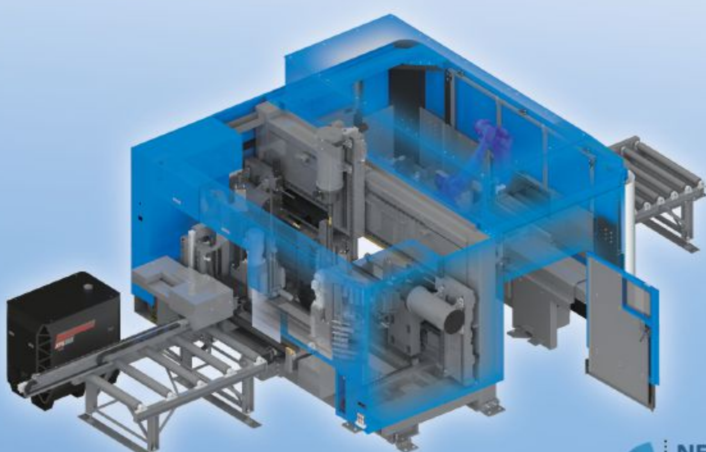

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editor's note

This past summer, I took a tour of Wrigley Field. As would be expected, I learned a lot about the history of the famed ballpark and the Chicago Cubs.

As part of the tour, I got the opportunity to play catch and take pop flies and grounders on the field itself for an hour or so. It was a lot of fun. I felt like a kid again.

Before the tour, I took a walk around the perimeter of the stadium. When I turned the corner at Sheffield and Addison, I came upon a two-story steel frame that, when completed, will house a sportsbook building with a penthouse and roof terrace. The structural engineer for the project was Thornton Tomasetti, whose scope of work included designing the gravity and lateral systems, including the steel roof trusses, along with the foundations, as well as performing vibration analysis in select areas. Gensler served as the architect, and AISC member LeJeune Steel fabricated approximately 250 tons of steel for the framing system. A significant amount of the steel is exposed, including several trusses that were designed to simulate those in the ballpark itself.

It's always fun to turn a corner on a walk and see a cool new building going up. Now, of course, this is a real-life, here-and-now steel project, the likes of which we feature every month. On that note, keep an eye out for an article on this one in the future. And speaking of the future, what will steel projects look like moving forward? Will we see, I don't know, an offshore oil rig repurposed as a cultural center? Or perhaps a graffiti-inspired, social media-driven forest of communication that encourages discourse between citizens and civic entities? Or maybe even a grocery store experience that lets shoppers feel like they're in a massive vending machine?

I didn't just make these up. All three concepts—and 11 others—were winners of this year's Steel Design Student Competition (SDSC). Sponsored by AISC and the Association of Collegiate Schools of Architecture (ACSA), the competition challenges college-level students to develop steel-framed designs that fall into one of two categories: a main category that changes every year and an open category where the sky is pretty much the limit. This year's main category encouraged students to design democratic public spaces for the 21st century.

You can read about these winning, futuristic designs, as well as see some amazing renderings, starting on page 44. And if you want an inside look at how one of this year's winners came up with his idea and how his faculty advisor helped him refine it, check out the Field Notes column on page 26.

Back to the present, now that Major League Baseball has wrapped up until next April (and Chicago wasn't represented in the playoffs by either of its teams), here's hoping the Wrigley Field project will spur the Cubs on to great things next season (and that they will still get swept by the White Sox).

Geoff Weisenberger
Chief Editor

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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**.

SCBF Supported by a Concrete Beam

We are currently designing a special concentrically braced frame (SCBF) that will sit on top of a concrete beam in the building. The braced frame anchorage into a concrete beam is designed per Section D2.6 in the AISC *Seismic Provisions for Structural Steel Buildings* (ANSI/AISC 341) for column bases. But does the local concrete beam longitudinal and shear reinforcement supporting this braced frame also need to be designed per the requirements in Section D2.6, or can it be designed for the forces of governing load combination per ASCE 7: *Minimum Design Loads for Buildings and Other Structures*, Chapter 12?

It is important first to clarify that this condition is not directly addressed in the AISC *Seismic Provisions* and will require the use of engineering judgment.

The Commentary to ASCE 7 states: "The standard specifies an overstrength factor, Ω_0, to amplify the prescribed seismic forces… This approach is a simplification to determining the maximum forces that could be developed in a system and the distribution of these forces within the structure. Thus, this specified overstrength factor is neither an upper nor a lower bound; it is simply an approximation specified to provide a nominal degree of protection against undesirable behavior."

I suspect that many engineers and the committee members involved in writing the design standards would feel that "a nominal degree of protection against undesirable behavior" is not sufficient for use with a steel special concentric braced frame. Therefore, they would design the concrete elements (including their steel reinforcement) for the expected capacity of the braced frame. This would ensure the system provides "significant inelastic deformation capacity primarily through brace buckling and yielding of the brace in tension," which is the basis of design for such systems.

Designing for less than the expected capacity of the braced frame could result in the failure of the concrete elements before the brace buckles or yields. Brace buckling and yielding is the mechanism that justifies the *R*-factor used with an SCBF. If this behavior cannot be achieved, then it is unclear how the *R*-factor would be justified.

Larry Muir, PE

Field Cutting Existing Moment Connection

We are working on a project where an existing beam that is moment-connected to a column needs to be removed. The column will remain, and we are concerned with uneven cutting leading to stress risers, excessive heat, etc. Does AISC have any recommendations related to this type of field modification?

There are no formal requirements. And because such a situation tends to be very project-specific, I believe there are no formal recommendations either. To some extent, the concerns you mention can be addressed by limiting the work at the column. For instance, if the column is to be enclosed (e.g., wrapped with cladding), then it may be possible to leave a portion of the beam in place. This would significantly reduce the heat to which the column is exposed. Uneven cutting will also be less of a concern if it occurs away from the column flange. There would seem to be little reason for the stress to take an excursion out along even a short stub of the beam to cause problems before returning to its original load path along the column.

If you cannot move the work away from the column flange, you must be more careful. It is generally a bad idea to heat a member under load, especially across the flange, as might be done for the condition you indicate. You may need to consider shoring if the work is performed at the column surface. If you cannot move the work away from the column, then to avoid nicking the column, you might need to cut the beam a short distance from the column and then grind to remove the balance of the beam stub.

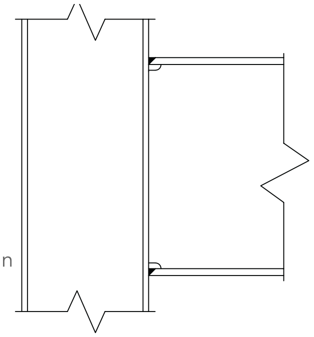

Fig. 1. Existing beam-to-column moment connection.

The following AISC publications might also be helpful to review:

- AISC Design Guide 15: *Rehabilitation and Retrofit* (Section 2.5: Thermal Cutting of Existing Members)
- AISC Design Guide 21: *Welded Connections – A Primer for Engineers* (Section 14.9.4: Welding and Cutting on Members under Load)

Larry Muir, PE

All mentioned AISC publications, unless noted otherwise, refer to the current version and are available at **aisc.org/publications**. *Modern Steel* articles can be found at **www.modernsteel.com**.

Compressible Material

Section 6.2 in AISC's *Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications* (ANSI/AISC 358) states: "The concrete structural slab is kept at least 1 in. (25 mm) from both sides of both column flanges. It is permitted to place compressible material in the gap between the column flanges and the concrete slab. Why does the concrete slab need to be separated from the column flange?

The commentary to Section 6.2 in *Prequalified Connections* provides an explanation for this requirement. The commentary states: "Sumner and Murray (2002) performed one test in which a slab was present. In this test, headed studs were installed from near the end-plate moment connection to the end of the beam, and the concrete was in contact with the column flanges and web. The lower bolts failed prematurely by tension rupture because of the increase in the distance from the neutral axis due to the presence of the composite slab. In later testing, Murray repeated this test but placed a flexible material between the vertical face of the end plate and the slab to inhibit slab participation in transferring load to the column. This specimen performed acceptably and resulted in provisions for using concrete structural slabs when such flexible material is placed between the slab and the plate."

As indicated in Sumner and Murray (2002), when the slab was present, the bottom bolts failed prematurely in tension rupture, as illustrated in Figure 2, in addition to buckling in the bottom flange (note that the moment connection was subjected to cyclic loading). A moderate amount of yielding was observed in the top flange, indicating that a large portion of the load was being transferred through the composite slab and not the flange. The connection performed adequately when a gap was provided and replaced with flexible material.

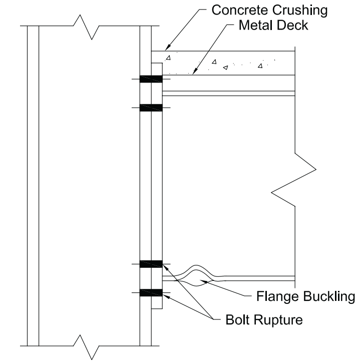

Fig. 2. Bolt failure.

Reference: Sumner, E.A. and Murray, T.M. (2002) "Behavior of Extended End-Plate Moment Connections Subject to Cyclic Loading," *Journal of Structural Engineering*, ASCE, Vol. 128, No. 4, pp. 501-508.

Carlo Lini, PE

Minimum Weld Distance

AISC Design Guide 4: *Extended End Plate Moment Connections*, regarding the calculation of the beam web to end-plate weld, states on page 33: "The applied shear is to be resisted by weld between the minimum of the mid-depth of the beam and the compression flange or the inner row of tension bolts plus two bolt diameters and the compression flange." Is the underlined text referring to the A dimension in Figure 3 or the B dimension?

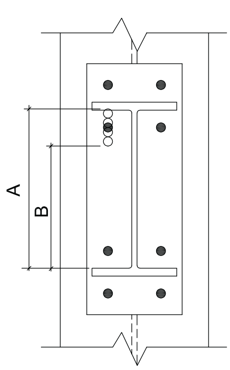

Fig. 3. Beam-to-column extended end-plate moment connection.

The text describes the B dimension, but note that the mid-depth to compression flange would control for the beam shown in Figure 3.

The idea is that if the assumed area resisting shear extended into the area of the joint resisting tension, then combined shear and tension would have to be considered in the design. This would be a significant complication. Since the area in tension would likely contribute little to the shear resistance, it is simplest to neglect its ability to resist shear altogether.

Since the compressive loads tend to be transferred through bearing, the interaction of shear and compression does not need to be considered.

The shear will also tend towards the compressive side of the weld due to two factors. First, since the weld on the compressive side is unloaded, it will tend to be stronger and will remain stiffer than the weld on the tension side. Load tends to be attracted to stiffness. Second, the bolts will act similarly. The shear will tend to be resisted through friction on the compressive side (similar to a slip-critical connection). The compression force will tend to increase the friction. Even if the bolt resists shear in bearing, again, the bolt is in tension and will tend to be less stiff due to the presence of tension, so again the shear will tend towards the compression side of the joint. There is a simpler and shorter load path between the bolts on the compression side and the welds on the compression side than between many other assumptions that could be made. More direct and short load paths tend to be better design assumptions.

Larry Muir, PE

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STEEL SOLUTIONS CENTER

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This month's Steel Quiz poses the question, "Are you properly specifying materials for your projects?"

We all love numbers, but sometimes it's challenging to keep all the current ASTM material designations straight. We're here to help—or at least to find out how much you've been paying attention. You can find hints (and much more) in the June 2022 SteelWise article "Are You Properly Specifying Materials?" by Jonathan Tavarez (available in the Archives at **www.modernsteel.com**).

Your task: Match the structural shape or product listed on the left with the current preferred material specification listed on the right.

TURN TO PAGE 14 FOR ANSWERS

	Structural Shape or Product	**ASTM Specification**
_____	1 W-shapes and WT-shapes	**a.** ASTM A36
_____	2 HSS	**b.** ASTM F436
_____	3 Steel pipe	**c.** ASTM A786
_____	4 Structural plates and bars	**d.** ASTM A572 Grade 50
_____	5 Raised-pattern floor plates	**e.** ASTM A992
_____	6 High-strength bolts	**f.** ASTM A53 Grade B
_____	7 Nuts	**g.** ASTM A500 Grade C
_____	8 Washers for structural bolts	**h.** ASTM F1554
_____	9 Anchor rods	**i.** ASTM A563
_____	10 Threaded rods	**j.** ASTM F3125

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**.

The preferred material specifications listed should not be taken as requirements but rather as guidance (just like the AISC *Steel Construction Manual*). AISC routinely surveys structural steel fabricators and producers to determine the most common and preferred material specifications for various shapes, plate products, fastening products, and more. This information is based on similar information slated for publication in the 16th edition *Manual* (available mid-2023). These are also the shop-standard materials for structural shapes listed in Section 6.1.1 in the upcoming 2022 edition of the AISC *Code of Standard Practice for Steel Buildings and Bridges* (AISC 303-22).

1 **e.** ASTM A992 (F_y = 50 ksi, F_u = 65 ksi). All ASTM A992 material has a minimum yield strength of 50 ksi. Structural tees are split from W-shapes, so the preferred material specification for W-shapes applies to WT-shapes. The availability and cost-effectiveness of W-shapes in grades other than ASTM A992 should be confirmed before specifying.

2 **g.** ASTM A500 Grade C (F_y = 50 ksi, F_u = 65 ksi). A500 Grade C requirements also meet the requirements of A500 Grade B, so you will likely receive A500 Grade C material regardless of what you specify. Therefore, it is best to specify Grade C to take advantage of the increased design strength. Note that for round HSS, a recent revision to ASTM A500 Grade C occurred in 2021, which changed the yield stress from 46 ksi to 50 ksi. (Generally speaking, only round HSS with the same cross-sectional dimensions as steel pipe are stocked and available.)

3 **f.** ASTM A53 Grade B (F_y = 35 ksi, F_u = 60 ksi). Remember, round HSS ≠ steel pipe. While ASTM A53 is the preferred material for pipes, round ASTM A500 Grade C (F_y = 50 ksi) can be specified for structural applications using pipe dimensions to take advantage of the increased strength.

4 **d.** ASTM A572 Grade 50 (F_y = 50 ksi, F_u = 65 ksi) for material up to 4 in. thick. While ASTM A36 and A572 Grade 50 should be readily available for structural plates and bars, it is more common for plate material to be ASTM A572 Grade 50. If the material is specified as A36, you will likely receive A572 Grade 50. See the June 2022 article "Are You Properly Specifying Materials?" for an important discussion on specifying material over 4 in. thick.

5 **c.** ASTM A786, since strength considerations rarely control the floor plate design.

6 **j.** The preferred material specification for high-strength bolts in steel-to-steel connections is the umbrella ASTM F3125 standard, which consolidates the ASTM standards A325, A490, F1852, and F2280 (which are now listed as grades in the F3125 umbrella standard). Grades A325 and A490 are hex-headed bolts, while Grades F1852 and F2280 are twist-off tension-controlled bolts.

7 **i.** The preferred material specification for heavy-hex nuts used for bolted steel-to-steel connections is ASTM A563. This is referenced in Section 2.3 of the 2020 *RCSC Specification for Structural Joints Using High-Strength Bolts*.

8 **b.** The preferred material specification for hardened steel washers for structural bolts is ASTM F436, which includes both flat circular and beveled washers.

9 **h.** ASTM F1554 covers hooked, headed, threaded, and nutted anchor rods. Remember, anchor rods ≠ bolts. This standard includes Grades 36, 55 (the most commonly specified), and 105. ASTM F1554 Grade 36 is weldable as is. Grade 55 can be welded if ordered with Supplement S1 (the most common approach when welding is required). Due to poor weldability, welding to Grade 105 anchor rods is not recommended.

10 **a.** The preferred material specification for threaded rods is ASTM A36.

All mentioned publications are available at **aisc.org/specifications**.


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Connection Chapter Changes

BY TOM SCHLAFLY AND LARRY MUIR, PE

The latest version of AISC's *Specification* includes several changes to its connection-focused chapters.

THE TWO AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360) chapters dealing with connection design—J and K—differ from each other in a few ways.

Chapter K deals with hollow structural section (HSS) connection design, and Chapter J addresses design for connection elements that are not restricted to HSS configurations. But there is another difference: Chapter J defines limit states for connection elements and provides nominal strengths for those limits. Designers of connections evaluate the configurations they want to design and apply the limit states where they are appropriate. Engineering education, the AISC *Steel Construction Manual*, and its companion design examples provide guidance on what limits to evaluate for sample connections, but the *Specification* neither limits nor requires any particular limit to be checked in any specific location.

Chapter K is very different. Much of Chapter K presents very specific connection configurations and then gives the limit states and strengths that usually control. This format can make connection design much easier because it eliminates the need for the designer to understand how the connection works and how it may fail. However, there is a catch. This straightforward method is only applicable to a limited range of conditions, namely those that are intended to be explicitly addressed in Chapter K. Chapter K addresses *additional* requirements for connections to HSS members and box sections of uniform wall thickness, where seam welds between box-section elements are complete-joint-penetration (CJP) groove welds in the connection region. *The requirements of Chapter J also apply.*

The engineer, regardless of what provisions are being used, must first correctly interpret the intent and then—especially in the case of Chapter K—understand how to deal with variations from the configuration shown. This is because, as stated in the Preface to the *Specification*, "The intention is to provide design criteria for routine use and not to provide specific criteria for infrequently encountered problems, which occur in the full range of structural design." It cannot be assumed that the condition encountered in practice is adequately addressed (or addressed at all) in the *Specification*. Before using any provision of the *Specification*, the user must judge the suitability and applicability of the provision relative to any specific application.

Chapter K is wonderful for demonstrating many useful concepts, but it can mislead a designer. In fact, inquiries to AISC's Steel Solutions Center indicate more misunderstanding of Chapter K than Chapter J. That may be the natural outcome of Chapter K providing guidance regarding which limits need to be checked and which ones don't, whereas Chapter J leaves that to the designer. While designers benefit from the guidance Chapter K provides, they must remember that Chapter J's limits still apply and should evaluate those limits that could control connection performance.

Chapter J

In 2016, AISC's Task Committee 6 (TC 6 - Connections) moved many limits from the configuration-based format of Chapter K to the limit state format of Chapter J. Early in the development cycle for the 2022 *Specification*, the committee received a general request to put many of them back into Chapter K. While the committee understands that many users perceive the configuration-based format to be easier, in practice it can lead to designs that are inconsistent with the intent. Cases of users overestimating strengths by a factor of three while believing they have satisfied the *Specification* have occurred. While these are extreme cases, it has not been unusual to see the cases misinterpreted or to see users apply specified configurations to modified conditions without accounting for the differences. The resulting list of substantive changes follows:

Bolt designations and methods. In previous editions, the task committee thought that designating three grades and two styles of bolts was confusing, so it grouped the bolts by strength and labeled them as Groups A, B, and C. We did not use numeric labels that indicate strength because the most prevalent bolts, ASTM A325, changed from 120 ksi to 105 ksi for diameters over 1 in. After the 2016 edition was adopted, a few events occurred that affected our previous decisions. ASTM eliminated the strength reduction in A325 bolts over 1-in. in diameter. ASTM F3148 bolts with a fixed spline and a strength of 144 ksi were approved and introduced. Suppliers of 200-ksi bolts advised that those bolts would not be made available in the U.S. in the near future.

AISC responded to these events by changing the bolt strength group designations to numeric labels indicating the bolt strengths: Groups 120, 144, 150, and 200. We did not delete Group 200, but these bolts are not presently available. Group 144 bolts have a spline like a tension-control bolt, but the spline remains in place after installation. The bolt is installed with a wrench that adds a controlled number of turns after applying an initial torque. A feature of Group 144 bolts is that RCSC and AISC have specified that they should be pretensioned to the same level as Group 150 bolts. Therefore, the slip resistance of a Group 144 bolt is the same as that of a Group 150 bolt.

Effective throat of welds. Previous editions of the *Specification* permit the designer to add penetration to welds where that penetration could be demonstrated to be consistently achieved. In the 2022 edition, this provision was restricted. Including extra penetration in the effective throat of fillet welds is still permitted but only for mechanized or automated processes and only when it is demonstrated by tests.

PJP joints in compression. For at least the previous two editions, Table J2.5 had different strengths for partial-joint-penetration (PJP) joints in compression for column splices designed to bear and for other joints designed to bear. This distinction has been eliminated. Larry Muir, chair of TC6, attempted to explain the reason for the previous difference in the December 2015 article "Bear It and Grin" (available at **www.modernsteel.com**), stating, "Again, it comes down to uncertainty about the joint. With a column, the configuration of the joint is well defined, and gravity will tend to aid in attaining bearing, but this might not be the case with other configurations." Obviously, gravity still acts in the same manner today as it did in 2015, so apparently, we have become less suspicious of configurations other than column splices.

The directional strength increase, and partially one-sided fillet welds. Single-sided welds subject to tension perpendicular to their axis have always been discouraged. These welds can rotate around the root, causing torsion at the root, and fail before reaching the design strength. Similarly, a compelling series of tests indicates that welds to the ends of square or rectangular HSS that are subject to tension cannot be designed using the direction strength increase. The equation format used to account for the directional strength increase was also revised.

A substantive result is that the strength increase is not permitted at the end of rectangular or square HSS.

Strength of threaded fasteners. The *Specification* has long provided nominal tensile strengths for threaded fasteners as a function of the nominal diameter. The calculation of the nominal tensile strength of threaded fasteners includes a reduction factor that accommodates the difference between the nominal area and the net tension area of the bolt. The 2022 edition of the *Specification* includes a footnote to Table J3.2 that permits the designer to use the minimum specified ultimate strength of the bolt and the net tension area instead of the reduced nominal area of the bolt. This is a less conservative and still a safe way to design larger threaded fasteners. If used with smaller threaded fasteners, it will produce more conservative strengths.

Bearing at "through-bolts." Previous editions of the *Specification* included a limit state of bearing on bolt holes. But that limit assumed that the material around the bolt hole was confined by the nut and bolt head. The 2022 edition includes a bearing strength around the bolt holes that are not confined, such as those where bolts are inserted through two walls of HSS connections.

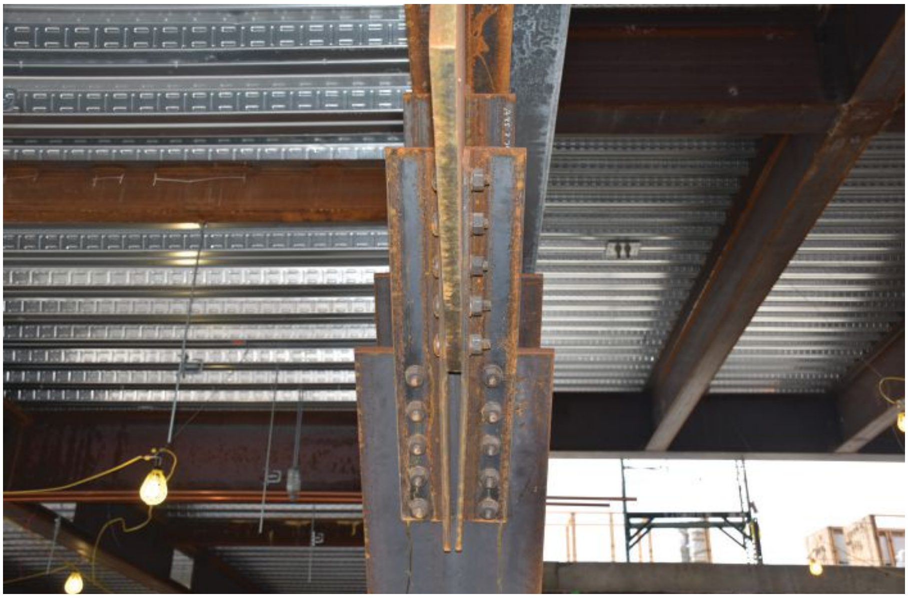
Rough. Previous editions of this *Specification* required galvanized faying surfaces in slip-critical bolted connections to be roughened after galvanizing. The University of Texas conducted tests, and the 2020 RCSC *Specification for Structural Joints Using High-Strength Bolts* adopted a provision saying that faying surfaces for slip-critical joints should not be roughened. The 2022 AISC *Specification* contains a provision stating that galvanized faying surfaces are permitted to be roughened or not roughened for slip-critical joints.

Disassociation. Previous editions of the AISC *Specification* included a list of differences between it and the AWS D1.1 *Welding Code*. Examples of differences between the AISC *Specification* and the RCSC *Specification* were shown in the Commentary. The 2022 edition of the AISC *Specification* deletes the list of differences from the AWS code and adds a corresponding list of example differences in the Commentary. This edition also makes it clear that where there is a difference between AISC and AWS or between AISC and RCSC, the AISC *Specification* controls.

Chapter K

Chapter J does not say that it is limited to connections with rolled shapes and plates. So why does Chapter K say it is for HSS? Chapter K does not just provide strengths for various limit states. It assumes connection configurations and then states where to apply those limit states. It is helpful and comforting. But providing that comfort can eliminate the need to understand the relevant issues.

The explicit changes in Chapter K are minimal. They include:



Branch(es) under in-plane bending. The condition of the branch(es) under in-plane bending is reintroduced to Chapter K. This was done fearing that users might not limit the maximum sidewall stress due to in-plane moment at cross-connections to 0.80 F_y, as was required in the 2010 *Specification*. The figure in Table K4.2 indicates that moments in both branches are reversible.

Where the moments resist each other, buckling of the sidewall should also be considered. This could conservatively be done by applying the web compression buckling provision of *Specification* Section J10.5. However, as stated in the Commentary to J10.5, "When l_b/d is not small, the member web should be designed as a compression member in accordance with Chapter E." If the ends of the sidewall are restrained against translation, then it is common to assume that the effective length factor, K, is 0.5, similar to the assumption of clamped edges employed in the yield line check for HSS. The check-in Section J10.5 assumes a width equal to the "clear distance" of the member. This assumption probably makes sense for this application as well. As indicated in the Commentary to Section J10.5, "Where the flanges are not restrained against translation… the buckling mode interaction between the member delivering the force and the supporting member needs to be considered by the EOR. Refer to Chapter C and Appendix 6 for additional information."

Where the moments act in the same direction, shear in the panel zone should be considered. Where buckling of the sidewall under shear is not a consideration, the provision of *Specification* Section J10.6 can be applied, though the additional inelastic shear strength recognized in Equations J10-11 and J10-12 should not be applied. Where buckling of the sidewall under shear is a consideration, "the shear strength should be determined in accordance with Chapter G," as indicated in the Commentary to Section J10.6.

Effective width. The effective width, B_e for local yielding and B_{ep} for punching shear, is a commonly employed concept in rectangular HSS connection design that addresses the fact that the surface between sidewalls deforms parallel to the force and does not resist load evenly across the

surface. Considering the effect of this uneven loading is simplified by the use of "effective" widths. The effective width is a reduction factor in the strength of a weld. It depends on the proportion of the connected parts and the configuration. There are now separate effective width equations for punching shear and local yielding.

Chord stress interaction parameter. Where branches connect to chords, Chapter K provides a chord stress interaction parameter, Q_f, to calculate the compression capacity of the chord after the branches have "used" some of that capacity. In some cases, the equations provided in previous editions of the *Specification* resulted in illogical results, such as imaginary or negative strengths. Changes to the equations in the 2022 *Specification* seek to resolve some common problems and produce reasonable results.

Every year AISC receives reports of more investigation of connections. More information on peak stresses or residual stresses, or strain-induced performance. AISC seeks economy and finds new issues to consider and new methods to consider them with. Connection design continues to include more investigation, and Chapters J and K will reflect those concepts as they become clear. ■

All mentioned publications can be found at ***aisc.org/publications***.

Change for Good Reason

The AISC Committee on Specifications knows that changes in the Specification are not welcome by engineers unless there is a good reason for them. TC6, in particular, began the cycle with a goal of minimizing changes. Changes usually come to us when provisions need clarification, when new methods are developed and adopted, or when new materials or products become available. In this cycle, TC6 faced another conundrum.

There are constraints. At a minimum, the *Specification* should include provisions required for safe design. Some would say that design standards should be no more restrictive than is necessary to ensure safety. However, users want design standards that are simple and user-friendly. On the other hand, they also want design standards that are as universally applicable as possible. It is often not possible to create provisions that are simultaneously safe, not unnecessarily restrictive, simple, user-friendly, and universally applicable. Simplicity and universal applicability are goals that tend to be mutually exclusive. AISC goes to great lengths to make our *Specification* readable. We provide webinars, material for university classes, design examples, and more than 30 Design Guides. In addition, European HSS producers have developed guides showing fundamental design rules for common HSS connection configurations, and these guides were the result of many connection tests. They assembled some design concepts that were derived from other limit states, and they added information such as effective widths for loads across a surface.

Both the format and the new information resulted in a document that was easier to implement and readable by many users. But it is not an ideal specification. It does not cover all the cases. It does not cover all the conditions, and it applies limits that may not be needed to be safe.

Therefore, in addition to the normal changes in the *Specification*, we have moved some provisions between Chapters J and K to try to achieve the best compromise between the competing goals of simplicity and applicability. A new edition of Design Guide 24: *Hollow Structural Section Connections* will be published soon, and that will further facilitate the applicability of the provisions. Even when that happens, engineers will still be required to look at those connections and assure themselves that all critical limits are safe, buckling will not occur, critical elements are properly braced, and deformations are reasonable. We understand that the extra changes might seem cumbersome, but if you understand our goal, you will understand why they were needed.

Tom Schlafly (**schlafly@aisc.org**) is AISC's chief of engineering staff, and Larry Muir is a consultant to AISC.

Of Ductility and Deformation

BY LOUIS GESCHWINDNER, PE, PHD

Changes to Table D1.1 in the AISC *Seismic Provisions* will help simplify designing with moderately and highly ductile members in seismic applications.

LIMITS ON width-to-thickness ratios for compression elements in seismic force-resisting systems have been part of the AISC *Seismic Provisions for Structural Steel Buildings* (ANSI/AISC 341) for more than three decades.

These limits were introduced in the 1990 edition of the *Seismic Provisions* using the same compact, noncompact, and slender terminology. In the 2010 version, new terms were introduced for the width-to-thickness limits as moderately ductile, λ_{md}, and highly ductile, λ_{hd}, since the term "compact" did not always reflect the limit states consistent with the *Specification*'s use of that term.

To provide for reliable inelastic deformations in those members of seismic force-resisting systems that required it, criteria were established for moderately ductile members and highly ductile members. The requirements were summarized in Table D1.1, which was then referenced throughout the *Seismic Provisions* for the specific systems requiring design according to these limits. A typical set of limits for flanges of rolled I-shaped sections were given there for highly ductile and moderately ductile members, $\lambda_{md} = 0.38\sqrt{(E/F_y)}$. Ten distinct cases, including two cases for composite members, were established in the 2010 edition.

To account for the reality that the expected (mean) yield stress of a particular steel grade typically exceeds the specified minimum yield stress, the 2016 edition introduced the R_y term—which was initially introduced in the 2005 *Seismic Provisions*—to express the expected yield stress as R_yF_y for capacity design into the width-to-thickness limits. The limits were then recalibrated to provide nearly identical results to the 2010 *Seismic Provisions* with the expected yield strengths of the commonly used materials. This required that a specific value of R_y be selected for the calibration of each case. Thus, for situations where a different material, with a correspondingly different R_y, is used, there will be differences between the 2016 and 2010 limits.

Four Changes

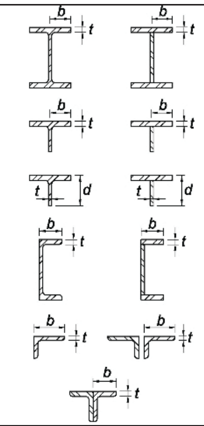
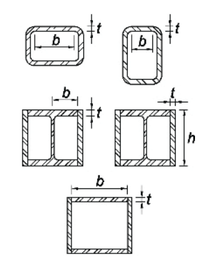
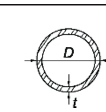
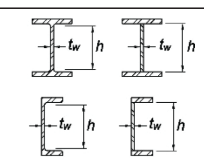
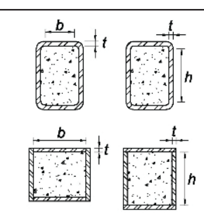
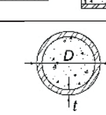
For the 2022 version of the *Seismic Provisions*, four changes were made to Table D1.1. First, the table was split into two tables, Table D1.1a for diagonal braces and Table D1.1b for all members except for diagonal braces. This was done to help distinguish between similar member shapes used in different applications, such as webs of rolled I-shapes, where the width-to-thickness limits are different for members used in diagonal braces and moment frames. Figures 1 and 2 show Tables D1.1a and D1.1b, respectively.

The second change was the addition of case numbers for each set of limits. This is consistent with the approach that has been in place in the *Specification* since 2010 and permits an easy way to reference the specific requirements. This, combined with the splitting of the table, results in 18 cases: six for diagonal braces and 12 for all members except diagonal braces; again, these 18 cases can be seen in Figures 1 and 2. Case 1 and Case 7 have identical requirements for flanges of I-shaped sections used as diagonal braces, Case 1, and as anything other than a diagonal brace, Case 7. Other cases are also repeated in Table D1.1a and D1.1b. Thus, the apparent increase from 12 cases in 2016 to 18 cases in 2022 does not reflect the addition of 6 cases in the *Seismic Provisions*.

The third change is more significant since it results in changes to all but two cases of the width-to-thickness limits. For capacity design, the 2005 *Seismic Provisions* introduced R_y to express the expected yield stress as R_yF_y, but it did not account for the influence of the expected yield stress on the limiting width-to-thickness limits. Recognizing the unfavorable effect of the higher yield stress on local buckling, the F_y term in Table D1.1 of the 2010 edition was replaced by R_yF_y for the 2016 edition. The committee intended to make the conversion in such a way that the resulting limiting values stayed approximately the same between the 2010 and 2016 editions. Some assumptions, and hence compromise, had to be made for that conversion. For example, consider the highly ductile limit $\lambda_{hd} = 0.30\sqrt{(E/F_y)}$ for flanges of rolled or built-up I-shaped sections with $R_y = 1.5$ for A36 steel and $R_y = 1.1$ for A992 steel. Since it was judged that this formula was used mainly for checking flange local buckling of rolled I-shaped members of ASTM A992/A992M steel, $R_y = 1.1$ was used for the conversion to $\lambda_{hd} = 0.32\sqrt{(E/(R_yF_y))}$ in the 2016 edition, even though this equation could be applied to shapes of ASTM A36/A36M steel. This resulted in an increase from $\lambda_{hd} = 7.22$ to $\lambda_{hd} = 7.35$ for A992/A992M steel but a decrease from $\lambda_{hd} = 8.51$ to $\lambda_{hd} = 7.42$ for A36/A36M steel. Thus, the idea that the limits would remain approximately the same was not actually accomplished. If applied to wide-flange shapes, this is not a particularly troublesome change due to the limit being increased. However, this same limit also applies to legs of angles, and at the time of approving the 2016 *Seismic Provisions*, the preferred material for angles was A36/A36M. Thus, for angles, the maximum limit was decreased, thus removing some angles from possible use.

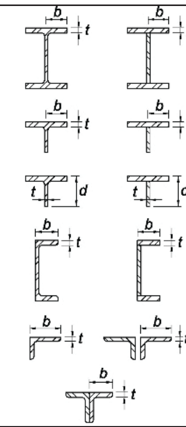
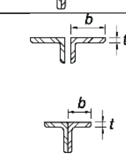
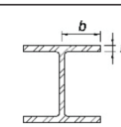
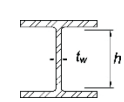
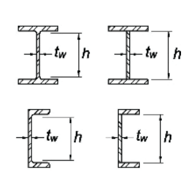
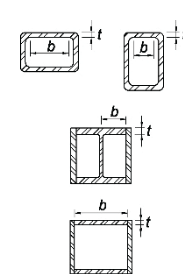
AISC appointed a special task group on local buckling in 2017 with the charge of assessing the implementation of limiting width-to-thickness ratios in both AISC 360 and AISC 341 and clarifying the objectives of these limits. The task group found

TABLE D1.1a
Width-to-Thickness Ratios: Compression Elements
Diagonal Braces

	Case	Description of Element	Width-to-Thickness Ratio	Limiting Width-to-Thickness Ratio: λ_{hd} Highly Ductile Members	Limiting Width-to-Thickness Ratio: λ_{md} Moderately Ductile Members	Example
Unstiffened Elements	1	1) Flanges of rolled or built-up I-shaped sections 2) Flange and stem of rolled or built-up tees 3) Flanges of rolled or built-up channels 4) Legs of single angles or double-angle members with separators 5) Outstanding legs of pairs of angles in continuous contact	b/t d/t	$0.30\sqrt{\dfrac{E}{R_yF_y}}$	$0.38\sqrt{\dfrac{E}{R_yF_y}}$	
Stiffened Elements	2	1) Walls of rectangular HSS[a] 2) Flanges and side plates of boxed I-shaped sections 3) Walls of box sections	b/t h/t	$0.65\sqrt{\dfrac{E}{R_yF_y}}$	$0.76\sqrt{\dfrac{E}{R_yF_y}}$	
	3	Walls of round HSS[a]	D/t	$0.053\dfrac{E}{R_yF_y}$	$0.062\dfrac{E}{R_yF_y}$	
	4	Webs of rolled or built-up I-shaped sections and channels	h/t_w	$1.49\sqrt{\dfrac{E}{R_yF_y}}$	$1.49\sqrt{\dfrac{E}{R_yF_y}}$	
Composite	5	Walls of filled rectangular HSS and box sections.[a]	b/t h/t	$1.4\sqrt{\dfrac{E}{R_yF_y}}$	$2.26\sqrt{\dfrac{E}{R_yF_y}}$	
	6	Walls of filled round HSS sections[a]	D/t	$0.076\dfrac{E}{R_yF_y}$	$0.15\dfrac{E}{R_yF_y}$	

[a] The design wall thickness, 0.93*t*, shall be used in the calculations involving the wall thickness of hollow structural sections (HSS), as defined in *Specification* Section B4.2.

TABLE D1.1b
Width-to-Thickness Ratios: Compression Elements
All Members Except Diagonal Braces

	Case	Description of Element	Width-to-Thickness Ratio	Limiting Width-to-Thickness Ratio: λ_{hd} Highly Ductile Members	Limiting Width-to-Thickness Ratio: λ_{md} Moderately Ductile Members	Example
Unstiffened Elements	7	1) Flanges of rolled or built-up I-shaped sections 2) Flange and stem of rolled or built-up tees 3) Flanges of rolled or built-up channels 4) Legs of single angles or double-angle members with separators 5) Outstanding legs of pairs of angles in continuous contact	b/t d/t	$0.30\sqrt{\frac{E}{R_yF_y}}$	$0.38\sqrt{\frac{E}{R_yF_y}}$	
Unstiffened Elements	8	Horizontal legs of double-angle members with separators or in continuous contact	b/t	$0.47\sqrt{\frac{E}{R_yF_y}}$	$0.54\sqrt{\frac{E}{R_yF_y}}$	
Unstiffened Elements	9	Flanges of H-pile sections per Section D4	b/t	not applicable	$0.45\sqrt{\frac{E}{R_yF_y}}$	
Stiffened Elements	10	Webs of H-pile sections	h/t_w	not applicable	$1.50\sqrt{\frac{E}{R_yF_y}}$	
Stiffened Elements	11	For moment frames, where used in beams or columns, as webs in flexure, or combined axial and flexure: Webs of rolled or built-up I-shaped sections and channels	h/t_w	$2.5(1-C_a)^{2.3}\sqrt{\frac{E}{R_yF_y}}$ [b]	$5.4(1-C_a)^{2.3}\sqrt{\frac{E}{R_yF_y}}$ [b]	
Stiffened Elements	12	Where used in beams or columns as flanges in uniform compression due to flexure or combined axial and flexure: 1) Flanges of rectangular HSS[a] 2) Flanges of boxed I-shaped sections 3) Flanges of box sections	b/t	$0.55\sqrt{\frac{E}{R_yF_y}}$	$1.00\sqrt{\frac{E}{R_yF_y}}$	

that the research upon which the limiting width-to-thickness ratios were based had used the actual yield stress, as determined from testing, but that for non-seismic design using the AISC *Specification*, the committee had replaced the actual yield stress with the specified minimum yield stress. This was not seen by the task group as a problem since the design strength based on the specified minimum yield stress, F_y, would be conservatively less than the strength based on the expected yield stress, R_yF_y, even if the member were no longer compact.

However, that was not the case with seismic design. With seismic design based on expected strength, buckling at the expected strength is important to be considered, and the committee introduced the expected strength into the limiting width-to-thickness limits in the 2016 *Seismic Provisions*. On further examination by the task group, it was determined that the *Seismic Provisions* prior to 2016 had already accounted for the expected yield stress. That is, the original source data and development of the coefficients for the limiting width-to-thickness ratios were based on the measured yield stress. Thus, it was only necessary to replace the measured F_y with R_yF_y for seismic design, and the change in coefficients introduced in 2016 was unnecessary. For the 2022 edition of the *Seismic Provisions*, the coefficients have been returned to the values used in the 2010 version. As a result, coefficients that are shared between the *Specification* and the *Seismic Provisions* will be more clearly recognizable. This means that the limits for all members and section types within the seismic system have been reduced from those in the 2016 edition—except for those in Cases 2 and 3. Cases 2 and 3 have not changed from the values found in the 2016 edition. For flanges of rolled or built-up I-shaped sections:

ANSI/AISC 341-10 had $\lambda_{hd} = 0.30\sqrt{(E/F_y)}$,

ANSI/AISC 341-16 had $\lambda_{hd} = 0.32\sqrt{(E/(R_yF_y))}$,

and

AISC 341-22 now has $\lambda_{hd} = 0.30\sqrt{(E/(R_yF_y))}$.

This means that for A992/A992M steel, the limits have changed from λ_{hd} = 7.22 (2010) to λ_{hd} = 7.35 (2016) to λ_{hd} = 6.89 (2022). The 2010 and 2016 limits excluded 54 W-shapes as not meeting the highly ductile limits, while the 2022 limits now correctly exclude 71 W-shapes as not meeting the highly ductile limit.

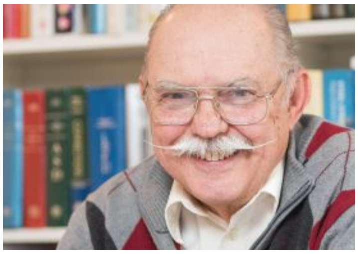
The fourth and final change to be presented here is Case 11 in Table D1.1b for webs of rolled or built-up I-shaped sections and channels in moment frames, where used in beams or columns in flexure or combined axial and flexure. This case had been included as a subpart of Case 13 prior to the 2022 edition. Previously, the limiting width-to-thickness ratios for this case were based primarily on research on I-shaped members and the effects of web slenderness on ductility under combined bending and axial compression under monotonic loading. This case was mainly used in practice to check webs of I-shaped columns for both moment and braced frames.

For both highly ductile and moderately ductile members, the new limiting width-to-thickness ratios for webs under combined bending and axial compression in Case 11 are based on recent studies for moment frames that included the cyclic loading effect. These studies also paid attention to deeper columns that designers often use to meet the stringent story drift limit in special moment frame (SMF) design. Steel wide-flange columns in SMF are expected to experience flexural yielding and form a plastic hinge at the column base. Because deep columns have h/t_w ratios that quite often are significantly higher than those of shallow—e.g., W14 or W12—and stocky sections, testing showed that the web was not that effective in stabilizing flanges under cyclic loading. It also showed that the interaction of flange-web local buckling occurred earlier than expected and caused significant strength degradation and axial shortening. Under cyclic loading, lateral-torsional buckling together with local buckling could also occur. The new Case 11 λ_{hd} and λ_{md} limits introduced in the 2022 *Seismic Provisions* for webs of rolled or built-up I-shaped sections and channels were based on a regression analysis of deep column responses from both testing and finite element simulation that considered the effects of boundary conditions and lateral loading sequence. These limiting ratios were developed for columns in moment frame structures, for which the axial force on interior columns remains relatively constant during ground motion. The proposed limits are conservative for exterior columns with varying axial loads due to the overturning moment effect. This revision can significantly impact which W-shapes and axial loads may be acceptable for use in moment frames. Engineers are encouraged to refer to the 4th Edition *Seismic Design Manual* for further guidance when it becomes available in 2024.

Case 11 is too conservative for columns and beams in braced frames, where the axial load is expected to vary significantly due to the overturning of the frames. Thus, Case 13, which is a direct carry-over from the 2016 edition with the adjustment for correct use of R_y as done in other cases, is to be applied for braced frames.

With these changes in mind, designing with moderately and highly ductile members in seismic applications should become a more streamlined process. ■

All mentioned publications can be found at ***aisc.org/publications***.



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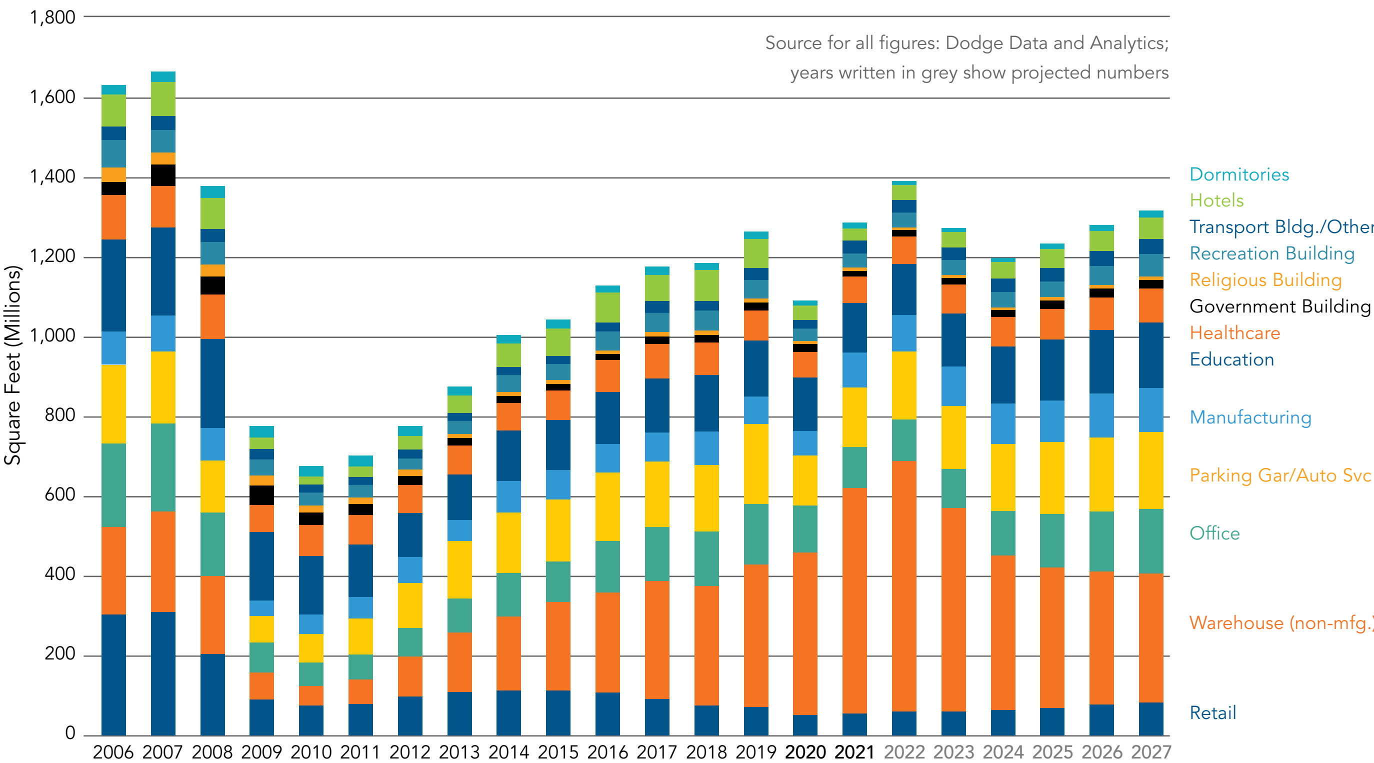
Shaky Ground

BY JOE DARDIS

While the general economy has been unstable as of late, some of the building types hit hardest by COVID are poised to make a comeback.

Fig. 1.
Historical and Forecasted Nonresidential Construction Starts



THERE'S NO DOUBT the economy has been a little shaky lately.

GDP growth has been in the red for the first half of 2022, and the Fed has enacted a series of interest rate hikes to combat inflation, which is typically a recipe for a general slowdown in economic activity and, subsequently, construction. As a steel fabricator or design firm, this is critical to understand in terms of planning, staffing, and capital expenditures, so getting a sense of the magnitude of the downturn and what sectors will be most affected can help you get ahead of any potential problems.

According to Dodge Data and Analytics, 2022 construction starts are still anticipated to exceed 2021 construction starts by around 8% (Figure 1), and square footage starts should continue a 12-year-long year-over-year increase (with the exception of 2020). However, Dodge also anticipates a significant contraction moving past 2022, with starts down 8% year-over-year in 2023 and an additional 6% year-over-year in 2024 before the market begins to pick up again.

What sectors stand to gain or lose the most? Figure 2 shows the percent change in square footage starts relative to 2022 and clearly illustrates that the bulk of the drop can be attributed to the projected decline in the warehouse sector. The warehouse market has been in a frenzy over the last few years, climbing 14%, 38%, and 11% (projected) year-over-year in 2020, 2021, and 2022, respectively. Given that warehouse starts currently account for roughly 45% of all nonresidential square footage, even a small movement in this sector could change overall square footage outlooks dramatically.

E-commerce—specifically Amazon, the largest player—was the largest contributor to this frenzy. However, Amazon has pulled back considerably in 2022 (Figure 3) after several years of very aggressive expansion. With warehouse vacancy rates still attractive in 2022, other builders filled the gap, but the vast amount of square footage built will spike those vacancy rates and slow

Fig. 2.
Percent Change in Square Footage Relative to 2022

	2023	2024	2025	2026	2027
Retail	1%	6%	15%	27%	33%
Warehouse (non-mfg.)	-19%	-38%	-44%	-47%	-48%
Office	-5%	8%	28%	45%	56%
Parking Garage/Auto Svc.	-6%	0%	6%	11%	14%
Manufacturing	6%	9%	15%	17%	18%
Education	2%	9%	18%	24%	27%
Healthcare	8%	11%	14%	21%	25%
Government Building	-1%	4%	11%	23%	31%
Religious Building	-3%	5%	17%	32%	35%
Recreation Building	2%	5%	13%	31%	46%
Transport Bldg./Other	2%	5%	10%	17%	19%
Hotels	4%	16%	34%	46%	55%
Dormitories	-1%	1%	12%	27%	37%
Total	-8%	-14%	-11%	-8%	-6%

Fig. 3.
Amazon New Warehouse Construction (Billions of Dollars)

2018	2019	2020	2021	2022 (Jan-Sept)
$2.40	$1.40	$4.60	$6.30	$1.80

down this sector for the foreseeable future. Regardless, warehouses are still expected to remain the largest project sector by square footage by a wide margin.

On the bright side, some of the sectors hit hardest by COVID, like offices and hotels, are expected to make significant gains moving forward. According to Kastle Building Systems, average workplace occupancy (as a function of workers who went into the office pre-COVID) is still hovering around the 50% mark. While this is a grim sign for near-term office construction, it is anticipated that this number will grow (although never reach) pre-COVID levels as workplaces have adopted permanent or hybrid remote policies. It is also important to note that data center starts are included with office starts, which we intuitively know are on the rise, and this tempers the projections for the office marketplace (although they are still positive).

The hotel sector had a few very difficult years but is expected to show continual and healthy growth over the next five years, as most business and leisure travel is back to normal. Hotels also had a very big financial hole to fill due to lost revenue during COVID, which put most capital spending on hold for the last several years.

Ultimately, the changing economy will affect the construction market, and we are expected to see a decrease in overall square footage in the near future. What's also important to consider is that 2022 is shaping out to be a very good year for construction starts, so a decline doesn't mean there won't be work out there. In fact, the "down" market is still expected to exceed start volumes for most of the previous decade. While a decline in warehouse square footage isn't great for the steel market, that can be offset by a rebounding office market and the "old faithful" healthcare and education sectors.

Want to stay on top of current market trends? AISC is always here to help! Visit **aisc.org/industrystats** (full members) or **aisc.org/economics**. Better yet, contact an AISC structural steel specialist at **aisc.org/steelspecialists** for a full briefing on everything that's happening in your area! ■

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Reimagined Rig

INTERVIEW BY GEOFF WEISENBERGER

One of this year's Steel Design Student Competition winners and his faculty advisor discuss the iterative process of transforming a decommissioned offshore oil rig into a cultural center.

Patanavin.

Fowler.

WHEN CALIFORNIA POLYTECHNIC STATE UNIVERSITY, San Luis Obispo (aka Cal Poly) architecture student Ron Patanavin needed ideas for his Steel Design Student Competition (SDSC) project, he looked to the sea.

He found the location for his vision there in the form of a decommissioned oil rig off the coast of Santa Barbara. He also found the inspiration for its design in the form of a marine organism that's native to the area, which also resembled the basic structure of a Native American canoe that became an integral component of his concept.

And with guidance from his faculty advisor, Thomas Fowler IV, the director of the Graduate Architecture Program and Design Collaboratory at Cal Poly, he created a project that would become one of this year's SDSC winners (in the Open competition).

In a conversation that spanned ten time zones—Fowler is in San Luis Obispo, I'm in Chicago, and Patanavin is currently studying in Rome—the two discussed the winning project, how they got into architecture, and more.

Field Notes is *Modern Steel Construction's* **podcast series**, where we interview people from all corners of the structural steel industry with interesting stories to tell. Listen in at **modernsteel.com/podcasts**.

Let's address the Rome Factor first. I understand you just moved there. What took you there? How are you adjusting? And most importantly, do you speak Italian?

Ron: I'm currently studying abroad with the Cal Poly architecture program in Rome. It's a one-semester program that gives students exposure to Italian architecture from Roman times up until today. The program focuses on a few different attributes of architecture, one of them being sustainability, which is demonstrated both in ancient Roman times and now, and there's also a component where we travel around and see different parts of the country, which I'm very excited about. I enjoy running, and I've been on a few runs and got to take a look at a lot of the different architectural styles. Today, we actually went to the Roman Forum and did some sketching exercises and kind of mapped out things, which was fascinating. And I do speak some Italian, but hopefully I will improve over the course of the program and be able to give my final review totally in Italian by the end of these three months!

That would be impressive! Can you both tell me how you got turned on to architecture in the first place?

Ron: I think architecture, at the very least, is a factor in everyday life. It's a background to our living. At its best, it can change your life and even dictate your health and your well-being. It's a very powerful field. I grew up in a house that wasn't designed well at all, and I think that's been a driving force for me to get into architecture. I realized how much good it can do when done correctly. So that's my idea of what architecture should be.

Tom: What inspired me to go into architecture had nothing to do with buildings. I was really interested in what I call the mystical powers of architects. I used to like taking things apart when I was younger, and it would drive my parents crazy because a lot of times, it would be, like, taking the TV set apart and maybe putting it back together. I was really interested in the process and what architects did to make buildings. I didn't really know what good architecture was. I grew up in a tract home on Long Island. I thought our house might have been designed by an architect—very naïve at that age—but I found out it wasn't. It was designed by a developer, and it was not a very nice piece of architecture. But the thing that really got me interested in going to architecture school was when I found that I had a cousin who was an architect, and I basically worked for him right out of high school all the way through my five years of college. And that's where I figured out what architects really did. Before that, I just thought they were pretty amazing and kind of magicians. But then my cousin informed me, through the work over the years in his office, what they really did. Without his mentorship, I probably wouldn't have survived school.

Let's talk a bit about your winning design, Tomols. The way I understand it, it's basically repurposing a decommissioned offshore oil rig to become a cultural center, and it looks like you're using the general concept of a canoe as the inspiration for a modular framing assembly.

Ron: I have to admit that it initially didn't start with a canoe at all. It started out with a study of ocean micrografts that were local to the Santa Barbara area. I studied this ocean creature in detail and geometry for how it could be used in a structural system and how I could trace its contours, for example, to create a structurally sound shape and put these shapes together. And as I worked more into the iterative process, I saw a resemblance to the native canoes called tomols, and we thought that was really interesting and went from there. A tomol is a type of Native American watercraft used by the Chumash people. They're really robust and they used them to travel across the Santa Barbara Channel to the Channel Islands, which is a really long boat ride even today.

Tom: The Chumash people actually used a naturally occurring, seeping oil to put the tomols together, so there's a deeper connection in some ways back to the oil rig. It was a fascinating discovery Ron had in making that connection.

What a cool design evolution! How far off the coast is this oil rig?

Tom: It's about two miles off. You can actually see it as you're driving on the 101. The platform is called Holly, and at night it looks like a Christmas tree out there. When you're driving along the coast, you have to be careful not to spend your whole time looking at it or you might have problems staying on the road, but it's pretty interesting how visibly accessible it is.

Can you talk about the collaborative effort when it comes to your design?

Ron: Tom has been a really inspiring mentor for my classmates and me, and I've learned so many things about the design process in his course. There were a lot of all-nighters, but that was the result of a lot of iterations, a lot of collages, a lot of drawings, which essentially is what the design process is all about—you know, letting your hands think and analyzing and reflecting as you go through this process.

Tom: I would say it's a pretty intense process that students go through to make these design discoveries. They start with a design hypothesis, and they spend the quarter trying to disprove the hypothesis and evolve into something else. Most people think design is arbitrary and it's based on a thought you have, and then you build it, but it's quite a cathartic process that we go through to understand what the possibilities are. I've been teaching for over three decades, and every quarter I'm always fascinated by what the students discover. And so it's fascinating for me, even as the instructor. I call myself the instructor-student. I'm a student at another level. Even if you're the teacher, you're always learning.

I understand you've been the faculty advisor for the SDSC for a while. Do you have a specific process when it comes to helping students with this competition?

Tom: There's always a warm-up project that they go through. There's a commitment to some version of the design concept with the idea that if you commit to something, you'll discover something else. To me, the most important thing is that I'm trying to empower the students to understand that they are all amazing. They have wonderful voices. They're wonderful storytellers, wonderful story-makers. And if I can get them set on a path, they'll make great designs. The big thing is to keep them on that path. I'm trying to get them to get rid of all the noise in the story that's not very interesting and keep the stuff in that is exciting. I'm not trying to embarrass Ron, but he tried to throw out his tomol concept maybe nine or ten times. And I told him no, you've got to keep this thing in there. This is the amazing part of the story. And so he kept it in and developed it further and got it to work for the four posters that the competition required. I've been advising students for this competition since it started back in 2000. It's crucial to be able to tell a compelling story. Students have to synthesize their story down to these four frames into their fantasy designs for people to understand the project, and I think it's an amazing process to go through with them as they become better storytellers. ■

*This column was excerpted from my conversation with Ron and Tom. To hear more from them, check out the November Field Notes podcast at **modernsteel.com/podcasts**. And to see some great renderings of Ron's winning SDSC project, check out "Equitable Spaces" on page 44.*

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

What's Your Higher Purpose?

BY DAN COUGHLIN

Identifying it and nurturing it can make you a better employee, a better leader, and, most importantly, a better person.

WE ALL HAVE TALENTS that make us productive in our careers, whether we're engineers, fabricators, ironworkers, architects, or anything else.

Those talents can also help us in achieving our higher purpose. So what, exactly, does that mean?

Simply put, a higher purpose is why a person is here at a given time.

A person's higher purpose can change as life circumstances change. When caring for an aging ill parent or a child with a serious disease, a person's higher purpose can be to focus on that one person. Perhaps a higher purpose could be trying to help young people learn valuable lessons for later in life regarding teamwork, communication, caring, and treating each other with dignity. Or if a person is less fortunate financially and is trying to clothe and feed six children, then their purpose may be to focus day after day on trying to be extremely disciplined in their spending.

Another type of higher purpose or focus may be to try to make a difference for a very large group of people. I often think about the people who started and who work at MADD (Mothers Against Drunk Driving), the Susan Komen Race for the Cure, and Alcoholics Anonymous. These are people who are trying to make a lasting impact in the lives of many people whom they will never meet.

Providing Clarity

On the road to inner excellence, identifying your higher purpose provides clarity on how you can gather your internal forces in terms of passions, talents, and values and direct them toward something you consider to be extraordinarily important.

One challenging aspect is that no one else can tell you what your higher purpose is or should be about. Only you can decide this. There is no right or wrong answer. No one should ever feel that someone else's higher purpose is better than their own. This is not a contest. Each of us must determine and pursue our own higher purpose.

This is an area where I encourage you to use your tools of reflection, discussion, meditation, discernment, and decision. Just as an archeologist must dig to uncover valuable remnants from the past, so too must you dig to uncover your higher purpose.

Here are a few questions that might help you in identifying or reidentifying your higher purpose:

- Beyond just existing and enjoying life, why do you think you are here right now?
- If you could make one difference in the world that you are not currently making, what would it be, and why do you want to make that difference?
- If you already have identified your higher purpose, who would be worse off if you stopped working to fulfill it, and why do you feel they would be worse off?
- Is there an idealistic dream or passion from your youth that could help people in some way today if you stirred your energies toward realizing it?

Please allow yourself the time and the energy to really pour yourself into answering these questions. It might take a week or two, or even much longer, for your answers to emerge. I encourage you to just start putting words on paper—or if you are a visual person, start gathering images until a clear answer starts to emerge. Little by little, you will mine out this jewel within you.

My Own Journey

This has been a life-long search for me. In grade school, I used to go to the YMCA with my siblings to learn how to swim. I had a dream of starting an organization like a YMCA where people could come to learn how to swim as well as things like teamwork and rope climbing and working together.

In college, I applied for a job as the director of a local youth soccer program. I wrote a paper for the interview called "Soccer Heaven." My idea was to create an organization where young people between the ages of 5 and 14 could meet to do their homework and learn life skills like goal-setting and action plans and self-esteem building—and, of course, playing soccer. I thought this would be a great way to prepare people for high school, college, and beyond, where soccer would play just one part of their development. I didn't get that job.

After I graduated from college, I was a college head soccer coach for five years. My focus was not primarily on winning games but rather on recruiting players from all over the country and bringing them together to develop them as individuals and as a team.

Then, starting in 1990, my focus moved to teaching high school students about self-confidence, self-discipline, goal-setting, and achieving their goals. By 1998, I realized that people in for-profit organizations were willing to pay me for fulfilling what I thought was my higher purpose. So I've spent most of the last 24 years being paid to do the very activities that I did before on a volunteer basis or for a small amount of money. During 18 of those 24 years, I volunteered to teach classes to middle school students at my local church on spirituality.

And now I'm 59. What is my higher purpose? Why am I here now?

I still have my day job as an executive coach, seminar leader, and guide for strategic business meetings. But there is something deeper and higher that is bubbling inside of me.

I want to help anyone around the world who is willing to listen and to do the hard work involved to develop themselves to fulfill their own higher purpose. I want to serve as a helper, a guide on the side, for these people. I really, really want to help people go on the inner journey that can flow into them becoming more effective as individuals, better at whatever they do, better leaders, better team-builders, better managers and executives, and better at fulfilling their higher purpose, whatever that might be.

My dream is that every person, regardless of any label that anyone might try to place on him or her, can identify and fulfill their higher purpose.

From Idea to Destiny

Starting back in 1985, I've seen several variations on the same concept, which basically says, "When we hear an idea, it becomes a thought in our head. If we hold on to that thought, it becomes an action. If we stick to that action long enough, it becomes a habit. Eventually, our habits become our character. And our character becomes our destiny."

When I first came across that concept in my first month after college graduation, it stuck with me. The starting point of changing our destinies is by focusing on certain ideas. And that became my life's work and my higher purpose. Over the past 37 years, I've tried to search for useful ideas and then combine and hone and teach the ideas that I thought would be useful for other people on their journey to fulfilling their higher purpose.

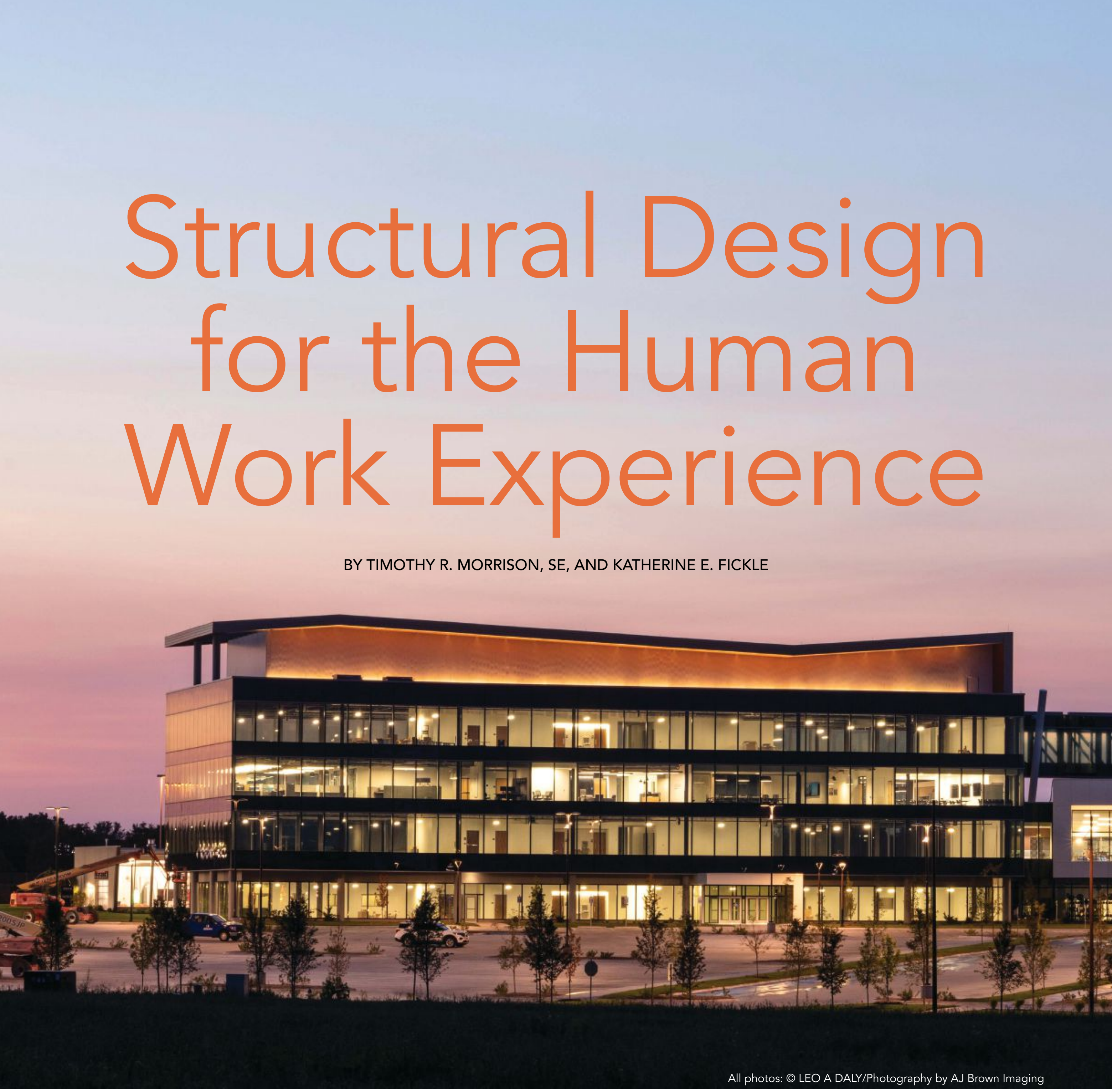
And that is where *my* life's higher purpose is taking me: to teach ideas to people of all ages all around the world and from all of life's various situations and circumstances who want to really dig in and take the work seriously on their road to fulfilling *their* higher purpose.

I can't say exactly how this is all going to unfold. The first step for me, and for you, is to identify or reidentify our higher purpose. Don't worry about how you are going to fulfill that higher purpose. For now, just focus on identifying it. ■

Since 1998, **Dan Coughlin** has worked with business leaders to consistently deliver excellence, providing coaching and seminars to executives and groups, as well as guiding strategic decision-making meetings. And now he is also focused on helping people on their inner journey to excellence. Visit his free *Business Performance Idea Center* at **www.thecoughlincompany.com**. Dan has also given several presentations in recent years at NASCC: The Steel Conference. To hear recordings of them, visit **aisc.org/education-archives** and search for "Coughlin."

Structural Design for the Human Work Experience

BY TIMOTHY R. MORRISON, SE, AND KATHERINE E. FICKLE



All photos: © LEO A DALY/Photography by AJ Brown Imaging

THE CARSON GROUP'S new Omaha headquarters was designed to be more than just an office building.

The new office for the business management and financial services firm serves as a "beacon for talent" through its architectural form, high-performance office space, and energizing social spaces to support the work-hard, play-hard culture of this growing financial advisory group. The structural design efforts—whether through structural system design, advanced vibration analysis, thoughtful connection design, or interdisciplinary coordination—integrate seamlessly into this modern office architecture.

The new office building is part of the 500-acre Heartwood Preserve development located in Omaha. The selected design was provided by LEO A DALY as part of a design competition against six other design firms from across the country. The design emphasizes Carson's principles of growth and transparency with an ascending roofline and electrochromic glazing envelope. The high-performance project involved interdisciplinary collaboration between architecture and multiple engineering disciplines in LEO A DALY's Omaha studio. The project totals 200,000 sq. ft and is comprised of a six-story building connected to a four-story building via a two-story "Carson Commons" amenity hub with a skywalk above. In addition to serving as Carson's new headquarters, the project provides Class A office space for other tenants as well. In fact, as design progressed, the project's contractor (JE Dunn) and developer (Goldenrod Properties Group) both decided to relocate to this new office space.

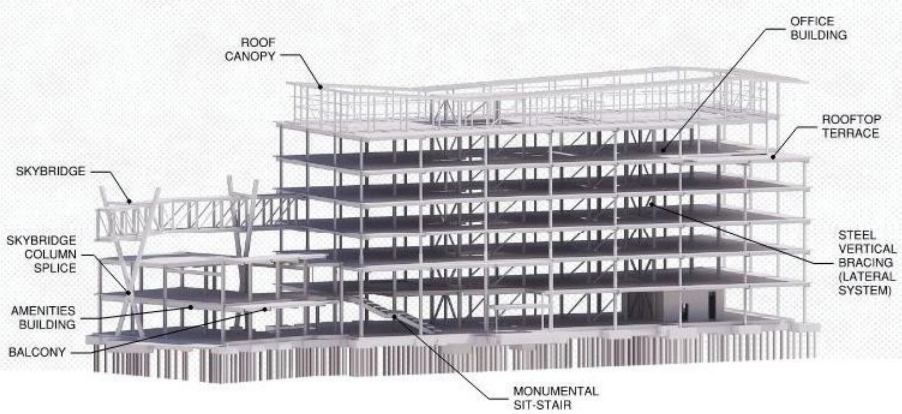
A new steel-framed Omaha office building was designed for an enhanced work environment—which is more important now than ever.

The new Carson headquarters building is part of the 500-acre Heartwood Preserve development located in Omaha.

The project architecture aligns with Carson's desire to provide a work-life experience for its people and an inviting environment for clients. SageGlass Harmony, an electrochromic glass envelope, was used in lieu of shading devices and automatically tints as daylighting changes, providing ergonomic daylighting with unobstructed views for occupants. Employees enjoy amenities within the Carson Commons central building, which includes a fitness area, café, balcony, and social spaces. A monumental "sit stair" in the two-story lobby serves as both a relaxed social space and a place for an "all hands" meeting for the Carson team in view of the 16-ft by 14-ft video wall. Other social gathering spaces throughout the facility provide a family atmosphere with areas accented by natural wood and daylight. The upper level of the six-story portion provides an elevated client experience through executive meeting spaces and a rooftop terrace with a bar, lounge, outdoor seating, and a NanaWall folding glass door system.

High-Performance Office Space

From the onset of design, structural steel was identified as the preferred solution for the gravity system due to ease of erection and future flexibility. Steel braced frames and concrete shear walls were investigated for the lateral system at the central stair and elevator cores. A steel braced frame lateral system was ultimately selected based on flexibility, construction schedule, and input from the contractor.



above: The project is comprised of a six-story building connected to a four-story building via a two-story amenity hub and a pedestrian bridge.

left: A 3D model of the framing system.

The new office serves as a "beacon for talent" through its architectural form and high-performance office space, including the traning room.

The typical office floor bays are 26 ft by 30 ft and consist of composite steel framing (typically, W16 beams and W21 girders). The concrete-filled metal deck is 3½ in. of normal weight concrete on 2-in. composite metal floor deck (5½ in. total thickness). The gravity system was designed for office vibration criteria per AISC Design Guide 11: *Vibrations of Steel-Framed Structural Systems Due to Human Activity* (**aisc.org/dg**).

The varying perimeter slab edge creates framing cantilevers that extend up to 9 ft, and slab edges are supported by cantilevered beams that are moment-connected to the wide-flange building columns. The W14 steel columns are supported by deep foundations consisting of reinforced concrete pile caps with auger cast-in-place concrete piles (16 in. and 18 in. in diameter, up to 80 ft in length).

The steel braced frame lateral system includes HSS6×6 to HSS10×10 square hollow structural sections (HSS) framing varying from the upper to lower stories based on strength and stiffness demands connected to gusset plates with a welded slotted tube connection. The braced frame beam-to-column connection consists of

Level 6 incorporates an exterior terrace that provides expansive exterior views of the nearby surroundings.

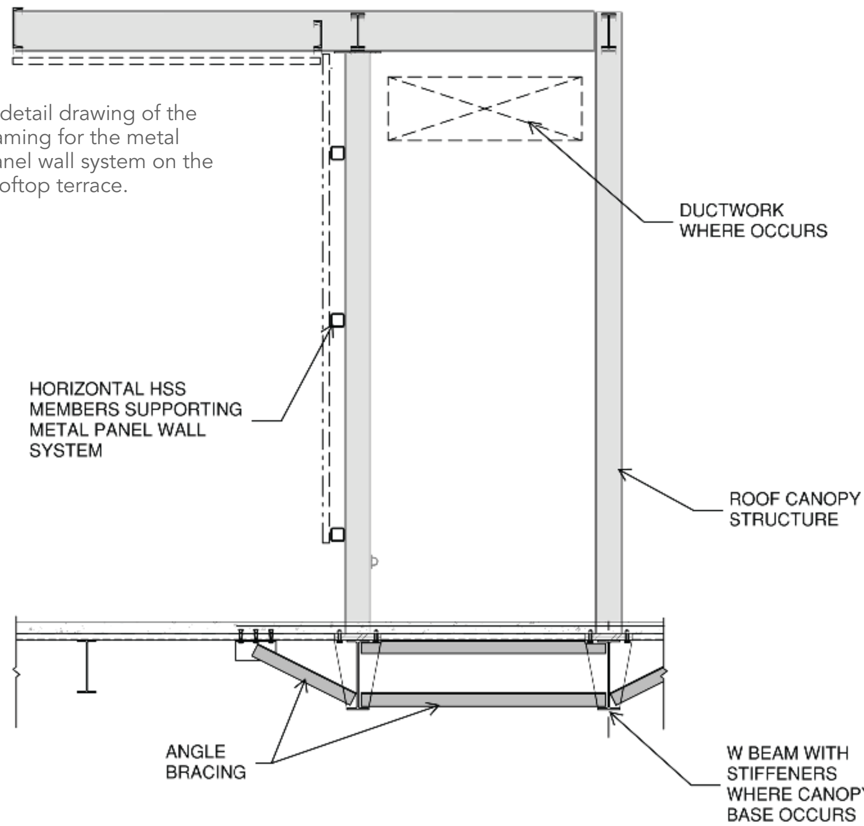
a double-angle bolted-bolted shear tab connection, and diaphragm loads are transferred into the lateral system using adjacent steel beams as collectors.

Level 6 incorporates an exterior terrace that provides expansive exterior views of the nearby surroundings. This was accomplished by providing a 28-ft-long header-supported NanaWall folding glass wall integrated with the curtainwall system. Structural steel for the NanaWall header and sill track was designed for vertical deflection criteria of the lesser of L/720 of the span or ¼ in. under full dead and live loads, and steel framing accommodated a 1-ft, 1-in. slab depression at some areas of the terrace to allow for the pedestal-supported paver system and tapered insulation. For the multi-tiered Level 2 training room, a 1-ft, 2-in.-deep slab depression was provided for the full training room area, and the crescent-shaped tiered floor was built-up using light-gauge metal framing.

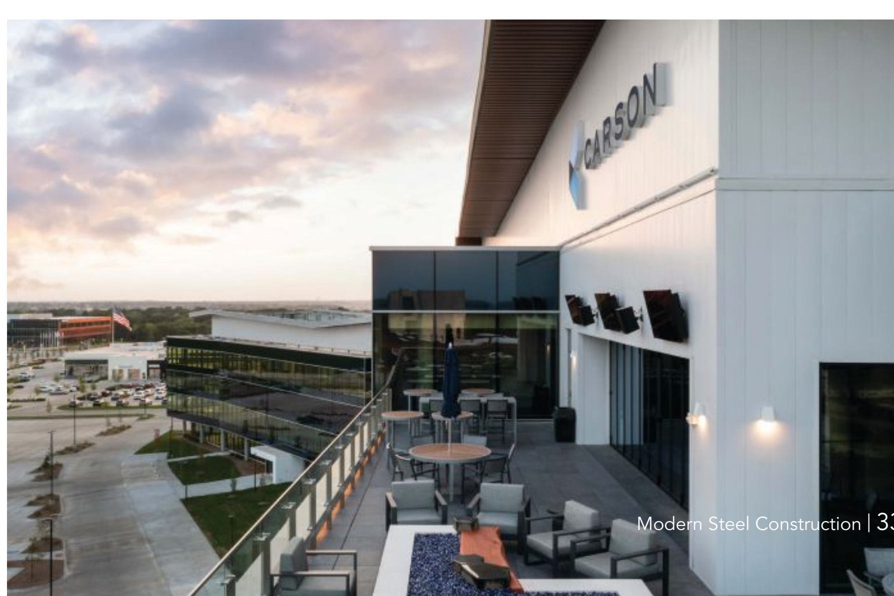
The two-story central amenities structure features a folding roofline and open areas for social and fitness spaces. Open, unobstructed views were achieved by using a steel moment frame lateral system, and the gravity system involved composite steel beams and concrete-filled metal deck.

Structural system design for the three office campus structures used RAM Structural System analysis software for full-building analysis, whereas RISA 3D was used for the monumental "sit-stair," sky bridge, rooftop canopy, and vestibules.

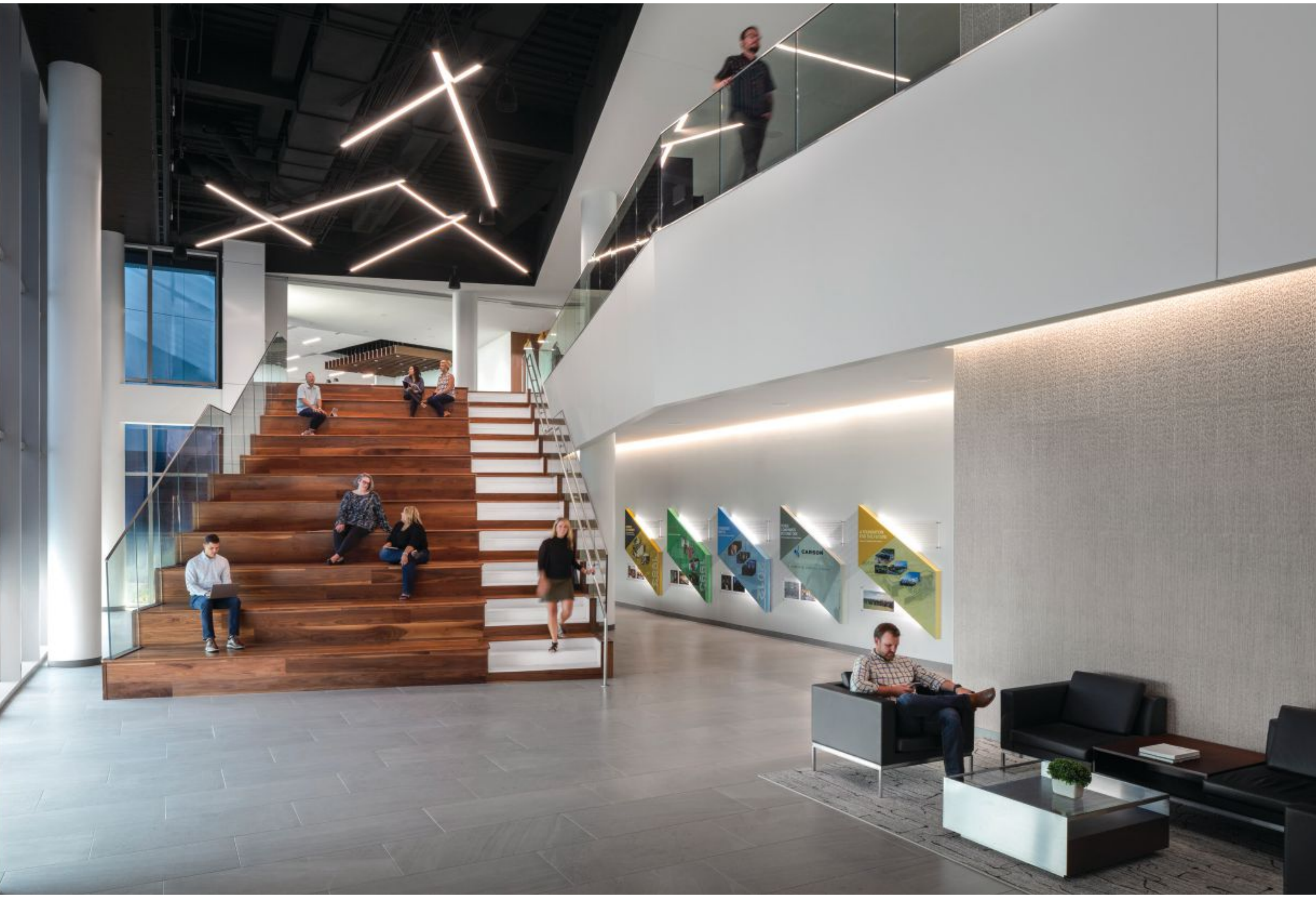
The building's roofline serves as both an eye-catching feature and a mechanical enclosure, as the architectural team and owner did not want the rooftop mechanical equipment to be viewable from any location along adjacent highway elevations. The galvanized canopy structure is an open steel-framed system detailed with horizontal bracing as required to transfer lateral loads due to the absence of metal deck. The cantilevered steel beams support suspended architectural steel elements to provide the look of a warm and airy wood slat soffit and a means of mechanical ductwork support. The canopy base includes detailing for the support framing and diaphragm to support these canopy loads.



A detail drawing of the framing for the metal panel wall system on the rooftop terrace.



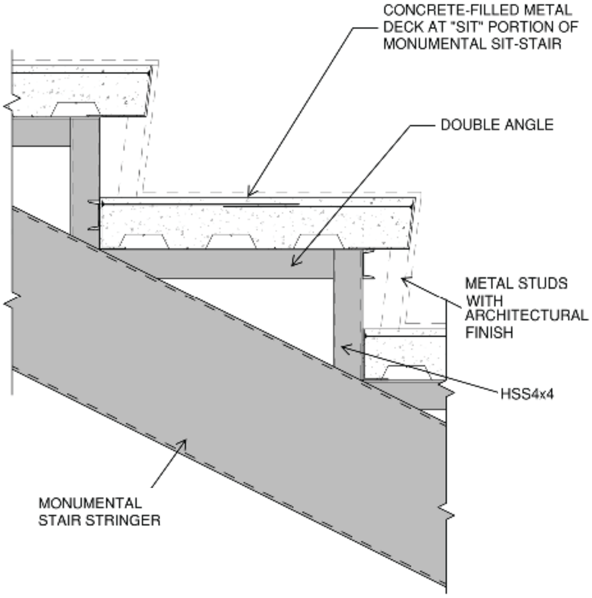
The building's roofline serves as both an eye-catching feature and a mechanical equipment enclosure.



above: A monumental "sit-stair" connects the two-story lobby to the second-level commons café and serves as a large group meeting space and informal workspace.

right: Building the stair.

below: A detail drawing of the stair.



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15	Angle Heel Out	OUTSIDE DIA.	8" x 8" x 1" Angle
16	Angle Heel Up	MEAN DIA.	8" x 8"x1" Angle
17	Square Tube	INSIDE DIA.	24" x $\frac{1}{2}$" Tube
18	Rectangular Tube The Easy Way (Y-Y Axis)	INSIDE DIA.	20" x 12" x $\frac{5}{8}$" Tube
19	Rectangular Tube The Hard Way (X-X Axis)	INSIDE DIA.	20" x 12" x $\frac{5}{8}$" Tube
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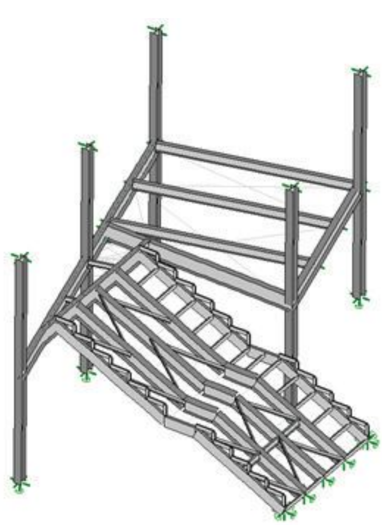
Structural Support for Social Spaces

A monumental "sit-stair" connects the two-story lobby to the second-level commons café and serves as a large group meeting space and informal workspace. Advanced vibration analysis methods were used to assess the performance of the monumental stair in order to limit distracting vibrations for seated occupants. Since the stair system is supported by multiple girders at the top of the stair and the perimeter two-story column heights, traditional stair vibration analysis would not have adequately captured these vibration interactions.

Vibration analysis was conducted per AISC Design Guide 11 (Section 7.4.3: Finite Element Method) for stair analysis. Using RISA 3D, sinusoidal point loads and time history analyses were used to determine frequency response function (FRF) acceleration magnitudes; the RISA 3D analysis model extents are based on anticipated vibrational mass region only, per the Design Guide's recommended best practices. Since the sit-stair is intended as an informal workspace, the vibration design involved using normal stair descent excitations for evaluating against the 0.5%g office vibration limit, and rapid descent and group descent loads were used in conjunction with "shopping mall" and stair acceleration limits. Rapid descents were deemed less likely due to alternating tread materials and the lack of a right-side handrail, which

A RISA 3D model of the stair. Advanced vibration analysis methods were used to assess the performance of the stair in order to limit distracting vibrations for seated occupants.



In addition to serving as Carson's new headquarters, the project provides Class A office space for other tenants as well. In fact, as design progressed, the project's contractor (JE Dunn) and developer (Goldenrod Properties Group) both decided to relocate to this new office space.

were architecturally driven features. The structural analysis used 1.5% damping due to the structure and suspended ceiling below the stair. The vibration load case assumed very few people are seated with a single occupant near midspan doing focused work.

Vibration performance was achieved using the steel framing's stiffness and concrete slab's mass. The monumental stair stringers span 38 ft, 6 in. with a typical spacing of 4 ft, 9 in. center to center. HSS20×8 are used for the outward stringers, with W21s being used for the interior stringers of the monumental stair. Concrete thickness on the seated portion is 5-in. normal-weight concrete on 2-in. composite deck (7 in. total thickness), and the concrete tread thickness for the integrated stair portion is 5 in. Since a heavier concrete tread was required than used for conventional stair construction, the stair's delegated designer was permitted to incorporate miscellaneous steel angles for intermediate support of standard tread bent plates. Since the stair portion is "inset" into the seating volume, structural details accommodated stair tread attachment at the end stringer and penultimate stringer. The final construction of stairs, seating, and glass handrails was achieved seamlessly without issue.

Design Guide 11's finite element method was also used for the amenities building balcony structure since cantilevered framing is beyond conventional vibration analysis constraints. Cantilevered framing layouts and moment connection detailing also accommodated an 11½-in. slab depression for the paver system in the balcony area.

A Sky Bridge Challenge

The sky bridge connects the fourth level of the two office buildings and laterally is structurally independent to avoid diaphragm eccentricity concerns for the two adjacent office structures. A software-generated dynamic analysis was completed on this structure to determine the fundamental frequency; based on the frequency and participation output, the structure's natural frequency was below 1 Hz. This analysis deemed the structure was dynamically sensitive, which impacted various design aspects.

A multidirectional slide-bearing connection at each office structure interface (office levels 4 and 5) provides vertical restraint against uplift and downward forces while allowing horizontal movement in each direction due to thermal and wind effects. The Pratt truss layout provides an orderly aesthetic, as the sky bridge vertical bracing is parallel when viewed from multiple angles. Coordination between the structural engineering team, steel fabricator, and erector during design involved the erection approach for the V-shaped sky bridge, as well as the erection sequencing over the in-place steel structure below.

Despite the COVID pandemic coinciding with the construction sequence, the project stayed on schedule and within its construction budget. And its forward-thinking approach will ensure that it remains an attractive office environment in a time when people are increasingly working from home. ■

Owner
Carson Group

Developers
Goldenrod Companies
Tetrad Property Group

General Contractor
JE Dunn

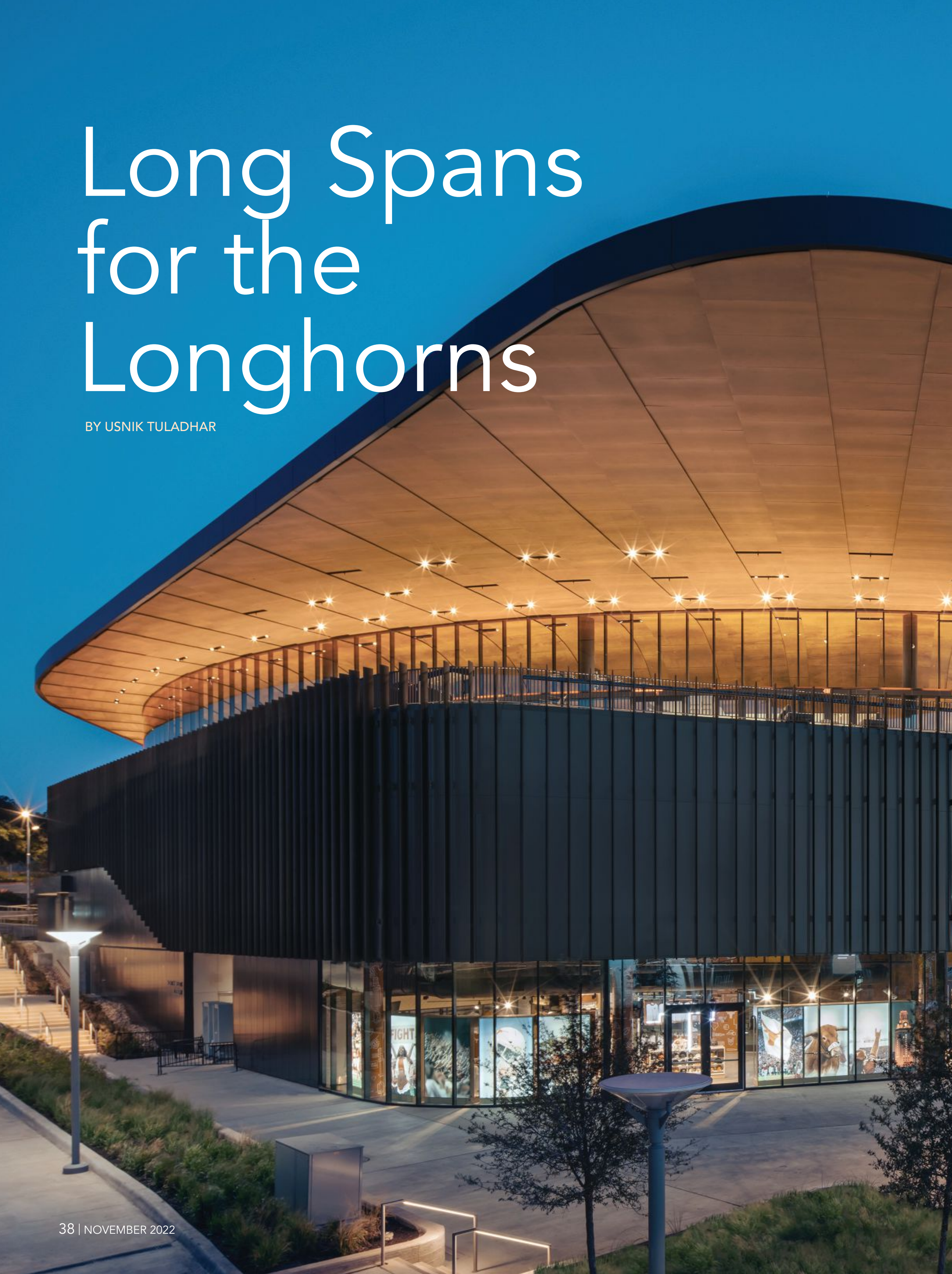
Architect and Structural Engineer
LEO A DALY

Steel Fabricator and Detailer
Drake-Williams Steel, Inc. (AISC Certified Fabricator)
Omaha

Timothy R. Morrison (trmorrison@leoadaly.com) is a structural engineer and **Katherine E. Fickle** (kefickle@leoadaly.com) is a structural engineer in training, both with LEO A DALY.

Long Spans for the Longhorns

BY USNIK TULADHAR



Structural steel is in the starting lineup at the University of Texas' new basketball arena, with a highlights reel that includes a long-span roof structure and impressive roof cantilevers.


© Chase Daniel

THE MOODY CENTER in Austin is making waves.

The multi-purpose arena, which opened this spring on the University of Texas (UT) campus, has already hosted musicians such as George Strait, the Eagles, Jack White, Roger Waters, and Andrea Bocelli, establishing itself as a premier venue in a city whose slogan is the Live Music Capital of the World.

The Moody Center also serves as the new home for UT's men's and women's basketball teams, replacing the 45-year-old Frank C. Erwin Jr. Events Center. The new arena, which was designed by architect Gensler and structural engineer Walter P Moore, has a seating capacity of 10,000 for basketball games and 17,500 for concerts and also includes 2,000 premium club seats, 57 loge boxes, 44 suites, and a 50-person VIP lounge. The exterior combines a 360° glass façade with approximately 400 black anodized aluminum fins that function as solar shades. Cantilevering beyond this façade is a steel-framed, wood-paneled high roof that facilitates shaded views of the UT campus, downtown Austin, and the State Capitol of Texas.

The new arena is one of three major sports/entertainment venues that have opened recently in Austin, with the other two being UT's Darrell K. Royal Texas Memorial Stadium South End Zone project and Q2 Stadium, home to Major League Soccer's Austin FC team. Located just south of and across the street from Texas Memorial Stadium and another soccer stadium (Mike A. Myers Stadium and Soccer Field, UT's soccer and track venue), the Moody Center is situated on a sloping site with an elevation change of 40 ft moving from west to east and below the Capitol View Corridor. A Texas State law aimed at preserving protected views of the Texas State Capitol dome from various points around the city prohibits any construction intersecting with the view corridor. Because of the associated height limitations, a significant portion of the facility had to be located below grade, and the event floor itself sits 70 ft below the high grade along the east entrance.

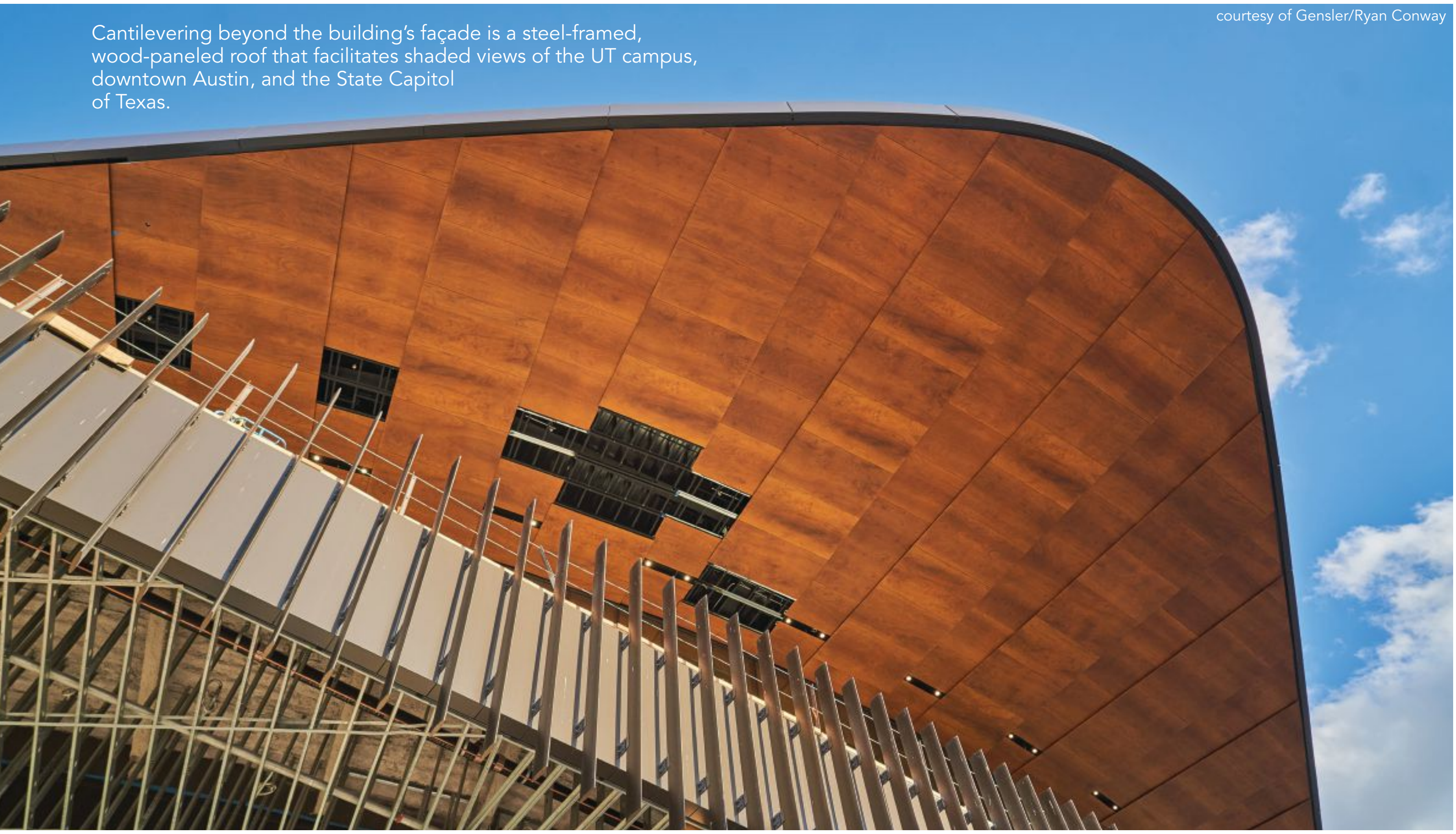
The Moody Center serves as the new home for UT's men's and women's basketball teams, replacing the 45-year-old Frank C. Erwin Jr. Events Center.

courtesy of Bosworth Steel

courtesy of Bosworth Steel

above: The roof structure supports amenities like a central retractable video board and a 125-ton steel-framed show rigging grid.

left: Framing for the catwaks in the roof system.



courtesy of Gensler/Ryan Conway

Cantilevering beyond the building's façade is a steel-framed, wood-paneled roof that facilitates shaded views of the UT campus, downtown Austin, and the State Capitol of Texas.

A Steel Crown

Because much of the arena is underground, concrete frames the seating bowl, but the roof framing and its support columns are steel. Around the perimeter of the building, the long-span steel roof cantilevers up to 75 ft beyond the building edge to create a shaded entry space for the warm climate of Austin and appears to float above the glass curtain wall.

"The thin profile of the cantilevered roof is a major design element of the building and required the versatility of steel," said David Lynch, principal and studio director at Gensler.

The entire roof structure is supported on a ring of exposed 24-in.-diameter structural steel columns, which are filled with concrete and designed for fire loads. The structural economy offered by these composite columns also yielded the benefit of avoiding the need to coat them with intumescent paint.

"A two-way grillage made of W36 steel girders was used to create a simple but stiff structure," said Mark Waggoner, senior principal and senior project manager at Walter P Moore, of the roof framing. "Because the cantilever length undulates across the corners of the arena, the longer cantilevers can lean on the shorter cantilevers through the orthogonal layer of the W36 girders."

The advanced roof structure supports amenities designed to make the building flexible for a variety of events. These include the central retractable video board, a 125-ton steel-framed show

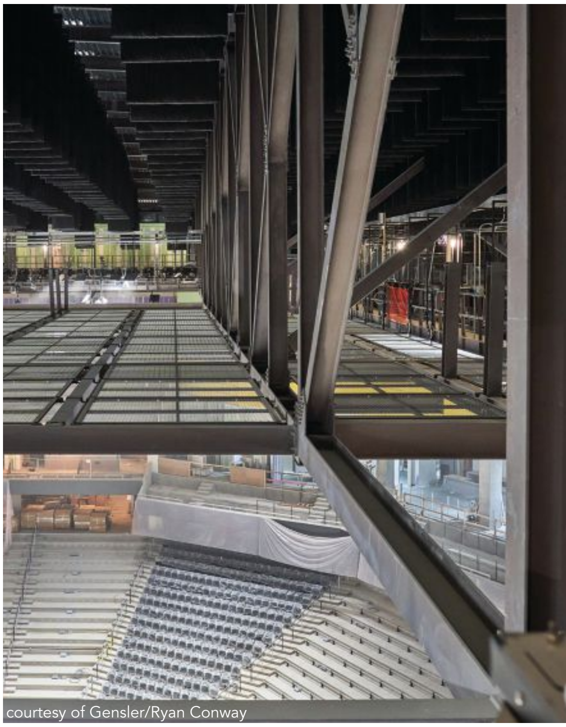
© Chase Daniel

courtesy of Bosworth Steel

above: Each roof truss was erected on two falsework towers.

left: The roof structure is supported on a ring of 24-in.-diameter concrete-filled hollow steel columns, and the wood paneling continues from the outside to the interior.

below: Looking down from the roof framing into the seating bowl below.



courtesy of Gensler/Ryan Conway

rigging grid including a tension wire rigging platform, and a mechanized closure system that lowers from the ceiling and can covert the venue from 17,500 seats to the 10,000-seat configuration in just five minutes. The project incorporates 2,654 tons of structural steel in all.

Due to the massive amount of construction materials as well as the complexity of the project, challenges faced by the building team were addressed early in the design process in order to keep the project on schedule. Steel fabrication began in August 2020 with the low roof structural steel, and steel sequencing was coordinated with the schedule of concrete placement.

"The off-site fabrication process allowed the building to be enclosed in an extremely efficient manner," Lynch said.

Coordinating the roof steel, catwalk steel, sky deck, safety cable system, and mechanical equipment presented a series of challenges regarding how the steel interfaced with the rest of the facility. After presenting the challenges to the other members of the building team, the proper solutions were resolved quickly and effectively, explained Monty Magner, project manager at fabricator Irwin Steel.

"One of the initial issues that had to be ironed out was how to address the camber," said Magner. "The roof trusses and the low roof perimeter steel had different cambers. We had to make adjustments with the perimeter lower roof being cambered and unshored while the roof trusses were shored."

Connected and Coordinated

Steel fabricator Irwin Steel, in concert with steel detailer Dowco, led a detailing process that included frequent exchanges of the Moody Center's steel Tekla model in order to facilitate review by the design team. This led to a smooth process for all members of the building team and allowed the steel fabrication to be completed weeks before it was needed on the construction site.

"Our shop is highly automated, and we need the electronic files to run the equipment," noted Magner. "It allows for easier coordination as the models contain all the connections and finishes."

Another challenging aspect of the Moody Center involved the steel erection, specifically keeping the low roof steel erection out in front of the high roof.

"Although we were able to use the tower cranes for some of the low roof steel, much of it had to be set with the crawler crane in the bowl," noted Vince Bosworth, president and CEO of Bosworth Steel Erectors. "This required a great deal of delivery coordination with Irwin to make sure the right material was delivered to the right hook."

According to Bosworth, the low roof erection was not a typical, "easy" low roof. Bosworth and erection engineer MXE Consultants (a wholly owned subsidiary of Walter P Moore) developed a robust erection procedure that considered the staged deflection of the structure over the course of construction.

"The large cantilevers required multiple elevation checks through the deflection process," Bosworth explained. "These were closely coordinated with Walter P Moore and MXE to make sure the final elevations were within tolerance."

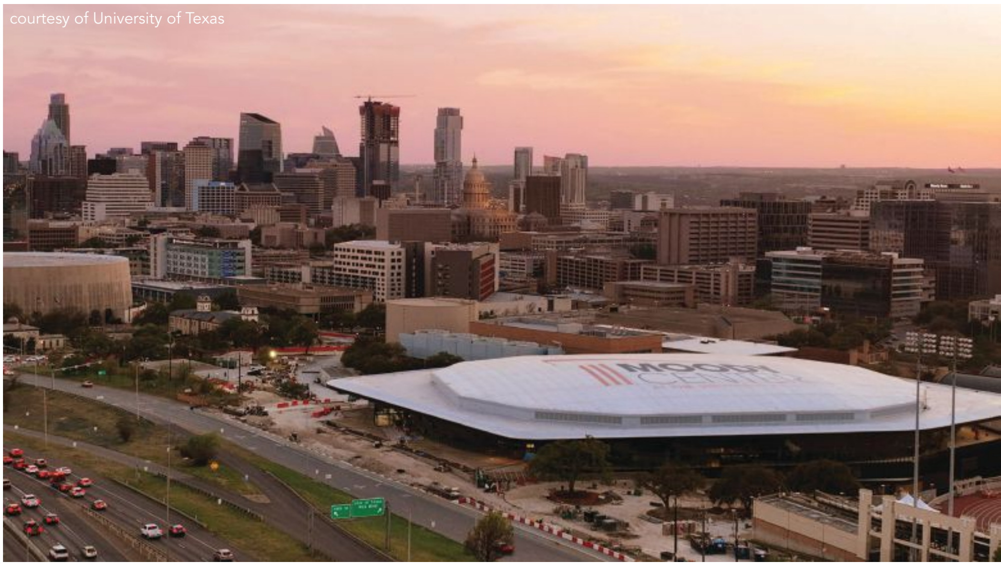
As the erection crew worked its way through the bowl from west to east, the bowl kept getting tighter, requiring the crew to reconfigure the crane's boom in order to knuckle down and disassemble with only feet to spare.

"Each truss was erected on two falsework towers," Bosworth said. "The staged decentering process developed by MXE worked perfectly."

courtesy of Bosworth Steel

above: Grillage posts at the end of one of the roof trusses.

below: Because of height limitations related to the Capitol View Corridor, a significant portion of the facility had to be located below grade, and the event floor itself sits 70 ft below the high grade along the east entrance.



courtesy of University of Texas

© Chase Daniel

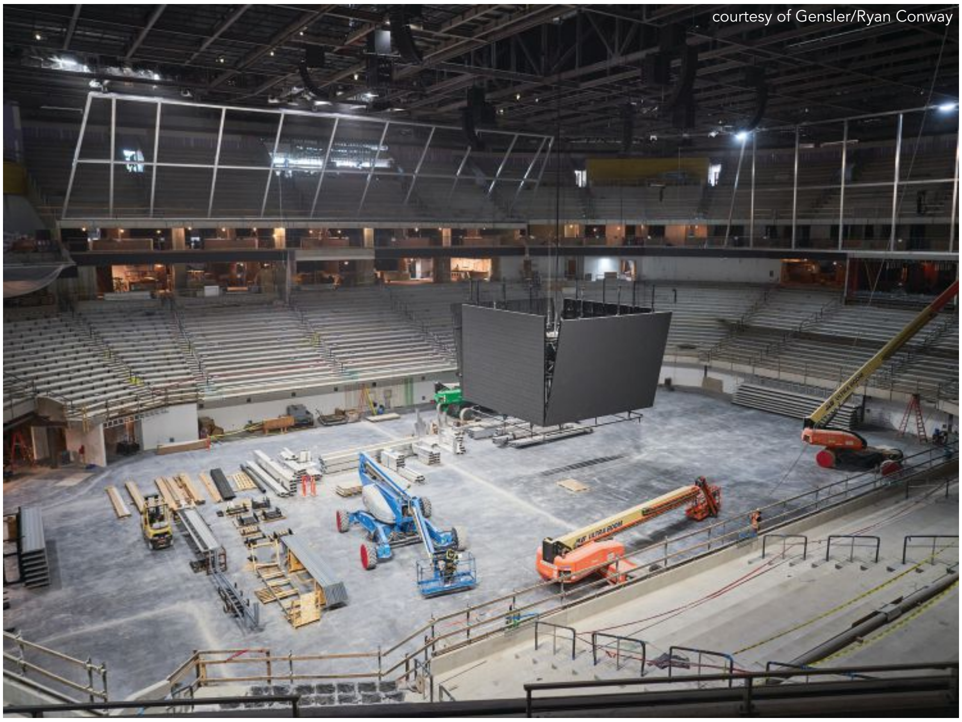
The multipurpose venue, with a seating capacity of 10,000 for basketball games and 17,500 for concerts, is ringed with approximately 400 black anodized aluminum fins that function as solar shades.


© Chase Daniel

The new facility is situated on a sloping site with an elevation change of 40 ft moving from west to east and below the Capitol View Corridor.

Thanks to the coordinated efforts of the various steel players and the rest of the design and construction team, Texas' capital city and flagship university now have a stunning, sturdy, and flexible new venue that serves as a new home for local sports teams as well as a state-of-the-art stopover for touring acts.

"We were able to realize our initial design vision in an efficient and cost-effective way," noted Lynch. "And ultimately, we created an iconic building for the University of Texas and the City of Austin." ■


courtesy of Gensler/Ryan Conway

above: Erecting the central retractable video board.

below: The long-span steel roof cantilevers up to 75 ft beyond the building's edge.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Owner
The University of Texas

Developer and Operator
Oak View Group

Project Manager
CAA/ICON

General Contractor
AECOM Hunt

Architect
Gensler

Structural Engineer
Walter P Moore

Erection Engineer
MXE Consulting, LLC (a wholly owned subsidiary of Walter P Moore)

Steel Team

Fabricator
Irwin Steel, LLC AISC CERTIFIED FABRICATOR, Justin, Texas

Erector
Bosworth Steel Erectors, LLC AISC ASSOCIATE AISC CERTIFIED ERECTOR, Dallas

Detailer
Dowco Consultants, Ltd. AISC DETAILER, Langley, B.C., Canada

Usnik Tuladhar (**utuladhar@walterpmoore.com**) is a project manager at Walter P Moore.

Equitable Spaces

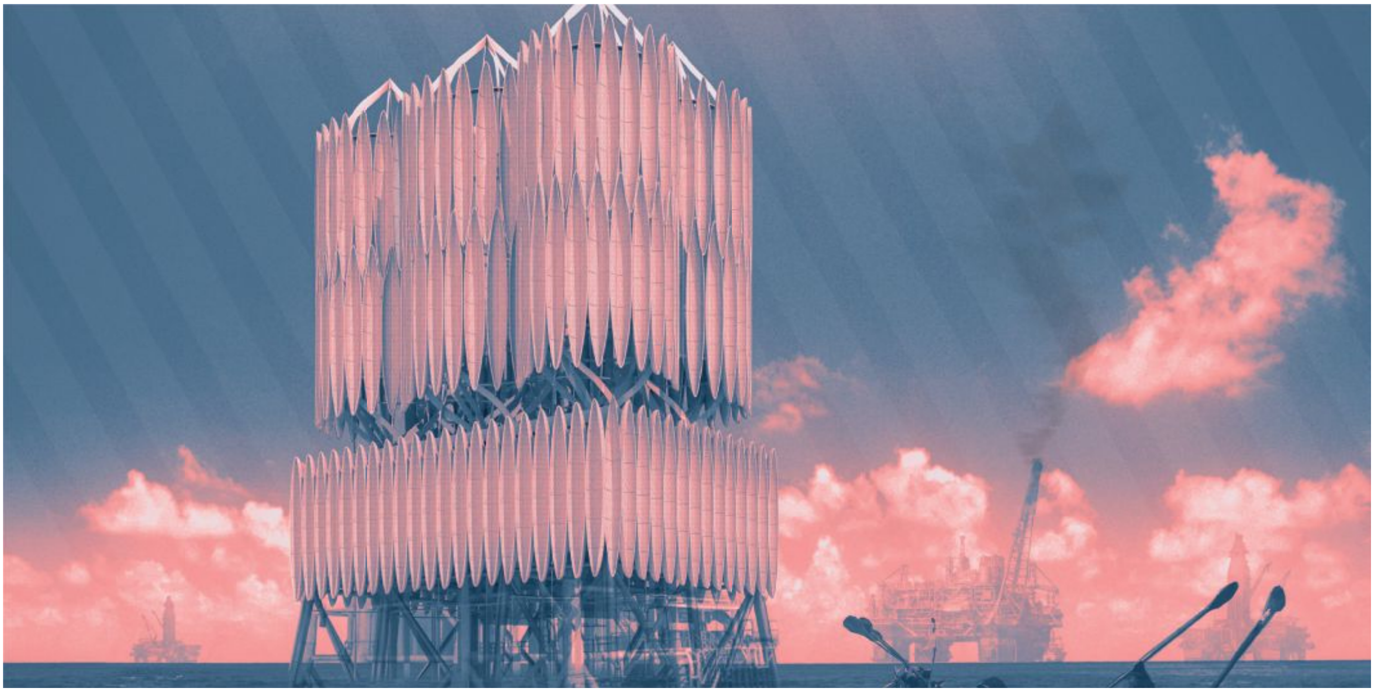
WHAT WILL PUBLIC SPACES look like in the future?

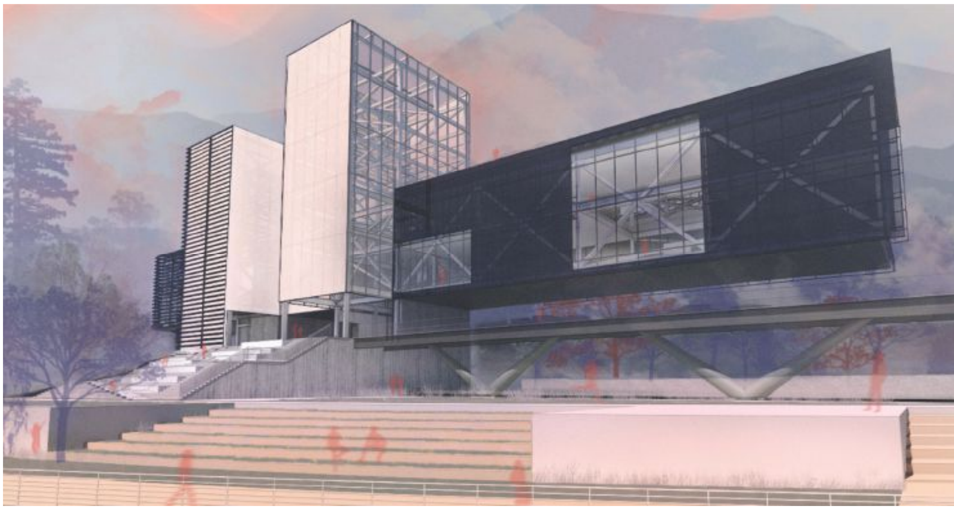
Participants in this year's Steel Design Student Competition (SDSC) have offered their visions.

Sponsored by AISC and the Association of Collegiate Schools of Architecture (ACSA), the SDSC offered an open category as well as a prompt that asked students to consider novel approaches to monuments and democratic public space in the 21st century.

"The future of our built environment is in good hands," said AISC's senior director of education, Christina Harber, SE, PE. "The concepts dreamed up by this year's entrants are very exciting—and they remind us all that dialogue and inspiration draw their energy from their real-world surroundings. It's thrilling to think about what could happen when communities come together in innovative structural steel buildings like these."

Fourteen winners were selected in this year's iteration of the competition. The winning projects range from a vision to transform a decommissioned oil rig into a cultural center celebrating local indigenous culture to a meeting space for families divided by the U.S./Mexico border wall to a public discourse space that allows communities to bring social media interactions into the real world.





AISC and ACSA are very grateful to the distinguished judges for their generosity and dedication. These jurors include:

CATEGORY I: TOWARDS A NEW MONUMENTALITY

- Julian Bonder, Roger Williams University
- Amanda Dean, Walter P Moore
- Mark Gardner, Parsons School of Design

CATEGORY II: OPEN

- Mohamed Ismail, Massachusetts Institute of Technology
- Soo Jeong Jo, Louisiana State University
- Eric Lumpkin, Thornton Tomasetti

More than 900 students submitted concepts for this year's competition. Students and faculty sponsors who worked on the following projects have won cash prizes that range between $2,000 and $500. For more information about the competition, visit **acsa-arch.org/competitions/2022-steel-competition**. And to learn more about and see stunning renderings of this year's winners, read on.

CATEGORY I:
TOWARDS A NEW MONUMENTALITY
Winners

CATEGORY I: TOWARDS A NEW MONUMENTALITY

This category asks students to creatively and critically consider novel approaches toward a new monumentality and the conception and creation of democratic public spaces for the twenty-first century. Students were invited to submit design proposals that would address a plurality of publics and generations and that, as agents for culture and dialogue, could serve to question, illuminate, and encourage new kinds of public engagement, with the goal of making the world a better place.

1st

Forest of Conscience

Students: Isis Orduno and Conny Salazar
Faculty Sponsor: Gerard Smulevich
School: Woodbury University

Through the concepts of graffiti and social media, Forest of Conscience envisions an unprogrammed and non-hierarchical space that balances individuality and collective power while emulating a forest of communication.

Social media expands the exploration of how graffiti can unapologetically be brought to the forefront of public discourse, from painting messages on the walls to creating a built-in physical and digital space where the ideas and opinions of many are projected as an ongoing 3D mass of information.

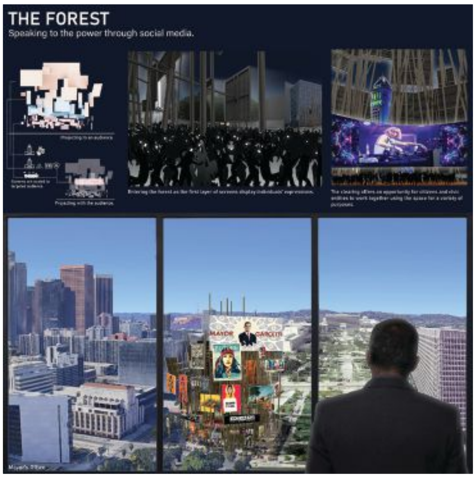
A tree of knowledge and clouds of light, composed of steel and LED screens, are the modules that repeat themselves at different scales to become a foliage of sorts in an urban environment, where local residents are able to share their content through an online platform to be displayed in the screen of their choice.

The outer cluster of screens projects outwards to target civic entities located around Grand Park in downtown Los Angeles, including City Hall, the Criminal Justice Center, and the Los Angeles Police Department. Inversely, the clearing encircles a central space where public discourse can occur in a 360° environment. It projects inwards through a ring-shaped screen that invites citizens and these civic structures to have a conversation and come together as one.

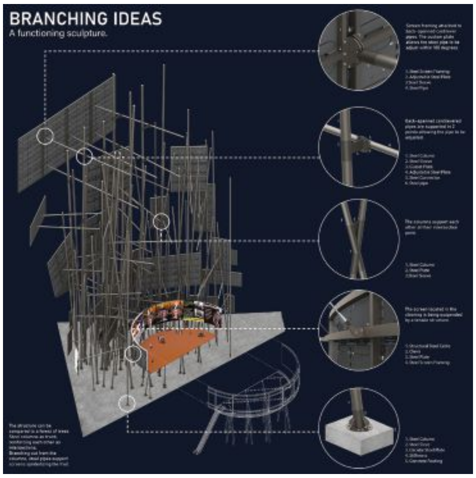
Overall, the project aspires to become a space that celebrates people, validates their opinions, and shapes the country toward a better future. Its monumentality is symbolically found in functioning as a forest of communication for the residents who are unknown in name but recognizable in number. The forest, the clearing, and the cloud of lights are the layers that create a space for digital content to be inhabitable and, therefore, a civic device for hyper-social media.

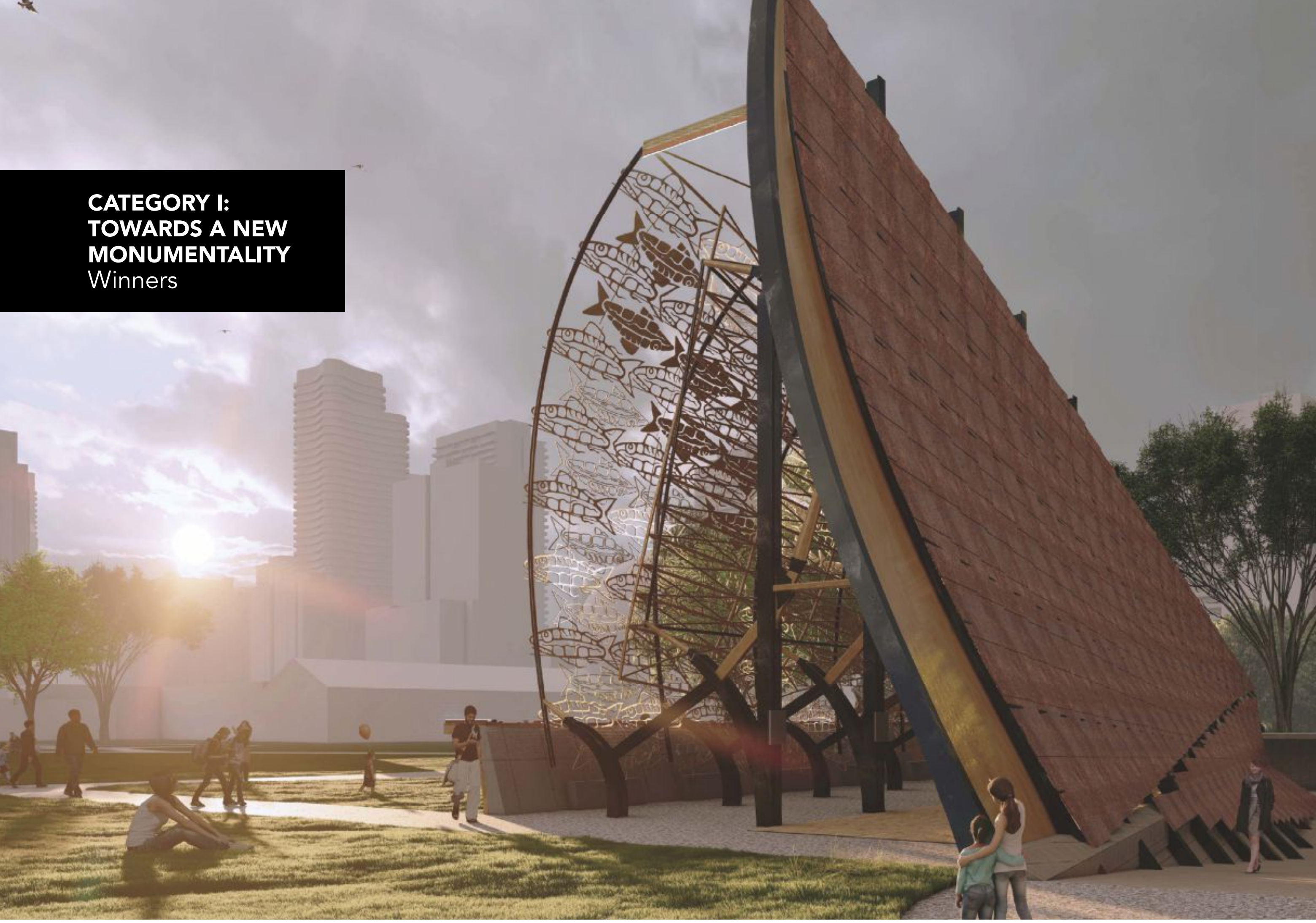

HAPPY
PRIDE!
LOVE IS LOVE


FOREST OF LIGHT
Projecting expressions about democracy through Grand Park.
Layers of Forest of Conscience
HAPPY PRIDE!


THE FOREST
Speaking to the power through social media.


FOREST OF CONSCIENCE
A civic device for hyper-social media.
Social media expands the exploration of how graffiti can unapologetically be brought to the forefront of public discourse. From painting messages on walls to creating a built-in physical and digital space where the ideas and opinions of many are projected as an ongoing 3D mass of information.
A tree of knowledge and clouds of light, composed by steel and LED screens, are the modules that repeat themselves at different scales to become a screen foliage in an urban environment. The Forest targets civic entities located on Grand Park in downtown Los Angeles while creating a space to invite these entities and citizens to have a conversation and come together as one.
This project becomes a monument by functioning symbolically as a forest of communication for the residents who are unknown in name, but recognizable in number. The Forest, the clearing, and the cloud of lights are the three parts that create a space for digital content to be inhabitable and therefore a civic device for hyper-social media.
LEGEND
Los Angeles City Hall
Criminal Justice Center
Los Angeles Police Department
LA Times
Arts and Culture
Grand Park
... creating a 3D mass of information.
From walls of paint to clouds of lights...
HAPPY 4th OF JULY!
I WANT YOU TO CELEBRATE 4th OF JULY
Celebrating Freedom


BRANCHING IDEAS
A functioning sculpture.



CATEGORY I: TOWARDS A NEW MONUMENTALITY
Winners

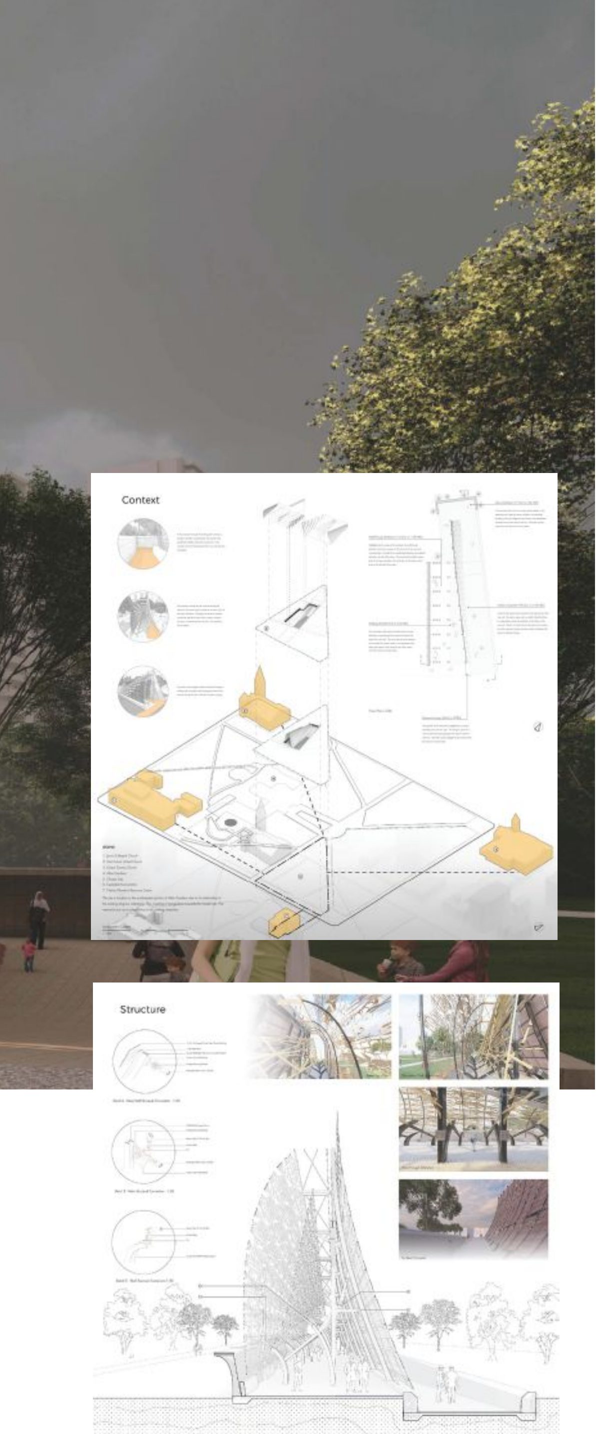
Indigenous Lives Memorial

1st

Students: Kristyan Calletor and Mathieu Howard
Faculty Sponsor: Vincent Hui
School: Ryerson University

Indigenous Lives Memorial is intended to be built in Toronto's Allan Gardens Park to inform the public about the truth behind Canada's Indian residential school system, a network of boarding schools for indigenous peoples that was active from the late 1800s through the mid-1900s, while also acting as a symbol of remembrance of the culture and individuals that were lost within the dismay of the notorious early education system.

The memorial seeks to create a powerful statement on the site, creating a journey that leads to a balance of emotions and thoughts while keeping the traditional first nations and indigenous design ideas of the Longhouse, Tipi, and Thule in mind. As visitors walk up to the memorial from the street, a sort of chaos is visible on the outer shell. A pattern of fish becomes visible, and beauty and order begin to emerge from chaos and disorder once viewed from the right angle; the fish is not only a symbol of food but also eternal life in the mythology of Canada's indigenous peoples. The memorial responds to the permanent damage made by the residential school systems in that a large part of the future generations of first nations were erased from the country's history while projecting the concept of eternal life through the symbolism of the fish and the permanence of the steel structure.



Chamizal Union

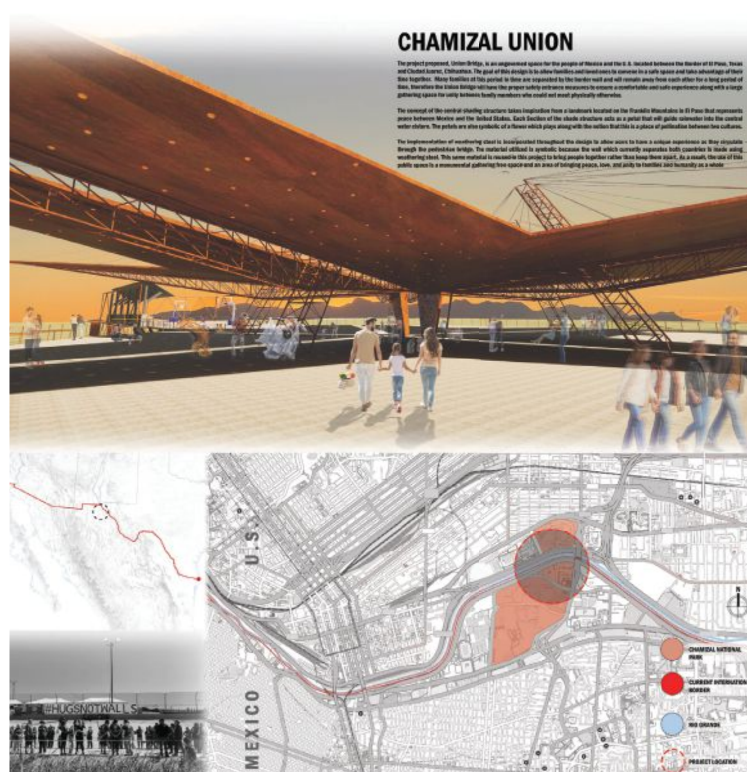
Students: Sam Ruan and Noel Parra
Faculty Sponsor: Candid Rogers
School: The University of Texas at San Antonio

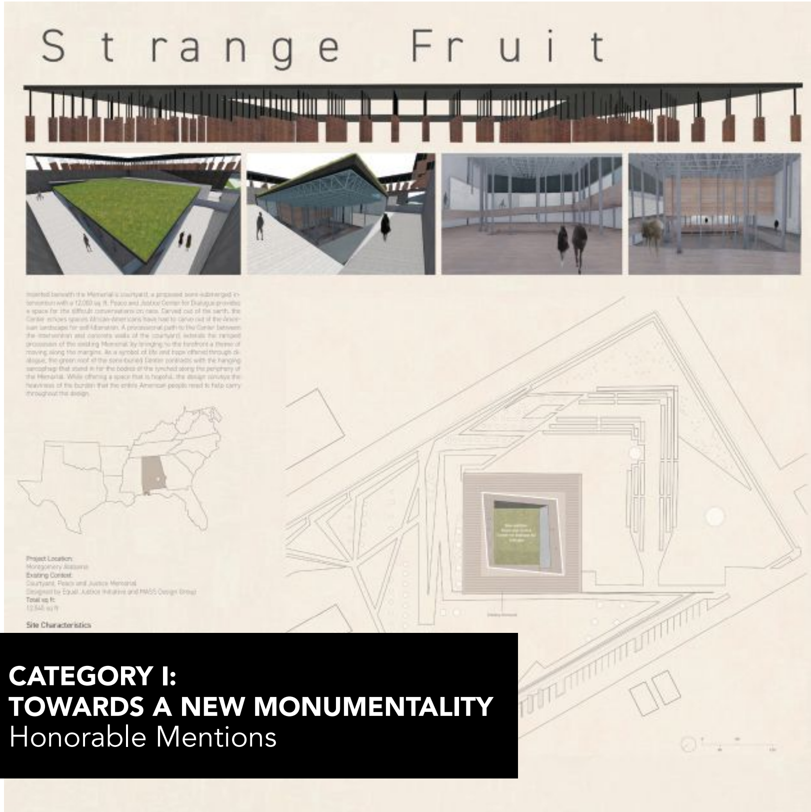
CATEGORY I: TOWARDS A NEW MONUMENTALITY
Honorable Mentions

Union Bridge is an ungoverned space for the people of Mexico and the U.S. located between the border of El Paso, Texas, and Ciudad Juarez, Chihuahua. The goal is to allow families and loved ones to convene in a safe space and take advantage of their time together. While many families are separated by the border wall and will remain away from each other for a long period of time, the Union Bridge will have the proper safety entrance measures to ensure a comfortable and safe experience, along with a large gathering space for unity between family members who could not meet physically otherwise.

The concept of the central shading structure takes inspiration from a landmark located in the Franklin Mountains in El Paso that represents peace between Mexico and the U.S. Each section of the shade structure acts as a petal that will guide rainwater into the central water cistern, and the petals are also symbolic of a flower, which plays along with the notion that this is a place of pollination between two cultures.

Weathering steel is incorporated throughout the design to allow users to have a unique experience as they circulate through the pedestrian bridge. The material is symbolic because the wall that currently separates both countries is made of weathering steel—but in this project, it is used to bring people together rather than keep them apart.





CATEGORY I:
TOWARDS A NEW MONUMENTALITY
Honorable Mentions

Strange Fruit: Peace and Justice Center for Dialogue

Students: Nastassia Chua, Rebekah Mireles, and Sharon Lott
Faculty Sponsor: Sheryl Tucker Vazquez
School: University of Houston

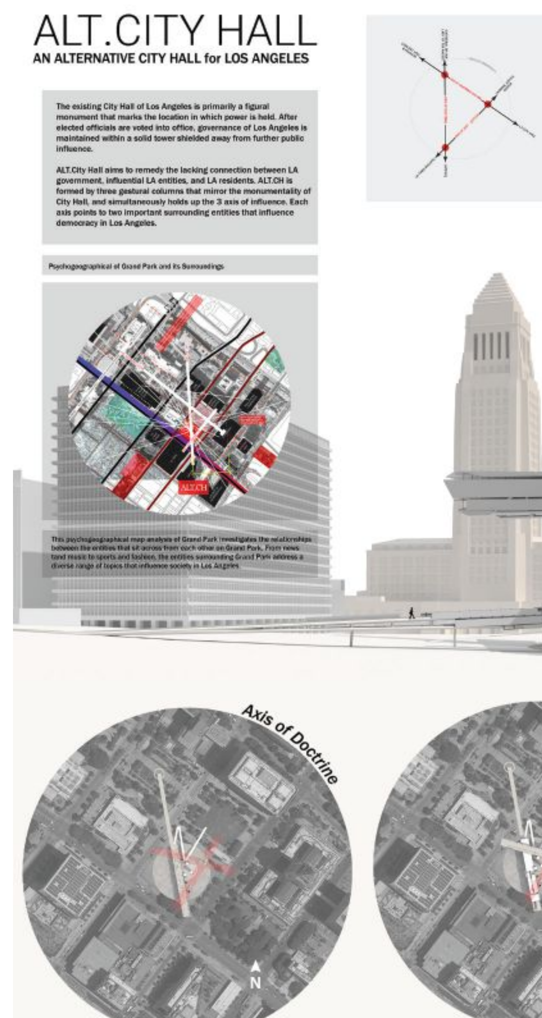
A proposed semi-submerged intervention completes the mission of an existing memorial for victims of lynching with a 12,000-sq.-ft Peace and Justice Center for Dialogue that provides a space for the difficult conversations on race that must happen to create a more equitable judicial system. The Center accommodates the memorial's current off-site exhibition space with the addition of classrooms for student groups and an auditorium for meaningful dialogue on race and social justice.

As a symbol of life and hope offered through dialogue, the green roof of the semi-buried Center contrasts with the hanging sarcophagi that stand in for the bodies of the lynched along the periphery of the memorial. Inspired by the art of Torkwase Dyson, the intervention uses the relationship between the visitor's body and space to convey a sense of the burden of Black life in America. Carved out of the earth, the space of the Center echoes the spaces African-Americans have had to carve out of the American landscape for self-liberation. Supported by a space frame, the curving green roof is inflected downward with the invisible weight of the dead but lifted 3 ft above the ground to reveal the literal weight of oppression as one descends into the earth below. A processional path to the Center between the new intervention and the concrete walls of the courtyard extends the ramped procession of the existing memorial and recreates the experience of a people pushed along the margins of society. As one enters the Center, a dropped ceiling over the lobby creates a compressed feeling before the section increases as one descends into the space. Once the path moves into the interior of the building, it is programmed as an exhibition space that leads visitors down to the auditorium. While offering a space that is hopeful, the design conveys the heaviness of the burden that all Americans need to help carry.

Alt. City Hall

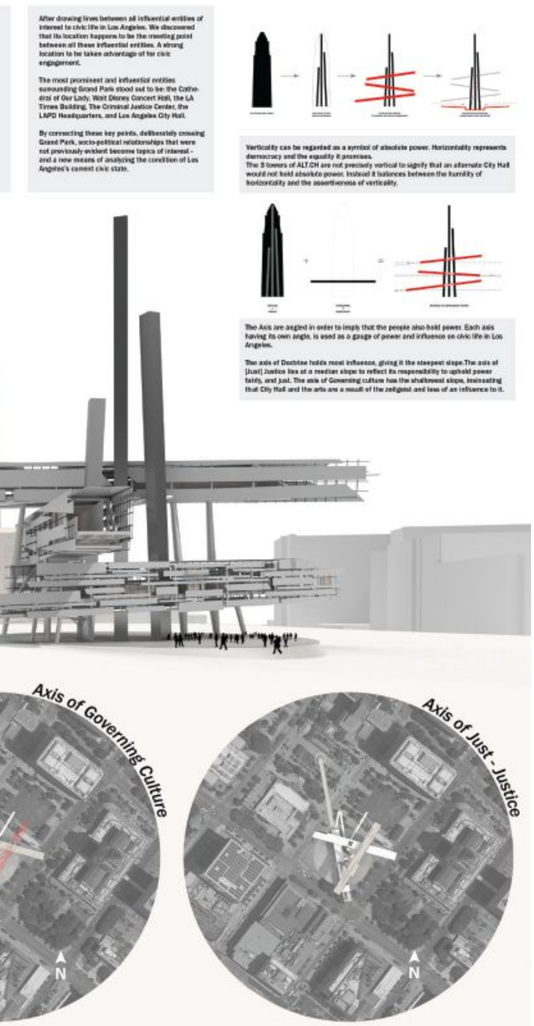
Students: Vanessa Romo and Dario Salgado
Faculty Sponsor: Gerard Smulevich
School: Woodbury University

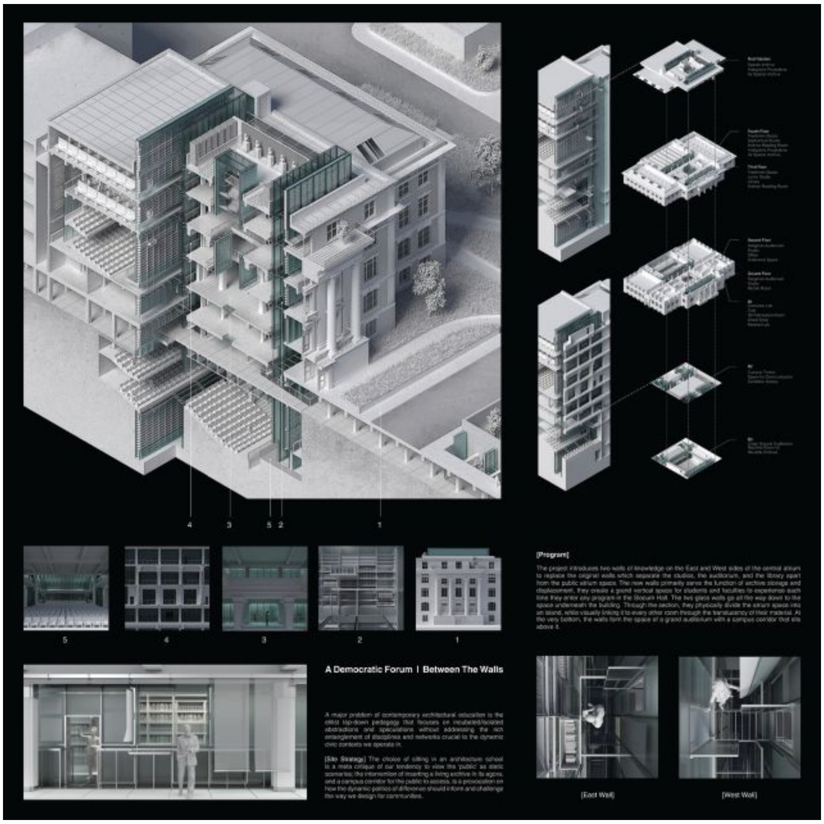
Los Angeles' existing City Hall is primarily a figural monument that marks the location in which power is held. After elected officials are voted into office, the city's governance is maintained within a solid tower shielded away from further public influence. Alt. City Hall aims to remedy the lacking connection between L.A. government, influential L.A. entities, and L.A. residents. The project is formed by three gestural columns that mirror the monumentality of City Hall and simultaneously hold up three axes of influence. Each axis draws influence from two important surrounding entities, using them as connecting



key points whose lines of sight deliberately cross in Grand Park. These intersections shine a light on the socio-political relationships that were not previously evident and create a new means of analyzing the condition of the city's current state.

While the current City Hall's monumentality is solid, the volume of Alt. City Hall is reduced to only what is necessary to support the three axes of influence. The ground plane gets treated with a slightly sloping surface that draws in people from the outside, leading to a central circular foyer that contains the bases of the three towers. While verticality can be regarded as a symbol of absolute power, the three towers are not precisely vertical, thus signifying that an alternate City Hall would not hold absolute power. Instead, it balances the humility of horizontality and the assertiveness of verticality.





A Democratic Forum Between the Walls

Students: Kaicheng Zhuang and Tianhui Li
Faculty Sponsor: Richard Rosa School: Syracuse University

If modern architecture is about rationality, an appeal to logic, then monumentality might well be its antithesis, a brute and unadulterated appeal to the senses and emotion. A Democratic Forum Between the Walls seeks to blur the dichotomy of monumentality and modernity.

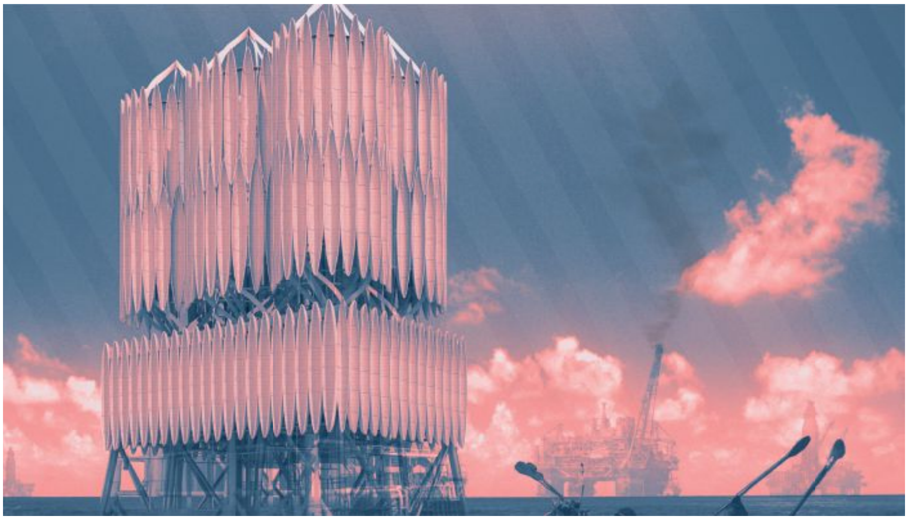
The project introduces two walls of knowledge on the east and west sides of the central atrium to replace the original walls that separate the studios, the auditorium, and the library from the public atrium space. The new walls primarily serve the function of archive storage and displacement, creating a grand vertical space for students and faculties to experience each time they enter any program in the architecture school. The two glass walls go down to the space underneath the building, forming the space of a grand auditorium with a campus corridor that sits above it. The corridor enables public access to the archive and makes them part of the architecture's academic discussion.

These two glass walls are each composed of a display wall and an archive storage wall. The display wall is composed of openable double-layered glass panels, where students and facilities can insert drawings and display them on both the atrium side and the inside of the wall space. The storage wall is composed of a great number of archive drawers covered with frosted glasses as well as rails for movable shelves to operate. Together, they form a gigantic archive shelf that goes through the entire building. The backside of the storage wall interacts with different programs behind it and can operate as a studio pin-up space on the fourth floor, a screen for the Selignmen Auditorium on the first and second floors, and even an exhibition wall inside the marble room.

The two walls work together to form a multifunctional space where archives can be displayed, lectures can be held, and studio criticism can take place. The archives are no longer stored in storehouses with limited access but rather constantly interact with the students, the building, and the public.

CATEGORY II: OPEN

The Open category offered architecture students the opportunity to select a site and building program using steel as the primary material.
This category permitted the greatest amount of flexibility for any building type.



1st

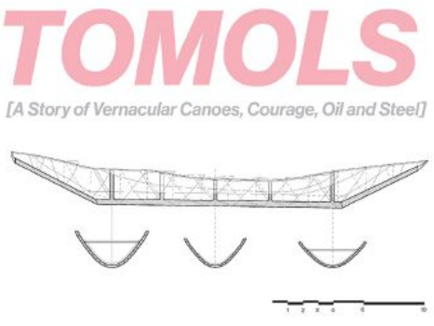
Tomols

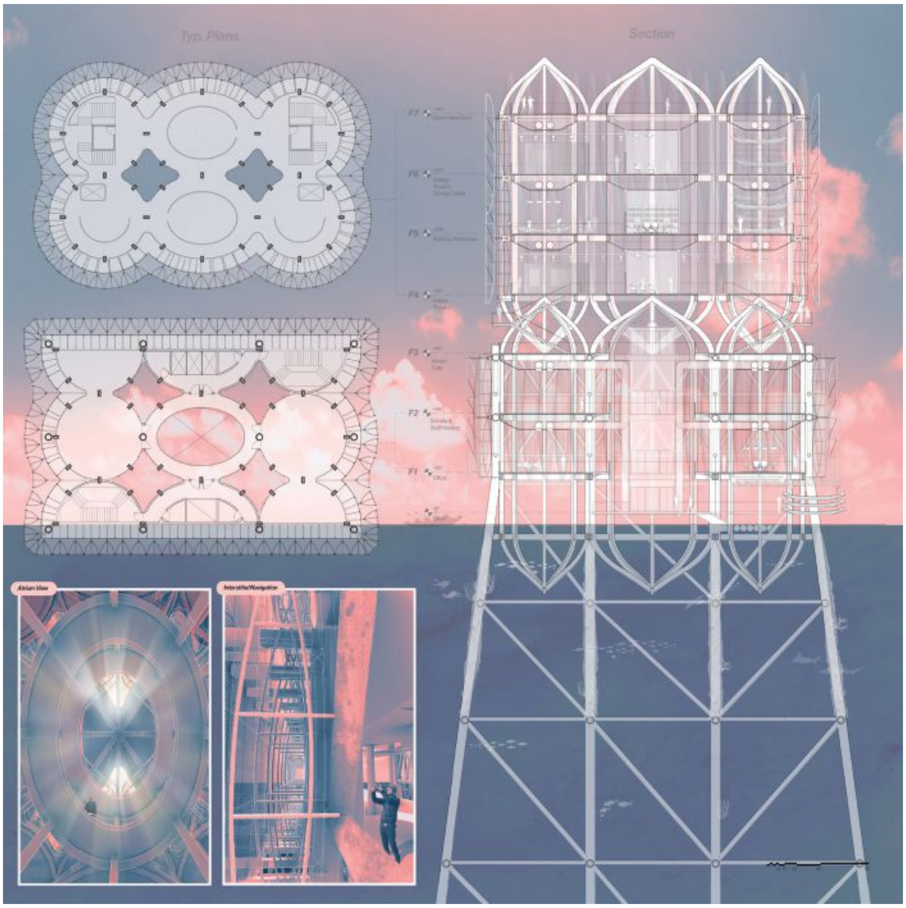
Student: Ron Patanavin
Faculty Sponsor: Thomas Fowler IV
School: California Polytechnic State University

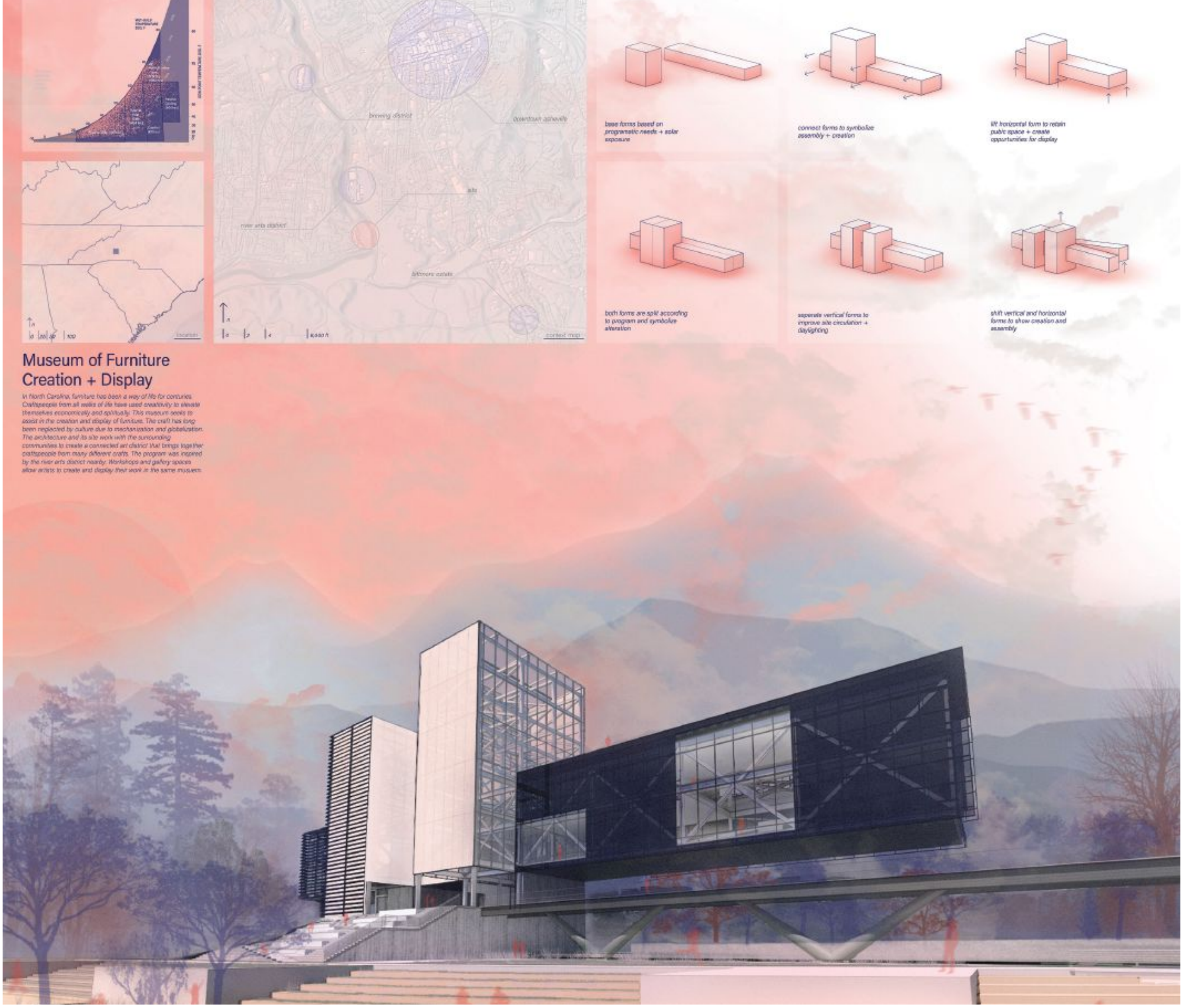
The ocean is a reminder of our small place in the universe. Chumash Indians, a seafaring tribe native to Santa Barbara, Calif., are no stranger to its grueling force. Using tomols, a type of vernacular canoe, the Chumash people traversed the rugged waters, living humbly off what the land had to offer. Their way of living demonstrates great courage, sustainability, and resilience, standing in stark contrast with today's exploitation of nature by the oil industry.

In 2015, Veneco decommissioned one of its oil rigs, Platform Holly, off the coast of Santa Barbara. The rig is located within the Chumash marine preserve and thus became the selected site for Tomols, a cultural center dedicated to the protection of Chumash heritage and values, serving as a reminder of the bleak past and a vibrant outlook into a more sustainable future.

To hear more about this design from Ron and Thomas, check out the Field Notes article "Reimagined Rig" on page 26.







Furniture Museum, Creation + Display

2nd

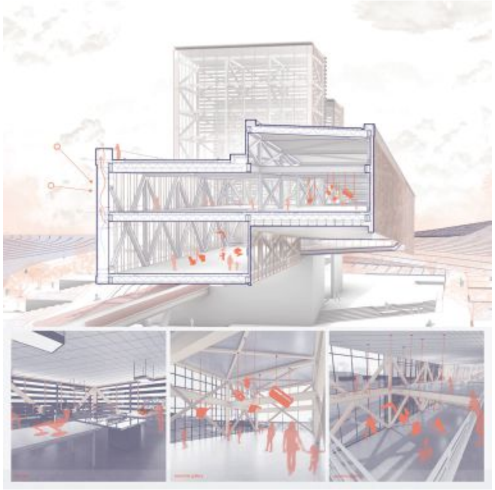
Student: Randolph Allison
Faculty Sponsor: Daniel Brown
School: Savannah College of Art and Design

A museum concept for Asheville, N.C., seeks to assist in the creation and display of furniture and pay homage to North Carolina's rich furniture-making history. Largely influenced by the millions of hardwood trees native to the area, furniture making became one of the most prominent businesses in the state early in its history. Crafting became a vehicle for financial mobility and remains one even to this day.

The museum is conceived such that workshops and gallery spaces could allow artists to both create and display their work in the same facility. Programmatically, the spaces are divided into two volumes. Spaces for creation are highlighted and put on display and are designed to enhance the experience of the craftspeople.

The large display spaces serve the craft by changing the perspective of the objects, creating a more dramatic interaction between the user and the objects. Two large vertical towers serve as "lanterns" for the museum. During the day, they flood the interior spaces with light, and at night, they act as a beacon, a guiding light for the lost craftsperson.

The site features many opportunities for interaction between user and craft. To the north of the building is the more formal park space, with outdoor gallery spaces, event spaces, and spaces for recreation. To the southeast of the building is the less formal park space. This area is designed to create interactions between users and the natural landscape. There are also spaces for relaxation and isolation that help visitors decompress after the museum experience.

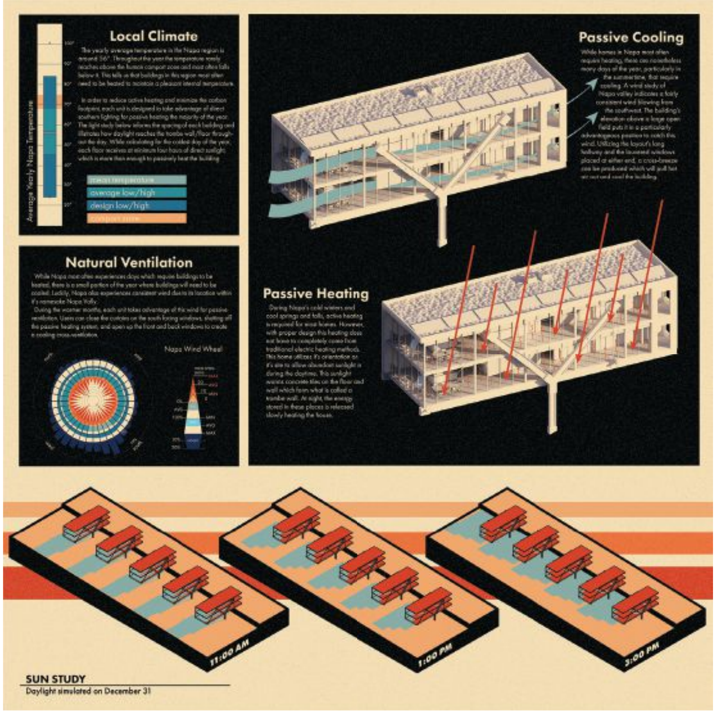


CATEGORY II: OPEN
Winners

3rd

The California Shotgun House

Student: Bryce Humbrecht
Faculty Sponsors: Gary Gilbert, Tara Street, and Kristopher Palagi
School: Louisiana State University



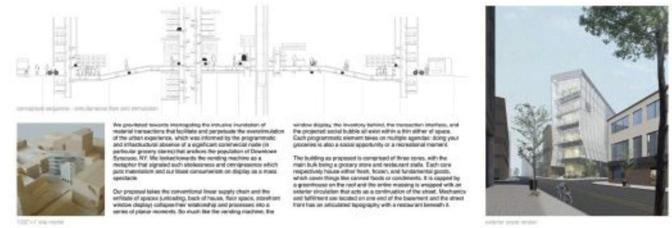
An odd lot sits on the border between a suburban neighborhood and a vineyard in California. On the edge of the city of Napa, this lot, lush with native vegetation, follows the curve of a ridge and a seasonal stream. The stream, Redwood Creek, flows into the Napa River and serves the important purpose of directing water down and out during heavy rains. The particular portion of Redwood Creek captured by this lot also hosts a pleasant dividing wall of trees and shrubs supported by localized runoff. The surrounding neighborhood is a typical middle- to upper-middle-class suburb. It's too far away from any destinations to walk, so most residents here need a car to get around. For these reasons and more, this site is best suited to house middle-class households of two to four people.

Enter the steel-framed California Shotgun House, whose design brings into harmony the aforementioned factors. It provides room for a couple and children, parking, office space for a remote working future, panoramic views of the adjacent vineyard, and importantly, on this difficult terrain, it remains minimally invasive to the existing landscape.

CATEGORY II: OPEN
Honorable Mentions

GrabHub

Students: Nicholas Chung and Chenhao Luo
Faculty Sponsor: Daekwon Park
School: Syracuse University



What if the typical grocery shopping experience were transformed to feel like a giant vending machine? Using downtown Syracuse, N.Y., as an example location, our proposal takes the conventional linear supply chain and the enfilade of spaces (unloading, back of house, floor space, storefront window display) and collapses their relationship and processes into a series of planar moments. Much like a vending machine, the window display, the inventory, the transaction interface, and the projected social bubble all exist within a thin sliver of space.

The building is comprised of three cores, with the main bulk being a grocery store and restaurant stalls. Each core respectively houses either fresh, frozen, or fundamental goods like canned foods or condiments. It is capped by a greenhouse on the roof, and the entire massing is wrapped with an exterior circulation that acts as a continuation of the street. Mechanics and fulfillment are located on one end of the basement, and the street front has an articulated topography with a restaurant beneath it.

Occupants engage the cores (transactions) through kiosks where they can browse, select, and add to their carts that track them, the same way one would shop online. When a specific product is summoned, pallets in the core bring the storage unit from the display window, meeting the occupant at the kiosk, which could also extend out to form countertops or kitchen units for local eateries to set up pop-up spaces.

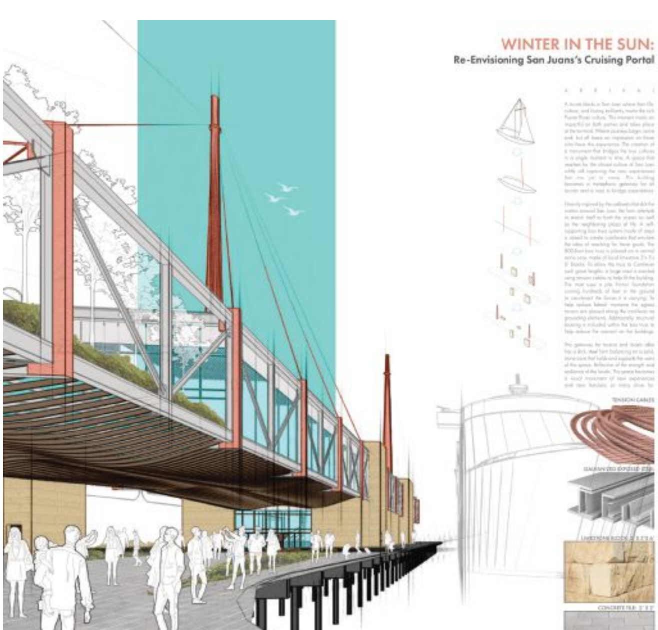
These cores are functional, tectonic, and structural, and the entire project branches out from them. The cores are columns tied in bands that allow for the interlocking floor truss to run through and cantilever outwards. The exterior façade is hung from the roof truss and drapes down both sides of the building. The circulation of people and goods also takes place in and around these cores, with a series of escalators bringing people up and down the interior space.

In addressing the passive systems, we looked at daylighting and how the built massing creates massive pools of shadows on the ground. There is a large range of solar gain throughout the seasons, and the area also experiences significant prevailing breezes. Therefore, the design employs a double-skin enclosure. A dynamic façade and summer balconies let air pass through and up the outer skin, and the flaps on the façade can be locked in place via electromagnets during winter, and an ETFE screen can be drawn out on the roof to shed rain and snow. There are also independent hydraulic pistons that allow for specific flaps or windows to be held open to meet specific interior microclimates.

The exterior dynamic façades are polycarbonate flaps held in 11-ft by 11-ft frames that have thin rods running through and stoppers in front. As the prevailing breeze moves along the façade, it causes the entire skin to flicker, thereby turning the vending machine and the people inside it into moving art of different transparencies. The polycarbonate panels also have different opacities depending on the amount of annual glare the façade receives. The result is basically a gradation where pockets of the interior are more visible to let more daylight in.

Arrival

Student: Matt Yearout
Faculty Sponsor: Awilda Rodriguez Carrion
School: Oklahoma State University



A tourist docks in San Juan, Puerto Rico, where their life, culture, and history brilliantly meet the rich Puerto Rican culture. This moment marks an impact on both parties and takes place at the terminal. Where journeys begin, some end, but all leave an impression on those who have this experience. The creation of a monument bridges the two cultures in a single moment in time. A space reaches for the vibrant culture of San Juan while still capturing the new experiences that are yet to come. This building becomes a metaphoric gateway for all tourists and a way to bridge experiences.

Heavily inspired by the sailboats that dot the waters around San Juan, Puerto Rico, the form of Arrival, a welcome center on the waterfront, attempts to stretch to both the ocean and the land. A self-supporting steel box truss system made of steps is raised to create cantilevers that emulate the idea of reaching toward these goals. The 800-ft box truss is placed on a central stone core made of local limestone blocks. To allow the truss to cantilever such great lengths, a large mast is erected using tension cables to help lift the building. The mast uses a pile friction foundation running hundreds of feet in the ground to counteract the forces it is carrying. To help reduce lateral moments, the egress towers are placed along the cantilever as grounding elements. Additionally, structural bracing is included within the box truss to help reduce the moment on the buildings.

CATEGORY II: OPEN
Honorable Mentions

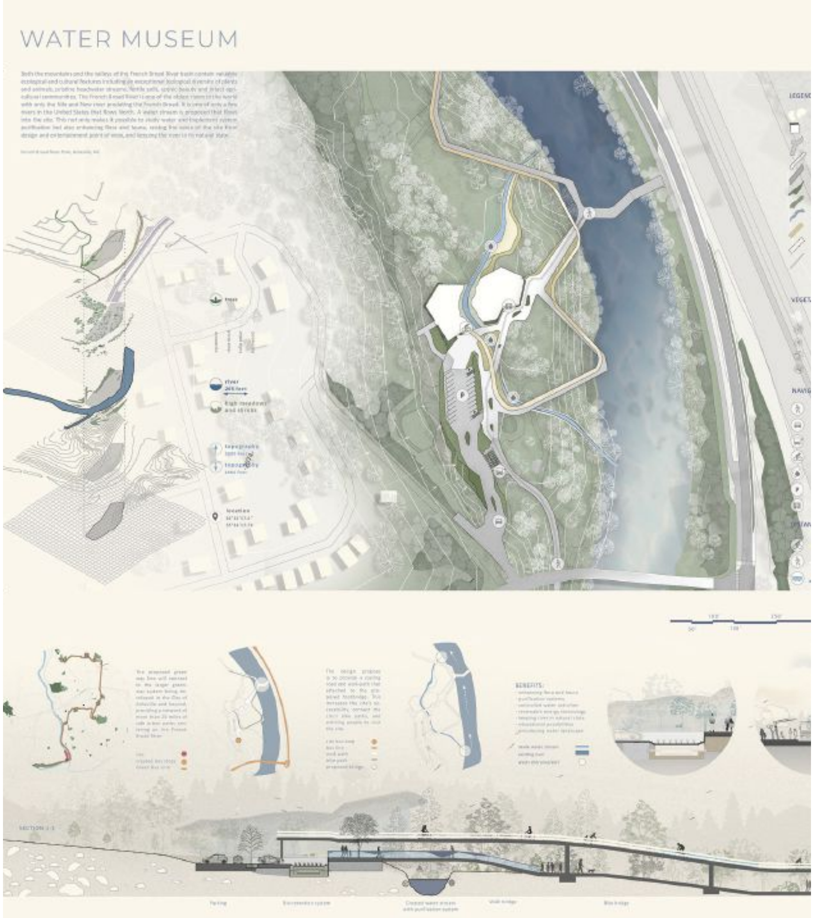
Water Museum – W/M

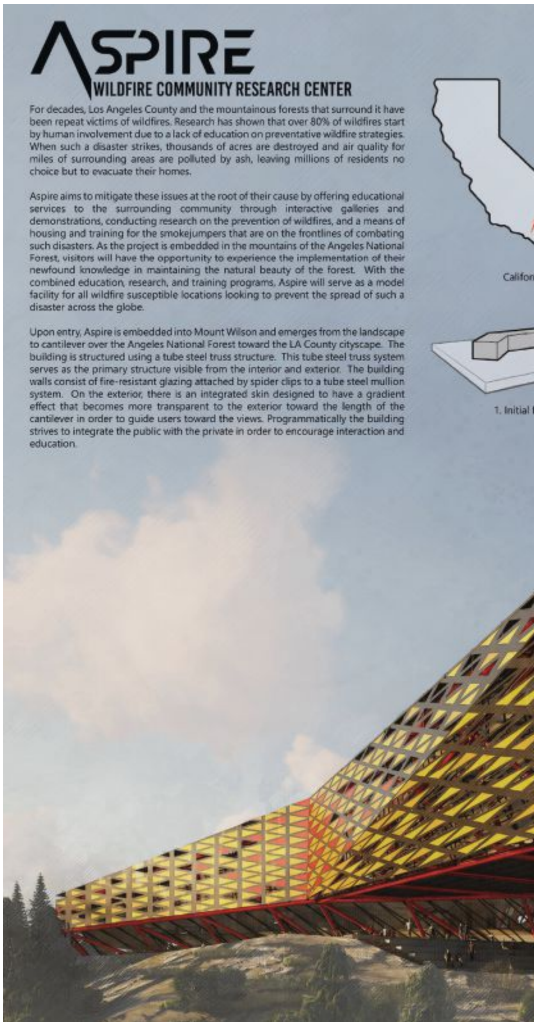
Student: Karalina Shastavets
Faculty Sponsor: Daniel Brown
School: Savannah College of Art and Design

The Water Museum (W/M) introduces innovative methods of water treatment, collects water samples from rivers and lakes around the world, and provides educational and entertainment programs. W/M visitors and corporate customers receive thought-provoking exposure to water, including engaging water experiments, inventions, installations, and teaching that reveal the value of pursuing water conservation.

The W/M is located in Asheville, N.C., near the French Broad River, one of the oldest rivers in the world. A water stream is created that flows into the site, not only making it possible to study water and implement system purification but also enhancing flora and fauna and raising the value of the site from a design and entertainment point of view. The water divides the museum into two parts, creating a canyon of sorts. The typology of the building consists of three important spaces. The first part of the building is a public exhibition, the second is semi-private, and the third space in the middle serves as the artery of life of the museum, a place of gathering, enjoying nature, and celebrating water.

The sun-adaptive envelope, water filtering, rainwater harvesting, and geothermal systems contribute to a sustainable facility. Photovoltaic adaptive modules are integrated into a dynamic shading system to generate electricity and balance energetic performance with architectural expression. The innovative filtration system incorporates aquaporin proteins to replicate nature's own water filtration process to filter water faster and more efficiently. A rainwater system captures, diverts, and stores rainwater from the curved rooftop.



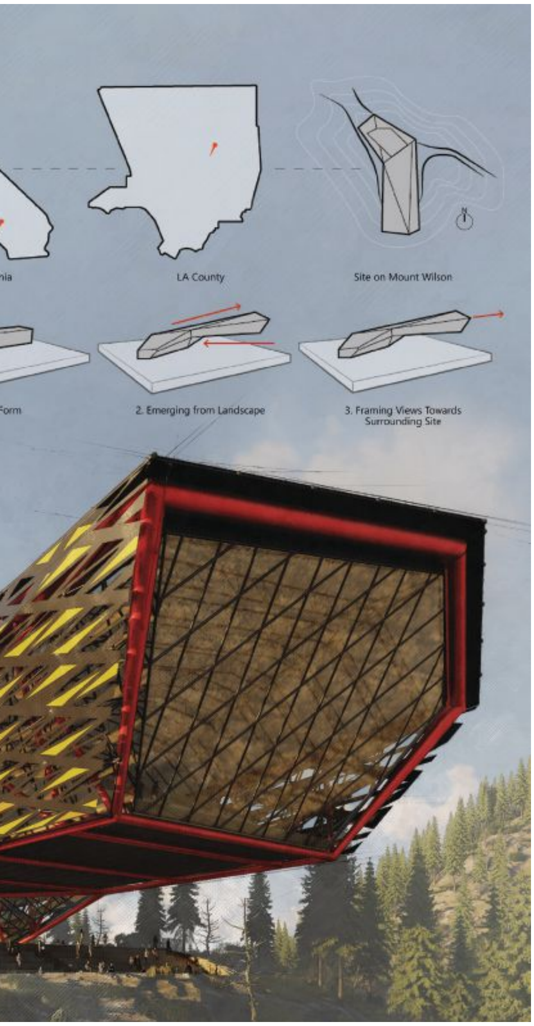


Aspire

Students: Madison Waldron and Jacob Forst
Faculty Sponsors: Pasquale De Paola, Kevin Singh, and Wei Zhao
School: Louisiana Tech University

For decades, Los Angeles County and the mountainous forests that surround it have been repeated victims of wildfires. Research has shown that over 80% of wildfires start with human involvement due to a lack of education on preventative wildfire strategies. When such a disaster strikes, thousands of acres are destroyed and the air quality for several miles around is polluted by ash, leaving millions of residents no choice but to evacuate their homes.

Aspire aims to mitigate these issues at the root of their cause by offering educational services to the surrounding community through interactive galleries and demonstrations, conducting research on the prevention of wildfires, and a means of housing and training for the smokejumpers that are on the frontlines of combating



such disasters. As the project is embedded in the mountains of the Angeles National Forest, visitors will have the opportunity to experience the implementation of their newfound knowledge in maintaining the natural beauty of the forest. With the combined education, research, and training programs, Aspire will serve as a model facility for all wildfire-susceptible locations looking to prevent the spread of such a disaster across the globe.

Upon entry, Aspire is embedded into Mount Wilson and emerges from the landscape to cantilever over the Angeles National Forest toward the L.A. County cityscape. The building uses a tube steel truss structure system that is visible from the interior and exterior. The exterior walls consist of fire-resistant glazing attached by spider clips to a tube steel mullion system and an integrated skin designed to have a gradient effect that becomes more transparent to the exterior toward the length of the cantilever in order to guide users toward the views.

The Metaphysical Museum of Reality

Student: Daniel Jaraba
Faculty Sponsor: Daniel Brown
School: Savannah College of Art and Design

The primary goal of The Metaphysical Museum of Reality was to make French Broad River Park in Asheville, N.C., a node that connects the city to itself and to the rest of the world and symbolizes the intersection between architecture and technology. By contrasting how we interact through the Internet and how we interact in the real world, I came to the realization that by overlaying a virtual space on a physical space, one could be inside both the "Meta-verse" and the real world simultaneously, thus generating an experience that transcends the visitor into a metaphysical state.

When you first approach the building, the architecture takes you on a journey where you slowly separate yourself from the real world by sinking beneath the ground, thus, progressively detaching your mind from natural reality. Once in the building, you will enter a hallway where you learn about the technology behind virtual worlds and artificial environments. From there, you will pick up a pair of AR glasses and enter an elevator (completely enclosed) that takes you up into a tall and narrow hallway that compresses your senses until the moment you turn the corner, and it releases you into a completely immersive environment where you interact with people from all over the world that log into the space virtually. As you go up the building, the enclosure gets less and less opaque, giving you a glimpse of the city of Asheville and the river, thus starting the process of reattachment to natural reality. Right before entering the observatory, you will get a final view of the virtual space from a viewpoint that doesn't allow you to interact with the interface or the people. From there, you turn around and go up the stairs into a space that allows a prime and pristine view of the river and the city. This place is meant for the visitor to reflect on what reality actually means and if it is even worth replacing.

To achieve this holistic experience, there are many factors involved, from the hidden steel structure hiding the cantilever to the responsive voxel screens. Externally, LEDs allow anyone to interface with the building on some level, which in turn democratizes the space. Sustainability within the project was addressed by cladding the building with photovoltaics and by using bio-mass gathered from the site to generate electricity. All in all, the form, the values, and the technology all work together to make this museum a place that celebrates the creative culture of Asheville and shares it with the world. ■

new products

This month's New Products section features new safety equipment for grinding and other applications, a highly customizable beam rotator, and a smart pendant that can call for help in the event of a worker fall.

Bendmak B-ZR Chain Rotator

Bendmak chain rotators can rotate and position long sections of parts for welding, cutting, or assembly operations. The desired welding areas can be positioned by rotating the part on an endless chain. It is also possible to adjust the height of the piece placed on the machine even at a preferred angle as desired, which provides enhanced convenience to the operator during welding. The B-ZR model offers an endless chain line, making any position on a beam easily obtainable, and is capable of precise and smooth rotations both clockwise and counterclockwise and can be moved up and down to provide the desired height. The machine is driven by two units, but this number can be increased based on application and weight. Both units can be driven synchronously or independently of each other to obtain the best rotation and angle. The standard weight capacity is six to 12 tons. For more information, visit **www.bendmakusa.com**.

SecuraTrac MobileDefender Model S

The MobileDefender Model S (MD-S) mobile emergency pendant is designed to ensure the safety of construction workers and others in the field, relaying information about employee locations while providing them with an instant connection to help if an emergency occurs. It also offers a built-in Fall Advisory capability that can detect horizontal and vertical movement, so if an employee falls on the job or is knocked over, he or she does not have to initiate a call for help. The MD-S will trigger one automatically. Leveraging existing SecuraTrac cloud-based location technology, the new MD-S adds the ability for Central Stations to respond to potential accidents. To improve battery lifespan, the MD-S was designed with a new Wake-on SOS feature, which allows the device to last over 30 days on a single charge. For more information, visit **www.securatrac.com**.

Milwaukee Tools BOLT

Eye visors, polycarbonate face shields, metal mesh face shields, and a specially designed BOLT REDLITHIUM USB headlamp are joining the BOLT safety lineup; Milwaukee BOLT is the first safety system that allows users to secure accessories simultaneously for a complete head protection solution. The new BOLT eye visors are classified as spectacles and can be used in place of safety glasses with a Z87.1+ rating. The polycarbonate face shields are designed for long-lasting visibility, featuring an ANSI Z87.1+ rating, a fog-free interior coating, and an anti-scratch exterior hard coating for an extended lifetime. Constructed with highly durable stainless steel, the BOLT Mesh Full Face Shield protects users from debris in chipping and cutting applications and provides maximum durability. The REDLITHIUM USB headlamp features an ultra-thin light head that allows users to raise and lower face shields and eye visors and delivers 600 lumens lighting. For more information, visit **www.milwaukeetool.com/ppe**.

IN MEMORIAM

Industry Remembers Alan "Ted" Sheppard

Alan Theodore "Ted" Sheppard, a long-time steel industry expert and advocate, passed away at 89 at his home in Beaumont, Texas, on Saturday, August 27.

"Ted was integral to connecting AISC with the erector community," said AISC senior vice president Scott Melnick. "He had friends everywhere and could always be counted on to make a needed introduction, offer practical advice, or join a group in a good glass of wine."

Born July 12, 1933, in Philadelphia, Sheppard attended Yale University, where he graduated with honors in 1955. A civil engineer by trade, he served on several AISC committees, including the planning committee for NASCC: The Steel Conference, the ad hoc Committee on the Erector Standard, and AASHTO/NSBA Collaboration Task Group 10 (Erection). At the time of his death, he was a sitting member of AISC's Certification Standards Committee, which he joined in 2011.

Sheppard was a fixture in the industry for decades. In a 2013 Steel Conference session, Bill Merrell noted that the AISC *Steel Construction Manual* was in its fifth edition when Sheppard started his career in 1951. AISC will release the 16th edition of the *Manual* next year.

He was also a long-time member of the Ironworker Management Progressive Action Cooperative Trust (IMPACT). He never officially retired and remained active with IMPACT. In fact, he was helping steel erectors achieve AISC Certification until just a few days before he died.

"Ted was a force to be reckoned with, as I learned when we served together on the Certification Standards Committee," recalled Todd Alwood, AISC vice president of membership and certification. "His insights into the world of structural steel erection were invaluable, as was his attention to detail. The latter did, however, cause some contention between us—he always delighted in reminding me that my parents had spelled my middle name (Allen, not Alan) incorrectly."

SSBC

2023 Student Steel Bridge Competition Rules Now Available

Pull out those ratchets. The 2023 Student Steel Bridge Competition is officially underway!

The official 2023 Competition Rules are now available. You can download them, as well as other important competition resources, at **aisc.org/ssbc**. We suggest you start with the Competitors Guide, which is full of information and helpful tips for experienced and first-time competitors alike. You can also share our team recruitment video to get potential teammates excited about the competition! If you are new to the SSBC, watch "SSBC: Bridging the Gap and Getting Started" to hear SSBC alumni share advice for building a successful team. And that's just to name a few! And check out the Team Resources link for even more helpful tools.

Speaking of resources, you might want to connect with a practicing structural engineer in your area for feedback on your design, analysis software advice, or general mentoring. We've partnered with the National Council of Structural Engineering Associations (NCSEA), which comprises 44 structural engineering associations across the United States, and each one has a delegate who can connect you with someone in your area. Visit **aisc.org/ssbc-ncsea** to learn more.

People & Companies

The **Steel Tube Institute (STI)** announced **Holly Schaubert** as its new director of hollow structural sections (HSS). "Holly represents the next steps STI is taking to continue the great work done to date by our HSS Committee and the retiring **Joseph Anderson**," said **Dale Crawford**, executive director of STI. "She has an extensive engineering background and a strong track record working with cross-functional groups. Her knowledge and expertise will help STI continue to promote the value and product benefits of HSS not only in architecturally exposed applications but also through the built environment."

Bridge design, inspection, and rehabilitation firm **Modjeski and Masters** announced its acquisition of structural engineering firm **Flanders Engineering Group, Inc.**, which focuses on electrical power and control engineering and structure balance engineering for the movable bridge industry. Through the strategic acquisition, Modjeski and Masters will be able to deepen its movable bridge expertise and expand its presence in Florida.

The **Council on Tall Buildings and Urban Habitat (CTBUH)** announced the induction of four new CTBUH Fellows, who are recognized for their ongoing contributions and leadership within the Council over the past several years. Two of the new fellows are **Abbas Aminmansour**, chair of the Building Performance Program at the **University of Illinois at Urbana-Champaign**, and **Kirk Harman**, managing principal of **The Harman Group** (now **IMEG**). Aminmansour is a member of AISC's Committee on Manuals as well as Technical Committee 4: Member Design and won an AISC Special Achievement Award in 2015. Harman is a member of the AISC Code of Standard Practice Committee and won an AISC Lifetime Achievement Award this year.

GOVERNMENT RELATIONS

American Structural Steel Leads the Way as White House Prioritizes Low-Carbon Construction Materials

Federal agencies will prioritize the purchase of key low-carbon construction materials, the White House announced recently, the latest action in its Federal Buy Clean initiative.

America's structural steel industry stands ready to support that mission, and it has already exceeded the Kyoto Protocol's emission reduction requirements by a factor of seven.

"We applaud the Biden administration's efforts to lower emissions in the construction sector, and we look forward to continued collaboration with the Federal Buy Clean Task Force," said AISC's director of government relations and sustainability, Max Puchtel, SE, PE. "As America already leads the world in producing low-embodied-carbon fabricated structural steel and transparently disclosing environmental impacts—all while responsibly complying with environmental and labor regulations—the structural steel industry is uniquely positioned to continue its leadership role and deliver on the administration's Buy Clean and Buy America priorities."

AISC has worked closely with state governments and the federal task force and provides resources and information about Buy Clean programs on its website at **aisc.org/buyclean**.

"A clean, green future is critical and it's already building in steel today. The hundreds of thousands of Americans in the structural steel industry have been working toward carbon neutrality for decades," said AISC president Charles J. Carter, SE, PE, PhD. "The smokestacks are long gone—in fact, the vast majority of the few emissions that remain from structural steel beam production now come from the power grid."

That's because today's American steel mills use electricity to turn scrap metal into new structural steel beams; the average steel beam or column made in an American steel mill contains 93% recycled material. That process emits 75% less carbon dioxide than traditional methods—and it's how every single American structural steel beam is made today.

It's also a stark contrast between American steel and foreign steel. Chinese steel has three times the global warming potential of domestic steel.

American steel will continue to get cleaner as more renewable energy sources come online, but the industry isn't waiting. Across the nation, mills are building their own sustainable power fields and installing carbon scrubbing equipment. AISC's member fabricators, who prepare steel for building and bridge jobsites, are taking their own steps to reduce their energy consumption, too. Fabrication shops can be vast, and companies are taking advantage of the space by installing solar roofs.

The American steel industry already thinks in terms of generations because it's a cradle-to-cradle material.

"Steel is the most recycled material in the world, and American structural steel leads the way," added Puchtel. "A new beam, fresh from the mill, contains 93% recycled cars, appliances, and other scrap—perhaps even the soup cans from your recycling bin—which diverts huge amounts of waste from landfills. At the end of a building or bridge's service life, steel goes right back into the supply chain to be recycled over and over again with no loss of properties."

correction

In the October 2022 article "Riding the Wave," the bender-roller was erroneously left off the team list. AISC member Chicago Metal Rolled Products served as the bender-roller for the project.

EDUCATION

Annual AISC Scholarship Winners Announced

AISC has announced the winners of its 2022–2023 scholarships.

A total of $361,000 in scholarships has been awarded to 100 deserving undergraduate and master's students for the 2022–2023 academic year.

The AISC David B. Ratterman Fast Start Scholarships program awarded a total of $76,000 in scholarships to 23 students again this year. The program awards children of AISC full member company employees who will be freshmen and sophomores during the upcoming academic year. The students may attend two- or four-year programs and may choose any area of study.

The annual student welding competition returned to Puma Steel in Cheyenne, Wyo., in the fall of 2021, and local high school students competed to win scholarships to attend the welding program at Laramie County Community College (LCCC). The AISC Education Foundation administered $9,500 to four competition winners who enrolled at LCCC.

The Student Steel Bridge Competition (SSBC) was back to its tried and true in-person format in 2022. AISC awarded scholarships to the top-scoring teams, as well as three team awards for spirit, ingenuity, and engagement, totaling $13,000.

Finally, the AISC Education Foundation, in partnership with several other structural steel industry associations, awarded $262,500 to 68 students. AISC is deeply thankful for the growing support of our industry partners and offers our sincerest thanks for their generous, continued contributions.

Without further ado, here are the winners of the 2022–2023 academic year AISC Scholarships.

The David B. Ratterman Scholarship Jury consisted of the following individuals:

- David B. Ratterman, Scholarship Committee Chair

AISC Board Members:

- Morgan DeLong Costello
- Hollie Noveletsky
- Philip Stupp
- Glenn Tabolt
- Jacob Thomas
- W. Duff Zimmerman

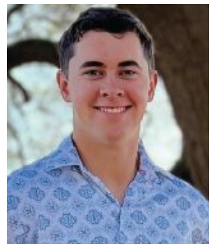
David B. Ratterman Fast Start Scholarships

$4,000 Award Recipients

- Garrison Blackwell, Tarleton State University
- John Cole, Creighton University
- Alexandria Gearhart, Bloomsburg University
- Kalash Kapadia, Purdue University
- Konnor Keller, Penn State University Park
- Jasmine Le, Dominican University of California
- Erin Meaney, University of Florida
- Grayson Seibert, University of Southern California
- Gavin Shull, Kennesaw State University
- Ruben Trevino, Virginia Tech
- Mallie Zielinski, University of Mississippi

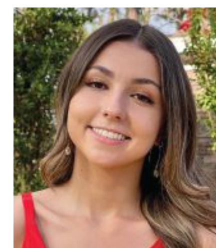
not pictured:

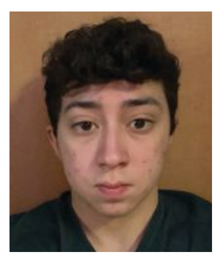
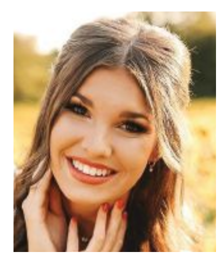
- Zach Boerner, University of Wisconsin – Platteville
- Jorge Contreras, Texas Tech University
- Santiago Diaz Murillo, University of Idaho
- Michael Zaronias, Purdue University









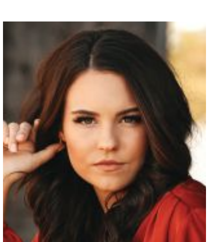
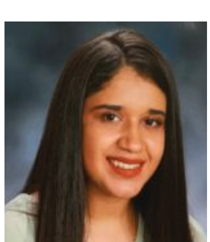





$2,000 Award Recipients

- Cash Bohannon, Laramie County Community College
- Creede Guardamondo, Otero College
- Mason Hastings, Arkansas Northeastern College
- Cassandra Sanchez Patino, Fresno City College
- Abagail Terry, Southeast Community College

not pictured:

- Zander Burke, Arkansas Northeastern College
- Aurianna Vargas, University of Phoenix
- Uniti Woodson, Sacramento City College


Rex I. Lewis Fast Start Scholarships

- Evan Smith, Laramie County Community College (LCCC)

not pictured:

- Ethan Bristol, LCCC
- Devin Meyer, LCCC
- Noah Kinney, LCCC

AISC/Cohen Seglias

- Kevin Brooks, University of Massachusetts Amherst

not pictured:

- Tyler Kleinsasser, South Dakota School of Mines and Technology

AISC/Ohio Steel Association

- JT Lemmermen, University of Cincinnati

AISC Scholarships for Juniors, Seniors, and Master's Students

- Joseph Almeida, New Jersey Institute of Technology
- Isaiah Amir-Townes, University at Buffalo (SUNY)
- Colin Arnold, Washington State University
- Lucas Arsenith, Boise State University
- Jacob Atkins, Oregon State University
- Jacqueline Badal, California Polytechnic State University
- Maria Boyle, California Polytechnic State University
- Zoe Choate (W&W | AFCO Steel Award), University of Texas at Austin
- Spencer Chuck, University of Colorado at Boulder
- Caelan Denley, Louisiana Tech University
- Michael Drummond, University of Cincinnati
- Carter Eldridge, University of Wisconsin–Madison
- Justice Forster, Virginia Tech
- Quenton Greiner, Michigan State University
- Robert Hardwick, California Polytechnic State University
- Simon Joyner (Havens Award), Clarkson University
- Heather Kennedy, Virginia Tech
- Berit Klein, University of Minnesota – Twin Cities
- Emma Kratz, Brigham Young University
- JT Lemmermen, University of Cincinnati
- Melanie Macioce, University of Arizona
- Erica Miller, Drexel University
- Jordan Nutter, University of Kansas
- Harrison Randolph, West Virginia University

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The AISC Scholarship jury consisted of the following individuals:

- Ezra Arif Edwin, Simpson Gumpertz & Heger
- Benjamin Baer, Baer Associates Engineers, Ltd.
- Nina Choy, CalTrans
- Jeanne Homer, AISC
- Luke Johnson, Nucor Corporation
- Matthew Streid, Magnusson Klemencic Associates

AISC Scholarships for Juniors, Seniors, and Master's Students

- Nathan Robey, Marywood University
- George Saphir, University of Arizona
- Noah Struck, University of Minnesota – Twin Cities
- Grace Zalubas, University of Michigan
- Ben Zook, Virginia Tech

not pictured:

- Cameron Hicks, Kansas State University





AISC/Rocky Mountain Steel Construction Association

- Natalie Caldwell, University of Wyoming
- Spencer Chuck, University of Colorado at Boulder


AISC/Southern Association of Steel Fabricators

- Sara Durr, University of Louisville
- Cheyenne Wimsatt, University of Louisville


AISC/Associated Steel Erectors of Chicago

- Rachel Becker, Rose-Hulman Institute of Technology
- Zachery Burks, Southern Illinois University Carbondale
- Christian Correa, University of Illinois Chicago
- Andrew DeLuca, University of Notre Dame
- Daniel Gentile, University of Illinois Urbana-Champaign
- Zachary Gold, University of Illinois Urbana-Champaign
- Olivia Hansen, Illinois Institute of Technology
- Prabin Kafle, Illinois Institute of Technology
- Amir Louaibi, University of Illinois Chicago
- Michelle Mo, University of Illinois Urbana-Champaign
- Kina Tamai, University of Illinois Urbana-Champaign

not pictured:

- Erin Haase, Trine University
- Kyle Hollenback, Western Illinois University
- Oliver Mate, Illinois Institute of Technology
- Elizabeth Sirkman, Illinois Institute of Technology

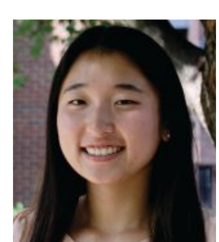












AISC/W&W|AFCO Steel/ Oklahoma State University




seniors
- Molly Hoback, Architectural Engineering

juniors
- Koda Oller, Civil Engineering Technology
- Raphael Wall, Civil Engineering
- Skylar Waters, Architectural Engineering

not pictured:

seniors
- Mason Egermeier, Civil Engineering

sophomores
- Georgia Giddens, Civil Engineering
- Elyssa Gowriluk, Architectural Engineering
- Weston Light, Civil Engineering Technology

AISC/UIUC Architecture Scholarship

- Jon Guttello, University of Illinois Urbana-Champaign

AISC/Indiana Fabricators Association

- Lauren Kimes, University of Notre Dame
- Matthew Yee, Valparaiso University

not pictured:
- Elisa Cardona, University of Evansville
- Lucas Jackson, Trine University
- Thomas Philip DiLavore, Purdue University
- Trevor Price, Purdue University Fort Wayne
- Sarah Shoemaker, Rose-Hulman Institute of Technology


Student Steel Bridge Competition

- Elise Hummel, Virginia Tech*
- Daniela Marín-Milian, University of Puerto Rico Mayagüez
- Halley Suarez, University of British Columbia
- Mady Weeks, University of Alaska Fairbanks

not pictured:
- Haylie Cortez, University of Alaska Fairbanks
- Fletcher Luke D'Arcy, University of Florida
- Jenna Hernandez, University of Alaska Fairbanks

**Recipient chose to begin their postgraduate studies at a new school. School listed does not indicate the winning SSBC team.*




Undergraduate Research Fellowships

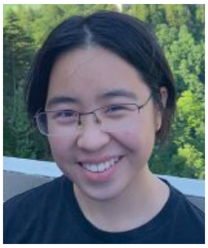
The AISC Education Foundation continued its Undergraduate Research Fellowships program, awarding two undergraduate students each with a $2,500 grant to conduct research projects during the fall 2022 term.

Congratulations to Haixin Zhou and faculty sponsor Hongxi Yin, PhD, from Washington University in St. Louis. Zhou is investigating Wire-Arc Additive Manufacturing (WAAM) in structural connections for buildings.

AISC also congratulates Aneesh Kakirde and faculty sponsor Sougata Roy, PhD, from Rutgers University. Kakirde is researching modular steel bridge decks for speedy construction and extended service life.

Learn more about the selected proposals and the new fellowship program at **aisc.org/research**.

If you are interested in donating to the AISC Education Foundation to support more of tomorrow's leaders, please visit aisc.org/giving for more information.

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ACCELERATED INSTALLATION

NEED FOR SPEED

Editor's note: This month's Structurally Sound takes the form of a letter to the editor—and also serves as a preview of next month's issue, which will focus on AISC's Need for Speed initiative and what dozens of companies have done to help achieve its goal of increasing the speed at which a steel project can be designed, fabricated, and erected by 50% by the end of 2025.

I READ, WITH MUCH INTEREST, your August Editor's Note focusing on Need for Speed. I've been in steel erection all my life, presiding over two different AISC certified erection companies. To say I have enjoyed this career would be an understatement. For me, it has always been the right combination of physical and intellectual work. And the opportunity to bring people into our industry and contribute to their education and success has been so rewarding.

Almost two years ago, we had the opportunity to work as a subcontractor for a company—Building Zone Industries (BZI)—on an Amazon fulfillment center in San Diego. Prior to this project, I had never heard of BZI. Come to find out they've been quietly building large distribution centers, warehouses, and similar facilities all over the country, using systems that they invented and patented, that allow them to erect steel from the top down. Needless to say, I was a little bit skeptical at first.

Well, seeing is believing. I and the rest of my company got to watch BZI crews panelize entire bays of steel, complete with beams or joists with floor or roof decking pinned in the proper spacing and location, then lift a whole panelized section with a huge telescoping boom forklift, tilt it 45°, drive it to the installation location within the structure, level it out, set it into place, and then cut it loose. This whole process took less than 10 minutes once the panel was attached to the forklift, and panelizing each complete bay on the ground took 10 to 15 minutes, depending on openings and such. This process was repeated over and over, and again, the work started at the roof and made its way down to the ground. I was so impressed with the people and the culture of BZI that we sold our company to them last year. (If you'd like to see videos of some of BZI's top-down construction solutions in action, including the MezzMaster telehandler jib and the Skybrace exterior bracing system—which replaces the temporary cable X-bracing used in bottom-up construction—visit **bzisteel.com/videos**.)

Of course, it's not for everyone, and it won't work on every steel structure. But who's to say there aren't other companies out there with their own ideas for building the proverbial better mousetrap? As some of these "new ideas" are outside the box, so to speak, they don't particularly fit the established methodologies that OSHA regulates, which are only periodically revised. Our industry should work together to request waivers for systems that prove themselves to be efficient, faster, and, above all, safe. The worst thing we can do is hamper creativity. ■

—Lee Shaw, Building Zone Industries


THE FUTURE
OF WELDING
STRUCTURAL
STEEL IS
HERE NOW!
CHALLENGER