An urgent need for larger facilities was quickly met, thanks to flexibility, cooperation, and the selection of steel framing.

Growing an Office

THE JOURNEY FROM an overcrowded office campus to comfortable, cohesive, and flexible workspaces began with a Fargo, N.D., software company's need to expand its workforce. At the same time, the company realized it did not have enough space for new hires. In fact, there was not even enough space for current employees, who had spilled out of the two existing buildings into leased space nearby, but off the campus, incurring additional cost and fracturing the workforce. As plans developed for a new building, it became clear that efficiency could be increased by bringing back on campus the resources that currently took employees off campus, such as eating spaces, meeting rooms, and presentation facilities. With this new perspective, the idea to build a new building became a plan to build two.

The company engaged three Minneapolis firms to work on its new two-building project: architects Perkins+Will, with Meyer Borgman Johnson as structural engineers, and JE Dunn as general contractor. Criteria for the project included an architectural design that complemented, but did not copy, the existing two buildings on the campus, and that would be as memorable as it was functional. No big box buildings. The owner also was interested in creating work spaces of a scale conducive to teamwork and collaboration among employees. The desire was for an open architecture capable of being flexible and responsive to changing needs. Because the need was imminent, programming began immediately with the project team designing within the constraints presented by both owner and site.

Aside from the owner's desires, the site itself presented strong challenges mainly because of the area's geology. Fargo sits within the shores of glacial Lake Agassiz, the remains of the last glaciers which melted some 10,000 years ago. This ancient lake bed comprises about 100 ft of clays and very fine silts, and for 10,000 years, these materials have been slowly drying out from the top down. To date, this desiccation has extended roughly 8 ft below ground level. Below this elevation, the ground consists of unconsolidated, undrained clay with very

Completion of the new Office (left) and Amenities buildings on this office campus permitted the entire company workforce to work within close proximity and in stylish and comfortable surroundings.

on the Plains

BY MICHAEL HEMSTAD, P.E., S.E.

low bearing strength. Deep foundations can be built, extending 100 ft or more to rock, but they are expensive. If economical shallow foundations are to be used, a relatively light structure is necessary. Fargo is also known for cold winters and strong winds. Concrete construction through the winter requires extensive tenting and heating and is at constant risk because of the wind.

Combining the owner's requirements with geology and climate considerations, structural steel framing was the obvious choice. Structural steel allows large open bays (varying here from 26 to 40 ft in floors), it can be erected quickly regardless of wind and winter weather, and it is lighter than concrete.

Schematic design began in the spring of 2007 and by mid-September, both buildings were sufficiently defined so that foundation plans and structural steel drawings could be issued. The Office building—its working name as well as its anticipated function—was configured in two parallel pieces called "bars" with a large glass atrium between them. Communication between the two bars was enhanced with footbridges across the atrium at the second floor.

Development of the second building, with the working name

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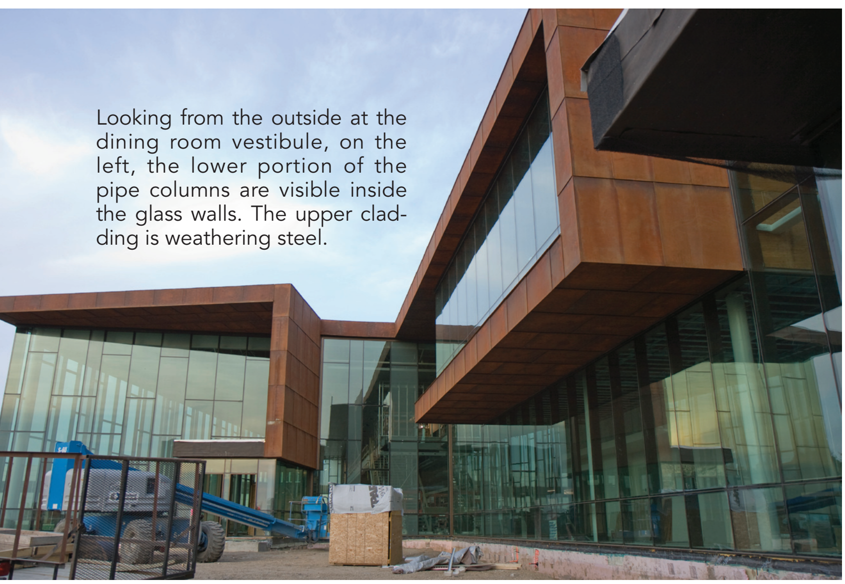
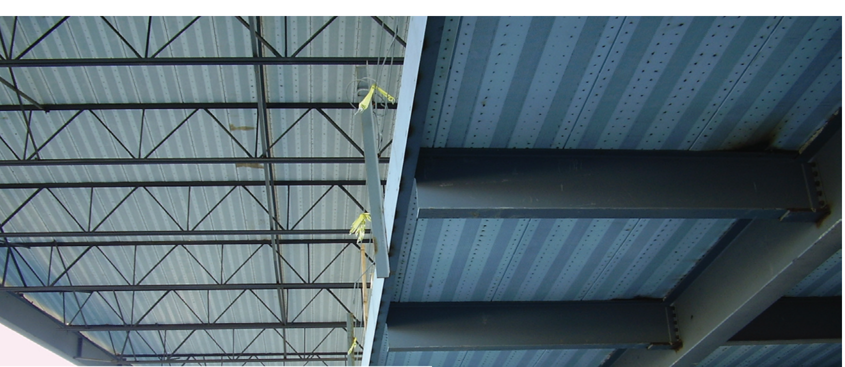
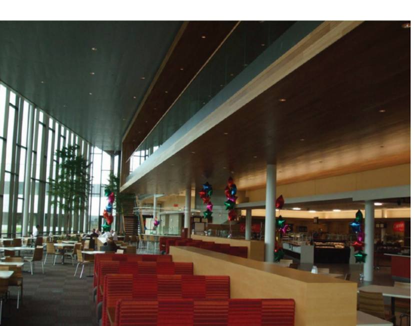
Left: This view of the dining room vestibule, from the inside looking out, shows the rigid frame on the second level. Note the offset in the pipe columns, by about half the pipe diameter, which was required to accommodate the difference in cladding between the upper and lower levels.



Looking from the outside at the dining room vestibule, on the left, the lower portion of the pipe columns are visible inside the glass walls. The upper cladding is weathering steel.





The dining area opens into a two-story open area and required a section of the second floor support to cantilever out from the columns.

of Amenities, lagged slightly as the architects assembled project teams for each building. It took shape as a relatively rectilinear cafeteria/kitchen area on the ground floor with a variety of meeting spaces and outdoor terraces above. An adjacent tall, triangular, single-story dining area surrounded with glass rendered the building more or less trapezoidal in plan.

The architect envisioned both buildings as modernistic and functional whose structure would provide much of the aesthetic treatment, especially the interior. Thus, much of the structure remains exposed. Round HSS were chosen for columns because of their simple form. Many areas had no ceilings or partial ceilings, but left the overhead framing exposed. For this reason, the architect requested that all beams framing any given area be the same depth. In this and many other instances, a small upcharge in steel quantity and cost was offset by other considerations. Where possible, simple bolted shear tabs were used for connections, as they are visually the cleanest and least obtrusive connections, in addition to being the most economical and easiest to erect.

As the architectural design continued to gain definition, our choice of steel framing proved to be a sound one. Both buildings demanded significant cantilevers, large suspended wall areas, and long spans supporting glass and other visually light elements, and would have been fundamentally different architecturally if built of other materials.

The exterior skin of both buildings is a combination of curtain wall, brick, and weathering steel panels. To express these walls cleanly, especially the curtain wall, the architect requested that columns be held several feet inside of the walls, requiring welded cantilever connections through the columns. Variations on these details became one of the structural signatures of the buildings.

In the large presentation spaces, desired roof heights combined with a mechanical requirement for very large ducts steered us to use bar joists, deeper than necessary, with the ductwork running through the joists, rather than running the ducts beneath the roof structure, which would have been easier to install.

Lateral systems were also challenging. In the Office building, each "bar" has a stairwell at both ends, so these spaces were designed as simple shear wall buildings, with an expansion joint between the two bars. However, the Amenities building uses open stairs inside, and the exterior walls are primarily glass curtain wall. A small elevator shaft was available for use as a shear element at one end of the building, and a bathroom core provided some capacity at the other end, but the entire dining area was left without significant lateral support. In addition, the roof of this area is about 5 ft lower than the adjacent high roof over the meeting spaces, so the building lacks a continuous diaphragm.

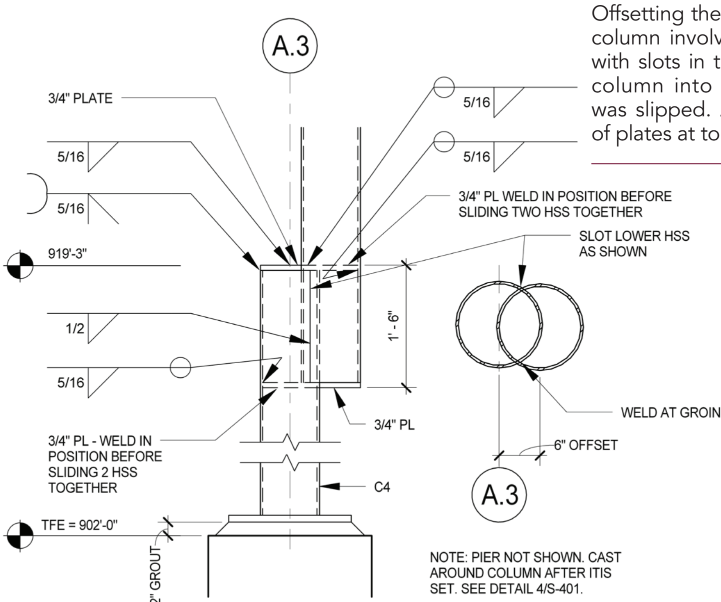
In order to provide lateral support to the dining area, framing supporting an entry vestibule and overhead eyebrow canopy was configured as a rigid frame, with bracing allowed in the upper 20 ft but not the lower portion. This framing consists of large pipe columns, offset at mid-height. Bracing in the upper half consists of pairs of large angles hidden inside a weathering steel wall. The entire frame is founded on a continuous concrete footing with helical anchors at each corner to resist uplift.

Adding to the challenge, the architecture in this area calls for these columns to be inside the vestibule at ground level. Above the vestibule, there is a decorative wall that is constructed flush with the face of the vestibule glass, and into which the columns extend. Thus, they needed to offset laterally within the ceiling of the vestibule. This was done by cutting vertical slots in the lower section within the overlap zone, sliding the HSS sections together, adding stiffener/closure plates, and welding.

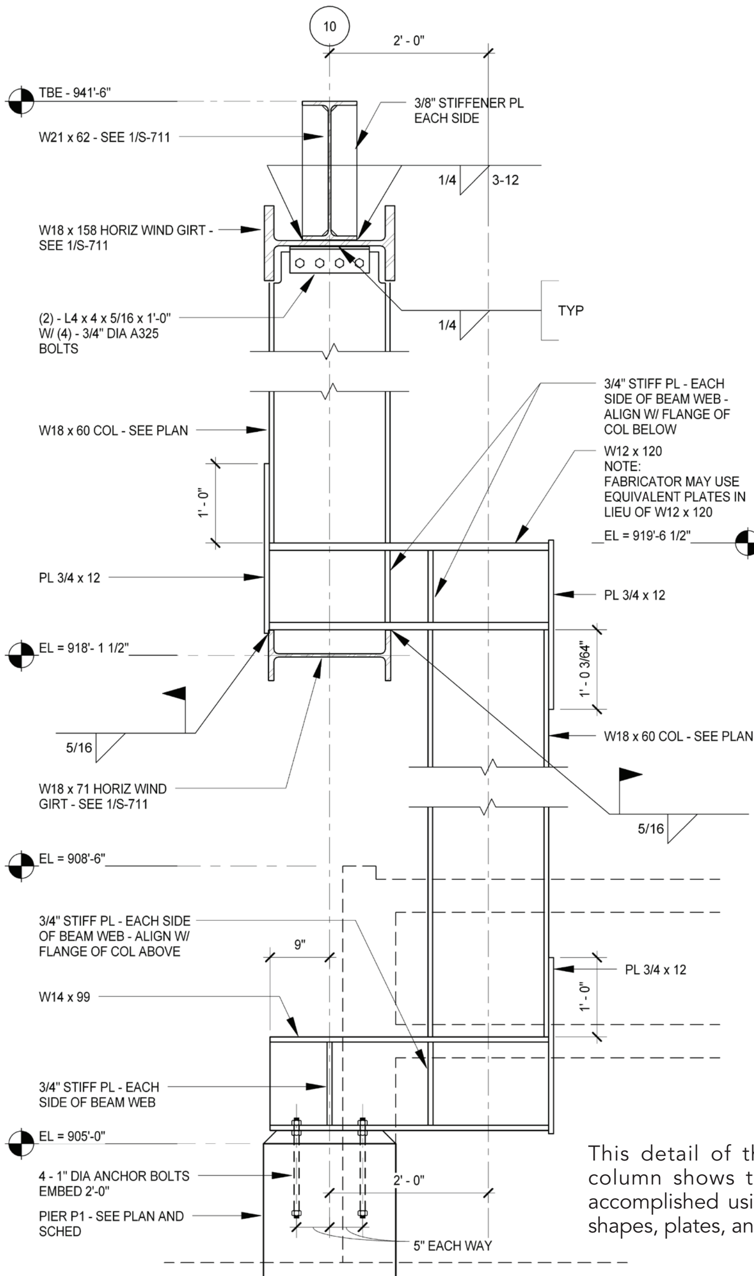
A similar issue arose at the east end of the building, in a large wall referred to as the "Shield Wall." A large decorative wall clad in weathering steel floats above a glass curtain wall which extends about 10 ft up from ground level. Again, columns are visible inside the glass, then offset horizontally and disappear into the weathering steel wall. These columns (which are primarily wind columns, i.e. bending members) are fabricated with wide-flange shapes, plates, and a lot of welding. Below the floor, the member was offset back on grid to ease erection stability concerns. In addition to strength requirements, the design paid careful attention to stiffness, ease of fabrication, and stress concentration and force flow at the structural discontinuities.

We resolved the discontinuity in the roof diaphragm by using a line of fabricated trusses at the change in height. The upper roof is supported by the top chord, and the lower roof by the bottom chord. Excess shear in the dining area roof diaphragm transfers through the trusses to the upper roof diaphragm, and is resisted in part by the elevator and bathroom cores in the two-story space. Shear perpendicular to the roof height change is resisted by column bending.

To accommodate the owner's request for outdoor spaces where employees could congregate and entertain clients, two large terraces, partially shaded by steel trellises, were designed to flank either side of the Amenities building. The owner's desire to provide pleasant, comfortable, and flexible spaces within which employees could work and play is reflected in the design of both



Offsetting the upper portion the pipe column involved a 1-ft, 6-in. overlap with slots in the lower portion of the column into which the upper pipe was slipped. Also note the inclusion of plates at top and bottom.



This detail of the shield wall column shows the 2-ft offset, accomplished using wide-flange shapes, plates, and welding.

These trusses provide the step up in the dining area of the amenities building. The angles on the top chord are what transfer the diaphragm shear through the truss.

buildings and their surrounding outdoor spaces. Though the journey to completion was often challenging, the completed project brings an architecturally rich environment to this northern prairie location, as well as the potential to increase employee satisfaction and productivity. MSC

Architect
Perkins+Will, Minneapolis and Chicago

Structural Engineer
Meyer Borgman Johnson, Minneapolis (AISC Member)

Steel Detailer and Fabricator
Mid America Steel, Fargo, N.D. (AISC Member)

General Contractor
JE Dunn, Minneapolis (AISC Member)

Structural Software
RAM, Revit

Fast-Paced Steel Design

Steel design for this project was produced primarily in RAM. Once each building's main structure was defined and sized, a model was exported from RAM to Revit. Drawings were then advanced based on the Revit structural model. The building model was shared and updated weekly among all members of the design team.

The initial steel drawings were intended as mill-order drawings and contained little detail. Due to the extremely rapid pace of development, they were regarded by the entire design and construction team as continuously evolving, snapshot-in-time documents. The entire team worked hard throughout the project to digest this stream of information and produce and erect structural steel, enabling the architecture while honoring the schedule and budget.

Obviously, document control and communication became a critical (and time-consuming) part of this project. Changes and clarifications communicated from owner to design team were often first designed, sketched, and issued to the contractor, fabricator, and field inspector (and, later, the erector) and then incorporated into the structural drawings with the usual change clouds and revision notations. Drawings for each building were revised and formally re-issued every other week, hop-scotching over each other. The structural engineers talked frequently with the architect to determine which areas were still in flux and which areas were more likely to remain unchanged, then shared this information with the construction team. Formal weekly meetings served as much to record these exchanges as to generate new ones. The fabricator was able to absorb some of these changes within its existing steel inventory. When this was not feasible or desirable, discussion usually produced a solution that worked for all parties.

Unlike the classic design-bid-build format, design and, especially, drafting of these buildings overlapped significantly with fabrication and construction. As drawings progressed through mill order to construction stage, fabrication and construction kept pace and at times threatened to get ahead of them. Again, constant communication with the contractor was necessary in order to deliver design for what was to be built next. "Just in time," a concept originating in manufacturing to reduce storage and inventory costs, became part of our vocabulary to reduce contractor downtime and engineering redesign, yet allow the architect's vision to emerge.