Consider Constructability

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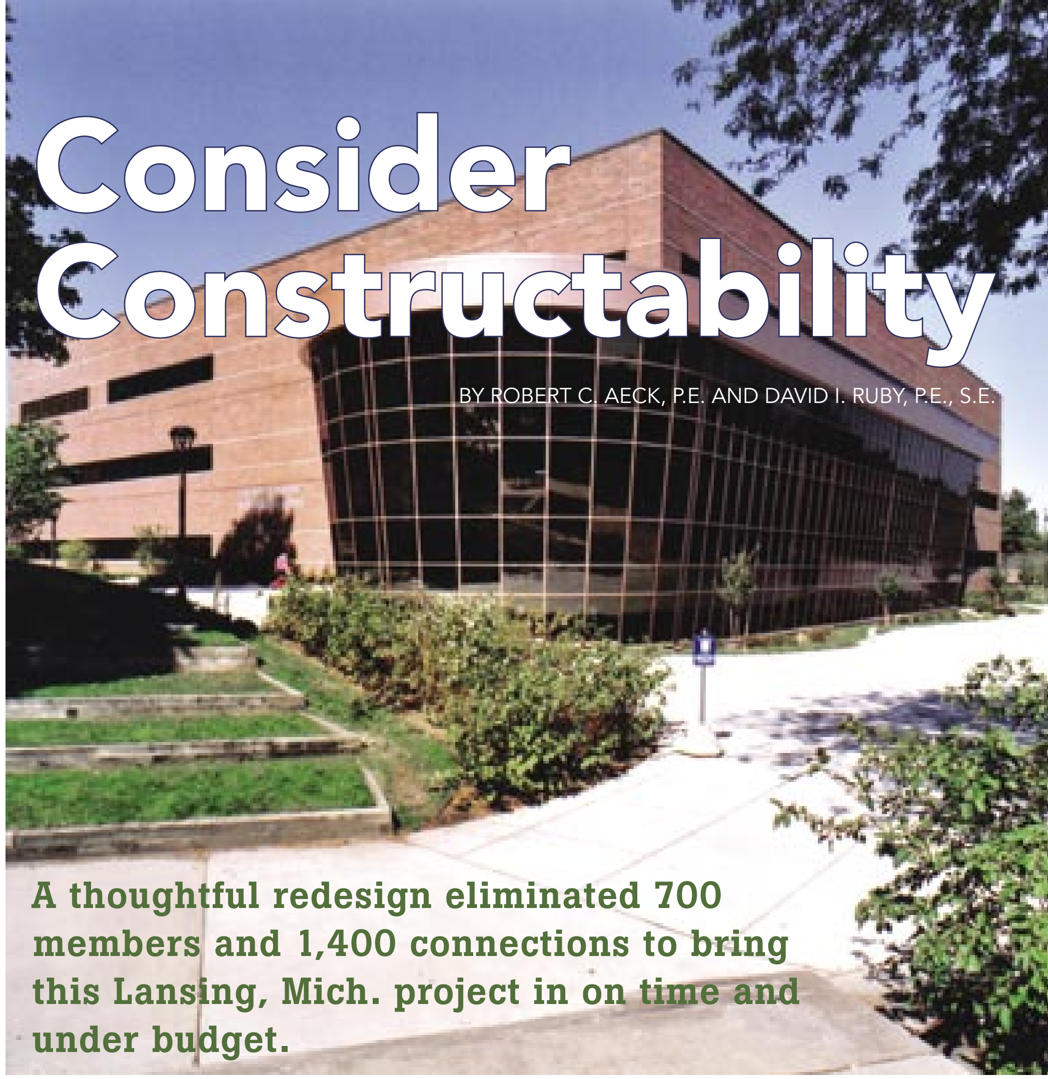

A thoughtful redesign eliminated 700 members and 1,400 connections to bring this Lansing, Mich. project in on time and under budget.

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PURSUE A REDESIGN OR SCRAP PART OF THE PROJECT: that was the choice Lansing Community College (LCC) had to make when the estimates for a new campus building exceeded their budget. The LCC Health and Human Services Career Building was originally designed as a three-story building with a future fourth-floor expansion—but the expansion exceeded the $2.5 million budget for steel fabrication and erection by $200,000.

Ruby and Associates (Ruby) consulting structural engineers entered the project and applied constructability principles to completely redesign the structural steel component of the building. This redesign saved enough money to enable LCC to construct the fourth floor upfront while bringing the project in approximately $100,000 under budget and on schedule.

Interoperability

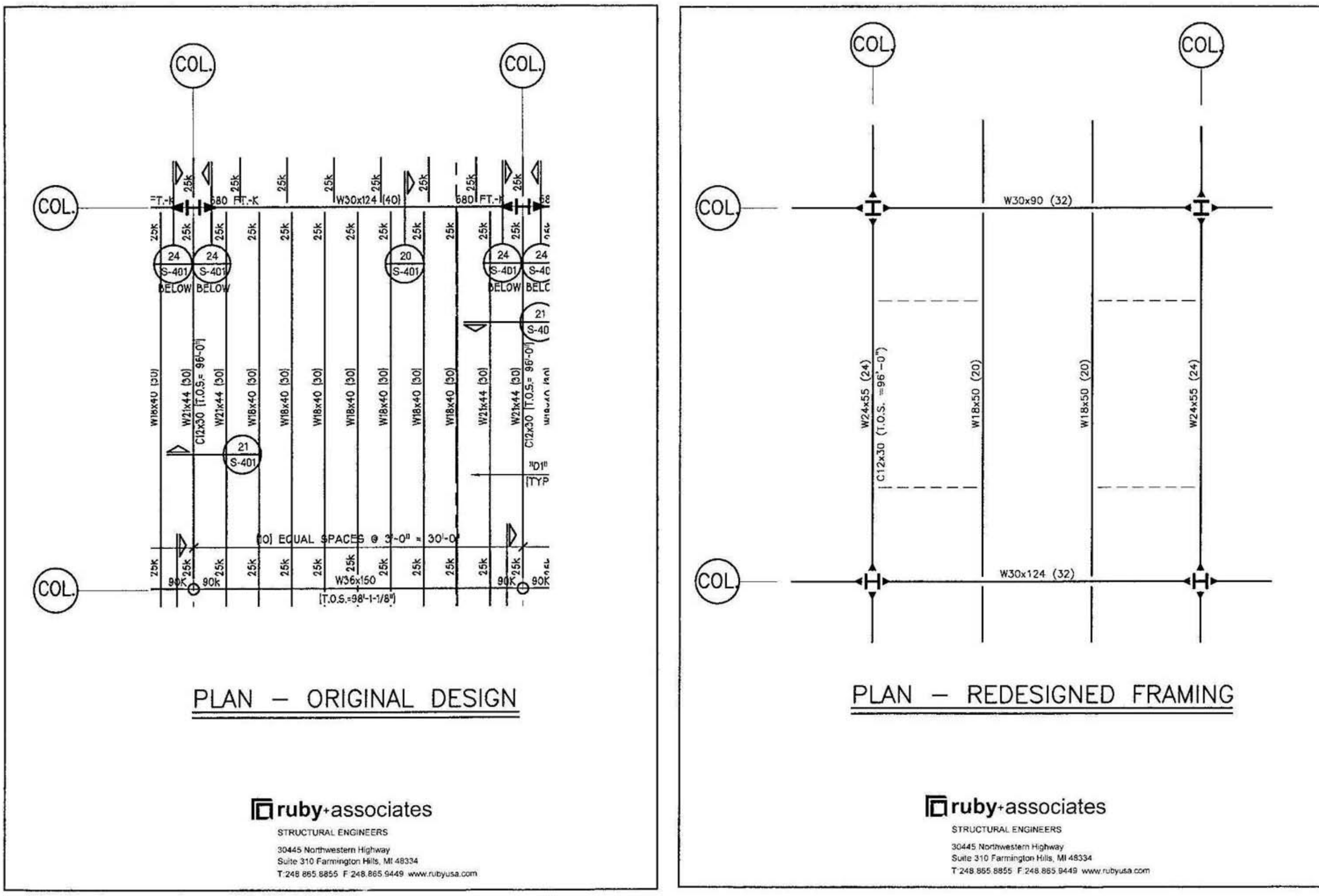
Interoperability—what used to be called EDI—was the key to turning around a complete redesign in three weeks. Interoperability facilitated by the CIS/2 standard data interchange format eliminated the need for manual re-entry of data between project team members and enabled Ruby to complete the redesign quickly, which kept the job on schedule.

The structural design was complete when Ruby was brought into the project. Plans and specifications had been released for bid, and AISC member Douglas Steel Fabricating Corporation was pursuing delivery of the project's structural steel component.

Douglas Steel asked Ruby to provide a conceptual constructability review of the structural design. Ruby completed a preliminary redesign in three days to confirm that the structure was a candidate for a constructability-led redesign. LCC approved the new design direction, and, moving into the role of structural engineer of record, Ruby developed a revised lateral-load resisting system and a new framing plan—accomplished without compromising the original architectural concept of the building.

Within one week, Ruby transferred a CIS/2-compliant model of the redesign to Douglas Steel, who then processed the model in SDS/2 and prepared the bill of material.

Interoperability also played a key role in expediting delivery of the design to the field. Ruby and Douglas Steel adopted electronic document sharing to seamlessly join the project's steel design, shop detailing preparation, and fabrication elements. Ruby electronically sent a CIS/2-compliant model from RAMSteel to Douglas Steel, which was directly downloaded into SDS/2, their



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By applying constructability to this project, the team maintained design intent and made the project easier to build. Seven hundred steel members and 1,400 connections were eliminated, while shear studs were reduced by 11,000. Overall, approximately 300 tons of steel were saved.

detailing program. Douglas Steel then generated erection and shop drawings for Ruby to review and make appropriate revisions online.

This paperless approach reduced the approval process from weeks to hours by facilitating "real time" collaboration. Douglas Steel had direct contact with Ruby during material procurement, shop detailing, and the fabrication process, allowing the concept of constructability to be exercised to the fullest.

Structural Redesign

Ruby applied constructability principles to the structural steel redesign by incorporating the steel fabrication and erection process into the design itself. The floor's structural system maximized the use of each component from the concrete slab and deck to the steel framing. Construction hours for the structure were moved from the field to the shop, where a controlled facility and climate allowed increased work efficiency and quality control.

The metal deck was the first element addressed. Ruby increased 2" deck to 3", which allowed the floor beam spacing to be increased to 10'. This reduced the number of floor beams by 78%.

The floor beams were spaced at approximately 3'-0" on center in the original design, with a very light metal deck and a reasonably thin slab. The lateral load resisting system consisted of labor-intensive full capacity moment connections in one direction and inefficient knee braces throughout the corridors in the other. Ruby's redesign reduced the number of pieces to be received, handled, fabricated, and erected. The redesign also reduced the field labor required to install the structural steel.

The redesign of the lateral load resisting system focused on delivering the necessary stiffness for satisfactory performance of the structure. Ruby changed the original mixed lateral load resisting system to moment frames in both directions. (The existing architectural constraints did not provide the opportunity for vertical bracing in either direction.) After the lateral load resisting system structure was re-analyzed, the connections were designed as field-bolted moment connections using the actual moments and stiffness required. This concept reduced field labor and simplified shop fabrication, while providing a lateral load resisting system that was stiffer than the original with fewer pieces and less field labor.

The redesign was a completely field-bolted structure. It eliminated over 700 members, as well as 11,000 shear studs from the floor system. The resulting metal deck system and a thicker slab added minimal dead load to the structure but increased the strength of the composite floor system. The re-

CONSTRUCTABILITY is defined by the Construction Industry Institute (CII) as "the optimum use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives." True incorporation of the constructability philosophy involves thinking through an entire project before beginning the actual design, which is rarely done. It focuses the team on maximizing the simplicity, economy, and speed of construction, while considering the site conditions, code restrictions, and owner's requirements. Constructability drives consideration of the entire construction process during the conceptual design stage.

INTEROPERABILITY is the ability to manage and communicate electronic project data between collaborating firms. It allows the exchange and management of electronic information, where individuals and systems are able to identify, access, and integrate information across multiple systems. The goal of interoperability is to create greater efficiencies by eliminating the manual reentry of data, duplication of business functions, and the continued reliance on paper-based information management systems. The steel design and construction industry uses the CIS/2 neutral file format to enable interoperability.

CIS/2 is a protocol through which seemingly stand-alone programs, such as structural analysis, CAD, and detailing systems, can communicate with each other. By providing a neutral data format, CIS/2 allows data interchange between wide varieties of program types—as long as these programs have translators written to interpret the CIS/2 neutral data into the programs' native format. Compliant software—Tekla, SDS/2, Bentley, RAM, FabTrol and others—can exchange data electronically with accuracy and speed. In fact, CIS/2 makes most structural steel design, detailing, and manufacturing applications interoperable. It enables the pertinent decision makers—the engineer, detailer, and fabricator—to look at a model in real-time, discuss the problem, and collaborate on a solution.

designed structure was easier to build, stiffer, and more economical—over 300 tons of structural steel were eliminated.

In 2005, the project was recognized by the National Council of Structural Engineers Associations (NCSEA) as an Outstanding Project Award Winner in its Excellence in Structural Engineering Awards.

Owner
Lansing Community College (LCC), Lansing, Mich.

Architect
Hobbs and Black Associates, Inc., Lansing, Mich.

Structural Engineer of Record
Ruby and Associates, P.C., Farmington Hills, Mich.

Engineering Software
RAM Structural System

Detailer, Fabricator, and Erector
Douglas Steel Fabricating Corporation, Lansing, Mich., AISC member

Detailing Software
SDS/2

General Contractor
Clark Construction Co., Lansing, Mich.