Structural Steel Delivery
Boosts Building Projects

Process improvements and novel methods for project delivery driven by the structural steel package, including labor/material reductions, fast-track delivery, BIM and IPD, as well as JIT manufacturing, result in schedule and cost advantages for commercial and institutional construction.

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Novel process improvements, including improved methods to reduce steel package materials and labor, are shown to increase control of nonresidential construction projects.

Related technologies and methods include building-information modeling, or BIM, and IPD (integrated project delivery). New ways to employ JIT (just-in-time) delivery of the structural steel package are also providing advantages to the Building Team. Changes to the organization and administration of the building project are shown to enhance these benefits.

The experience of one joist-and-deck supplier demonstrates the result of the approach, including cost savings, reduced conflicts and corrections at the jobsite, improved project coordination and shorter schedules for similar work. Case studies and research are presented to support the summary recommendations.

SECTION 1:

White Paper Overview

For commercial and institutional building projects, the critical path of the structural steel package is vital to the successful management of the construction process. What may initially be minor issues in steel delivery, design or detailing can produce cascading effects that ultimately impact the project broadly. This paper demonstrates through the firsthand experience of one steel joist-and-deck supplier – and through a broad review and analysis of current literature on commercial construction practices – how a variety of process improvements now can provide significant advantages to the building team, benefitting project owners and developers. Benefits include reduced costs, improved scheduling, minimization of errors and conflicts, as well as enhanced safety and work quality.

Among the specific improvements reviewed here are novel ways to reduce the total weight, cost, labor and transport associated with the structural steel package. On the job site, these advantages "cascade" into numerous benefits, such as fewer structural members to erect, fewer connections to bolt/weld, and improved overall coordination with other suppliers and subcontractors.

According to expert sources, two new technologies are poised to enhance these benefits. These include building information modeling (BIM) and integrated project delivery (IPD). Combining process improvements with state-of-the-art information technology, BIM and IPD are shown to be important elements in limiting the chain reaction of challenges that occur in many typical building projects. In addition, manufacturing techniques such as just-in-time (JIT) delivery also provide bottom-line benefits to the project team and owner.

> ***"Earlier involvement of the steel supplier, particularly on negotiated-cost projects, is shown to reduce overall costs for the project."***

The white paper also shows how common building practices with respect to the steel package delivery should be modified for even greater advantage. For example, earlier involvement of the steel supplier, particularly on negotiated-cost projects as well as on hard-dollar-bid projects, is shown to *reduce overall costs* for the projects. These impacts are felt in many areas and so are not limited to the structural steel package itself.

Among the ways to reduce costs include design reviews, schedule improvements, reduced conflicts and errors on the job site, and more efficient warehousing, transportation and logistics. Project quality and jobsite safety are also improved as a result of the approach.

Because BIM is not standard across the construction industry, the paper emphasizes that BIM currently is not the total solution – although JIT manufacturing and IPD both will benefit greatly from this technology. The main benefits today come from cost savings associated with how to take tonnage out of a project – and how to use this opportunity to reduce costs downstream in the construction process. This chain-reaction of savings promises: less trucking and transport; up to 20% less materials used; 20% less lifting (at labor costs per hour); up to 20% less bolting and erection (at prevailing hourly labor costs); as well as improved scheduling.

SECTION 2:

The Case for Improving Standard Practices for Nonresidential Building Projects and Structural Steel

While technological advancements and lessons learned from accumulating years of experience are contributing to improvements in nonresidential project delivery, the fact remains that construction industry productivity is not up to par. As Dr. Paul Teicholz, founding director of the Center for Integrated Facility Engineering at Stanford University, points out, constant contract dollars of new construction work per work hour has gradually declined over the past 40 years at an average compound rate of -0.59% per year, according to U.S. Bureau of Labor Statistics and U.S. Department of Commerce data for contract dollars.

Beleaguered by inefficient collaboration amongst trades, rising material costs, and challenges integrating building systems and components, there is growing recognition that current project practices are inadequate.

At the same time, Brian Weiss, vice president of product management for the Project Management Institute (PMI), Newtown Square, Penn., points out that the fundamental drivers for a project—cost, schedule, and quality compliance—are providing incentive for teams to embrace new or improved standard project practices.

Getting started

Because a project's structural design serves as the conceptual, design, and physical foundation of a project, this is perhaps an appropriate place to start making improvements in order to maximize efficiencies downstream.

"When the steel package is efficiently designed, engineered, and erected, the owner's buying power is maximized," points out Carl Pugh, P.E., engineering manager with New Millennium Building Systems, Salem, Virginia. "You eliminate a chain reaction of costs ranging from field delays to unnecessary added fuel costs, as all subsequent trade participation is integrated into the steel package at their professional best."

For example, by simply leveraging the structural steel fabricator's knowledge of product availability, this can ultimately lead to faster-track projects, fewer change orders, and better coordination between the trades. As Joe Jun, former national project director, American Institute of Steel Construction (AISC), Chicago, explains, this enables engineers to specify short-lead-time products and create a greater opportunity to develop an economical steel structure.

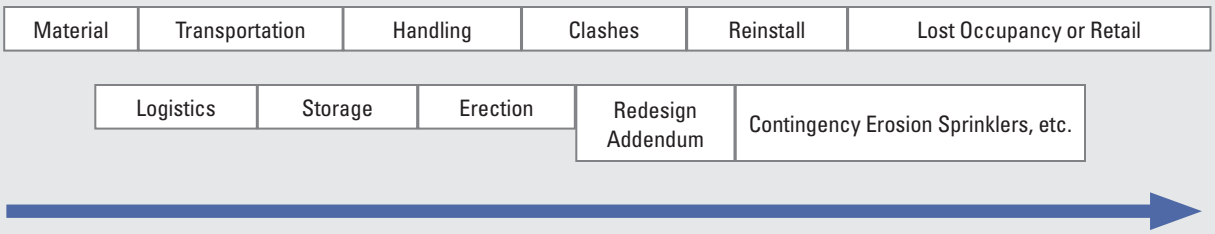
Of course, this is simply one aspect of the fabricator's expertise, which can go a long way toward positively impacting the project's outcome in numerous ways.

For instance, savings accrued from more economical steel packages, compressed project schedules, reduced labor and transport costs can come about as "a direct result of the fabricator knowing the steel process, market, erection issues, and fabrication efficiencies better than any other individual on the project design or construction team," asserts John P. Cross, P.E., AISC's vice president. "The fabricator is a specialty contractor that does not provide just material to a project, but provides his expertise in the successful completion of the project."

Citing data from two recent projects, New Millennium Building Systems has shown that it reduced material costs by $124,883 for a savings of 9.74%, and achieved a tonnage reduction of 78.54 tons for a transportation savings of 8.3%.

Another approach to achieving true gains in productivity, says Charles Besjak, S.E., P.E., director, Skidmore, Owings

Cost Saving Implications of Collaborative Joist/Deck Design:



& Merrill (SOM), New York, is empowering the building team with tools and technology to better enable them to design, engineer, and construct better quality steel projects in more efficient ways, ultimately reducing overall cost.

For example, "We know how to take tons of steel out of a job through engineering analysis and collaboration at the early stages of design, and we can help an architect achieve distinctive design ideas more cost-effectively," says Art Ullom, general manager, with New Millennium Building Systems in Butler, Indiana. "But beyond this, through design collaboration, we can prevent clash-related costs that can extend from redesign and rework, to a prolonged completion date and lost tenant or retail revenues."

Essentially, the supplier's contribution goes far beyond offering cost reductions for steel joists and decking, Ullom explains. "We can do a lot to minimize the costs of miscommunication and oversights that come with current process complexity," he adds.

SECTION 3:

Involvement and Coordination of the Structural Steel Supplier

Experts in construction and steel fabrication and detailing point out that one of the keys to accomplishing the stated objectives in Section 2 is involving the structural steel supplier and the joist/deck supplier early on in the project. For starters, the supplier can provide pre-project planning and schematic-phase guidance regarding steel rolling schedules and details to reduce shop or field labor, or both, according to Lanny J. Flynn, P.E., S.E., principal of Magnusson Klemencic Associates, Seattle.

From a project-management perspective, "Bringing the steel supplier in earlier can help steer the decision-making process during design and enable the engineer to understand the processes and preferences of the steel detailer and fabricator," explains Andrea K. Reynolds, S.E., P.E., LEED AP, an expert in steel structures for commercial facilities and a principal and director of structural engineering with SmithGroup, Detroit.

Perhaps the biggest benefit, however, is the specialized expertise that suppliers and fabricators can bring to the table, say construction experts. According to Weiss, this valuable input can include:

- Improving both cost and material delivery by taking advantage of time or commodity discounts based on factors such as phasing, sequencing, and mill run schedules.
- Providing options for basis-of-design through materials selection in terms of metallurgy and strength.
- Providing connection options and details that benefit construction efficiency.
- Determining shop versus field activities such as coatings, pre-assembly, and accessory attachments.
- Current knowledge of industry trends and technologies – particularly those that benefit production costs and delivery.

- Assistance with constructability issues, such as temporary steel configurations required to bring equipment into a building, when working in conjunction with designers and contractors.

Avoiding missed opportunities

Some cases where the steel trade's input is particularly indispensable are for structures with one or more of the following, says Besjak:

- Intricate geometry.
- Complex site logistics
- Unusually large members and connections.

Although it would seem obvious to the building team to take advantage of such expertise, the fact is that it often goes untapped. According to the findings of some well-represented industry focus groups conducted by AISC in late 2006, while it is general practice for contractors to consult with the M/E/P trades early on in a project, it is not common to make the steel fabricator part of this team until much later on. Consequently, AISC describes this is as a missed opportunity because early fabricator involvement can potentially reduce the cost of the structural steel package by up to 20%, according to AISC Vice President John Cross, in addition to:

- Enhancing safety as erection schedules are better coordinated, reducing clashes and minimizing reworks.
- Enabling better coordination with other trades.
- Accelerating the project schedule via more efficient sequencing. As opposed to a traditional linear sequence, tasks can be performed in an overlapping manner, taking 30% to 40% out of the steel portion of a project schedule.

Yet another key way to save on costs is taking tonnage out of the project. For example, simply reorienting the framing can save 0.25 lbs./ft. or $0.50 per square foot, and enable the steel subcontractor to coordinate with the exterior wall contractor, potentially saving thousands of linear feet of bent plate and work through tolerance issues before all the connections and fire safety details have been established. Also, updated diaphragm load data promises to expedite the metal-deck fastening process, making it possible to reduce the deck gauge and save on the steel package.

In a nutshell, New Millennium's Pugh states, "It all comes down to this: Fabricators and joist/deck companies are the steel package experts. They must show architects the new design possibilities of steel, advise structural engineers on ways to minimize material and fabrication costs, and work with erectors to see a project through to its successful completion."

SECTION 4:

Novel Methods for Steel Fabrication, Manufacturing and Delivery

While one way to influence a project's successful outcome is taking advantage of the fabricator's specialized know-how, another strategy is the fabricator's ability to make internal improvements – whether it's more efficient fabrication methods, updating equipment, incorporating management approaches such as just-in-time (JIT) manufacturing, or the use of sophisticated software.

For example, by shifting more fabrication and assembly from the field to the shop, PMI has seen savings of up to 35%. In addition, such practices reduce site labor and time, afford better quality, and can be particularly useful for long-span roof structures or when complex site logistics exist, says SOM's Besjak.

After reviewing best practices among U.K. fabricators, the Warren Centre for Advanced Engineering, Sydney University, Australia, reported that investing in the latest steel fabrication technologies – such as high-speed drill lines, plasma cutting, beam lines, and high-capacity welding lines – is significantly reducing labor

cost per ton. As for shop logistics, roller conveyor systems, better organization, and careful planning are optimizing the handling, processing, and storage of steel.

Similarly, the "Fabrication and Erection" chapter, authored by AISC's Director of Research Thomas Schlafly, in the *Structural Steel Designer's Handbook*, explains that once the larger steel sections are ready, they should efficiently travel to fabrication stations where the detail material is waiting and ready for assembly to the shipping piece. In order to reduce material handling, organized storage is also key.

Doubling production efficiencies

Utilizing such lean manufacturing principles, one East Coast fabricator essentially doubled its production by altering the factory layout, identifying waste, and reducing it.

Another success story came about from a simple request from one West Coast fabricator to use bolted double-angle connections, as opposed to welded shear tabs, to detail steel beams. According to Brent Forslin, S.E., structural engineer with HGA Architects & Engineers, Sacramento, this change reduced production time and increased shop capacity. Through collaboration on a recent project, Forslin also observed the fabricator opting to purchase pre-cut plates and tabs from specialty fabricators as it was more cost-effective than producing them in their own shop.

As mentioned, utilizing the latest technology for the shop floor is also a very effective way to reduce labor costs, which coincidentally is the biggest expense facing structural steel fabricators.

According to a recent article, "Technology makes shops structurally sound," in the May 19, 2009 issue of *The Fabricator*, some technological highlights include:

- Drill lines, which utilize carbide tools, capable of drilling up to 50 inches per minute without coolant.
- Product control packages for increasing automation and improving material handling practices.
- High-definition plasma cutting machinery applicable to plate applications for reinforcement, base plates, and connection plates.
- Software which can extract individual members straight from a BIM model and then process them directly through the drill line.

Another increasingly popular technology choice is robotic fabrication, which offers greater speed, accuracy, and repeatability as compared to semi-automatic welding systems. According to a recent article in AISC's *Modern Steel Construction magazine*, these robotic systems can be programmed to accurately match weld sizes to the applied load, thereby avoiding over-welding and reducing waste. Some of the latest robots are also equipped with vision sensors capable of orienting, examining, and verifying part fit-up.

Just-in-time – JIT

Although it's much easier said than done, JIT philosophy vastly reduces jobsite inventory and storage by receiving material from the steel mill just before planned fabrication runs. The fabricator then turns around and ships finished parts to the site for immediate erection. In addition, this reduces the oxidation of aesthetic finishes that can occur during prolonged on-site storage.

By precisely packing and sequencing on-site deliveries and construction, this is where the greatest savings can be captured. Consequently, JIT enables the team to bypass the extra time, labor, and "turf wars" associated with material laydown.

Granted, JIT has much to offer; however, the coordination involved with structural steel production can make it quite challenging to practically achieve. Due to the one-of-a-kind nature of construction projects and variables associated with the structural steel supply chain, more systematic study and measurement is required if these uncertainties are to be better managed and minimized, asserts Iris D. Tommelein, an associate professor with the University of Berkeley's Construction Engineering and Management program.

"Admittedly, this is not any easy task," acknowledges Tommelein, "but this is what lean-production systems design is all about: achieving flow where possible and thoughtfully locating buffers and sizing them to achieve cost-effective decoupling with minimal impact on cycle time."

One way to better enable JIT manufacturing is the use of advanced software such as materials management and production programs, and integrated enterprise resource planning (ERP) software. For example, one structural steel fabricator in South Africa implemented FabTrol, a steel-fabrication management software, to manage documents and drawings, procurement, fabrication, and logistics. In addition, the metalworker developed an in-house materials-tracking system to provide real-time progress reports to suppliers. These changes, in addition to other technological improvements, enabled the fabricator to increase its capacity by 37% and overall productivity by 7%, reports South Africa's *Engineering News.*

Similarly, ERP software plots out the specifics of an order from the materials and scheduling down to each part. With such data on hand, the software's scheduler feature can identify potential bottlenecks and delays, and determine whether the shop has capacity to run the order or if outsourcing may be in order.

Another important feature is accessing a real-time database of suppliers. With up-to-the-minute knowledge of pricing and production schedules, steel companies can ensure they are procuring the most cost-effective materials, explains David Caruso, a Scituate, Mass.-based consultant specializing in manufacturing, supply-chain, and technology strategy. In addition, a strategic competitive advantage can be gleaned from such a close connection to the supply chain as the steel company is equipped to quickly adapt to demand fluctuations, supply chain disruptions, and other market trends.

SECTION 5:

Research and Experience in Joist-and-Deck Supply

Regarding the importance of the joist-and-deck supplier's involvement, Robert R. Hackworth, managing director of the Steel Joist Institute (SJI), Forest, Va., offers a few suggestions to improve the value this subcontractor can bring to the project.

First of all, Hackworth emphasizes the importance of following standards such as the AISC *Code of Standard Practice* (COSP) and the SJI's COSP for joists. "These should become mandatory and not just a guideline that can be disregarded," he states. "When it can be shown that these standards are not adhered to, it should be the industry practice to note any 'substandard items' to the preparer, and changes or corrections should be a requirement, not a recommendation."

A noteworthy development in this arena is a recently completed two-year effort, on the part of New Millennium Building Systems, to expand architectural joist specifications based on standards established by the SJI. Consequently, for engineers seeking to create innovative roofline designs using steel joists, these ready-made detailed specifications are an excellent resource, essentially saving engineers time and effort during the design specification process.

Expanded specs

Offering additional advice on improving joist-and-deck delivery, Hackworth explains that the level of quality of the steel package is directly related to the quantity and quality of information submitted by the building team. For example, the joist-and-deck company can easily spend as much time trying to track down

missing information as is spent actually manufacturing the parts. “The lack of dimensions on bid documents and/or documents released for detailing is a major deficit that needs to be addressed,” he states.

Another obstacle is the limiting nature of current project practices as steel-and-joist experts have no incentive to provide engineering or detailing consulting services up front for a job that they will have to competitively bid later. “I can think of several occasions where one spent days working with a steel fabricator and engineer on the building design to find ways to make joists work for the building only to have the job given away to a competitor,” laments Hackworth.

To begin addressing this issue, Perry S. Green, PhD, SJI’s technical director, is seeing a number of joist manufacturers establishing partnering relationships with customers, steel fabricators, and general and specialty contractors. “The basis of this relationship is effective and timely communication, which can result in a tremendous payoff, in terms of shorter schedules, improved reliability, and smoother project completion,” says Green.

On the technical side, SOM’s Besjak has observed larger and better-quality product offerings from the joist-and-deck trade. In fact, in SJI’s latest catalog, the Institute essentially doubled the span, depth, and load-carrying capacity of joist girders. And in the upcoming 2010 Catalog, a significant addition to the current long-span and deep long-span standard specification will be included.

Similarly, Besjak has been impressed with newer decks spanning 30 feet, capable of meeting fire-resistance and vibration and acoustical control standards. “This allows the structural steel cost to be significantly reduced and limit the time of construction by reducing the number of crane picks for both steel and deck assemblages,” he adds.

For metal-deck attachment work, construction crews are benefiting from new high-speed screw fastening systems and high fastening-rate stand-up, ergonomically designed powder-actuated fastening systems. Such products are reported to require less expertise, offer better reliability, and enable higher productivity rates.

SECTION 6:

The Use of BIM and IPD in Steel Package Design and Delivery

While a number of factors are currently adding value to the steel package design and overall project delivery process, perhaps the biggest impact has come about through building-information modeling (BIM). Tongue in cheek, New Millennium’s Pugh aptly describes BIM as a “communication solution that requires multiple trade disciplines to play well together in the same sandbox.”

With multiple trades working simultaneously on a 3-D model of the building, significant efficiencies are realized with teams focusing more on the actual design and much less on things like change orders and requests for information (RFIs). According to Peter Griem, P.E., principal of the S/L/A/M Collaborative, a Glastonbury, Conn.-based architecture and construction firm, some other benefits of BIM include:

- Easier visualization and building system coordination.
- The ability to communicate more information, resulting in tighter bids.
- Shorter lead times and construction schedule compression, enabling cost savings and added value.

On the structural side, BIM enables designers to better benefit from supplier expertise. For example, the structural engineer can enlist the help of structural detailers to help model and add detail to the design for easier fabrication and erection. Similarly, product vendors can provide parametric objects, cost and scheduling data, and product specifications to the model.

In addition, design, detailing, and fabrication can be performed concurrently with the design model and shop drawings created in tandem. This then enables the

mill order to be submitted sooner, with fabrication and erection following at an expedited rate.

Although it's still pretty cutting-edge, some fabricators have begun taking data directly from the model and using it to generate Computer Numerical Control (CNC) codes, which then process the precise measurements and attachments for each piece. An even newer software feature called "4-D" enables the CNC machine to communicate with the original model to colorfully display which structural components have already been fabricated in the model.

As for construction, the collaboration leveraged by BIM offers easier bonding, fewer lifts, fewer code violations and punch outs, increased safety, and reduced labor.

Integrated project delivery

While BIM is an amazing tool, some claim that its potential can best be unlocked through integrated project delivery. IPD, as described by the American Institute of Architects, is a way to leverage early contributions of knowledge and expertise through the utilization of new technologies, enabling all team members to expand the value they can provide throughout the project life cycle. The results, says SmithGroup's Reynolds, is eliminating waste and maximizing efficiency.

Whereas the conventional transaction contractual structure creates a more liability-conscious, every-man-for-himself type of environment, IPD sets up one prime contract to which all the primary team members share risk, profit, and project performance, according to Owen Matthews, Westbrook, and Orlando-based M/E/P contractor, as presented at a Lean Construction Institute symposium. In other words, transactional contracting essentially forces trades to reserve their best ideas in order to win the bid. As a result, much innovation is lost with such valuable ideas coming in after the initial design.

On the other hand, the IPD prime contract unites all team members together, enabling them to freely share ideas and information early on to best benefit the design and project schedule. At the same time, in order to make it work, HGA's Forslin explains that the project team and owner must all be on board. "The 'what if's' have to be forthcoming, and there must be a receptive participant to evaluate the suggestions," he says.

The integrated project delivery (IPD) prime contract unites all team members together, enabling them to freely share ideas and information early on to best benefit the design and project schedule.

But the payoff can be significant, and not only for the current project: Successful IPD projects may result in repeat collaborations between the team members on future projects, he says.

SECTION 7

Project Data and Insights from a Joist-Deck Supplier

Drilling down to more details – and hard numbers – presents a most compelling case for the value the joist-and-deck supplier actually brings to the project. Citing New Millennium Building Systems as a prime example, the company's method of collaboration on the design package ultimately reduces multiple cost factors. These include:

- Materials.
- Transportation.
- Product handling.
- Design errors and reinstallation.
- Lost occupancy.
- Logistics.

- Storage.
- Erection.
- Addendums and contingency erosion.

These factors are covered in detail below.

Materials reduction. By leveraging the joist-and-deck supplier's expertise, steel tonnage and quantities can actually be taken out of a project, with no compromise on quality.

Some of the approaches employed include: optimizing joist depths; optimizing joist girder depths; increasing joist spacing to optimize steel deck design; and increasing joist spacing to reduce the number of pieces to handle. Also, the design can be based on "Load per Foot Joists," in lieu of standard "Load Table" joists.

In addition, load zones can be identified where mechanical units occur instead of designing an entire roof for collateral loads. Also, joist and joist girder design can be based on actual concentrated loads, rather than using standard KCS joists.

Depending on project size, actualized material savings can range from 3% to 20%, but most commonly, between 5% and 10%. Case in point: On a recent mid-sized project, New Millennium Building Systems saved the client $124,883 in materials on a redesign of a $1,282,000 project, achieving an overall material savings of 9.74%.

Transportation savings. Of course, the obvious implication of less material is that fewer trucks will be required for transportation.

On average, 17 tons of joists can be loaded on a truck. Consequently, based on the fact that the company successfully reduced tonnage on a recent project from 926.77 tons to 848.23 tons, only 50 trucks were required instead of the original 55 trucks. This translated to $6,276, or 8.3% savings in transportation costs, for an overall joist cost project reduction of 0.5%.

Project handling. Moving down the cascading chain of events, fewer lifts are then required to load and unload the trucks.

Based on a $10 per ton estimation for loading and unloading, New Millennium's client on this project cashed in on savings of $1,700 for project handling, equating to 0.1% total project savings.

Design errors and reinstallation. When design and fabrication are not optimized, manufacturing errors – often fostered by incomplete or wrong structural drawings – can be costly. In addition to the time and cost associated with executing change orders, a number of sample scenarios illustrate the different places where time and money can potentially be lost.

For instance, if five 30K12 bar joists needed to be redesigned and re-supplied by the manufacturer, estimated costs would be 2.1 tons at a price of $2,835, plus $1,025 for freight to the jobsite. As can be seen in a possible scenario (see Table 1, page 11), using a nominal cost of $60 per person per hour, many hidden costs can quickly accrue.

While this is a relatively simple, nominal example, even such a minor problem tacked on $6,360, representing a 0.5% increase to the original project cost.

Lost occupancy. Although the cost of lost occupancy can vary greatly, depending on the business type and facility size, delayed occupancy is usually costly.

Based on data from their recent financial performance, Table 2 (page 12) demonstrates the weekly revenue and net income loss potential for Wal-Mart and AutoZone.

Logistics. Supervisory time and related costs for transportation logistics includes truck routing and on-site delivery. A portion of these costs may traditionally be absorbed by the supplier, but related on-site costs are absorbed by the project team, and ultimately by the project owners or developers.

These cost savings vary based on local market conditions and vendor agreements.

Storage. Due to the fact that proper sequencing of the material for a project is crucial to the timely, organized installation of all products for a project, early coordination with the joist and deck supplier can result in significant time savings for the owner. By carefully coordinating the

sequencing and scheduling, only the joists and deck that are to be erected for the current erection area of the building are delivered.

Ultimately, this reduces jobsite joist storage and reduces sorting time to find the needed materials.

Erection. Through the design and fabrication of lighter joists and fewer pieces, erection savings are achieved. Granted, lighter joists usually don't save much unless the erector is able to rent cranes with smaller capacity; on the other hand, the use of fewer pieces result in direct savings.

On the recent, redesigned project cited above, piece count was reduced from 1,841 to 1,571, representing 14.7% reduction in the quantity of pieces to handle and install. While specific numbers were never calculated, based upon the approximate cost of $1 per square foot for erection, the project likely netted 10% in erection savings, potentially amounting to around $60,000 in total savings.

Addendums and contingency erosion. Acknowledging that typical project "contingency" fees often range up to 12% or more of the total construction fee, based upon expectation that planning will not be thorough down to the executable level of detail – and that miscommunications will naturally occur when collaboration is less than optimal – there are savings to be capitalized upon.

Based upon New Millennium Building System's experience in the realm of steel joists and deck supply, more thorough and detailed collaboration has resulted in fewer errors and redesigns. By understanding the interactions of various trades early on, many problems can be alleviated before they occur.

Savings will vary based on the size and nature of the project, as well as the percentage set aside as contingency.

This last point raises significant questions as to the real cost of any project. How much is it worth to be able to locate mechanical units in specific areas, so fewer joists have to be designed for concentrated loads? Or how much does it save to know sprinkler locations upfront, so joist panels can accommodate their passage?

At the end of the day, better and earlier collaboration between all parties results in significant savings to everyone, especially to the project owners and developers, who are the real winners.

TABLE 1

Description of Lost Time	Hours Lost	Cost
Time lost at jobsite figuring out what the problem is	4 persons @ 2 hrs	$480
Time lost by supplier verifying what the problem is	2 persons @ 2 hrs	$240
Overhead to process replacement joists	Estimate 6 persons @ 0.50 hrs ea.	$180
Re-manufacturing replacement joists	See above	$2835
Reloading trucks at supplier's factory	$100 min	$100
Freight	See above	$1025
Unloading truck at jobsite	$100 min	$100
Moving and resetting up crane (required sometimes)	4 hours crane & crew @ $200/hr	$800
Reinstalling replacement joists	4 men & crane @ $300/ hr (2 hrs)	$600
TOTAL		**$6,360**

TABLE 2

	Wal-Mart	AutoZone
Time Period	Fiscal Year 2009	12 Months ending August 2008
Sales	$405.6 Billion	$6.8 Billion
Income	$13.4 Billion	$665 Million
No. of Stores	7,870	4,092
Annual Revenue per Store	$51.5 Million	$1.66 Million
Wkly Revenue per Store	$990,000	$31,900
Annual Income per Store	$1.7 Million	$162,500
Wkly Income per Store	$32,700	$3,100

SECTION 8

New Developments in Trade Groups, Codes and Standards

Pushing structural steel delivery and precision up a notch, a few key standards have become accredited by the American National Standards Institute (ANSI) in recent years. For steel decks, the Steel Deck Institute's *Composite Steel Floor Deck, Non-Composite Steel Floor Deck,* and *Steel Roof Deck Standards,* offer comprehensive design guidelines and have joined the ANSI family of standards. And for joists, all of SJI's *Standard Specifications and Load Tables,* in addition to the *Composite Steel Joist Code of Standard Practice,* are ANSI-approved

Similarly, SJI's *Standard Specifications for K-Series, LH/DLH-Series, and Joist Girders* — currently under development — are slated to go through the ANSI-approval process, according to Green.

A couple of key code changes which will affect structural steel design include a new tie-force requirement in IBC 2009 and responsibility for the construction of a main wind- or seismic-resisting system on the part of the contractor, as mandated by the 2007 California Building Code.

Regarding the former, Besjak explains that a direct connection to the steel columns will be required and, in many cases, will force the architectural design to not have openings located directly on column lines, thereby minimizing the column bracing members to be offset from the columns.

For the wind/seismic resisting systems, a written statement of responsibility must be submitted to the building official and owner prior to construction, according to HGA's Forslin.

SECTION 9

Action Plan: Using Process Improvements, JIT and BIM/ IPD for New Construction and Renovation Projects

Offering a better sense of just how much of a difference IPD can make, the architecture/engineering firm SmithGroup is currently designing two similar projects for the same client—one using IPD and the other not using IPD but instead a traditional delivery methodology. For the latter project, it took 10 months to complete the design documents, and the owner is pushing for the steel package just a month later, but four months before the M/E/P contract documents will be completed. "Now the entire project team is scrambling to understand what information needs to be given to enable the most complete early packages possible," relates SmithGroup's structural practice leader, Reynolds.

In contrast, design documents for the IPD project are only taking three months with the steel package going out to bid shortly thereafter. In all, Reynolds anticipates the IPD project resulting in a better coordinated design, a reduced total project schedule, a more efficient and cost-effective building, and a construction team that, as a whole, is more understanding of the project goals and each other.

Another IPD/BIM success story is the Capital Preparatory Magnet School, Hartford, Conn., designed by the S/L/A/M Collaborative. Utilizing CIS/2, an electronic data exchange file format for structural-steel project information, the architect conveyed the model — including steel sizes, material, general geometry, and beam end reactions — to the fabricator. Through BIM, the detailer quickly picked up on missing dimensions in the drawings and offered suggestions to economize details. Ultimately, IPD enabled lower bids, reduced lead times for structural steel, and steel package delivery six to eight weeks ahead of schedule.

Similarly, the Denver Art Museum was designed with the help of BIM and CIS/2 by Studio Daniel Libeskind and Davis Partnership Architects, with Mortenson as the lead contractor. An architecturally complex project, the building team was surprised when the job, which began two months behind schedule, finished up three months ahead of schedule – and $400,000 under budget.

Even more significant, a $158-million, 503,000-square-foot hospital project using BIM/IPD was completed four months early, with $4.85 million in savings, according to the construction manager Barton Malow. As for the structural steel package, it was awarded a full two months before design development was even finished, enabling the owner to avoid a $200,000 price increase from the steel mill and speed up the steel structure top-out by one month. As opposed to a typical five-to-six-month lag time, steel erection began just one month after the shell and enclosure went out for bid.

Ultimately, IPD enabled lower bids, reduced lead times for structural steel, and steel package delivery six to eight weeks ahead of schedule.

Although much success has come about through IPD and BIM, interoperability issues do exist amongst BIM modeling software packages. Consequently, building teams are sometimes forced to recreate models. According to SOM's Besjak, structural engineers typically create an analysis model merely simulating the real structure as it can be very time-consuming and difficult to create an exact replica of the original structure, especially for complex projects. In addition, it can be challenging to keep both models synchronized when changes occur.

Fortunately, the industry is actively working out such kinks and Reynolds anticipates that it won't be long until before models can be seamlessly translated from one program to the next through the design and construction process.

SECTION 10

A Supplier's Suggestions for Process Improvement: Cost Accountability and Reduction of RFIs

Experience has shown that a steel joist-and-deck company can help building teams achieve their design ideas and reduce a range of related costs from a project.

Need for process improvement for project cost reduction.

Research by New Millennium Building Systems has shown a need among design-build firms and AEC teams for design/construction process improvement for the purpose of project cost containment, meaning: Maximizing design details early; knowing best-cost options based on project-wide thinking; and starting with steel material minimization (tonnage reduction) but extending to the planned reduction of other related costs such as unnecessary drayage, storage, handling, installing or erecting. This will also include the anticipation and prevention of clashes (especially MEP) and related costs for redesign, repurchase and reinstall.

All of this results in reduced use of contingency fees, and in some cases eliminates the loss of an on-time or earlier install date, which could have resulted in owner/operator loss of tenant or retail revenues.

Benefits of collaborative joist/deck design on project costs.

On a building project, the steel package comes early in the design phase, and it must account for all subsequent trade materials. The joist-and-deck design must be especially mindful of all electrical, HVAC, plumbing, and voice-data-video routing.

Cost prevention here is a matter of clash prevention by way of early joist-and-deck design collaboration. This works well in a "negotiated" work arrangement, whereby the design-build or AEC firm is not tied to low-bid supplier selection but wants to work with a preferred joist/deck partner.

Benefits of collaborative supplier relationships.

Research by New Millennium Building Systems has further confirmed that a project's need for tighter collaboration is fostered by the tendency for subcontractor and supplier structural drawings to be up to 40% incomplete as to their dimensions.

In this context, the current Request for Information (RFI) process is dysfunctional. In too many cases, RFIs are being used by participants as a tool for documenting and defending inertia, clashes and project delays that lead to inflated use of contingency fees, rather than using the RFI process as a tool for fostering communication and the prevention of such costs.

Factors driving process improvement.

Process improvement is being driven by owner/developer interests as represented by the federal government (as owner/developer) by way of requiring building-information modeling (BIM) on all GSA projects effective in 2012. In addition, the recessionary economy has further dictated the need for any project work to be scrutinized as to cost accountability.

The RFI process is a failed default method of forcing communication – at a time when project owners and managers need collaborative design communication more than ever.

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Founded in 1999 in Butler, Indiana, New Millennium Building Systems was built around a dynamic manufacturing model to enable flexible design, manufacturing and delivery, along with highly proactive project collaboration. The company manufactures a complete range of steel joist products, including bowstring, arched, scissor, double-pitched and single-pitched joists. Depending on jobsite location, steel joists can be furnished single-piece up to 15 feet deep and 125 feet long. By using field splices to increase lengths or depths, possibilities are virtually limitless. A wholly owned subsidiary of Steel Dynamics Inc., New Millennium also provides cleaning, painting and roll forming of steel deck. Sheet-steel materials for deck products are readily available.

Credits and Sources

The following groups have been cited or quoted in the development of this White Paper.

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Project management Institute

Pacific Northwest Steel Fabricators Association

Steel Joist Institute

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Construction Users Roundtable (CURT)

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