

INNOVATIVE DIMENSIONS

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FABRICATION DRAWINGS A Paradigm Shift



Innovative Dimensions in Structural Design

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Fabrication Drawings – A Paradigm Shift

A Call for Action

The recent growth of Building Information Modeling (BIM) has affected the way most design professionals complete their designs. Its adoption has heralded challenges to traditional corporate workflows as well as caused apprehension about sharing information with the design team and other members of the construction team. However, BIM provides opportunities to those who are looking for innovations.

Fitzpatrick Engineering Group believes it is time for a radical change in the way structural steel is procured and delivered. This white paper details the current inefficient process of shop drawing preparation, review and fabrication and proposes a disruptive technology to leverage the inherent advantages of BIM and deliver measurable time and cost savings to a project.

Traditional Steel Delivery

The process of preparing structural steel fabrication drawings has remained essentially unchanged for decades.

The design team works together over the course of several months to develop a complete design for their client. Collectively, they summarize their 3D design into a package of flattened 2D drawings which they hand off to a contractor. The contractor awards the steel superstructure to the lowest priced fabricator. Because structural steel is typically on the critical path for the construction schedule, the pressure is now on the fabricator to get the steel into the field.

The fabricator hands the 2D drawings to the detailer who is expected to interpret the 3D design intent in a fraction of the time it took to create the 2D drawings. This is usually coupled with a wave of formal requests for information (RFIs), as the detailer tries to understand the engineer's design. It is also common for the fabricator or detailer to hire a second engineer to design all the building connections. Finally, when the shop drawings are "ready" (which typically means there is enough information to begin the review process yet not enough to be considered complete), as many as five or six paper copies of these drawings are printed and sent to the contractor for review.

On average, preparing the fabrication drawings consumes eight to nine weeks of the schedule.

Once the contractor has reviewed the fabrication drawings (in a fraction of the time that even the detailer got to create them), he or she forwards them to the architect. The architect forwards the drawings to the structural engineer. These reviews and hand-offs add another two to three weeks to the schedule.

The structural engineer typically gets ten working days to review the drawings and check that the detailer has correctly interpreted the intent of the 3D design. The structural engineer marks up corrections on every set of drawings, plans and detail sheets, and then provides all the sets to the architect. The architect reviews them, checking for any items that might affect architectural details. The architect then returns all the reviewed sets to the contractor, who ultimately returns them to the fabricator.

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The compressed schedule for fabrication drawing preparation and steel delivery still requires an average of 17 to 20 weeks for a typical project.

The fabricator reviews the comments and modifications with the detailer. The detailer then makes the changes to the drawings, often followed by a change order arising from misunderstandings in interpreting the drawings or missing details on the design contract documents. Finally, fabrication begins.

Depending on the size of the project and the sequencing of the steel package, the structural engineer's time to review all of the fabrication drawings can consume six to seven weeks. Add another week or two at both the architect's and contractor's offices for review and document management, plus time spent in transit from office to office, and another six to seven weeks is lost.

Recent Changes to the Traditional Approach

In recent years, particularly with the rise of the "new normal," the demand for shortened construction schedules has resulted in attempts to compress this cumbersome and dysfunctional traditional process. It is common now for the fabricator to send one electronic copy of the fabrication drawings out for review in shotgun fashion – to the contractor, architect and structural engineer simultaneously – thereby reducing the travel time between offices and allowing all reviews to occur concurrently.

Each reviewer then prints his or her own copy for internal review (a redistribution of expense, by the way) and returns a marked up paper copy or a PDF. The fabricator and detailer now receive multiple review comments with potentially conflicting changes that must be further vetted via more RFIs.

In the very recent past, the schedules have been so compressed that it is not uncommon for the structural engineer to be the only one reviewing the fabrication drawings. The engineer reviews the drawings, returns a marked-up paper set or PDF to the fabricator, and the architect and contractor simply receive a transmittal.

All questions about how to interpret the design drawings are still funneled through the architect and contractor. This creates more paperwork, mostly so that everyone can keep score for the potential change orders.

This compressed schedule for fabrication drawing preparation and review still requires an average of 17 to 20 weeks for a typical project.

Don't Blame the Fabricators

The fabricators aren't really to blame here. They are subject to the same pricing and scheduling pressures we all are. In the past, a really good fabricator could look at a set of drawings at just about any level of completion, know what information was missing and adjust the pricing to the contractor accordingly. We rarely saw significant change orders. If the scope of work changed significantly, sure, we would certainly expect some additional compensation for the fabricator – and rightfully so – but not for the typical detailed information that is shown schematically at a mill order package.

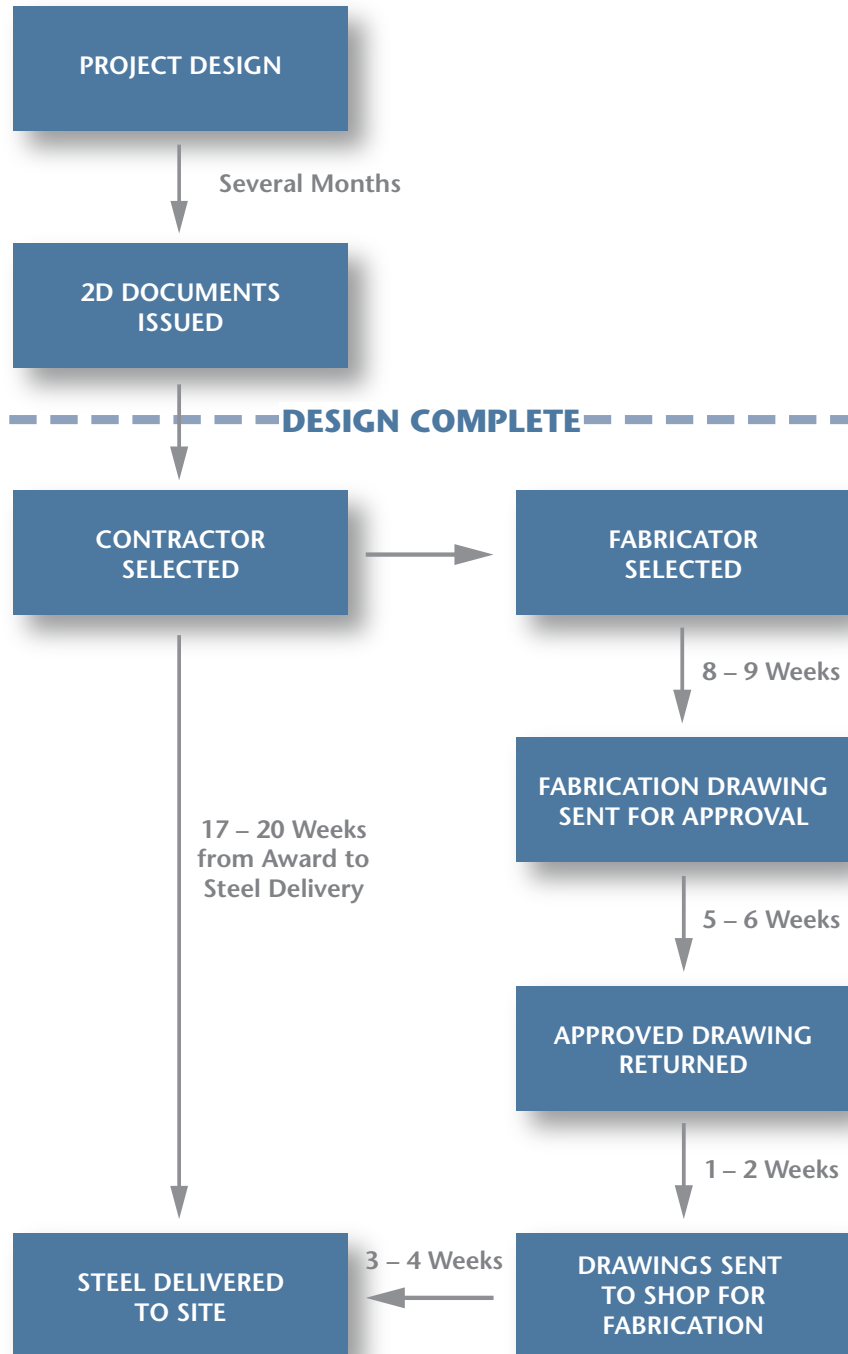
Today, these same fabricators are forced to "price it like they see it." Even though they know exactly what is missing from the drawings, any attempt to make an allowance in their fees for the absent information will likely result in their losing the job because the other fabricators are pricing what they see.

To make matters worse, the fabricators are asked to give GMP-type pricing based on incomplete drawings at even earlier stages in the project. The only way for them to protect themselves in this environment is to outline exactly what they are pricing and request change orders for anything added to the project later.

Unfortunately, although this approach to estimating and pricing is born out of necessity, it certainly is not beneficial to the project as a whole and makes everyone look bad.

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Current Structural Steel Delivery Model



Observations on the Traditional Approach

The preceding narrative should make it clear that although the traditional way fabrication drawings are prepared has been compressed, the time saved does not balance out the new problems introduced. As messy as this process has become, let's back up and take a 30,000-foot view of it:

- The design team members get relatively all the time they need to understand and complete the 3D design the owner envisions for the project.
- The design team presents that wealth of knowledge to the contractor in a flattened 2D format.
- The fabricator and detailer are often brought into the project relatively late after the design has been completed, when time is of the essence, and are asked to reinterpret the 3D design intent from the 2D drawings.
- To complete their work, the fabricator and detailer are allowed just a fraction of the time the design team enjoyed.
- The fabricator and detailer typically hire another engineer to help with connection design.
- The fabricator and detailer create everything from scratch even though they're given the least amount of time to prepare their work.

This situation begs several questions:

- Why is the person who does the most detailed work (the detailer) given the least amount of time to complete this task?
- Why are we still printing, transporting and handling paper review copies when technology has made the rest of our design and collaboration tasks much simpler?
- Why is there a need for anyone to re-interpret a project's structural design intent in the first place?
- What if the engineer takes responsibility for the design and modeling?
- What if the building engineer – and not someone else – provides the connection design?
- What if the engineer prepares the fabrication drawings?
- What if you could truly leverage all the work and modeling that has already been completed in previous phases of a project?

A New Paradigm for Fabrication Drawing Preparation

Fitzpatrick Engineering Group believes it is time to change. We propose a paradigm shift in the way steel is detailed and fabricated. Consider:

- What if the structural engineer who designed the building superstructure was responsible for providing the detailed fabrication drawings?
- Who best understands a building's structural design intent?
- Wouldn't bidding the structural steel framing in a truly competitive way improve the project's profitability?

What if the structural engineer...was responsible for providing the detailed fabrication drawings?

Fitzpatrick Engineering Group has developed and implemented a new method for preparing fabrication drawings.

- What other activities could design and construction team members focus on instead of reviewing, processing and verifying change orders and RFIs related to structural steel?
- How would clients react if a steel framed project could be constructed and delivered weeks, even months, ahead of the current traditional schedule?
- What if the detailer is involved early to make sure that the right questions are answered during design, reducing if not eliminating change orders after a fabricator is brought on board?
- What if you could leverage fabrication shop efficiencies and still enjoy competitive pricing for the steel superstructure?

The clients of Fitzpatrick Engineering Group know the answers to these questions because, some time ago, we shifted the paradigm. Taking advantage of efficiencies in BIM technology, we have developed and implemented a new method for preparing fabrication drawings.

Fitzpatrick Engineering Group Has Been Utilizing BIM Since 2006

Our first BIM project literally required us to share our structural model data with the fabricator. As a result, we saw the direct impact of an accurate structural model on downstream productivity, realized the benefits in 3D coordination and uncovered the potential savings in time. Ever since that first project, we have been developing ways to leverage the data we create in our models and add value to our projects.

Recent enhancements to BIM and detailing software have enabled us to raise our modeling expertise to a new level. By using direct electronic communication between BIM and detailing software, we can now develop, review and approve fabrication drawings concurrently. Instead of performing tasks one after the other as in traditional workflow, we prepare, review and approve a drawing in parallel during the project design phase.

Here is how we do it.

The detailer begins preparing the shop drawing at the conclusion of the design development phase. The first wave of beams and columns are read into the detailer's model and typical connections are assigned. Meanwhile, the design team continues to work on the design.

Several weeks later, an electronic structural model update is sent to the detailer and incorporated into the fabrication model. Engineering approvals can start at any time in areas that are considered unlikely to change. Those approvals, resubmissions, comments and sketches are transferred back to the detailer electronically and incorporated into the model. Additional updates are sent to the detailer and engineering approval continues until construction documents are issued.

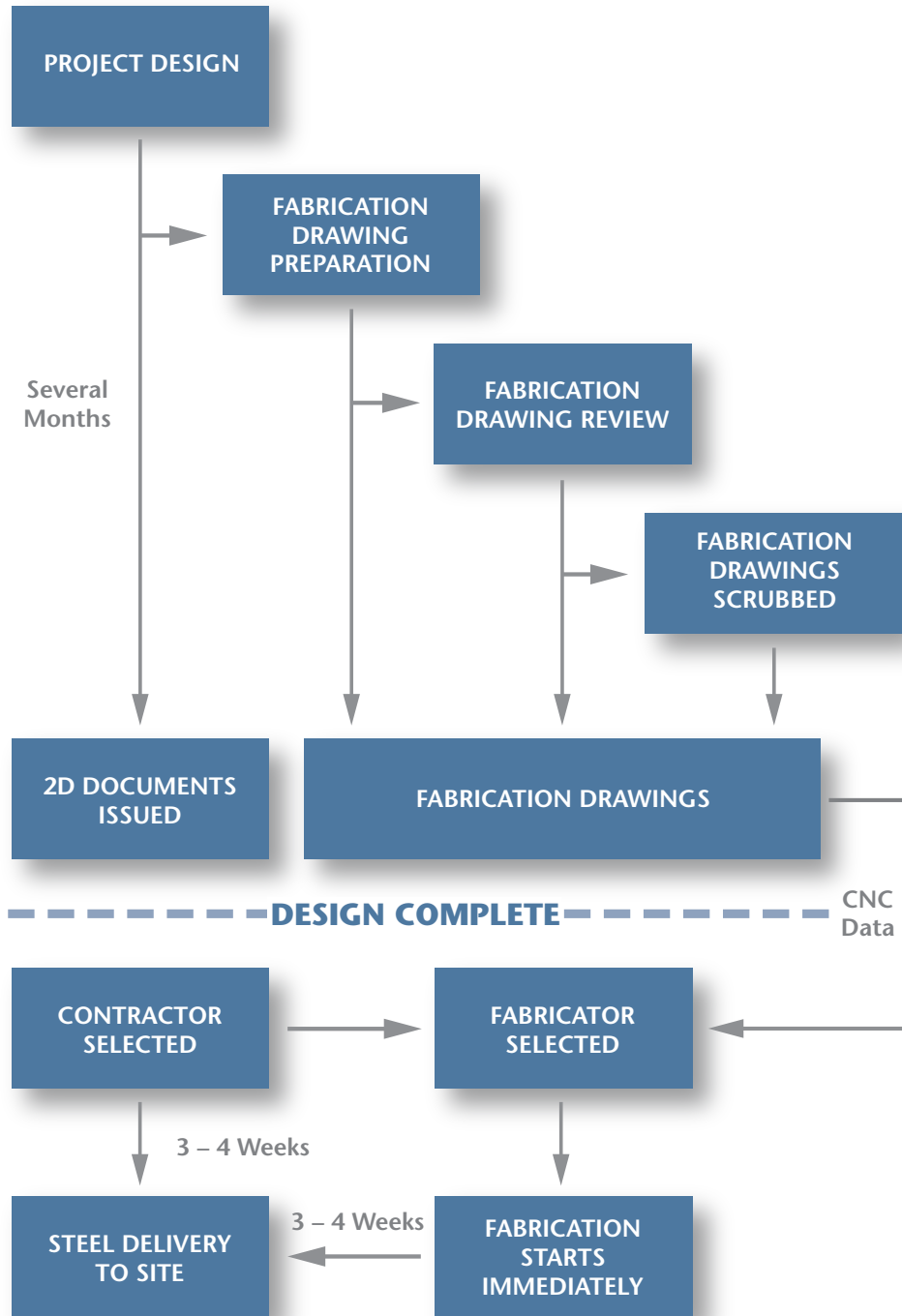
The resulting workflow is streamlined and significantly more efficient. Structural design and fabrication detailing proceed concurrently, yielding a shorter construction schedule, which translates directly into cost savings for the building owner.

If the fabricator is part of the early collaboration, his or her detailing preferences and shop fabrication efficiencies can be incorporated into the fabrication drawings to leverage even further economy.

The contractor receives fully completed steel fabrication drawings for the steel superstructure at the same time as traditional 2D construction documents are delivered to the project design team.

Structural Steel Delivery – A New Paradigm Shift

Fully completed steel fabrication drawings... can be made available to the contractor at the same time traditional 2D construction documents are issued by the project design team.



Fitzpatrick Engineering Group has the expertise to use recent BIM and detailing software enhancements to increase the efficiency and lower the cost of structural steel buildings.

Benefits of this Disruptive Technology

The benefits of this paradigm shift are significant:

- Structural steel delivery is no longer on the critical path.
- Structural steel can be competitively bid with final quantities of material already known at bid time.
- RFIs are virtually eliminated.
- The detailer is no longer required to assess the engineer's design intent in a matter of weeks.
- The Engineer of Record is responsible for connection design for the project. A second engineer is not needed.
- Shop drawing preparation, review and approval is completed during the design phases of the project.
- The potential for large change orders associated with pricing at mill order is significantly reduced.
- Time traditionally spent reviewing, processing and verifying change orders can be devoted to more meaningful and profitable tasks.
- The construction schedule can be reduced by weeks, even months.
- The fabricator is able to plan a more consistent production schedule.

Fitzpatrick Engineering Group Has the Right Team

Fitzpatrick Engineering Group has experienced detailers to make this process and these potential savings a reality. Structural engineers know how to check shop drawings but having a seasoned detailer on our team who knows the critical items contractors and fabricators need to make their jobs easier and more efficient is the key to our process.

Scheduling and sequencing of steel delivery is all coordinated prior to submitting the drawings for fabrication. Numerical control data is provided for the awarded fabricator's equipment as well as erection drawings and piece mark details so the fabricator has all the same information traditionally required.

Contact Doug Fitzpatrick by calling 704 987 9114 and let us show you how to deliver real value to your projects.

About Fitzpatrick Engineering Group

Fitzpatrick Engineering Group specializes in structural engineering solutions for commercial, institutional and health care buildings. We provide innovative engineering distinguished by design economy with a strong client focus. Experts in Building Information Modeling (BIM), we can reduce design time while delivering more accurate information to the architect, contractor and fabricator.

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