The steel industry is a much more integrated industry than it used to be, especially on larger projects. As a steel fabricator my business is very capital intensive: I've invested in a lot of machinery that reduces my need for skilled labor while increasing my accuracy, efficiency, productivity and overall quality. Not only that, it also decreases my waste (consumables) and allows for very accurate scheduling, planning and forecasting. Let me explain:

Winning the project:

Yes, competitive bidding is still around but it's rare. Even so, we bid from models now. Some narrative and specification is of course still needed but even that is embedded in the model. There is very little room for speculation. The model is much more than 'design-intent' as the contract drawings of the past used to be. The model we get is so complete, even at bid stage, that we can quickly enhance it, run it 'virtually' through our shop and provide a very detailed estimate of our own costs, down to our projected power bill. We know to the minute how long the project will take to process and fabricate. After that it's a case of building in variables and risk and we're good to go. We can have an estimate back in minutes.

Most of the time though, we are selected based on our qualifications and the value we bring to the overall project. We are involved in Collaborative Delivery Methods (CDM) 90+% of the time.

In these cases, once chosen (and we are chosen very early in the design phase), we provide a digital model of our shop capabilities so the project team can use it as a tool to constantly refine and improve the design for maximum benefit to the owner. Providing access to a digital virtual fabrication shop enables the designer to see the cost and schedule effects of various designs on the fly. Steel prices and projected availability are also automatically embedded in the model, even during the design stage. This ensures the designer uses available steel shapes that fit the schedule and also provides the contractor with up to date pricing information. It's actually a two way street: The mills and suppliers also use the information about what is being designed and where the job is, so they can plan their rolling, production and stock levels accordingly. The ability for mills to access this information across the country has stabilized steel pricing, reduced lead times and schedules, and improved the cost estimation of steel framed structures beyond belief.

Technology, Information Sharing

Technology has come a long way – and technology has been the real enabler that has improved communication and collaboration, and enabled project teams to work to a shared vision. As I said above, Collaborative Delivery Methods are the norm, and while we still need lawyers, the cases they fight are very different from what they used to be.

Back maybe 8-10 years ago it looked like technology was going to converge in a way that made it difficult to distinguish where one software capabilities ended and another's began. Steel detailing software, structural analysis software, connection design tools, planning and scheduling tools, coordination and collaboration tools: All appeared to be merging and overlapping and generally confusing the market. But in the end, the lines between them actually ended up being much clearer. This was due to the emergence of IFC as a viable means of sharing data that can be effectively used by other applications. AISC took IFC and drove forward with their BIM\Steel initiatives to ensure the steel supply chain could successfully interoperate. The adoption and popularity of IFC meant there was less pressure from end users asking their software tools to do more in the same environment; they could just as easily share data with other software tools to get the job done. From a software developer point of view, the success of IFC meant they could focus on their core strengths and their own niche product while pursuing IFC exchanges as a means to satisfy the real world needs of their clients. This actually strengthened the vendor/client relationship.

Back then it also looked like the convergence of technology and the adoption of BIM would lead to a confusing mass of changed roles, changed responsibilities and shifting risk and liabilities. To some degree and in some areas this has happened; roles have changed, but again, the development of IFC, the ability to share information wisely, the advancement of technology in general and the overall increase in quality output from each and every player in the industry has actually helped maintain (and enhance) roles and disciplines as we always thought of them. The architect has become the master builder (again), the general contractor is a master of organization, scheduling, and coordination and the sub-trades are streamlined, efficient 'machines'.

As a steel fabricator, the advancement of technology, IFC development and secure methods of sharing information has had a profound effect on my business. Beyond the fact that I get to choose the tools I want to use when I want to use them, without concern about being able to work with others, my overall fabrication business is simply more efficient. No longer do I have to guess at costs and schedules. No longer do I need to (re)build a model from a designer's set of drawings. No longer do I need to issue paper for engineers to review. And no longer do I have to issue thousands of files to my fabrication shop.

Getting the model ready for fabrication

On a typical project we will be working alongside the designer. The model we need to fabricate from is an enhancement of theirs. We take in the information, we add what we need (connections, process and other fabrication data, scheduling data, any architectural or additional elements, etc) and we are ready for fabrication. Because this is a seamless process, with information constantly shared, updated and coordinated between the various roles we move directly from finished model to fabrication without interruption. In the past, we had to go through a painful and schedule altering review and approval process – a process that was necessary to ensure we had interpreted the designer's intent correctly. That whole process (and others) is now gone and it saves us and the project a lot of time and money.

As we get the model ready for fabrication, we are constantly running the project through our virtual fabrication shop to find the best schedule (among and against other projects) and to assess our overall shop utilization. By the way this also enables us to have input to the design should we need to change something for the good of the overall project.

Fabricating Steel

Our fabrication shop is largely driven from an office: An office anywhere. Sure we have people on the shop floor but not nearly as many as we used to have. Our shop floor workers are split primarily into two groups: We have a group who maintain machines – keep them in top condition. And we have a group that we still need, for complex assemblies. We have a couple of people to manage stock and material logistics, but otherwise the shop runs itself: It literally is one big, linked machine managed by a single production manager. An Integrated Steel Fabrication Shop (ISFS).

As I said above we run fabrication simulations several times during the design process to maximize our efficiency. Once it is time to start fabricating a project we know exactly when the optimum time to start is and almost exactly when it will be finished. The production manager controls the whole operation from their desktop. The steel is released for fabrication in a manner not too different from 10 years ago, but what happens next still amazes me.

The ISFS receives the work order and from here everything is automatic. Stock material is automatically analyzed for optimum usage and the material is then located and loaded into the system. Now, fair enough, sometimes this requires a human, depending on the location and size of the piece, but most times this is an automatic process. The ISFS then takes the raw material and routes it through the shop, running it through the processes required – saw, drill, cope, etc. This is ‘pre-processing’, and once complete, the individual pieces are then automatically routed to an assembly machine. The assembly machine collects and then connects the clip angles, plates or stiffeners as required with spot welds and moves it through to the robotic welding machine. The multi-head welding robot quickly lays the required welds and as required non-destructive testing can be specified to occur. The philosophy, at least in our shop, is that each machine performs just a single task (or parallel tasks) and then moves the piece on. We find this reduces bottlenecks and supports the Lean process.

Throughout the process the production manager gets real time feeds of what each machine is doing or where each piece of the project is at. There is no guessing anymore: Or no hiding, depending on how you view it. Additionally, at each stage of this process, laser scanning checks the validity of the piece against the model, and this is also the last check, running the finished assembly through an airport like laser scanner to check dimensions and quality and at the same time feeding back the fabrication status of that piece to the project team. We have virtually eliminated the need for humans to do quality checking.

For the complex assemblies I mentioned above we have a small crew to deal with things like big trusses and very complicated projects. Prior to assembly each of the pieces still runs through the pre-processing as required but they are then routed to specially fitted out assembly bays. During pre-processing, one of the machines is responsible for applying sensors that adhere to the steel and allow the workers’ heads-up displays (built into their safety glasses) and sensor lined gloves to recognize the piece, its orientation and position (etc). Every piece they touch or pick up is recognized by the technology and step-by-step visual instructions are provided for an accurate fit-up. Hand held welding robots perform the welding as specified in the model and in about half the time it used to take, the job is done. (The sensors also come into play when at the jobsite ready to be installed).

At the Jobsite: Erecting Steel

We still need brave people who aren't scared of heights and who can place a bolt through a hole and tighten it. We haven't managed to replace this skill yet, although there are small climbing robots that can erect smaller projects with specially designed connections. TarMart (I still can't believe Target bought Walmart) has already erected several stores this way and several of the companies that build self-parking garages also utilize similar capability. Generally though, we still need people on site, although our crews are smaller and our use of robots is increasing.

The jobsite has largely become an extension of the design office. Erection of the whole building is planned very early on in the project and from here, constantly refined and fine-tuned right up until the final day. Planning shipping among different trades, from different locations is a crucial part of the overall process, especially as there are virtually no jobs where site storage is allowed or tolerated: Material arrives as it is needed – not a day or an hour too soon.

The site planning and erection sequence is stored and refined within a virtual model accessible from anywhere. As on the shop floor, holographic displays are available to everyone through his or her heads-up displays or in the site office. These displays include the location of people, tools and machines – live: The location of everyone and everything is precisely tracked at the job site and again, there is no guessing. Augmented reality overlays highlight the work to be done and along with material sensors and precise instructions, ensure everything is done right first time. Safety is still the number one priority and there have been several developments that have improved safety records (and efficiency) at construction sites by over 1000%: 'Smart tools' know where they should be when, shutting off when not in the proper location; UCSUVs (Unmanned Construction Site Utility Vehicles) deliver materials and supplies (even lunch) when they are needed (avoiding the need for human traffic and therefore increasing safety); Hazards are pre-analyzed in the model and are flagged for attention as they arise during construction (i.e. openings, edges, trip hazards and crowded work zones are forecast and prepared for); Crane placement and loading is part of the virtual model and live-linked with the placement of people, materials and progress, avoiding unexpected issues.

At the end of the day, when everything is installed and finished the model becomes *the* handoff: A fully detailed virtual building. Laser scanning or photogrammetry has been an ongoing process throughout the life of the construction cycle, constantly adjusting and updating the virtual model and providing a precise copy of the as-built project.

And there you have it – a technology built project. This is not your father's construction industry!