Meet George Jetson,
the fabricator of the future.

product
expert series

TOMORROWLAND

BY CHRIS MOOR

THE STEEL INDUSTRY is more integrated and automated than ever before.

We've already seen on several projects what's possible when building information modeling (BIM), in tandem with a collaborative team environment, is adopted or a highly automated fabrication workflow is employed.

And, as you can imagine, integration, automation and 3D modeling will continue to drive the construction process moving forward.

This isn't just speculation. I've taken the liberty of interviewing a fabricator from the not-too-distant future. (I won't get into the details on how this was possible, but I'll just say that as AISC's director of industry initiatives and chair of the National BIM Standard–United States Project Committee, I have access to some pretty amazing technology.) As he'd prefer to keep his identity a secret, let's just call him…George. George Jetson. My discussion with him was very revealing and confirms many of my projections on what the future holds for the fabricated structural steel industry.

Chris Moor: How has your current workflow affected your costs?

George Jetson: As a steel fabricator my business is very capital-intensive. I've invested in a lot of machinery that allows me to use my skilled labor more effectively while also 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.

CM: Where does software come in?

GJ: The advancement of technology, IFC (industry foundation classes) development and other secure methods of sharing information have 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.

CM: Does 3D modeling play into the bidding process?

GJ: Are you kidding? We even 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—which of course is something that's been possible for a long time, now—and provide a very detailed estimate of our own costs, even 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.

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.

CM: So it's a situation of the best model wins the project?

GJ: Oh, no. Most of the time, 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 if not more.

In these cases, once chosen (and we are chosen very early in the design phase), we provide the 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 that 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.

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CM: How did software evolve to its (your) current state?

GJ: For a while, it appeared as though technology was going to converge in a way that would make it difficult to distinguish where one software package's 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 in large part to the emergence of the IFC data model as a viable means of sharing data that can be effectively used by other applications. AISC took IFC and drove forward with it, as well as its other BIMsteel initiatives, to ensure that 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's 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.

CM: On that note, how has BIM affected your relationship with the other players on the design and construction team?

GJ: Early on, there were concerns that 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."

We generally work alongside the designer. The model from which we need to fabricate is basically an enhancement of the designer's model. 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 then 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, which 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 use. (This also enables us to have input to the design should we need to change something for the good of the overall project.)

CM: What effect has this evolution had on personnel?

GJ: Our shop is largely driven from an office—an office that can be anywhere. Our shop workers are split primarily into two groups: one to maintain machines and keep them in top condition, and another to perform complex assemblies and big trusses. We have a couple of people to manage stock and material logistics, but otherwise the shop runs itself. It's one big, linked machine managed by a single production manager, what we now refer to as an intelligent steel fabrication shop (ISFS).

CM: Take me through a typical project.

GJ: The ISFS receives the work order, and from that point forward everything is automatic. Stock material is automatically analyzed for optimum usage and the material is then located and loaded into the system. (Of course, this sometimes requires a human, depending on the location and size of the piece, but most of the time it's 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 "preprocessing" and once it is 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 the assembly 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. 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. There is no guessing anymore. 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.

Prior to assembly all pieces still go through preprocessing, as required, but they are then routed to specially fitted out assembly bays. During preprocessing, one machine is responsible for applying sensors that adhere to the steel, allowing the workers' heads-up displays, which are built into their safety glasses, and sensor-lined gloves to recognize the piece, its orientation and position. (The sensors, a relatively new technology, also come into play when the assemblies are at the job site, ready to be installed). 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. Mobile welding robots perform the welding as specified in the model and in about half the time it used to take, the job is done.

CM: What about the job site?

GJ: The job site has largely become an extension of the design office. Erection of the whole building is planned very early on and 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—all in real time. The location of everyone and everything is precisely tracked at the job site and, as in the shop, there is no guesswork. Augmented reality overlays highlight the work to be done and, along with material sensors and precise instructions, ensure everything is done right first time.

CM: So what's your advice for the fabricators of 2013?

GJ: Don't stand still. Accept that change is inevitable. While some of the processes and technologies I've mentioned will be very new to your readers, others are already taking place to a certain degree. Back in 2014 I attended NASCC: The Steel Conference in Toronto and learned what was already available to help kick-start the future.

I'll also add that you don't need a brand-new facility to start thinking about employing the technology and machinery we have (much of which was available in its early forms back in 2013/2014). You can start small, with one machine, in one bay or one section of your shop. Our facility is over 100 years old. We didn't have the luxury of starting with a new, fully planned and purpose-built facility. We had to work with what we had. But we did have a plan—a vision—and we shared that vision with our suppliers and worked with them to achieve what we have today. It took a while but it was worth it! MSC

This article was written as part of the National BIM Standard–United States 2021 Vision Task Force (VTF). The VTF (chaired by the author) has collected more than 30 of these visionary papers from all corners of the construction industry in an effort to build a roadmap for the industry to become more efficient. We are in the process of weaving the essays together to create a single, compelling and tangible vision of what the future may look like, along with the steps the industry may need to take in order to get there.