Is a **Robot** in Your Future?

BY IVAN JIVKOV

As various machine control technologies begin to mature, the prospect is great for increasing your competitive advantage with robotics.

NOVEL AND ATTRACTIVE opportunities for improving productivity and quality in the structural steel industry have regularly come to light as the overall state of technology has advanced. Today computer modeling and machine control have both reached levels of maturity that permit their interface far more easily and effectively than was previously possible. This article offers a brief discussion of how implementing state-of-the-art automation technology, including things like robotics and BIM, can effectively utilize process simulation prior to fabrication to gain a competitive advantage.

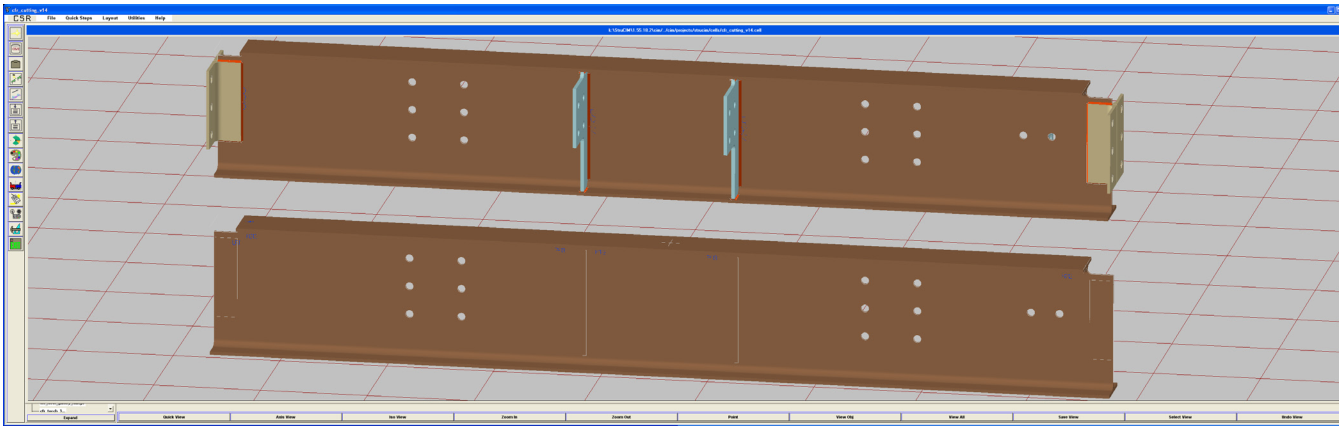
To support interoperability among both existing and emerging technologies, CIS/2 was adopted about 10 years ago as an open standard for data exchange among different software for structural steel design, analysis, detailing and fabrication. Design data in the CIS/2 format includes information required in each phase of data processing: project and product definition, parts features (including holes, copes and welds), joint systems, material, location, geometry, unit references, etc. Completeness of the information, in a qualitative sense, was much deeper and more robust than in the alternative DSTV format, which is commonly used as the information link between CAD design and CNC equipment. For example, unlike DSTV, the CIS/2 file format can be used to import assemblies complete with all features and attributes from a manufacturing model.

Unfortunately this technology has had a very limited adoption rate in the steel fabrication environment. One factor contributing to this has been the perception that the only efficiencies to be gained through such a switch to an open standard were in modeling. In its earlier days, many people didn't see the huge potential for productivity gains through use of robotic welding machines, which open standards can facilitate. Even today, few fabricators comprehend that adopting this technology will bring structural steel fabrication to a totally new, higher level of productivity. Fabrication time can be dramatically reduced with the use of robotic technology but requires software capable of accomplishing these specific tasks:

- Intelligent programming interface capable of creating 3D CAD geometry and features of individual parts and their assemblies, which for maximum interoperability would be based on CIS/2 or some other open standard.
- "On the fly" automatic generation of tool paths.
- Work cell simulation involving collision detection and optimization.
- Postprocessor for converting tool paths into robotic programs, and their translation into robotic language.

With these programming capabilities, off-line simulation can be done very quickly and easily. However, it is well known that manual operations are the most expensive that a fabricator faces. Therefore, the gains of even the most efficient and timesaving software easily can be consumed with just one manual operation hampering the whole process. For example, CNC machines can produce layout marks to facilitate manual layout, but a CNC programmer first has to enter proper location of these layouts into the program. Because it is extremely time-consuming, this process limits the ability to use CNC marking systems in full measure.

On the other hand, CIS/2 and possibly other open standard exchange protocols offer solutions for overcoming this limitation. Whether a CNC machine or a robot, if it is able to read properly formatted and complete data, the problem can be solved. All features, including surface positions and weld locations and other parameters, can be expressed in a data file. Piece marks can be easily assigned and incorporated into the file. The only step that separates this information from a programming robot is the translation. With this



done, translated data about features and sub-material layout can be imported into robotic OLP software. There it can be used to automatically rebuild the 3D model, followed by automatic definition of surface intersections and tool path generations, clash detection and further robot program generation.

As this technology becomes available, fabricators can seriously consider converting from expensive CNC machinery to economical and efficient robots. The solution is so practical that it is often regarded as just a matter of time before it comes to the structural steel domain. Any type of layout and piece marking—drill, plasma oxyfuel, spray, etc.—may be used for scribing with the existing CIS/2 format, however, no one in the industry has done this yet.

The inherent advantages of automatic versus manual welding are hard to dispute. Automatic welding is generally acknowledged to be from four to 10 times more efficient with regard to weld quality, consistency, amount of scrap generated and variable labor time. The caveat for structural steel fabrication, however, is that the product is not repetitive. Nearly every assembly is unique, which means that each assembly requires either manual material layout or programmed layout generated by a software operator. In either case a human has to spend time doing the job. Many fabricators are trying to become more competitive using BIM detailing software with a DSTV interface. Though DSTV simplifies a portion of the fabricator's work, DSTV-based software still cannot automate the generation marks for welding layout—the standard simply doesn't support the required data.

The CIS/2 format, however, can support all the information needed for welding layout definition, and is available for automatic parsing and translation. With support of automatic surface intersection definition and tool path generation software, future systems can fully eliminate manual intervention of an operator. This allows layout and welding time to be reduced by up to a factor of 10, and that represents only the welding process. If the layout preparation is automated as well, a fabricator could be positioned to save additional time.

▲ Limitations inherent in DSTV restrict the digital representation to the lower of these two images, whereas additional data in the CIS/2 format enables adding pieces and welds as shown in the upper image.

Numerous articles have discussed the ability to import data from the detail drawings directly to the CNC machines. In reality, when using CIS/2 or other open standards, or even perhaps proprietary application programming interfaces (APIs), drawings may no longer be needed. Instead, it may be possible for design data to be translated directly from a design model to offline programming (OLP) software, automatically programming the robot controller.

Some robotic systems are now commercially available to cut steel, either by importing DSTV data or allowing manual programming by means of macros, but this approach is limited to cutting. However, with an appropriate software interface, using robotics will allow structural steel fabricators a much broader range of capabilities, including automatic cutting, coping, layout marking and welding. Additionally, because programming for robotic fabrication can be so dramatically simplified—even automated—the efficient automatic fabrication of individual parts soon can become a reality. MSC

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