Automating Layout in Steel Fabrication

BY LUKE FAULKNER

Advances in automated layout are accelerating the process and eliminating many potential errors.

JAMES SMELSER KNEW there had to be a better way. Roughly 30% of his shop labor consisted of fitters, and 60% of their hours were being spent on layout and marking. Layout work is a classic example of a limiting factor in production; it is tedious and time consuming, and even the best fitters are prone to human error. Using a tape measure and manually making marks on a piece part with soapstone takes as long as, or longer than, almost any process on the shop floor, essentially dictating the rate of production.

Smelser had watched for decades while the rate of production increased in other areas of the shop. The industry got better and better at cutting and drilling beams as more and more technology was applied to those processes, but the layout issue persisted. For Smelser, the answer was very clear. The layout and marking process needed to have a significant amount of automation added, and it required a medium capable of marking very quickly and reliably.

To the steel industry, this represented a relatively rare opportunity—the chance to apply technology to *eliminate* human participation in a process, in this case, layout and marking. CAD, for example, was a great application of technology to a process that remains an activity. Lines and symbols became consistent, eraser marks disappeared from paper and drawings became easier to read, at least in theory. What CAD didn't do was eliminate a process involving people. Drafting simply migrated from one platform to another. In the case of layout and marking, the bottleneck of manual layout is actually being removed.

For years Smelser and his company, Nicklebutt Automation, asked—and occasionally begged—for help developing his vision for automated marking. Finally, in late 2010 Nicklebutt partnered with Controlled Automation to offer the LLP5020, the first machine to offer automated layout via laser marking, but they're certainly not alone. As early as 2005 certain fabricators were pushing Ficep to offer a machine capable of scribing multiple surfaces at once.

Several manufacturers now offer robotic and CNC-based solutions to a complex problem that has vexed the industry for sev-

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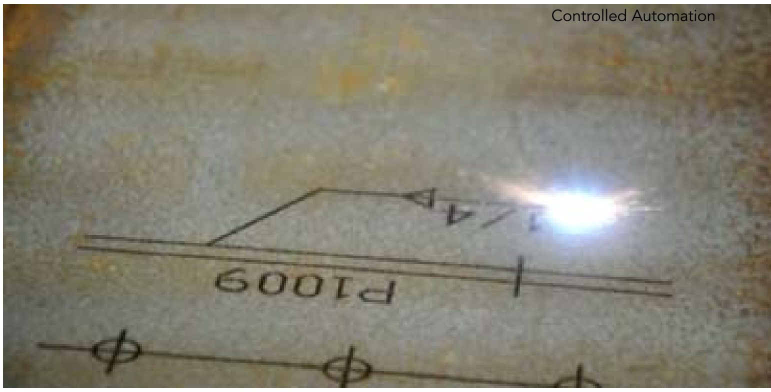
Rather than removing material, the Laser Layout Printer marks with what is known as dark oxidation, a process that survives the shop environment remarkably well.



Controlled Automation

eral decades. The automation solution eliminates errors, hastens the process, and at the same time copes with the declining number of highly skilled fitters. It's no stretch to see how automated marking offers a significant upgrade over manual operations; even the best layout person is prone to make a measuring mistake or have his marking misinterpreted. Both of these issues are immediately taken off the table with automated scribing, and in some cases the capacity to do so can be integrated directly into an existing beam line.

For all the promise of automating the layout process, when all the requirements are vetted the options for marking are relatively limited. Various manufacturers at one time or another looked at an industrial ink-jet type application for marking, which ended up being unrealistic because it could not survive the media blasting process. A similar powder-based application was examined as well, but in an industrial application like the fabrication shop, nozzles were constantly clogging. In the end three technologies have emerged as truly viable options: milling, plasma and laser.

Milling

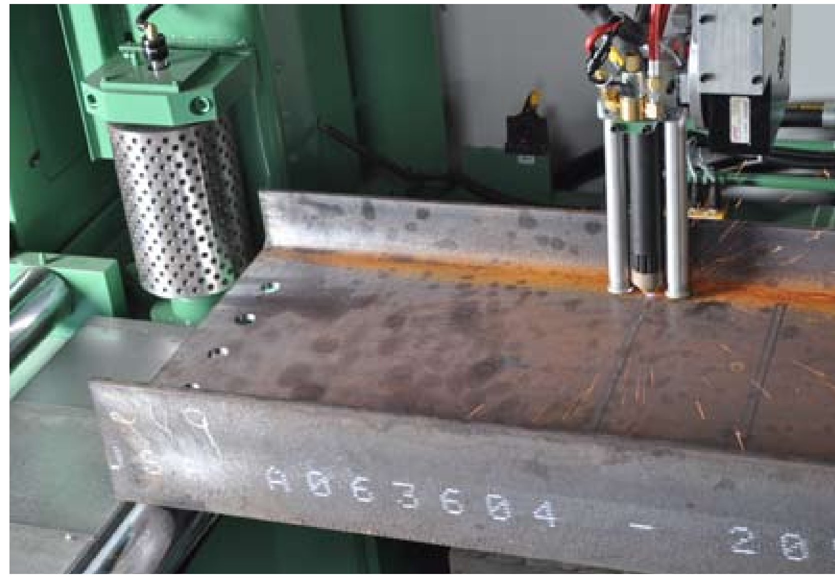
Despite the amount of technology that goes into a machine, the process of milling is decidedly low tech. It relies on what is essentially the simplest method of marking. One manufacturer even said it might be more accurately called scratching.

Milling uses a modified drill head that simply removes material, leaving a mark. While milling is a slightly slower process than plasma cutting or laser marking, it still represents a significant improvement over manual marking. Voortman uses this technology and claims writing speeds up to around 160 in. per minute. Despite the slower speed, there are considerable upsides to milling. For example, it requires fewer consumable items. The simplicity of the tool means it needs only compressed air to operate, so not only are consumables reduced, but logistics are somewhat simplified because there are no storage requirements for gas canisters. In addition to the reduction in consumables, milling offers the advantage of using less power than plasma or laser because there is not the continuous electrical arc. Milling is considered to survive the shot blasting process relatively well, and the surface condition of the material (scale, grease, rust) does not negatively impact ability to write.

Like plasma or laser processes, milling is not without its relative downsides; in addition to slower speeds milling and drilling are often done by the same machine. This means that time has to be spent changing out tools to transition from drilling to marking. In addition, the milling tool is quite expensive compared to the other two.

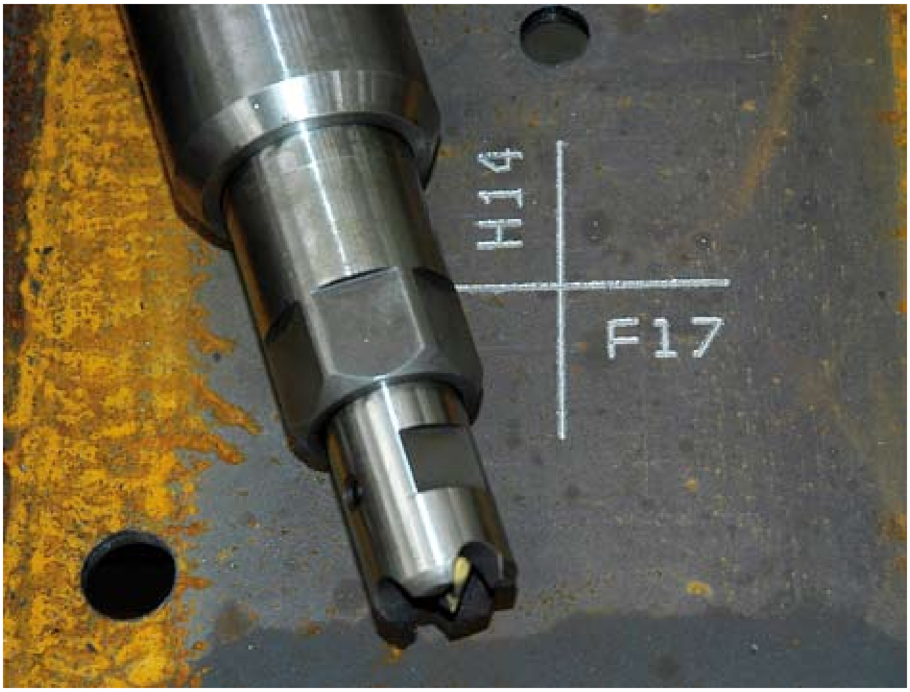
As expected, depending on the machine, you may be able to mill on multiple surfaces at the same time. In the case of Ficep, you can mill on up to four surfaces, cut to length, cut to angle and drill in a single pass with all of its drill line machines.

Low-tech though it may be, it represented the first big breakthrough in automated layout and marking. The breakthrough, though, was related to the ability of Ficep machines to extract data from detailing software and import it directly to a machine for automated scribing. Just recently Ficep was awarded a patent for method of extract-



Photos this page by Peddinghaus Corporation

Above, center and below: The PeddiWriter uses a plasma torch to mark the surface of the steel.



Ficep milling tool and fit-up marking.

ing data from detailing software and creating from that an XML file for scribing.

Plasma Marking

Plasma *marking* uses the same torch-based technology as plasma *cutting*. Instead of cutting all the way through a surface, the superheated charged gas cuts into the surface of the beam, enough to leave very clear markings without any structural compromise. In some cases this is done with the same machine used for cutting and coping, such as the Voortman V808. In other cases it's done with a dedicated machine such as the Peddiwriter from Peddinghaus.

For those that may not have taken any physics classes for a while, plasma is a superheated, ionized gas. The gas is so hot that negatively charged, excited electrons break their bonds with their nuclei.

In the case of cutting and marking, a highly pressurized cutting gas such as hydrogen or oxygen is passed over a negatively charged electrode at high speed and pressure while being shielded by an inert gas (argon, for example). To create the plasma, an arc must first be created; this happens when the tip of the torch briefly contacts the steel and completes a circuit. The spark thus created heats the gas and creates the plasma. This process is repeated at every stop and start.

Constant stopping and starting is one of the main disadvantages of plasma. Every start and stop means consumables; plasma requires a cutting gas, and a shielding gas, which will increase depending on how many stops and starts are required, particularly at 90º angles, where the torch must stop, change direction and then restart.

The constant power needed to power the continuous arc means that a plasma system also has a higher electrical consumption rate than milling, for example.

On the plus side, plasma offers excellent ability to mark on a variety of surfaces. Rust, grease and scale do not affect the ability of plasma to write on a surface, as opposed to a laser, which can on occasion have issues with the reflectivity of a surface. Plasma is also extremely quick; Peddinghaus has been able to achieve 300 in. per minute with its Peddiwriter. This may vary depending on the marks required and the number of stops and starts.

While the constant power consumption required for the electrical arc is a concern for some, plasma marking usually operates in the 6-8 amp range. This is somewhat less than what would be expected for plasma cutting and also less than laser power usage.

Unlike milling, plasma does not require a change in tooling. That is a benefit if you choose to forgo a stand-alone machine and use the same machine for coping and marking.

An example of parts marked by the Ficep scribing system.

Laser Marking

It sounds like science fiction, but laser marking is a very real option offered through Controlled Automation's LLP5020. As opposed to a plasma torch or milling, laser marking removes very little material, but marks instead with what is known as dark oxidation. Although the laser marking survives remarkably well in the shop environment, it is removed by the blast cleaning process, which is a benefit in applications like AESS, for example.

Needless to say, the process of creating lasers is not simple, but the end result is emission of directional light, with phased wavelengths and wave fronts. There are myriad uses for lasers ranging from the ubiquitous laser pointers used by PowerPoint presenters, to high-powered military grade solid state lasers capable of destroying cruise missiles.

In the case of the LLP5020, fiber optic lasers are incorporated in a machine that gives a fabricator the capability to mark on 12 surfaces simultaneously. At 200 in. per minute it clocks in somewhat slower than the 300 in. per minute claimed for a plasma system. It does, however, handle 90° angles, stops and starts, and intricate lettering more adeptly than plasma, meaning that in some cases it may be faster. The developers also continue to improve performance and have in some instances achieved a marking rate of 410 in. per minute.

NB Automation claims that a smaller fabrication shop can expect an automated layout machine to pay for itself within a year—even sooner as the number of fitters in a shop increases, and possibly in as little as 17 weeks.

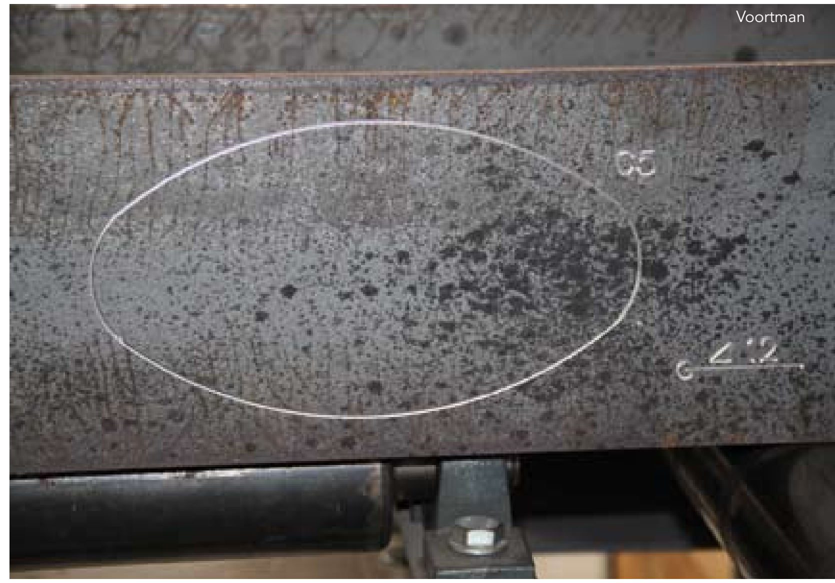
As a relative newcomer to the marketplace (unveiled in May 2011), there is not a long track record for laser layout. Power consumption may be considerably more than plasma or milling, which may be made up for by the lower cost of consumables. Aside from power consumption and shorter track record, laser marking has garnered a lot of buzz, but it may be sometime before it gains wide acceptance as companies have just started taking delivery.

Some machines allow a fabricator to combine the functions of cutting or drilling with layout. In these cases a drilling head may be replaced by a marking tool, or in the case of plasma, the total amperage reduced to a level where the steel is marked as opposed to cut. The advantage of this is cost savings realized by combining the function of two machines. The down side, as one might guess, is that the machine is generally only performing one of the functions at a given time, for example either drilling or scribing, or in the case of plasma, coping or marking.

Tying It All Together

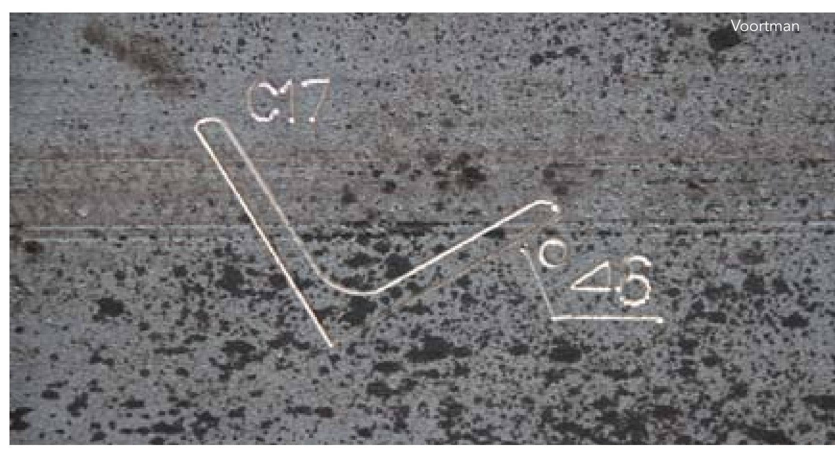
What is the technology that drives these machines? To look at the machines performing layout and marking functions, you probably wouldn't notice much of a difference. A CNC tool, or more likely tools, articulate around a piece part to make a mark. How they work varies by manufacturer, each of whom has developed one or more interfaces between detailing packages and their marking machines.

These interfaces can be based on an open standard or data can be transferred using a direct link. For example, the PeddiWriter has a direct link to Tekla Structures. Alternatively it can use a neutral file format, such DSTV+ or SDNF, which is then translated into the proprietary system of the marking machine.



▲ Location, piece mark and weld symbol milled on a steel surface by Voortman's V704 automated layout and marking system.

▼ Layout markings on a steel beam show the location, identification and required weld.



Another example is Voortman's VACAM software, which imports DSTV files from any source. VACAM first translates the data, then pushes the information through to the CNC machinery, such as its V704M. Ficep also extracts data directly from the detailing software files and translates it to XML.

Because it is critical that the data from detailing applications is translated accurately, developers have taken great care in this area. For an error to show up in the layout and marking operations, it must have been present in the detailing data.

Ultimately, the desire to seamlessly import and export accurate information and the need to reduce any residual manual layout will be what drives further improvement in the automatic layout and marking process. MSC

More information on the various products referred to in this article is available from the various company websites.

www.controlledautomation.com
www.ficepcorp.com
www.nicklebutt.com
www.peddinghaus.com
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