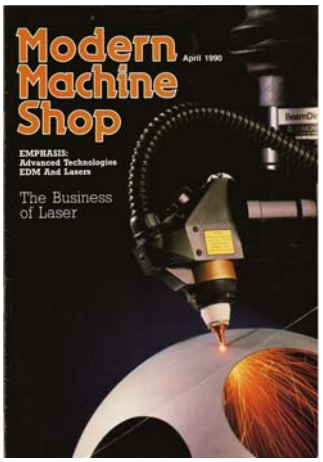


EMPHASIS: Laser

The Business Of Laser

Can a five-axis laser offer a productive future for a small manufacturer or job shop? It depends on how much you value flexibility.

By Tom Beard,
Associate Editor

This article is about laser, in fact, a five-axis laser. But we're not going to talk much about the process itself—things like light amplification, assist gasses, or CO_2 vs. YAG. The subject here is the business of laser. What is it like to own one, to operate it profitably? Published statistics show the U.S. substantially behind Japan and Europe in the use of this technology. Are we really missing an opportunity here, or are we showing prudence in waiting to see if a laser can really pay its way—both in terms of process

capability and reliability-relative to more tried- and- true methods? These are reasonable questions.

Taking on a five-axis laser machine is, after all, a substantial undertaking for any manufacturer. For one thing, they're not cheap; the better machines can go upwards of $500,000. But just as daunting, it's a whole new technical challenge. There's the laser unit itself to consider as well as a motion control mechanism far more sophisticated than the standard fabricator's fare.

Auto Metal Craft's Kurt Woody (foreground) with an array of typical prototype parts. In the background is operator Joe Dewolf with the company's five-axis laser.

Still, users increasingly are turning to multi-axis lasers in part because the process is getting better, but more so because it provides capabilities unmatched by any other manufacturing method. To date, the majority of these machines have gone to product line manufacturers (rather than job shops), a statistic that probably has more to do with big shop resources than anything else. But it's the job shop that presents the largest potential since most stake their livelihood precisely on what a laser has to offer.

Large or small, users can usually sum up in a single word why the laser works for them: flexibility. A five- axis laser can intricately cut virtually any typical flat or formed part, with no hard tooling and only the simplest of fixturing. (It can also handle welding, heat treating and marking of these same parts, but here we'll concentrate on cutting.)

Changeover from one job to another can usually be executed in minutes. And programming is not as difficult as you might expect.

To help explain the business of five-axis laser, we spoke to a leading builder, Laserdyne in Minneapolis, MN, and an experienced user, Auto Metal Craft in Oak Park, MI. Both have plenty of hands-on experience with the process. Besides building laser systems, Laserdyne also maintains a thriving job shop business using their own equipment. Auto Metal Craft has made a five-axis laser the centerpiece of its prototype fabrication business.

The Worth Of Five Axes

Whether or not a five-axis laser is a reasonable investment depends, of course, on what it's compared to. But when Auto Metal Craft's Pat Woody compared it to hand labor two years ago, the answer was an unequivocal *yes*.

Laser operator Joe Dewolf uses the teach method to do basic programming on most parts, but often does subsequent editing to add detail. This part is typical.

The business Mr. Woody runs with his six sons revolves around service. They make prototype metal stampings for the automotive industry. Delivery dates are usually ASAP, and lot sizes are seldom larger than 100 pieces. Before the laser they would typically stamp a part, and then finish fabricating and trimming with such high-tech tools as band saws, drills, and hand files. The process was laborious, but there was simply no better way. Hard tooling was out of the question since part designs frequently went through several iterations before arriving at the final configuration.

The five-axis laser has eliminated hand work. Because the laser head can freely be oriented normal to almost any surface, extremely complex contours can be followed, and there is hardly any limitation on the intricacy of the cutting path. In fact, the laser now cuts many features that were previously unreachable with a punch and die due to the contours of the part.

The laser not only does the job better, it also does it faster. One part, for example, was made of galvanized steel, 0.030 inch thick. It required trimming and a number of holes to be cut. Doing the job by hand took about an hour. With the laser, it took about 45 minutes to

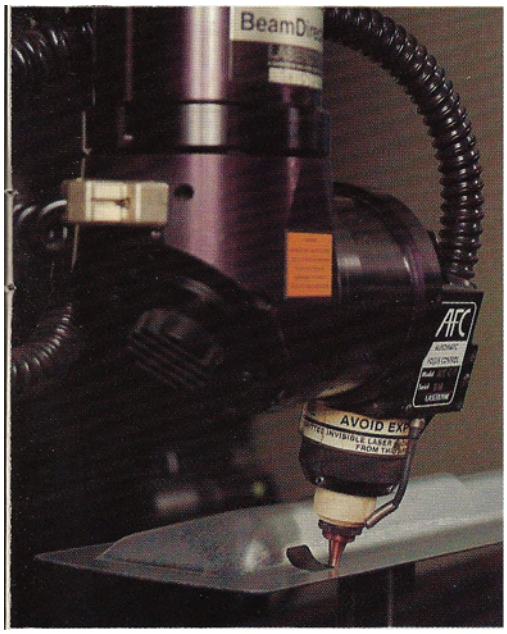
program, and parts were produced at a rate of about twenty per hour.

Looking at this kind of productivity enhancement from another angle, Mr. Woody figured he would soon have to add ten to twelve people just to keep up with his shop's growing work load. Instead, they bought the laser, hired no one, yet gained additional capacity to spare. That fit perfectly with the company philosophy of holding the work force to a small number of highly skilled people, and providing those individuals with secure employment. Mr. Woody maintains that should the work load ever slack off, he would shut off the laser machine before he would lay off any people.

Though it would be hard to find a more ideal application than Auto Metal Craft's, multi-axis lasers do make sense for many other manufacturers as well. It is a very good process for cutting tube. Such systems typically use a three-axis laser (since following free-form shapes is not an issue), complemented with a synchronized fourth rotary axis which turns the part.

And there are other advantages.

The laser cutting process imposes virtually no force on the workpiece. Thus, intricate patterns can be cut without distorting the part as punching operations often do. Moreover, simple fixturing will suffice since a highly rigid setup is not required.



A five-axis laser can follow complex contours, remaining normal to the surface at all times. Automatic focus control brings accuracy and consistency to the cut, even with parts that exhibit high piece-to-piece irregularities such as stampings that spring back unpredictably.

Because the beam moves, rather than the workpiece, a five-axis laser can handle parts considerably larger than it's working envelope simply by repositioning the workpiece each time work is done on an individual segment. Using this technique, Laserdyne has cut tubular parts up to 22 feet long on standard equipment in their own shop.

The moving beam also provides an opportunity to streamline setup not unlike the way pallets permit offline workpiece setup on a machining center. Because the table is stationary, one part or fixture can be mounted while another is being processed without compromising either function, or needlessly imperiling the operator.

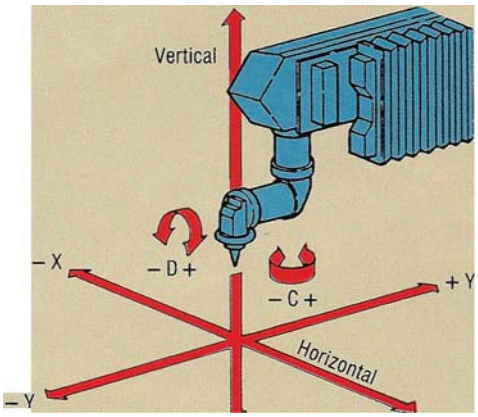
Best of all, the laser is an extremely quick means for handling new opportunities. Design changes can be accommodated without having to retool. Replacement parts can be created on the spot by digitizing an old part, and immediately cutting new ones. In fact, one well known vehicle manufacturer uses a multiaxis laser to support both the prototyping and spare parts replenishment of their exhaust components. New programs are produced in minutes, and old programs are considerably more manageable than thirty years worth of hard tooling, not to mention more space efficient.

All told, multi-axis laser should be considered when volumes are low and parts are intricately featured or dimensionally complex. These days, the laser can be applied on thicker materials, sometimes up to ~ inch. However, it is the nature of most five-axis applications to be in the thinner sheet or tube stocks. So material thickness seldom becomes a practical process limitation.

Ramping Up

For many prospective users, justification is the largest obstacle to a multi-axis laser. The most common justifications are eliminating tool costs, rapid changeover, and quick response time for just-in-time delivery. But once that hurdle is cleared, someone still has to make the laser work in the shop. The good news is that, although a laser will bring on a host of new process variables to consider, day-to-day operation and maintenance is not significantly more difficult than many other computer-controlled machine tools.

The process parameters of the laser itself are not unlike EDM (electrical discharge machining), though laser is much faster. Beam intensity, pulse frequency and duration are all factors that should be balanced with cutting speed to obtain a desired surface finish and minimal heat-affected zone. A knowledge of how different materials respond to the process is required, but material hardness can virtually be ignored. Many new users go in thinking that all these variables must be painstakingly controlled. However, they soon find that the process is surprisingly forgiving. Moreover, in the case of Laserdyne's equipment, the CNC can automatically handle much of the power management if the operator so chooses (more on this later).



Full contouring capabilities are achieved with three linear axes and two rotary axes for laser head articulation. Individual axis feed rates can go as high as 500 ipm in the X and Y axes, 300 ipm in the Z axis and 32 rpm in the rotary C and D axes.

Motion control is usually a greater concern. The whole point of a five-axis laser is its ability to execute intricate cutting patterns over contoured surfaces, and it is here that skilled practitioners concentrate their attention. It's not surprising, then, that the best prospects for laser operation tend to be people who already possess modern machinists' skills-the ability to think in three dimensions, and a general understanding of computer numerical control.

Maintenance is a consideration.

It's fairly difficult to break the machine through operator error; in fact, lathes and machining centers are much easier to crash. Laserdyne's laser head includes sensors that detect the presence of a surface and shut down rapid traverse when one is near. But laser or electronic failures can occur which most likely will require the services of a factory technician since generic laser repair shops can seldom be found in the Yellow Pages.

The average user can do routine maintenance, things like changing oil and filters, cleaning mirrors, and so on. However, Mr. Woody chose to have all that taken care of in a service contract, reasoning that the prospect of unscheduled downtime was a far greater financial risk than the cost of the contract. In fact, because he was putting so many of his eggs in one technological basket, the availability of local service weighed heavily in his decision on which equipment to buy.

It's All in the Control

Although the light beam usually gets the glory, the CNC is just as responsible for the versatile capabilities of a multiple-axis laser. And it is skilled programming that allows users to get the most out of their production investment.

Just like most other CNC machine tools, the laser uses standardized G and M codes and can be programmed off-line or with manual data input (MDI). With the five-axis machine, however, these methods alone are often impractical due to the geometric complexities of the workpiece. This is why Auto Metal Craft does most of their programming with the teach method. It works like this:

Typically, they start with a layout master. The part has been stamped, blued, and then scribed to indicate trim lines and features to be cut. The master is mounted on the laser table and the beam is powered to a very low intensity, just bright enough to be seen. The operator then steps through a manual digitizing process, using the beam just as you would a touch probe. With a teach pendant, the operator orients the light on a scribe line as normal as possible to the surface, records the point, and then moves up the line to record the next point, and so on. The laser has an automatic focus feature which maintains a constant distance from the tip of the laser's nozzle to the workpiece surface. Once all the points are collected, they are "splined", a complex mathematical process executed by the CNC that connects the points into a smoothly-curved cutter path.

Some features, such as slots and holes, are more accurately programmed than taught. In those cases they will typically use the teach method to locate the feature on the part-to indicate the centerpoint of a circle, for example-and then come back and edit the program to the specific geometry of the feature.

The control also has other capabilities that help simplify programming. For example, the head can be programmed to pivot around a single point in any plane, making circular paths easy to teach, even if the workpiece surface is highly irregular. This feature, called F-Lock, is similar to what is often called Tool Point Center on five-axis machining centers. Another feature automatically calculates appropriate cuts for two intersecting tubes. The programmer simply indicates the tubes' centerlines and diameters, and the control generates the laser path code.

Laserdyne's CNC also has the capability to automatically alter the laser power or pulse pattern relative to the feed rate. This ability can be particularly important on delicately featured parts. Cutting energy is ramped up in the straightaways to achieve high cutting rates, and down in the tight curves to avoid excessive heat absorption in the part.

There are other features as well.

But the important point to remember is that current technology makes it possible to dynamically link the operating parameters of the laser to those of the machine axes. The operator can use control-resident software to manage much of this relationship if he so chooses. Or he can write it all into the NC program. Either way, he can have a highly controllable and consistent metalworking process.

Focus

Laser is such a fascinating subject, it's easy to get overly infatuated with the technology. Successful users, however, don't seem to get caught in that trap. Laserdyne's own job shop manager, Ron Sanders, expresses an appropriate perspective this way: "Think of the laser as a light bulb; we concentrate on the part." In other words, a laser at its very best is still only a tool. How it works is not nearly as important as what it can do.

What it has done for Pat Woody is to enable his company to provide better service to its customers at a justifiable cost. And that's good business any way you cut it.