Technical Guide: How to Match Today's Laser Cutting Technology to Application Requirements

By Markus Klemm, R&D Software Engineer, Spartanics

Laser cutting, a.k.a. digital die cutting, uses high-powered lasers to vaporize materials in the lasers' beam path. The powering on and off of the laser beam and the way in which the beam path is directed towards the substrate effects the specific cuts that the artwork requires. Because cut away parts are vaporized the hand labor or complicated extraction methods otherwise needed for small part scrap removal is eliminated.

These basic facts about laser cutting are as true today as they were when laser cutting systems were first put to practical industrial uses in the '80s. However, recent advances in laser cutting technology, and especially those that relate to the sophistication of the software engineering underlying laser cutting controls, have created dramatic improvements in the type of outputs that can be expected from laser cutters. Today's lower cost laser cutting systems made from less expensive components have far superior capabilities to the expensive systems that were designed and engineered only a few years ago. At the top end, state-of-art laser cutting systems are able to consistently cut far more intricate designs in a wider range of substrates and with tighter tolerances than ever before.

The challenge to those making investments in laser cutting technology is to source machines that are well-matched to application requirements. One can still find laser cutting systems in the marketplace that force compromises in quality or production output that should not be brooked in light of engineering advances in laser cutting technology. On the other hand, those with more straightforward application requirements are often well-served by lower cost models of laser cutting systems that are powerful and versatile enough for the jobs at hand. In this white paper, we will discuss how to match today's laser cutting technology to application requirements and offer insights into how various features of laser cutting systems translate into capabilities for quality and throughput as summarized in Figure 1 – Laser Cutting Technology Comparison Chart.

<u>Choosing Between Laser Cutting vs. Tool-based Die Cutting Systems</u>

A preliminary step to sourcing the right laser cutting technology is to first determine if laser cutting capabilities are a good addition to your finishing department.

There are numerous advantages to laser cutters as compared to tool-based die cutting systems. Most of these advantages derive from the tool-free nature of laser cutters. Because there are no tools, there are no costs for tools or production delays for time to make tools. This is the major reason why laser cutters provide a rapid prototyping niche for those that use them. Laser cutting systems are called digital die cutters because they can take any vector-based digital image and import it into their operating software to set up a job. Today's best-in-class laser cutting systems can complete set up from these imported digital images in just a few minutes. The 'digital die cutter' term that is used interchangeably with laser cutting speaks to this advantage that tool-free cutting systems provide, especially when used in combination with digital printers. This combination allows one to move from artwork to finished product in just a few hours, or even less for very short runs.

In tool-based mechanical cutting there are always intrinsic limitations from the physical contact between the cutting edge and the material being cut. A laser cutting systems bypasses that situation, which makes them able to cut many materials that are very difficult or impossible for tool-based cutting systems to handle. For example, cutting adhesives is far easier with laser cutting systems because of the tendency of adhesives to literally gum up the works in mechanical cutting systems. Similarly, the ability of tool-free laser cutting systems to reliably handle thin substrates is a big advantage. In these thin substrate applications, cut-to-print registration is not constrained by the physical limitations of weighty dies interacting with flimsy substrates. Another example is in the better handling of abrasive materials, which literally wear mechanical dies down such that cutting abrasives with mechanical cutting systems is often prohibitively expensive because dies have to be continuously replaced. Here too, tool-free laser cutting systems sidesteps this problem altogether.

The relative ease with which laser cutting systems create special features is also a considerable advantage. Perforations, score lines, kiss cuts, consecutive numbering, creasing, personalizing and other special features are done as a matter of course by laser cutting systems. This is especially the case with today's laser cutting technology that uses far superior software engineering to precisely control the movement of laser beams making cuts. In fact, the only relevant physical limitation in laser cutting systems is the width of the laser beam--- for example in 200mm x 200mm working fields or greater the spot size can be as small as 210 microns in best-in-class systems. While any die-based cutting system would have difficulties in producing corners that are less than 30 degrees, this is not in any way challenging for a laser cutting system. And, laser cutting technology also allows one to skip the step of creating mechanical knicks to facilitate parts extraction as is typically required with a tool-based cutting mechanism.

There are limitations to laser cutting systems, as with any technology, but also there are mistaken notions as to what these limitations are. In some quarters laser cutters are thought of only as prototyping tools and not up to the requirements of full production runs. While there are many applications where laser cutting may be slower as compared to platen presses, rotary die cutters or optically-registered gap presses, they are considerably faster than the earlier laser cutting systems that used to predominate. In fact, most users of today's laser cutting systems ARE using them for full production line capabilities. For one thing, today's laser cutters are generally galvo (galvanometer) type lasers that make minute adjustments in mirror angles to move laser beams around artwork. This galvo mechanism is considerably faster than gantry systems with XY plotters that physically move lasers as a whole or the whole sheet of material being cut, not just the laser beams. Newer galvo technology takes this speed improvement to the next level by fine tuning software to shave milliseconds off of most operations, with a combined effect of significant speed improvements. The higher the wattage of the laser, the faster the cutting proceeds in most applications. The difference today is that faster 200-watt and 400 watt lasers that were prohibitively expensive five or so years ago are now available at competitive prices. These new lasers also make a higher quality laser beam, which in turn ensures that cutting quality is maintained even at higher cutting speeds. The upshot of all these combined speed improvements is that today's laser cutters do far more than prototype samples; they are used for full production runs without creating production bottlenecks. (Note: Manufacturers' claims on linear cutting speed are not meaningful in most instances. Actual cutting speed is determined both by the complexity of the artwork and ability of the control software to optimize cutting in that geometry, as explained below.)

Another misconception that one still finds is that laser cutting is a dangerous operation that burdens a workplace with safety risks. Though it may seem counterintuitive to some, laser cutting systems are in many ways a safer alternative to tool-based cutting systems. The initial installation of a laser cutting system takes care to eliminate the chance of stray beams creating workplace hazards if workers do not wear safety glasses. Tool-based systems, on the other hand, pose a continual risk of severe worker injury if they are not operated properly. Although such accidents are rare, they can be catastrophic. Costly injuries to tooling are somewhat more common, such as when technicians leave tiny screws in a cutting area that end up destroying the custom tooling.

It is also thought, and correctly so, that laser cutting systems cannot handle any and all substrates. However, the boundaries of that limitation continue to shift along with better engineering of laser cutting technology. For example, polycarbonate substrates used to be beyond the reach of laser cutting technology because of the laser cutters' tendency to leave poorly cut edges with a heavy brown discoloration on the substrate. This is still true of the thickest polycarbonates, but not so with the thin polycarbonate substrates that older systems couldn't tackle. (Note: Unfortunately one can still find laser cutting systems in the marketplace that leave edge discolorations on thin polycarbonates, but there is no reason to settle for this substandard technology.) Many still think that PVC (polyvinyl chloride) is not a good match with laser cutting technology, but that notion too is a bit out-of-date. It is possible to cut PVC materials so long as additional components are added to protect the existing machine components near the laser beam from the corrosive action of PVC cutting byproducts and that appropriate filtering systems are added to protect operators from noxious fumes.

The real disadvantage of laser cutting technology – and the reason that most companies that use laser cutters do so in conjunction with one or another tool-based cutting system—is that it is less cost-effective for many relatively straightforward long run applications which are not beyond the reach of mechanical cutting. If part geometries are easy for a physical tool to achieve, if the substrate is not too thin, too sticky, too abrasive or in some other way troublesome for a physical die, and especially if it involves a relatively long run length where the cost of the die becomes a negligible factor, tool-based cutters (platen presses, rotary die cutters, electro-optically controlled gap press technology) often prove the better finishing tool.

<u>Quality and the Soft Marking Standard</u>

Laser cutting systems that were engineered just a few years ago were often not up to the challenges of cutting complex designs, especially when there were many sharp angles in the artwork geometry. One can still find inferior laser cutting systems being sold today that similarly are plagued by the quality problems usually evidenced by pinholes at the start and stop of cutting sequences or burnthroughs. For example, Figure 4 shows the difficulties that less sophisticated laser (see PDF copy) cutting machines have whenever turns are required in sharp edges. Here you can see the telltale black burnthrough marks at turning points that show points where the lasers lingered too long in that spot. One might think of the analogy of a car making a turn, and the usual need to decelerate in order to make the turn. Here the deceleration of the laser beams was so pronounced that it burned through at critical turning points.

Figure 5 (see PDF copy) shows a laser cutting machine that has just the opposite problem. In attempting to avoid the burnthroughs shown in Figure 4, the lasers were accelerated. However, the control of this acceleration was inadequate. Instead of the sharp corners that the artwork requires, the edges are rounded. Here, the laser beams are moving too fast to make the sharp corner details.

Improvements in the software engineering of today's better laser cutting machines obviate these historic quality problems. Soft marking, where the laser movements are better synchronized with artwork geometry and tightly controlled during the entire cutting sequence eliminate the burnthrough problems yet make the sharp angles required, as show in close-up in Figure 6 (see PDF copy) and in the finished product Figure 7. Older systems often left pinholes at the start of a cut because of the time it took to move the scan head (mirrors directing the laser beam) off from that initial start point. In contrast, the better quality laser cutting systems of today create better edges, don't leave pinholes at the start of cuts, don't leave burnthroughs at sharp corner turns. This is not because better lasers are used but rather because better algorithms improve control of the movement of the mirrors that point the laser beam. Soft marking is no small feat for the control software of laser cutting systems to achieve, and it is only the manufacturers of laser cutting technology that have made significant R&D investments in better software engineering that can deliver the defect-free soft marking that most applications require.

To example how cutting speed potentially affects quality, consider Figures 8, 9, 10 and 11 (see PDF copy) showing the laser cutting of a small folded box. In Figure 8, the frequency of the laser output is so slow, 10 kHz, that the single pulses of the laser give the cut more the appearance of a dotted line as opposed to the continuous line cut that is desired. Figure 9 shows a laser cutter without algorithms for optimizing the laser movement to geometry and cutting speed when it is operating at a fast cutting speed. Here the cutting speed is too fast for the scan head mirrors to follow the contours of the artwork in a synchronized way. What results is not exact. Contours that should be sharp are rounded. What you are looking at is the output of a less sophisticated laser cutter where the mass of the scan head mirrors and what it takes to move this mass are not adequately handled by its software. These problems are even more pronounced when the cutting speed is doubled as shown in Figure 10. In contrast, laser cutting systems that can match the cutting speed to the part geometry and optimize the powering on and off of lasers accordingly is shown in the greatly improved quality output of Figure 11. Here, the algorithms the laser cutting software is using can match the speed of cutting to the design in an optimized fashion.

Improved quality in today's better quality laser cutting systems is seen not only in better edge quality but in the far more consistent cut-to-print accuracy afforded by the new level of systems integration in the best-in-class laser cutting machines. For example, earlier systems had no way to compensate for the rotation in the working field that can occur as the web moves through the laser cutting machines. Today's best-in-class systems not only use high resolution cameras but also integrate the camera information with the laser software that is controlling cutting. This means that as the camera systems determine any X/Y offset values, they communicate these to the laser control software, which is adjusted accordingly. If a laser cutting machine does not integrate inputs from a camera system to the laser cutting controls it does not have a way to make needed corrections. Tight systems integration where one component (the camera) communicates with another (the scan head) is key to the higher quality output of today's best-in-class laser cutters.

The quality of the laser source itself will also have bearing on the cutting quality possible. Better lasers with smaller spot sizes (e.g. 210 microns) will facilitate crisp cuts, IF the control software uses advanced algorithms to move the better shaped and smaller sized beam along. Better quality lasers combined with advanced laser control software will also avoid the excess heat that can literally muck up the works in label applications where excess heat can melt adhesives onto release papers making it difficult to automatically remove labels from the release papers in subsequent production steps.

The type of laser tube one a system uses—open or closed—will also have bearing on how the laser can be controlled and how this affects cut quality. Although open unsealed lasers are getting better in quality they are still rarely up to the demands of many applications. There are several intrinsic problems with an open laser tube design. CO2 is usually one of several gases in a laser tube, with helium, nitrogen and hydrogen making up the balance. The proportion of each of these gases in the mixture will affect the laser power. This ratio is apt to shift in an open laser tube design. With open tube designs there is a requirement to frequently change one open laser tube CO2 tank for another. This makes it is nearly impossible to save settings because there almost always is a difference in gas mixture ratios from one CO2 tank to another. These shifting ratios affect how the laser powers and the quality of its cut. To achieve the same quality cut an operator will need to fuss with adjustments every time they switch tanks, and even then, there will likely be variations. In contrast, the sealed laser tubes are not as likely to change in gas ratio composition and only require replacement every 10,000+ hours of operation. This translates into a much better ability to control cutting and to get a consistent result.

Cutting Speed vs. Web Speed

Today's laser cutting systems are faster
for a variety of reasons. One is that higher-powered lasers that cut faster are more affordable, such that most users of laser cutting technology today opt for 200-watt+ systems. Secondly, the more sophisticated algorithms used in today's better quality laser cutting machines are able to shave milliseconds off of each cutting operation, which cumulatively result in faster cutting speeds. The third and most important reason why the better quality laser cutting machines of today are faster is that they are able to better optimize the cutting sequence resulting in much faster web speeds.

To illustrate the impact of software that can optimize for web speed see the first example of the US map shown in Figures 12 and 13 (See PDF copy attached). In each figure the blue dotted lines show where cutting has stopped while the laser repositions for a next cut. In Figure 12 a cutting sequence is shown where there is absolutely no optimization done by the software on how the cutting sequence should proceed. In such non-optimized cutting, the path follows the lines of how the vector drawn image was first created in Solidworks or equivalent software. This non-optimized cutting sequence is so slow that the web would only be able to advance intermittently. In Figure 13, we see a significant improvement in web speed that is done automatically by the sophisticated algorithms in the control software. This improved web speed is determined during the setup of the job, before it is run. A second step in the web speed optimization during job set up is shown in Figure 14 and 15, where the maximum web speed is 17% higher and is achieved by splitting the single image of the US map up into two separate images, and optimizing the web speed for the split image. This optimization is also done automatically by the software. In fact, the software can tell the operator whether it is best to cut the geometry as a single image, two images, four, etc. Today's better laser cutting technology can seamlessly stitch these multiple images together, which is done in this case to maximize web speed, and in other cases to allow for cutting a design with dimensions longer than the width of the laser cutter's working field.

It is important to not be confused by various manufacturers' claims on cutting speeds, as this is not particularly relevant to the actual web speed in most applications, which is the all important consideration in actual production. Figures 16 and 17 showing a scalloped edge design created with older technology that cannot optimize for web speed and the same scalloped edge design created by today's better laser cutters that CAN optimize cutting sequences for web speed. Note that the marking speed (a.k.a. cutting speed) is 0.6 seconds in both cases. However, the cutting sequence that is not optimized for web speed proceeds at approximately 9% of the web speed shown in Figure 17, where the cutting sequence is optimized for web speed.

Figures 18, 19, and 20 (depicting the cut of three rows of Spartanics logos) (see figures in PDF) show further examples of how non-optimized cutting compares to cutting that is only optimized for maximum cutting speed vs. cutting that is also optimized for maximum web speed. In Figure 18 the cutting sequence is not in any way optimized for speed, but instead proceeds along the lines of how the artwork was originally drawn. This is the worst case scenario and examples how more primitive laser cutters without software improvements of any kind operated. In this case this means that the cutting proceeds at 37% of the cutting speed achieved as that show in Figure 19 where the cutting sequences are optimized for the fastest cutting speed. Until recently, this was the best that laser cutting machines could do. Now, the state-of-art algorithms in today's better quality laser cutting machines take this to the next step by figuring in the adjustments in the cutting sequence that would need to be done that take web speed into account. If the web is moving from right to left this means, for example, that the geometry details on the far left need to be cut first and that the way in which the scan heads are moved will depend on the web speed being used. This is shown in Figure 20 (see PDF copy attached), where the cutting sequence is also optimized for web speed, not just cutting speed, such that a 350% faster web speed is achieved. Thus, optimizing for cutting speed alone can result in slower web speeds and buyers of laser cutting systems are well-advised to ignore manufacturers' claims re: cutting speeds and instead focus in on demonstrations of the ability of the system software to optimize for web speed. These web speed optimizations are done automatically by the better quality laser cutting systems and do not require any operator training.

The more sophisticated software algorithms in today's better quality laser cutters that optimize for web speed also give an unprecedented ability to continuously laser cut pictures that are longer than half of the working field. Obsolete models of laser cutters that can only optimize cutting for cutting speed, and not web speed, restrict the sizes of pictures to be cut to be no larger than half the size of the working field. These same algorithms that optimize for web speed also eliminate the need for up to 90% of the hard cuts and quality issues that arise when you try to stitch two images together. They do this automatically, in contrast to obsolete models of laser cutting machines that require operators to manually reset the cutting sequence to avoid hard cuts in the artwork.

<u>Fallacy of the Double Scan Head Advantage</u>

Another area that can get confusing to those who do not understand the specifics of laser scan head design is the use of so-called double scan head systems in hopes of accelerating cutting speed. These higher-priced double scan head laser cutters are actually at times no faster or even a tad slower than single scan head laser cutters that use higher wattage lasers coupled with more sophisticated algorithms in the laser control software. Although it might sound good, i.e. the idea of using two lasers at once to double your production speed, this both creates significant quality issues and cannot truly double speed because of the physical constraints of putting two laser scan heads next to each other and the compromises that this forces one to make.

When you are stitching two halves of the web width together, it is often possible to have more parts on one side of the web as compared to the other side, as shown in Figure 21. In such a scenario, with a double scan head machine you will lose web speed because the laser on the overloaded side will cause a slower web speed. To solve this problem, manufacturers of double scan head systems usually position the two
laser scan heads as close together as possible across the web width to create the greatest possible overlap between their two cutting fields.

However, for wider material there is always an interplay between the size of the scan heads, how closely they are positioned together, the spot size that results, and the extent to which there is overlap in the cutting area of the two scan heads and the related stitching involved.   If the scan heads are large such that they cannot be placed very close together, there will be less overlap in the cutting area and more need to stitch, which is an eventual challenge to quality, as shown in Figure 22 (see PDF). Alternately, if small can heads are used and positioned closely together, there might be a greater overlap in cutting area but the spot size would need to be much larger, as much as 280+ microns, which is also an eventual challenge to quality.   A third option, which also undermines quality, would be to use small scan heads positioned a distance apart for a smaller spot size, but again creating a need for stitching because there is a much smaller overlap in the cutting area, as in Figure 23 (see PDF copy).

Another constraint is that there are always areas beyond the reach of the other laser scan head, as shown in Figure 24 (see PDF copy attached), which means that you must contend with the difficulties of stitching two objects together that have been cut by different scan heads.   This ALWAYS means some compromise in quality, because different scan heads will have different temperatures resulting in different drifts during operation.   Realistically, there are very few laser cutting applications that are forgiving enough for the quality issues that such stitching engenders.   It is not only applications with stringent cut-to-print registration requirements that are challenged by stitching the cut images from each of the dual scan heads. For example, if there is an offset of the two cut parts by more than +/- 0.1 mm this can create a knick during waste removal due to the misalignment during stitching.

Thus, the higher cost of double scan head systems is not justified especially if one compares these systems to single scan head laser cutters that are designed for cutting at higher speeds. Double scan head systems often cannot use the 200 –210 micron spot size lasers that avoid the excess heat which can cause problems such as burnthroughs, adhesives sticking to release papers, etc. Moreover, the costs for higher wattage single scan heads is considerably less than the dual scan head designs, yet the production speed they afford is typically the same or a bit faster.

Systems Integration, User-Friendliness and Production Output

The quality improvements that are possible when high resolution camera systems communicate to scan head control software to determine required X/Y offsets is only one example of the benefits of systems integration in top quality laser cutting machines. The extent of systems integration in one or another laser cutting system can largely determine how user-friendly they are to operate and has great bearing on the production outputs that can be achieved. For example, older systems required users to obtain a separate camera system, and required operators to additionally master the camera control software. In contrast, today's better quality laser cutting systems come with cameras fully integrated with the laser software. Operators do not have to learn set up of a separate camera system, as this is now done directly from the laser control software, and in the best-in-class systems only takes three simple steps.

The better quality laser cutting systems with full integration of all systems components are in fact the only laser cutting machines one can find in the market today that work seamlessly with variable images from digital printers. These better quality laser cutters allow one to create laser jobs with multiple pictures with different geometries and different step-ups. This is only possible in today's fully integrated laser cutters where there is ongoing communication between the PLC and the camera system. It's a good illustration of why laser cutters that do not feature a high level of systems integration are now obsolete machines. They simply can't keep up with the demands of working with variable data and variable images for which digital printing is so ideally suited.

This same feature of integrating cameras with machine controllers allows today's high quality systems to automatically compensate for variations in prints, such as those that are created by shrinking as inks dry. These better laser cutters automatically account for variations in step-ups from one part design to the next and can only do so because of that ability for the machine controller to communicate with the camera system. Because these better laser cutting systems feature full communication between the camera system, the laser software and the machine controller they can automatically determine the step up of each job. They are self-calibrating and operator input is not required to measure or input step-ups. Antiquated technology that does not have this level of systems integration simply has no mechanism available to automate the start of jobs, the calculation of step-ups, or to compensate for variations in step-ups created by other steps in the production process.

In today's systems with a high level of systems integration, there is a new ability to vary the job stop criteria by part count rewound, by rewinder diameter, or the rewinder roll length as shown in Figure 25 (see PDF copy). Here too, this is only possible because the software that controls inputs, outputs, and the laser cutting per se work in concert and are fully communicating with each other.

This same systems integration feature of top quality systems also facilitates the fastest setup of repeat jobs. This is because ALL the machine parameters needed for a specific job---web speed, dancer arm pressure, camera system settings, etc.—are saved in one file. This means that at the very start of the job you can achieve required cut-to-print accuracy without having to fuss with reloading parameters for different system components separately.

You also can always identify the better laser cutting systems that have full systems integration by their smart stop systems, which are lacking in lower quality laser cutters that are devoid of systems integration. These smart stop systems monitor all possible fault conditions such as web breaks and off-positioning of the dancer arm, or full rewinder rolls. When there is a fault condition anywhere in the system it pauses and the error message is displayed on the operator screen. Such smart error messaging facilitates maximum throughput and is only possible in fully integrated systems where there is seamless communications between operating software for registration, lasers, laminators, slitters and rewinders.

Thus, the upshot of systems integration in the better quality laser cutting machines is a faster throughput. Though throughput varies from one plant to another, and one job to another, a reasonable expectation is that throughput with today's better quality laser cutting machines will be significantly faster than what is possible with non-integrated technology.

Better yet, estimating production time is now automated by the software in today's better quality laser cutting machines. These systems' software creates a database that stores laser settings for various types of cuts (e.g. kisscuts, creases, etc.) for the particular substrate being cut. Using this data, the same software capability that optimizes a job for web speed will calculate this optimum web speed and the production rate that is possible. This job simulation is done by the software, before the job is run, and gives users of today's better quality laser cutters an ability to make very accurate cost projections of new job runs.

Selecting System Components

You can expect a cost difference of up to 20 % between laser cutting systems made from high-end components and those that are made with components of lesser quality. As a manufacturer of both high-end and more affordable laser cutting systems, Spartanics estimates that nearly four times as many users–but certainly not all-- will be adequately served by lower cost systems. It is important to know that your source for laser cutting technology is not married to particular component suppliers. Best-match components for particular applications (laser source, laser scan heads, etc.) can be sourced worldwide. Lower cost systems can produce high quality outputs IF the underlying software engineering and systems integration are expert.

Figure 1 & 26 (Laser Cutting Technology Comparison Chart) outlines some of the key differences between lower cost and high-end systems, and the obsolete technology that they both replace.

Knowing your real quality requirements is the first step in zeroing in on whether your operation is better served by low cost or higher quality laser cutting systems. However, there is a baseline of quality that should ALWAYS be achieved such as avoiding burn-through marks and ensuring that there is a crisp narrow cut precisely following the artwork geometry. A laser cutting machine must have a high quality laser source with a small spot size to achieve these results. In label applications, this also allows for much better control of the heat transmitted to the release paper on the back of labels. Inferior laser sources with larger spot sizes often make it difficult to remove the cut labels because melted adhesives cause the labels and release paper to stick together. If a laser cutting system presents burn-throughs it usually reflects both a poorer quality of software engineering to operate the laser power and an inferior laser source with a large spot size. The soft marking capabilities of today's better quality laser cutters should be considered as a non-negotiable feature, whether a system is high-priced or low-priced. There are systems at all price levels that can and cannot achieve this level of quality and thorough investigation is required.

The wattage of the laser should be carefully considered. Many of the commercially available lasers have the best laser beam quality with full power. For lasers of that type, if you end up using only 10% or less of the laser power from your laser source you can expect significantly diminished laser beam quality. For example, a converter making kisscuts with easy-to-cut materials that has a 300 watt laser in their cutting system may be using only a small portion of available laser power and would be better suited by a lower watt laser. A converter making many throughcuts, including more difficult to cut release paper, which also wants to achieve high cutting speeds would need that 300 watt laser.

The smaller the maximum working area the smaller will be the spot size of the laser. Smaller spot size means better cuts because the energy is concentrated and you need less laser power to achieve the same depth of cut. Less heat is transferred to the material being cut is always the desired scenario. One of the differences you will find in lower-priced systems is that they sometimes use lower cost air cooling for lower power lasers, as opposed to the more costly water cooled lasers.

The edge quality that a particular laser cutting system delivers will vary with the spot size of the laser. In systems with smaller working fields (e.g. 200 x 200 mm field size) this is not as much an issue and one can expect both the better high-end and lower-priced systems to have a 210 micron spot size. If the working field is larger, however (e.g. 300 x 300 mm field size) one needs to be able to make due with a 280 micron spot size when considering the lower-priced system. As an example, generic label converters might be well-served by a system with such larger spot sizes but those involved in RFID applications might need the greater precision in cutting edge quality.

Smaller spot sizes not only affect edge quality of the cuts but also will have bearing on cutting speed. It is very important to verify that a system can maintain the desired edge quality and cut-to-print accuracy at the maximum cutting speed of the system. Some of the more poorly designed laser cutting systems cannot maintain cut-to-print accuracy over time. The lower cost laser cutting systems may use sensors for registration, or in more demanding applications use the sophisticated camera technology to deliver the very tight tolerances in cut-to-print registration that are typical of high-end systems. If these camera systems are fully integrated with the laser scan heads they are able to apply the offset values to keep cuts to a precise registration. Here too, it is not only the quality of the camera but the underlying software engineering that has great bearing on the tolerances that are achieved at varying speeds.

Features that bear on user friendliness and ease of operation are found in both the low-priced and high-end better quality laser cutting machines, reflecting the high level of systems integration in better quality laser cutters at all price points. Smart stop systems, job simulation software, automatic image splitting and optimization for web speed, variable job stop criteria, and one step job setups of all operating parameters make these systems straightforward to operate, even for lightly skilled workers. Because the software is handling most operations behind the scenes--- registration, web control, laser powering, laminating, slitting—and because there is full communication between different system modules, the operator's work is relatively simple because the software does the difficult jobs automatically. Obsolete technology does not have these various features for ease-of-operation. Some out-of-date designs do not even give operators the capability to change job settings while the laser cutting machine is operating, nor directly on the machine. These type of laser cutters, that force operators to stop cutting operations entirely and reload a job from scratch saddle users with unnecessary drags on production that today's better quality laser systems bypass altogether by giving operators numerous ways to amend job parameters without shutting down the production line.

(Note: Spartanics has taken user-friendliness to the next level with the introduction of the only step-by-step instructional video wizards for laser cutting as semi-interactive Help Menu options on all Spartanics Finecut Laser Cutting Systems as shown in Figure 27. These interactive video wizards do not rely on language and are designed to help overcome language barriers that exist in many workplaces around the world and to quickly bring workers at all skill levels up-to-speed in operating sophisticated laser cutting technology. The instructional video wizards cover a range of topics such as camera set up, performing test shots, and job setup. When a topic is selected, a short step-by-step interactive video plays showing the sequence of operational steps required to perform that function. The videos play on one screen while the operator can directly interact with the laser system on another screen while the instructional video wizard is in progress. Lessons are taught by visual example rather than spoken or read-then-do techniques.)

Suggested Method for Sourcing Laser Cutting Technology

To begin sourcing the best laser cutting technology for your operation, you must first determine your application requirements in terms of: complexity of geometries to be cut; production rates required; sheet vs. web; type of materials (PET, ABS, polycarbonate, etc.). One is best served by contacting several manufacturers that build laser cutting systems to request that samples be run on your materials using a few of your part configurations. The manufacturers should then be able to recommend the model of their laser cutting systems that will be correct for cutting your parts from your materials. Of course, it is very important to ensure that these manufacturers are equally adept at creating lower-priced laser cutting systems AND more sophisticated technology such that they can deliver best-match solutions. If a laser cutting system integrator is married to particular components – whether they are lasers, scan heads, etc.—consider it a red flag that they are not set up to match laser technology to real application requirements.

After receiving your cut samples from the prospective manufacturers of laser cutting systems, and after receiving their recommendations on the proper model of laser cutter and their budgetary pricing, request a personal visit to manufacturers of interest to see actual cutting of your parts and materials. If you spend one day at the individual manufacturers you should be able to get a good feel for the degree of difficulty cutting your parts. A visit also provides an excellent opportunity to see their plant, to understand their people that you could be dealing with in the future, and to examine the ease of use of importing drawings of parts into the laser cutter and converting the drawings into a useable cutting path.

As with any equipment purchase, it's also advisable to determine the extent of service support that is available from each manufacturer, as this can make the difference between a relatively short period and a much longer period of downtime in the future. Better quality laser cutters, both low-priced and high-end, include complete remote diagnostic capabilities.

The best case scenario of comparative shopping would also include use of laser cutting system manufacturers' contract manufacturing services. These would provide not only proof of concept but would allow expert software integrators to fine tune operations to your exact application requirements.

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Markus Klemm is, R&D Software Engineer, of Spartanics of(www.spartanics.com) which engineers and manufactures a range of automated equipment for laser cutting, die cutting, screen printing, card punching, counting, and inspection used by global label manufacturers, converters, printers, card manufacturers, among others finishing flat stock material. Spartanics is headquartered in suburban Chicago, USA and its worldwide service organization also maintains offices and spare parts in Europe. Questions and comments can be forwarded to info@spartanics.com.