

Laser cutting (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.

Advantages of Laser Cutting

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.

Quality and the Soft Marking Standard

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.

Less sophisticated laser cutting machines have difficulties whenever turns are required in sharp edges. One might think of the analogy of a car making a turn, and the usual need to decelerate in order to make the turn. These same control difficulties in antiquated laser cutters also are evident by round corners where there should be sharp corners. This is because 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. And whereas 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, newer high-end systems do not have that problem.

These quality improvements are not due to better lasers 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, even as cutting speed is increased.

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.

In non-optimized cutting, the cutting 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 generally only be able to advance intermittently.

Today's better system show a significant improvement in web speed that is done automatically by the sophisticated algorithms in the control software, for an improved web speed that is determined during the setup of the job, before it is run. The software can tell the operator whether it is best to cut the geometry as a single image, two images, four, etc. This better laser cutting technology can seamlessly stitch these multiple images together to maximize web speed or to allow for cutting a design with dimensions longer than the width of the laser cutter's working field.

Thus, 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. In fact, optimizing for cutting speed alone can actually 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.

Fallacy of the Double Scan Head Advantage

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.

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 μ to 210 μ spot size lasers that avoid the excess heat which can cause problems such as burnthroughs, adhesives sticking to release papers, etc. 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.

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.

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 rewind, by rewinder diameter, or the rewinder roll length. 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.

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.

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.

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.

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.

www.spartanics.com