"Tuning UP Your Laser!" Published A&E Magazine

Most of you who now own a laser already know how to clean your optics and rails etc., so in this article I will be talking to the new laser owner at first. Then I will attempt to take your knowledge of the laser a little bit further- first some General background on Lasers in our Industry.

The laser has become a workhorse for a large percentage of this industry, equaling its big brother the rotary engraver. It is, for most of us, the other half of our equipment team. I tell customers that to be competitive in today's marketplace you need a small engraver, a large engraver or router, and a top of the line laser. So today we will discuss the workings of a class 1 'CO2' laser.

Laser theory is pretty straightforward, a LASER tube is just gas (encased in a metal jacket, holding in this case CO2 gas) with a power supply sending an electrical signal, usually 30 volts DC to it. This creates a reaction that produces a beam of light that is modulating at such a high rate that it is hot or has friction. This is so the beam will burn materials very precisely. Now the beam is usually controlled by its own electronics, which determines the percentage of power going out the tube. So, 100% power on a 30-watt tube is 30 watts (-/+ 1) of power at the source, so the larger wattage of the tube the more power you can hit the material with. There are lasers that range from 12 watts in some desktop models to 500-1000 watt tubes in the large industrial open bed lasers like "EuroLaser" and have table sizes of up to 8x12 feet. But the most popular wattage is 30-to-60 watts -- this gives good power for an economical price. But with the advent of faster motion systems we will find that all of us will be purchasing higher wattage's to take advantage of the speed. And my friends, if you do not care about speed, realize that your competitor's do. The faster units are running at speeds of up to 150 inches per second (IPS), with a small over-travel; this equates to a 5-minute job on a standard laser would take 2 minutes on a speedy unit, with a short over-travel. While we are on it, over-travel is how far the laser carriage must go passed the target area to stop and turn around to go back over the target area again and again. So if the head must go 2-inches past -- it will take longer to finish that job than if it goes a half a inch passed at the same speed. This is the same as a standard engraver having a high Z- lift between characters. Think of it -- a 3-hour job on a 12x24 sheet only taking 40 minutes, Amazing!

Remember, with laser engravers, the power at the material source -- or how much power you hit the material with -- is directly related to how fast the motion system is moving. This ratio of power to speed controls depth and quality, and is the basis of everything that a laser does. Look at it this way, if I pull my hand through a flame quickly I may only feel a little heat, but if I pull it through a flame torch, I will get burned. Also so when measuring Power, measure at the material or table, not at the tube: I only care about the burn on the material. If I have good power at the tube, but half as much at the material some thing is wrong. Check Beam alignment, your unit is clipping the beam or hitting something beside the mirrors, don't worry we will get into Beam Alignments.

The Laser's general construction breaks down into the tube and its electronics, the optics, the motion system and its electronics, the support electronics, software or a print driver, and the cabinet with the exhaust and Z-axis platform control. We will go over each one these, and then talk a little about troubleshooting and maintenance.

First the tube – as we have stated, the tube takes voltage from its power supply and with the miracle that is laser technology produces a hot beam of light moving at a frequency that will cut or etch. Remember with a laser beam that is below 240 watts if you can cut something you can etch, but there are items that you can etch that cannot be cut by this style of CO2 lasers (class 1.) A class one laser is very safe and falls into a category with a Discman CD player. The beam that goes out of the tube is reflected off of the primary mirror and then travels up to the mirrors that are attached to the motion system -- in this way we can have the beam burn where and when we wish. The beam goes through a lens last, this lens controls the focus length of your laser beam. So a 2.5-inch focus length means that you focus the lens 2.5 inches from the material. A Laser beam coming out of the lens forms an hourglass pattern, so you focus the beam into that center point of that invisible hourglass by raising and lowering the table platform to the material. Keeping in mind that, there are 5-inch focal lens' and better, these are generally used for industrial applications, like cutting deep acrylics or on material like stone that produce residue that can hurt the lens, and will allow us to cut a straight edge deeper. Additionally, there are laser engravers out there that use an auto-focus sensor, and even units that can control focus from their own software. These units will allow you to put images or cut on angles or uneven surfaces.

Now once the beam is focused (done by controlling the table platform), the system needs to be able to get the beam to move over a material like cherry wood. If I just wish to draw out a name, (JOE) the laser will vector out a name with an engraving or true-type font, as an outline. The laser will halt the beam to move between letters. This process is used to put small detail in the case of the single line engraving font into material, and to cutout items in the case of the true type font or an outlined Logo's or borders. But we can cut-out a single line vector in the wood material, by increasing or decreasing the power to speed ratio. So if I told the laser to put something at a 1-inch baseline it would do it, by positioning the lens on the spot on my material I choose in the software and vector cutting the item out by using a beam generated at the X/Y speed and power setting I choose. Now with lasers you can (as we stated) move just like a rotary engraver halting the beam between letters or sections of a logo, and just vector cut your image, either lightly or deeply. But you can also raster. Rastering is were the beam moves over the material quickly turning the beam off and on at different intensities to create a gray scale image logo or picture, for example. This is why most lasers are driven by Servo motors, because with most tubes that have a fast firing rate, (this is how fast the beam turns itself on and off) only a servo motor could move at 80 to 100 inches per second. Though some Lasers can control Micro-stepper Motors (6400 IPS) at speeds up to 70 IPS. This feature gives a laser its unique place in our industry. There is only one rotary engraver that can raster that I am aware of, and that is just for 3D applications. So, in review, the faster I raster or sweep back and forth across my material the lighter I will burn at the same power setting, but if I have for example a 100 watt laser I can run at top speed, burning on most materials at great enough depth to get a good image. So, speed is a big factor for Rastering, where the ability to move slower is a variable on vectoring, the slower I can move the beam the deeper I can cut. Especially, if I can pulse the beam, turning it on and off quickly from the software, so I do not melt my edges; most CO2 lasers can raster at 40-150+ inches per second and vector at .001 to .300 inches per second for slow speeds for deep cut vectoring and for top vectoring speed for putting small details into wood for example. The top vector speeds are 2 to 15 inches per second. So, if you are looking for a laser, ask about speed ranges; speed ranges are controlled by the movement of the motion system.

Motion System: The Motion system is simply a series of two motors one for the 'X' and one for the 'Y' axes. X-axis motor controls movement from left to right and is where most of the rastering is done. The Y-Axis motor is for back and forth movement; the motors work together for vectoring like they do in a standard engraver. They get their signal for positioning from amplifiers for Servo-drives and Driver Boards for Micro-Steppers. (For a motor to be a micro-stepper it needs to step at or above 4000 Steps per inch or it is just a half-stepper. The more steps the more accurate the motor -- servos are 800 times more accurate than micro-stepper motors). Next in the motion system is the rails -- for the Y-axis the rails are on the left and right sides of the laser and are attached to the ends of the X-axis Bridge. There is a belt or series of belts that attach to the motor that give movement to the Y-axis. The X-axis is also driven by it's motor by a belt as a rule. It pushes the lens carriage, left and right on its bridge, as the Motion system goes through a job it controls the beam of light from the tube through the optics.

The Optics of a laser are a series of mirrors controlled by the motion system to guide the laser beam to the lens that focuses to it focal length to put the burn on the material. Mirror one (or the primary mirror) is directly in front of the tube, then the beam is directed up to mirror two usually at the far right back corner of the of the laser, then across to mirror three on the right hand side of the bridge of the X-axis then across the bridge to the mirror four or the carriage mirror then down to the lens. Beam Alignment is important; the beam is centered on most of the mirrors to better center it when it hits the lens. There are adjustment points on each of the mirror holders, learn what they are, BUT do not touch them without factory assistance. A rookie can make an alignment so out of whack even a skilled Tech. could have trouble getting it into position and dialed in. In each laser there is beam alignment control's on the pendant. This allows you to fire the beam at specific power and time intervals, and then you put a target like a post-it note in front of the mirror and burn a small hole in the center of the paper by adjusting the mirror directly behind it. Some times fine-tuning two mirrors behind the target is helpful. This alignment is directly related to max. power at the material. The efficiency of the burn is controlled, as we said, by the focus of the laser lens -- and the focus is controlled the z-axis of table platform.

Z-axis or table Platform: This is simply just the table base, usually it uses three lead-screws for levelness,. Remember, the more level the table the easier it is to get a even burn across a 12x24 sheet of material. If the table is not level, the lens is going to go in and out of focus. A Three Lead-screw system also allows us to rise and lower larger weights (usually up to 200 lbs). There is of course a motor for this; it can be under the control of the auto-sensor material focus or by the software. Lasers can also control focus from the pendant for both auto and manual focus features.

The Electronics on these units break down into the power for the tube, the power supply for the motion system and/or the logic circuits. The Logic circuits are the part of the system that does the thinking. It takes its lead from the software or print driver, and controls everything from power to speed ratio to the auxiliary circuits like auto exhaust control. On this subject, remembering that we are burning things -- with that fact -- where there is fire, there is smoke. That smoke must be exhausted, so you will need an exhaust blower pulling the smoke from the laser to the outside of your building. Some lasers will turn the blower on and off automatically, which is very cool, because if the blower is on all the time, then you will have higher air conditioning or heating bill, not to mention having to listen to it constantly run. Additionally, the better the blower the cleaner the optics -- this is why many engravers like air-assist, It blows air or a corridor of air at the beams contact point to reduce flame-ups and give a better cut. Now the balance of the electronics is to power the motor that raises and lowers the table platform for focusing.

The software associated with most lasers was not designed specially for that laser -- there are a few that have software or graphics packages designed specially for laser use, these are great. They are designed for the lasering process; they remember all power, speed, offset settings etc. with the job. But many times you can us your own software and can just send information to the laser via the printer port. These print drivers can remember power and speed settings as attached files and can manipulate the image on the screen for rubber stamps or 3-D effects, as well as, straight engraving. In these print drivers you assign color to different parts of your job on the screen, and then assigning the colors power and speed settings, as well as vector vs. raster. A big question to ask is how does my software information get to the laser --is it a Print driver, Comm. Port, USB or Ethernet? Ethernet is the technology of the Internet and allow one Graphic station to feed and control up to 254 lasers or 254 Graphic stations can feed to one laser. Though USB is cool for a single hook-up it does not give the control or memory storage that Ethernet does. An Ethernet laser can keep a history time included or every job ever done on it, schedule a whole years worth of work, and even remember all of its settings through even a print driver, they are just cool! This saved information is critical for billing your time out properly.

The Pendant or control panel: The pendant is where you can control laser function at the laser. Now most of these features you can control in the software or Print Driver. The START key is here, focus control, etc. Many are programmable so as the technology gets more advanced; you can just download the upgrade. But the service modes are here as well -- few lasers come with service software to control features like tickle (beam timing) from your PC, but they do exist. ATM type touch screen are cool as well, some will even give a graphical display at the pendant.

Let us review the basic areas of a laser and add a few minor points:

Tube: where the hot beam comes from.

Optics: the Mirrors and lens that the beam bounces off to get the material:

Motion System: This system controls the placement of the beam and its velocity.

Exhaust System: This helps the blower remove the fumes of the cabinet.

Electronics: These Boards feed signals to the motors of the motion system, it also controls PC interface to get jobs from the computer to the laser.

Control Panel: That area of the laser where you can control operations from the laser itself

Platform or Z-axis: This is the Table of the laser that raises and lowers to control focus.

Cabinet: this is the case that is all comes in.

Software interface; Whether you have a Print Driver or you have software designed for your unit, it is the interface that gets the data from the PC to the laser with the control coordinates.

Now we are ready for maintenance: This is very simple on a laser. You clean the mirrors and lens of the optics system, as well as the rails and belts of the motions system, they need it about once a week at a

minimum. The rubber stamp folks usually have to clean once or twice a day. The way you clean the optics varies a little, but using the optical cleaning solution that the manufacturer suggests and the cleaning cloth, wet a section of the cloth with it. Pat the mirror or lens to remove particles. Then using another wet area lightly rub the mirror clean, and once again rub lightly with a dry area of the cloth, and you are finished. Now wipe down the rails and the belts of the motion system -- some units require Lubrication and some do not. If you have a unit that does, there is a self-test in your controller, or you can create a job on the PC to make the laser move fully right to left and back and forth, to work in the Lube.

Troubleshooting: before you call for help use an elementary process of visual checks on the unit. Number one is -- are the doors and interlocks closed? The laser will not run if the door(s) are open. Check to see if the unit will set up on home, by turning the unit off then on. If so, send a job to the laser. If it will not start, is your cable hooked up? If you are having problems with quality and the motion systems rails are clean, turn the unit off and manually pull the lens to the far right bottom corner. Now feel if there is something stuck to the belts, also feel if the travel is even and smooth, if not your motor could be bad (realize that a bad motor is rare). Try a different job, if that job works but the other does not - it is in the job. If you cannot find what is, just re-create the job. For jobs that are large, e-mail the job to the factory -- most of those guys can walk you through brain surgery on the phone. Remember, for major items like beam alignment, get some help on the phone. You can make a simple problem worse if you don't ask for help.

In review, a laser beam is hot light that burns, and is sent to the material via mirrors and a lens, that you focus to the material. You control the image from software or via a print driver, and thus position the image on the laser with the motion system. It is magic, but the real trick in today's market is to learn what laser is right for you and use it to the fullest ability. If your factory support is good, you will do well with a laser in your arsenal. But never forget -- no one can sell you one super box, a 21st century shop needs both a rotary engraver and a Laser, how many of each depends on the shop.