**LASER CUTTING**

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**Abstract**

Laser cutting is one of the greatest inventions which promises to ease the activity of many people assisting them to achieve perfection in various fields. The paper explores the world of laser cutting as a special combination of technological precision and artistic skill, with significant impact on our daily life. We will deal with the history of laser cutting, the structure of a laser cutter, the process of laser cutting, the advantages, disadvantages and the risks of using laser cutting as well as its applications.

**Keywords:** laser cutting, engraving, CNC, diode, precision, applications, risks

**Introduction**

Have you ever needed to cut something accurately and did not know how? Many companies today are willing to cut things for you in just a couple of hours. But how do they manage that? Well, the answer is simple. With the technology going up, they use a CNC (computer numerical control) and a diode to direct the energy through the nozzle. You just come up with the idea, they create the graphic in a vector program (CorelDraw, for example) and send it to the laser via a print command. As easy as it may sound, the actual process is much more complicated.

The aim of this paper is to introduce the art of laser cutting to young engineers who may be inspired afterwards to make their own laser cutter at home. The paper is structured into three main parts. The first part deals with the history of the laser cutter, focusing on the time it was invented and the way it is built. The second part discusses the actual process of working with a laser cutter and the advantages and disadvantages it brings. The third part highlights the significant improvements this invention has brought to our life, through its variety of applications. Finally, some conclusions will be drawn regarding this technology and its impact.

**1. Throwing back time**

In 1961, a man called Kumar Patel started his research into laser cutting and later, in 1963, he developed one type of laser, the CO2 laser. In 1965 the first production laser was used to drill holes in diamond dies and after that, in 1967, it was used by the British to cut metal. [1]

The biggest part of this machine is the cooling system and the circuit, and on the other side of the metric, the smallest part is the actual laser pointer (that can be easily made from a diode).

In short, a laser cutter is made from a working table, a laser cutting head and an X and Y axis host machine. Connected to them, we have the cooling system and the control one. In what follows, I will divide the laser and explain each part.

The **laser cutter frame** helps the laser move on the X, Y, Z -axis and helps the movement of the cutting platform. This component must be very precise and stable in order to improve the precision of the laser cutting.

The **laser generator** is the source of the laser light. It is one of the most powerful sources of this machine and one of the most expensive parts. Also, we have **lenses** that are used for the laser to have different functions. They can affect the whole process as they directly affect the output power of the laser. The **laser cutting head** is the laser output device that contains the lenses.

The **CNC system** is the most important part of the machine as it controls the machine tool to realize the movements on the axes and the power of the laser. The **regulated power supply** makes the connection between all the components and prevents the external power network interferences and the **control platform** controls the whole cutting process.

The **motors** are the core components of the laser machine. They can affect the whole performance of the cutting. There are two main categories of motors: **stepper motors** and **servo motors**.

The **water chillers** are used for cooling the laser generator. Without them, the excess of heat could damage the work. [6]

**2. The actual process**

Laser cutting is usually used for cutting different materials, mostly metal, or for engraving them. When I said mostly metals, I was referring to the fact that whatever is cut is going to heat up really fast. If we use materials such as plastic or polymers, there is a big chance to melt the whole workpiece.

There are three main types of lasers used in laser cutting: ***CO2 lasers*** for cutting, boring, welding and engraving; ***neodymium lasers*** for boring where we need a great amount of energy, but a small rate of repetition and ***neodymium yttrium-aluminum-garnet lasers*** for boring, engraving and also welding. [4]

We have a lot of different **methods** of cutting with a laser, depending on the material we are using. Some of the most common ones are *vaporization*, *melt and blow*, *thermal stress cracking*, *scribing*, *cold cutting* and *burning stabilized* laser cutting. [1]

The process of cutting consists of three major **steps**.

The **first step** is to prepare the artwork. You must come up with an idea of what you are going to cut. After that you use a vector program to design it on a computer and check to see if it is fine for the laser cutter and the material you would like to cut. The program then reads vector strokes of hairline thickness or as thin as you would like to make them.

The **second step** is to configure the laser cutter settings. What does that mean? You must put your material in the machine bed and configure it to cut your design. You have to adjust the power, speed and frequency to suit the material. Sometimes, you can use a protective backing during the laser cutting so there will be no burning marks and the surface will be protected from heat. This protection then can be peeled away after the process is completed.

Finally, the **third step** is to wait for the machine to do its job. It will follow the path of your drawing strokes in order to cut out the design. [3]

Obviously, to generate such a great heat and cut through metal, laser cutters will have high energy consumption. Small laser cutters use somewhere between 10 to 15kw, but industrially, stronger ones are used.

They can cut mostly through anything between 0.2mm and some centimeters depending on the power of the laser and the material we are using. To be as efficient as possible and give a clean cut and smooth finishes, the laser beam is kept as close as possible to the material that we wish to cut, so the heat will not affect the material integrity. The cutting temperature is adapted to the material that we wish to cut, to its thickness and its characteristics.

The **advantages** of laser cutting are: **flexibility** as you do not need a new setup for every cutting process, **precision** compared to other thermal cutting methods with an accuracy of +/- 0.1mm without needing after-treatment. Another advantage is **automation** as this job needs little manpower. [7]

One of the **disadvantages** is that this process is very expensive and not anyone can afford it. Even if you want to make your own laser cutter, the cost may go around $2000 to $5000, which may vary, though.

Despite the fact that this may not sound as a disadvantage, the laser beam can easily reach several thousand degrees, so a moment of inattention can cost a person’s life or major personal injuries, so one should be extremely careful when handling it. Obviously, a laser cutter should be operated only with protections on, because of the risk of blindness, burning or cutting as well as electrocution. Indeed, you can get electrocuted because these tricky things use a lot of energy, and, as you may know, it is not tension, not intensity, but energy that kills you.

**3. Applications**

One of the many applications that they can have is, of course, cutting and engraving anything, mostly tungsten, steel, aluminum, brass or nickel, but the list can continue. We can use them to create beautiful jewelry, as it can cut stones or gold.

Perhaps one of the most intelligent uses of this technology is in the medical field. Having such great precision, they can be used, for example, to vaporize human tissue, or in eye surgery, mostly in precision surgical procedures. [2]

Another application of laser cutting is in the clothing industry. Because laser cutting is extremely fine, and no material adjustments or no other tools are further required, there is no quality loss and it significantly saves costs for high quality raw materials thanks to the nesting function.

Laser cutting can also be used in architecture or automotive industry as it can be applied on a wide range of materials and it has a high level of precision during cutting small details, no cleaning being necessary after that.

The utility of laser cutting is wide. Filters, membrane switches, plastic and wood handcrafts, furniture, toys, musical instruments, military or police equipment are all made with the help of laser cutting. [8]

**Conclusion**

The world is constantly evolving and trying to make things easier with the help of technology. Laser cutting has become one of the man’s best friends and keeps helping people to achieve perfection.

Everywhere we look there must be at least one thing that was made with the help of laser cutting. For example, the phone that we use daily has the camera cut with a laser cutter and all the circuits that we cannot see are cut with a laser, as well.

In the medical field, I think that with more research on how laser cutting may be used, it could save more lives and ease all the hard work that doctors must deal with.

All in all, it is obvious that laser cutting has improved our lives and with the technology advancing, it could help doctors significantly and also companies.

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