Competitive Analysis

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Existing DIY laser cutter examples abound. There are also a huge variety of commercially available ones.

Things most laser cutters have in common:

At a very high level, most laser cutters are the same: they use some kind of laser, propelled by some kind of computer guidance system, in order to 'trace' a shape onto a medium.

The major differences show up when comparing DIY to commercial lasers.

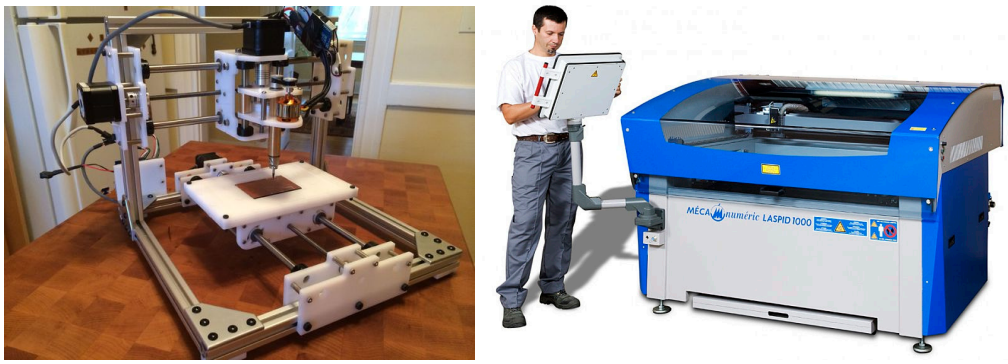

Figure 1: DIY (left) vs commercial (right) laser cutters

How they differ:

(1) Lasers

They begin to differ vastly once you take a closer look. The majority of DIY laser cutters employ some kind of solid state laser, possibly salvaged from a DVD writer, while the commercial ones are larger and might make use of gases. The reason behind the differences in laser type affect two areas most broadly: price and the type of material to cut. Cheaper lasers are less powerful, and less powerful lasers have lesser cutting ability. So they might be used to laser cut paper, or etch on plastics or maybe even wood burning. Commercial cutters are used to cut acrylic, through thick wood, and sheet metal. But with greater laser power comes greater need for safety precautions, thus only trained technicians are operating the commercial cutters.

(2) XY table infrastructure

The XY table setups also wary widely, where the chief differences are choice of which components are stationary vs. moving, and method of moving.

In terms of mobility, there are three parts that require consideration: the Y motion, the X motion, and the material to cut. Most DIY are smaller and lighter, and use correspondingly smaller and lighter lasers, so the material to cut is put on some sort of platform that moves, and the laser is held stationary. By contrast, most commercial lasers are used to cut large objects, so it makes little sense to try to move a large piece of material: they move the head of the laser instead.

(3) Software

The third biggest difference is the software used to compute the laser path. You can use any small computer (Arduino and Raspberry Pi are the favorites), to run a program designed for the purpose called "Grbl". I assume the commercial cutters have some more sophisticated system in place, due to need for safety precautions.

Other DIY examples I've seen around the Web:

The website "Instructables" is the best source of projects. The first I saw was the "MicroSlice", by SilverJimmy. It's a very good guide, and a huge help to getting me thinking about how I wanted mine designed. Ultimately, I didn't follow much of his design, as there was a limit to what the CMU Robotics Club could lend me.

Attributes I want:

- Material to be cut does not move; laser moves.
- Laser must be light, or carriage will be unstable.
- Laser must be solid state (to make it lighter, safer).
- Fan to cool material.
- Heat sink for laser. NOT water-cooled (stability issue); maybe just metal with huge surface area?
- Lens to focus laser, so no need for too many watts. (<1W?)
- Adjust speed of laser movement to make a deeper cut/burn.
- Start with cutting black paper, because absorbs energy more readily.

Attributes I don't want:

- Super high-powered laser that requires permit to use. Must be safe to use at home, maybe with eye protection. Therefore, use lens to focus less powerful laser.
- Don't care about ability to collapse setup and move it around.
- Doesn't need to look pretty; it chiefly needs to work.

- Don't want it made of something that the laser can cut into (like MicroSlice's wooden frame).

Conclusions:

The hardest part will undoubtedly be the laser. Choice of laser involves three parameters: (1) wavelength, (2) power, and (3) lens.

The wavelength (essentially "color") of the laser is dictated by the type of material to cut, since some materials are "opaque" to certain wavelengths. Since I'll be cutting black paper, I don't think I need to worry about color. As long as it falls in the visible range, of course.

Power is a bigger concern: there is a whole classification on laser safety (see "laser classification" reference), and CMU's EHS will throw a fit if I use a laser too powerful. This couples with the lens issue, because a lower powered laser can be considered high powered once the beam is focused. MicroSlice uses order of magnitude 0.1W, which is still quite powerful, with no focusing. I think getting an order of magnitude lower in power (tens of mW) would be alright, with the help of a lens, and maybe really slow XY movements, to mitigate the costs and safety concerns of using a higher powered laser.

Resources:

- Image 1, left: http://cdn.instructables.com/F28/3BVE/HUFW7V03/F283BVEHUFW7V03.MEDIUM.jpg
- Image 1, right: http://img.directindustry.com/images_di/photo-g/16536-2380561.jpg
- MicroSlice Instructable: http://www.instructables.com/id/MicroSlice-A-tiny-Arduino-laser-cutter/?ALLSTEPS
- Laser classifications: https://en.wikipedia.org/wiki/Laser_safety#Classification