



Digital Fabrication Project Guide
Laser-Cutting Edition

www.ponoko.com

A note for tutors

Introduce your students to the exciting world of digital fabrication – it's the future of manufacturing.

We live in a time when fabrication tools are becoming available to the everyday person. Designing, making and selling a manufactured product is more accessible than ever before.

Using Ponoko's Personal Factory 4, your students can learn how to create a real physical product using a computer.

You can:

- * Introduce your students to this emerging technology
- * Inspire them to think of compelling and inventive products
- * Help students make real products which are sent back for them and their peers to study
- * Expose them to every step of the design process, from conception to creation to realization

This document is designed to help you start thinking about what you might like to cover in a project or course.

What is covered:

- * The possibilities and limitations of laser-cutting
- * Suggested materials to use for beginners.
- * Advice for keeping costs down
- * Tips and tricks for creating problem-free designs
- * Examples of project timeframes and outcomes

If you're interested in running a project or course through Ponoko, please get in touch with us. Email our Community team at service@ponoko.com and we'll be happy to help.

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Possibilities and limitations of laser-cutting

Laser-cutting is a fantastic entry point into the realm of digital fabrication and an incredible creation tool.

To be more specific - here are just a few reasons your students may want to use it:

1. to make something so fine it would take forever to cut out by hand.
2. to make something with materials which are otherwise difficult to cut and work with – such as acrylic.
3. to make multiples of a design, which you can reproduce cheaply and potentially sell.

Making possibilities of laser-cutting

Cutting out shapes , engraving fills and vector images

- uses include signage, stencils, jewelry to name just a few.
- suggested materials: acrylic, MDF, 0.5mm styrene, 0.5mm PETG



Styrene stencil
by Ponoko



Acrylic pendant
by Chromatophobic



Plywood brooch
by madebydan



Acrylic necklace and earrings
by Clark Bardsley



Towel labels
by Ponoko

Making flat shapes to interlock and create 3D forms

- uses include furniture, containers, toys
- suggested materials: acrylic, MDF



Whiteboard wine rack by madebydan



Spinning top by madebydan

Creating 3D forms with soft materials

- uses include jewelry, household items
- suggested materials: felt, polypropylene



Felt coasters by Chromatophobic



Leather wallet by madebydan



Polypropylene cup holder by Vanilla Design

Making limitations of laser-cutting

As with any method of manufacturing, there are constraints you need to work within:

- * Designs must fit on one of three standard material sheet sizes as per our Making Guides.
- * You cannot cut material at an angle, cut part-way through the material, or engrave on both sides of a sheet.
- * You cannot easily create fluid 3D forms (sculpting and molding processes), grooves and recesses (routing process), miter cuts (table saw), chamfered or radius edges (routing process and finishing).

Material limitations of laser-cutting

Again, there are some limitations as to what materials you can use:

- * You cannot use glass, stone, silver, copper, vinyl, polycarbonate or mirrored acrylic.
- * You cannot use materials thicker than 10mm.
- * It is not possible to supply your own materials. Materials can be selected from the online catalog for each Ponoko making hub. It is possible to request a special material if you have a Ponoko Prime account. This process can be protracted however, so please contact us for assistance.

Students can browse the Ponoko Showroom to get an idea of what is possible and be inspired by other products.

Suggested materials for beginner projects

Some materials are easier to work with than others. This list of material recommendations is based on structural consistency (they won't warp during cutting), cost and ease of handling for beginner users.

- * **2mm, 3mm, 4.5mm Acrylic**
- * **3mm Felt** – will require cleaning upon delivery to remove ash residue and burnt smell
- * **Styrene, Polyprop, PETG** – ideal for stencils
- * **6mm Corrugated Cardboard** – the cheapest material and the fastest to cut & excellent for prototyping
- * **MDF, MDF Veneers**

Check the materials catalog on www.ponoko.com for more detailed information on specific materials.

Contact us for assistance if you're unsure whether a material is suitable for a project.



Keeping costs down

Making costs vary depending on the material you choose and the amount of laser-cutting time required.

To keep making costs to a minimum, you might like to set some or all of these as parameters for your student project:

Start small

Creating a P1 size design will minimize material cost and constrain the amount of making time used.

Keep designs simple

The more intricate a design is, the longer it takes to cut and more expensive it will be. Curved lines also take longer to cut than straight ones - so intricate curves will result in an even higher making cost.

Use materials which are fast to cut

The thicker and harder your material is, the longer it takes to cut and more expensive your design will be.

Be wary of raster fill engraving

Raster fill engraving is often the most time consuming part of a design because the laser must pass over the filled area many times to engrave it. If you do use raster fill engraving, try and keep all of the filled areas close together in the design.

Place objects as close together as possible in the design

This will reduce waste, and make the most of your material cost. You can also share cutting lines when you have objects in your design with straight lines that can be placed side-by-side (see the Design tips and tricks section).

Basic design file formatting

These are some of the basic concepts you'll need to cover with your students:

Ponoko templates

You must use our templates to create your designs. You can download these from the Make section of our website.

Cutting out your shapes

The core of your design will likely be the shapes you want cut out. The easiest way to visualize how this translates to your design is to imagine laying the pieces you want to make on a sheet of paper, then tracing around the edges before taking them away. Your design should look like the lines left on the paper.

Colors are the key

The way you instruct the laser-cutter what to do is by using differently colored lines or shapes. Blue lines indicate that you want a line cut out completely. Red, green or magenta lines indicate you want a line engraved. Black or gray fills indicate you want a filled shape engraved. Each color has a specific RGB value, as listed in the starter kits.

Engraving types

You can use two types of engraving on your design. We call them 'vector line engraving' and 'raster fill engraving'. Line engraving is very similar to cutting, but the laser etches into the surface of the material rather than cutting all the way through. For raster fill engraving the laser passes over the filled shape many times to engrave the area.

Vector format is required

Everything in your design must be in a vector format. This means that any text or images you add must be converted to 'vectors' - often referred to as outlines or paths.

See our Starter Kits in the Make section of www.ponoko.com for detailed information on formatting your designs.

Avoiding common design problems

Following our Starter Kits in the Make section of www.ponoko.com will help the design process go smoothly. Our Design Tips on the next page also provide some good ways to prevent common problems during creation.

Ideally students should ensure each new object they add to their design is formatted correctly before proceeding - if they are creating a complex design or series of designs, small problems can be very tricky to find later on.

Finally it is a good idea to check that files are formatted correctly before you upload them. We suggest you ask students to pass their design to a neighbor to check and then repeat the process.

Here is what they should look out for:

1. Using incorrect line weights
2. Not using correct RBG colors
3. Crossing, overlapping or doubling-up of lines.
4. Not converting text or images to vectors.
5. Design elements outside the template guidelines.
6. Design details that are too small.
7. Not expanding into vectors any 'transformations' or special brush strokes.

If you are using Adobe Illustrator, a useful command for checking your design is **Select > Same > Fill and stroke**.

With this command you can ensure all the common elements are formatted correctly very quickly.

Design tips and tricks

Things to cover with your students:

Viewing your file in Outline mode

Each software package has multiple view modes. By viewing your file in 'Outline' mode, you will see the true vector information within your design. This is the ideal way to spot hidden elements, or see whether the way a design appears in default view is how it will be made.

Print out on paper

The best way to check the size and proportions of a design is to print out the design on paper, scale 1:1 and line weight 0.2mm. This is also an excellent way to check how the design will be affected by the laser kerf – the amount of material burnt away during cutting. You can also cut out your printed design to create a free initial prototype.

Sharing cutting lines

By placing the objects you want to make directly side by side, you can share a cutting line between them. The catch here is that you may end up with two overlapping lines, one of which must be removed. You can find out how to do this in our Starter Kits for each different software package.

Prototypes make perfect

It's impossible to know exactly how a design will turn out until it's made, so often one or more prototype will be needed before getting an optimal result from a digital design.

For regularly updated tips and tricks, check out: <http://blog.ponoko.com/category/ponoko-related/making-help/>

Finishing and embellishing laser-cut designs

It's important to consider how you might want to finish off or embellish your laser-cut pieces. For example, you might laser cut pendants and then add chains to them to turn them into necklaces. You might make coasters from wood, and then add polish to them and sand down the edges which have been laser-cut. Considering these options from the beginning of the process will help ensure the best possible outcome.

Timeframe considerations for classes or projects

Here are some things to think about when planning your course timeframe:

- * Our standard fabrication time for free accounts is 2 weeks plus shipping, so remember to factor in shipping time. Prime subscription orders are generally made in around half that time, and then shipped. Contact us to get a better idea of how long it will take for your specific project.
- * For a project or course that is short in duration, you might want to finish with sending off designs to be made.
- * If you can run a project in weekly installments over a longer timeframe, you may be able to allow time to get a set of initial prototypes back and then have the students revise them into final products.
- * If the timeframe covers the full making process, make sure you allow finishing and assembly time.

Case examples

Ruth Corver | The Learning Connexion International School of Art & Creativity - Laser cutting Course

Brief: use vector files and laser-cutting to explore the design process and create a physical object. Students set their own brief to compliment other courses they took

Project duration: 21 hours over seven weekly classes

Student type: wide ranging, including Diploma level art students & many older students with minimal computer experience

Project outcomes: stencils, decorations, photo holders

Surprises: getting amazing detail out of felt and the really satisfying experience of seeing the object in the flesh translated from the digital line drawing.

Tips for others teaching with Ponoko: allow time to teach the necessary computer skills



Fione Lucy Henderson



Deborah Wardle



Megan Hand



Jaqueline Benndorf

Gilbert Ridelbauch | Australian National University's School of Art - CAD course.

Brief: There are two laser cutting projects each at the beginning of the 1st and 2nd semester. The first project is laser cutting a 2D shape. The second project is creating a 3D object with laser-cutting. In both projects, students set their own brief, limited only by single template design and minimising cost.

Project duration: 2 to 3 days for each of the two projects

Student type: second year students from different design disciplines: Ceramics, glass, gold and silversmithing, furniture design, sculpture and textile design

Learning objectives: how to convert ideas into physical products via a computer, using Illustrator for 2D design and FormZ for 3D design

Creative outcomes: lamp, simulated rubik's cube

Surprises: how much one has to know about digital technologies before a fully controlled outcome can be achieved. However once this steep learning curve has been climbed then opportunities are great. Also, the level of assistance provided by Ponoko service team.

Tips for others teaching with Ponoko: There is good help on ponoko's blog and do not hesitate to ask for support. Get students to open their own Ponoko account to check that their files work before submitting them to the tutor for final upload.

Nadia Arbach | Victoria and Albert Museum in London - Digital Design course

Brief: Use a P1 piece of either acrylic, wood, or felt and design as many pieces of Medieval and Renaissance inspired jewelry as can fit on the template.

Project duration: 13 hours over two days in the V&A's Digital and Design Studios.

Student type: Adult students wanting to learn how to design things so that they could make them in a way that was completely different from their usual way of making.

Learning objectives: How to turn inspirations into design, how to use vector drawing software, how to design jewelry, how to assemble jewelry.

Creative outcomes: Necklaces and earrings

Surprises: How much design can be achieved in two days!

Tips for others teaching with Ponoko: Bring examples of things you've made and specify exactly how long it took you to create the design. Explain how making is priced. Plan time for corrections.



Ring by Rebecca Frolley