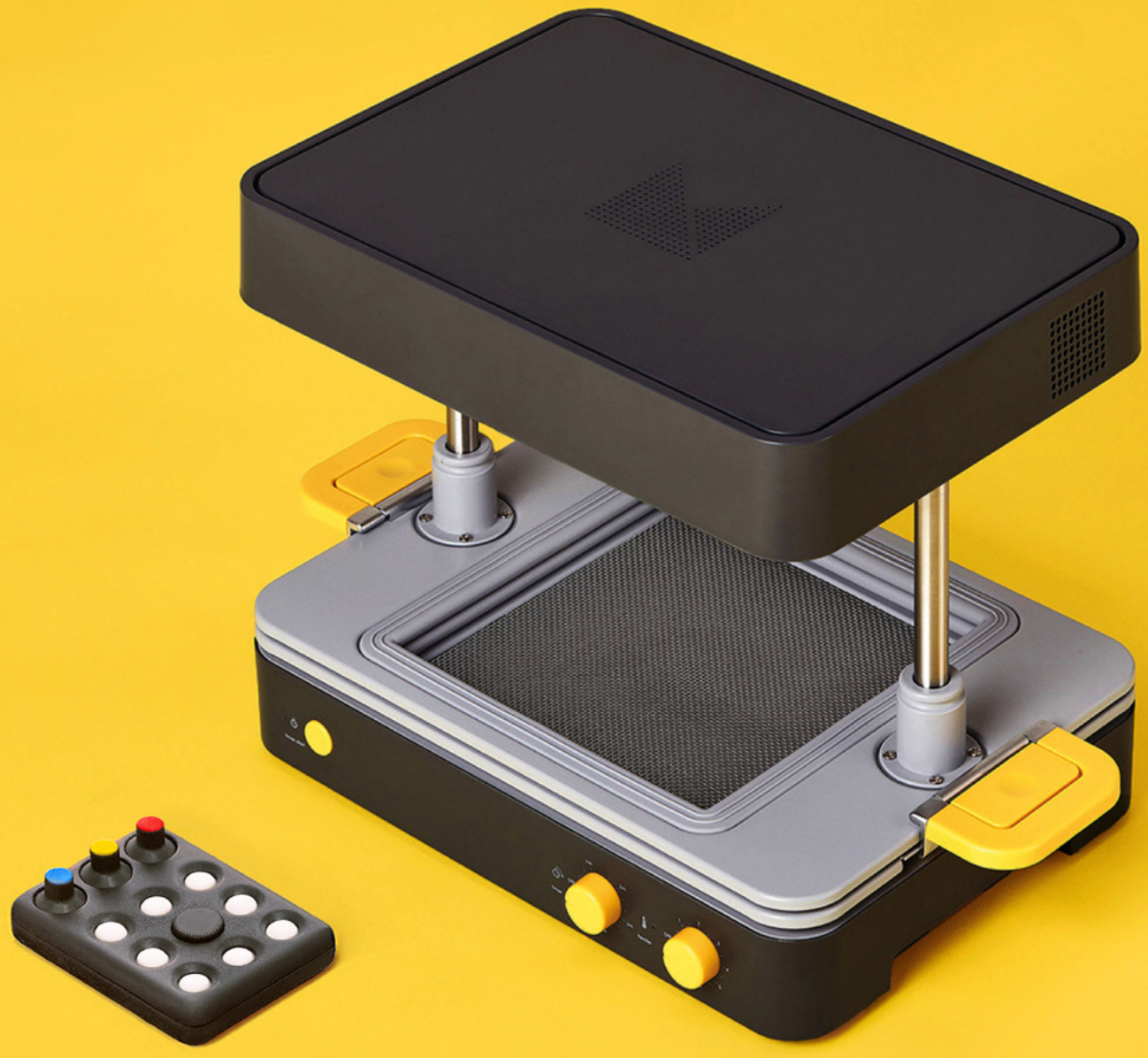
Save money and time on product development with the Mayku FormBox



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Contents

- **From prototyping to production**
  How the FormBox can benefit your business
- **How to guides**
  Learn how to make with the FormBox
- **Design guidelines**
  Designing for the FormBox
- **The numbers**
  Exactly how much money and time the FormBox can save you

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From prototyping to production

Vacuum forming is a powerful tool for model-makers, product designers and industrial engineers. The FormBox can help you reduce your lead time on parts, save money and speed up your development cycle. In this guide you will learn how to:

- Create product casings with different material finishes
- Cast small batches of precision parts in silicone and resin
- Create custom housings for electronics
- Work with transparent materials such as polycarbonate
- Create professional grade packaging from your desktop
- Work with flexible materials
- Manufacture short runs of working products for user testing

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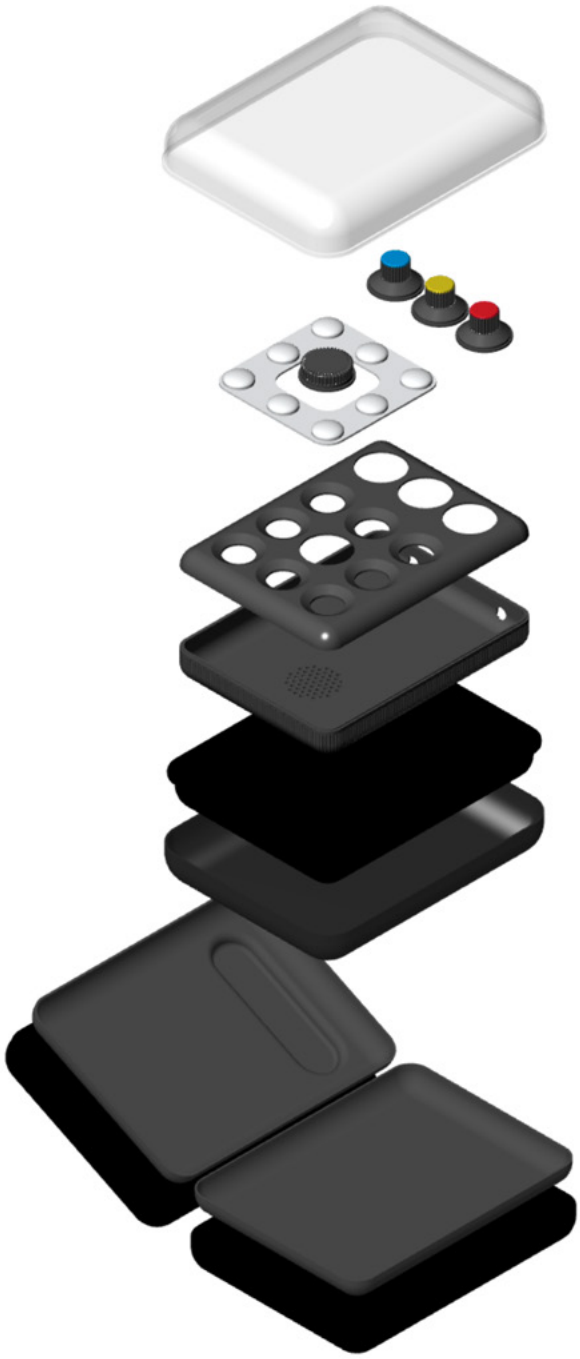
From method to melody

**Making short runs of production-level machines quickly and cheaply:
Each part of this fully functioning synthesizer was made using the FormBox**



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CAD to reality in no time at all

The FormBox can be used to create product casings in a number of different materials, colours and finishes

See how >

No more outsourcing

Make short runs of your product for quick and easy prototyping

See how >

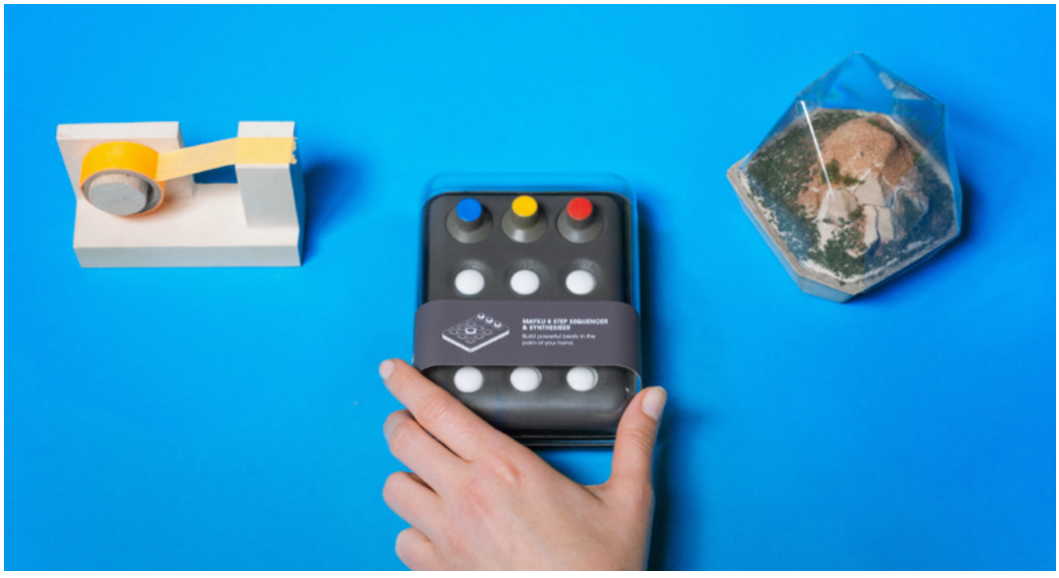
Purchase a FormBox >

Work with transparent materials

The FormBox helps you create optically clear parts out of transparent materials. Adding a whole new dimension to your desktop manufacturing toolbox

See how >

Quick, affordable custom packaging



Make short runs of your product for quick and easy prototyping

See how >

Purchase a FormBox >

Prototype using production grade flexible materials

Use the FormBox to work with diverse materials

See how >

Test and learn

The FormBox's speed enables comprehensive pre-production user testing

Purchase a FormBox >

How to guides

Guide	#01	Make product casings
Guide	#02	Cast short runs of parts in silicone and resin
Guide	#03	Build custom electronics housings
Guide	#04	Work with transparent materials
Guide	#05	Create professional grade packaging
Guide	#06	Use flexible materials

Guide #01

Create product casings

How we made the synthesiser's shell

COST PER PART	COST SAVINGS	PRODUCTION TIME	TIME SAVINGS
£1	£100	60 mins	3 days

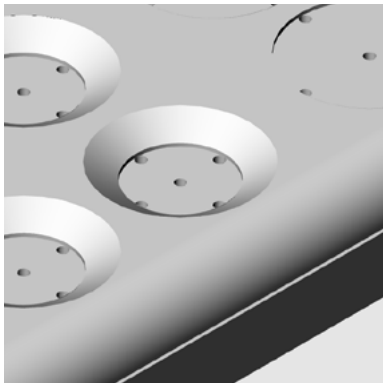
1

The shapes are designed using CAD

2

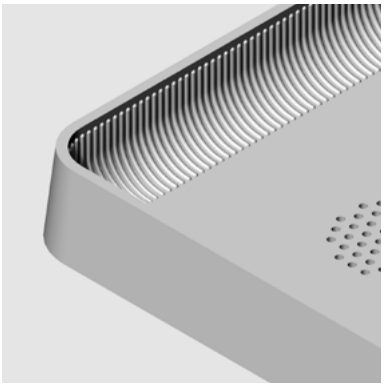
The designs are translated into templates

3



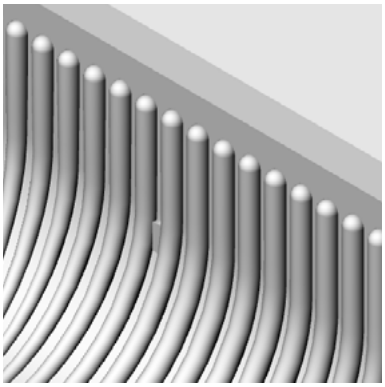
Holes are added to vent air out

4



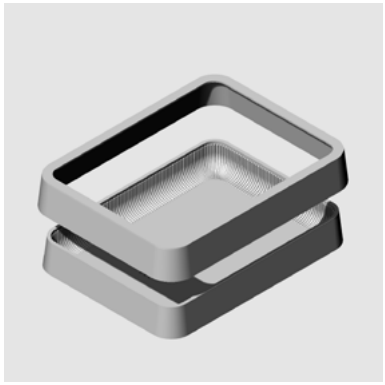
The texture on the bottom is designed so that there are no undercuts

5



Marks indicate where component holes on the side will be

6



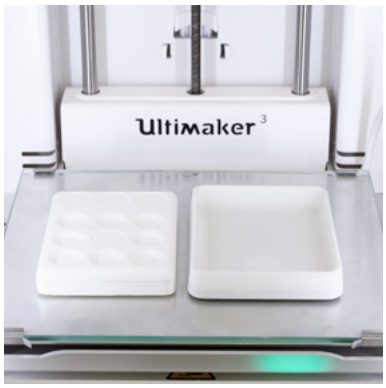
A two-part skirt is added to the lower template creating a lap-joint at the seam line between the upper and lower shells

Guide #01

Create product casings

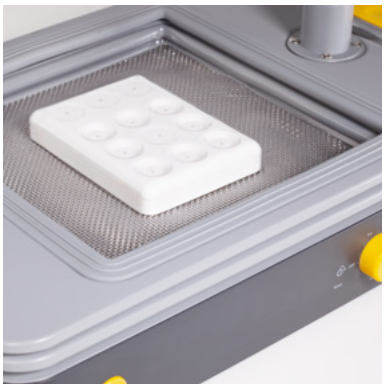
How we made the synthesiser's shell

7



The templates are 3D printed

8



Both parts are formed from a 1.00mm transparent polycarbonate sheet

9

A trim line on the edge shows where to cut with a scalpel

10

Holes for the various components are drilled out

11

All the raw edges are sanded smooth

12

The plastic shells are painted with a durable enamel spray paint

See design considerations

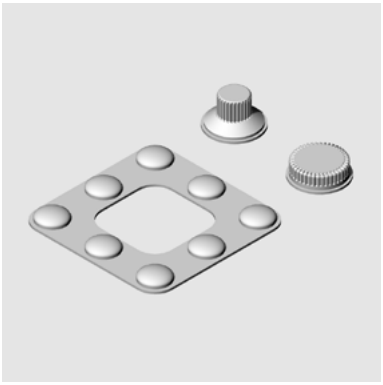
Guide #02

Cast short runs of parts in silicone and resin

How we made the synthesiser's buttons and dials

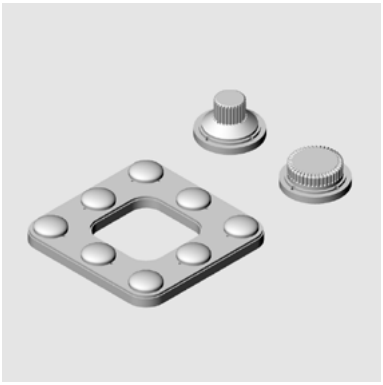
COST PER PART	COST SAVINGS	PRODUCTION TIME	TIME SAVINGS
£2	£150	1 day	5 days

1



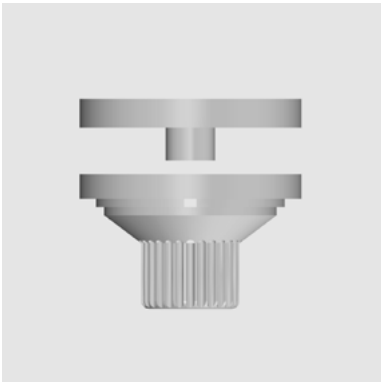
The shapes are designed using CAD

2



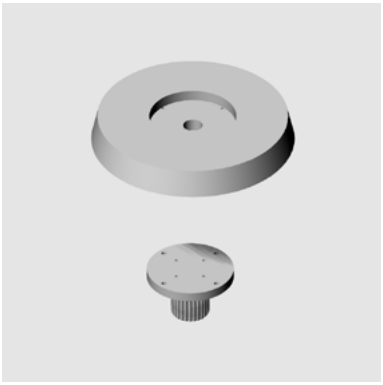
The design is translated into a template (we want to keep our detail on the inside so the template needs to be a positive)

3



The part needs to have a space for the potentiometers, so a two-part mold is required

4

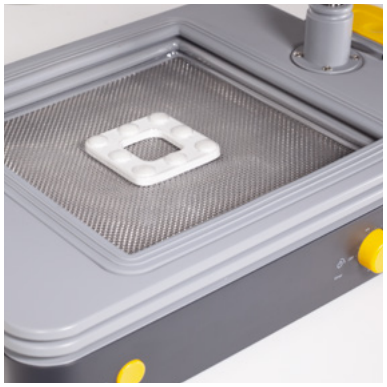


A snap-fit skirt is incorporated to ensure that the two molds remain aligned

5

The templates are 3D printed

6



The template for the silicone buttons are formed with a Mayku Cast sheet

Guide #02

Cast short runs of parts in silicone and resin

How we made the synthesiser's buttons and dials

7

A medium shore-hardness RTV silicone is mixed with a pigment so it's translucent white and poured into the mold

8

The silicone left to cure and removed from the mold

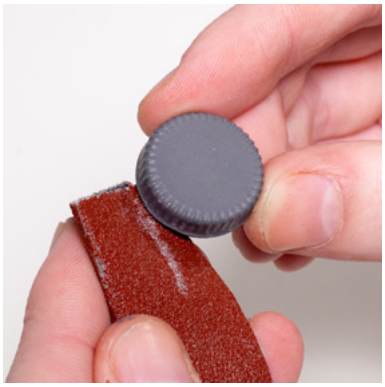
9

The inner and outer templates for the resin dials are formed with a polypropylene sheet

10

A durable plaster based resin is mixed with a pigment and cast in two stages to make dials with coloured caps

11



Any roughness or flash on the cast parts is sanded and polished

See design considerations

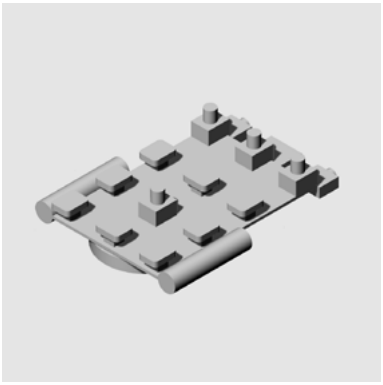
Guide #03

Build custom electronics housings

How we made the synthesiser's electronic housing

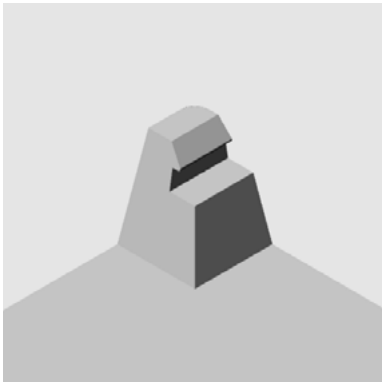
COST PER PART	COST SAVINGS	PRODUCTION TIME	TIME SAVINGS
£1	£50	15 mins	3 days

1



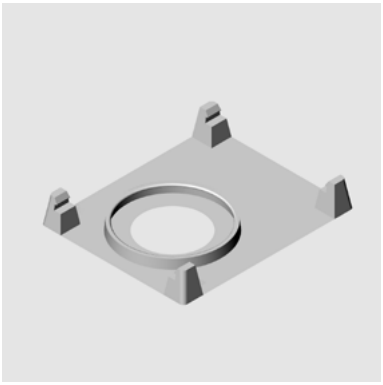
Each component we are using is replicated in CAD

2



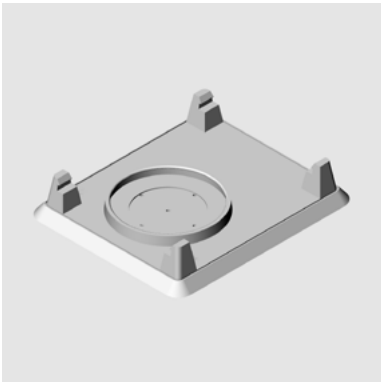
Snap-fit clips for our circuit board are incorporated into the template to hold it in place

3



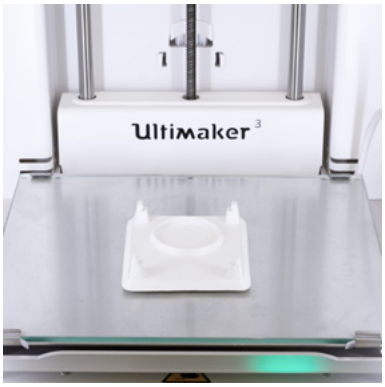
A snap-fit retaining ring is added for the speaker

4



The design is translated into a template

5



The template is 3D printed

6

The template is formed with a Mayku Form Sheet

Guide #03

Build custom electronics housings

How we made the synthesiser's electronic housing

7

A trim line shows where to trim the part using a scalpel

8

The part is glued into the base of the outer shell

9

The circuit board and components are inserted

10

The silicone buttons are laid onto the switches

11

The dials are glued onto the potentiometers

12

The upper shell is joined to the lower shell

See design considerations

Guide #04

Work with transparent materials

How we made the synthesiser's illuminated logo

COST PER PART	COST SAVINGS	PRODUCTION TIME	TIME SAVINGS
£1	£50	60 mins	3 days

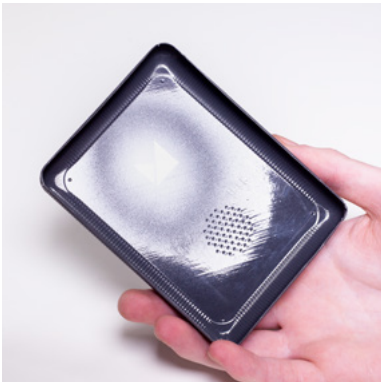
1

Before painting the transparent polycarbonate outer shell, the logo is masked with self-adhesive vinyl

2

After the paint has dried, peel off the vinyl to reveal a transparent logo

3



The shell's back is spray painted with frosting to diffuse the light from the LED behind

See design considerations

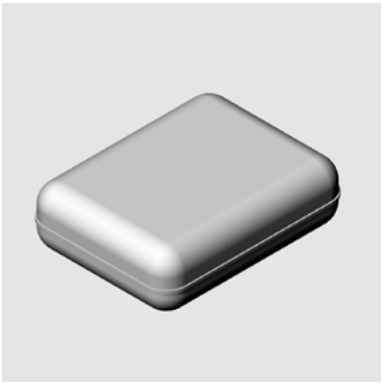
Guide #05

Create professional grade packaging from your desktop

How we made the synthesiser's packaging

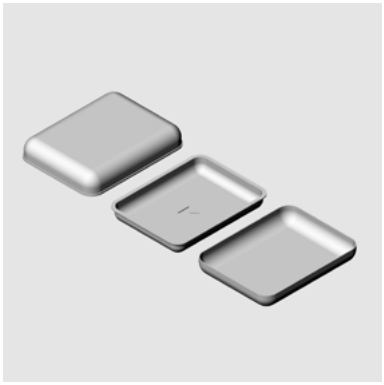
COST PER PART	COST SAVINGS	PRODUCTION TIME	TIME SAVINGS
£3	£100	60 mins	5 days

1



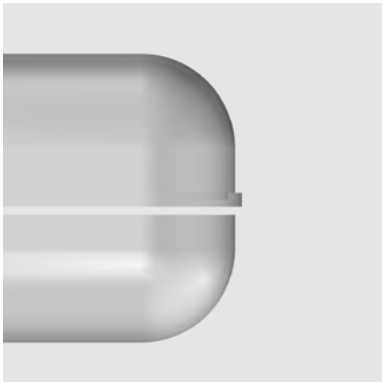
The shapes are designed using CAD

2



There are three parts to the packaging: a base, a tray and a cover

3



Our cover has a return built into the design to create a lap-joint between the upper and lower parts

4

The designs are translated into templates

5

The templates are 3D printed

6

The base is formed using a black ABS sheet trimmed with a scalpel and a trim line

Guide #05

Create professional grade packaging from your desktop

How we made the synthesiser's packaging

7

The tray is made with a black flocked HIPS sheet and trimmed using a scalpel and trim line

8

The cover is formed with a transparent PETg sheet and trimmed using a scalpel and a trim line

9

The tray is glued into the base and the cover is placed on top

10

The assembly is secured using graphics printed onto a translucent adhesive label

See design considerations

Guide #06

Using flexible materials

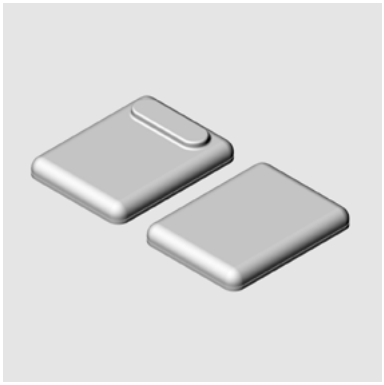
How we made the synthesiser's carry case

COST PER PART	COST SAVINGS	PRODUCTION TIME	TIME SAVINGS
£4	£200	1 day	7 days

1

The shape is designed using CAD

2



The two parts are translated into templates

3

The templates are 3D printed

4

Both parts are formed from a PVC sheet and trimmed using a scalpel and a trim line

5

Napa leather is gently stretched around the PVC shells using a contact adhesive to bond the layers

6

Any excess is trimmed using a pair of scissors

Guide #06

Using flexible materials

How we made the synthesiser's carry case

7

A sheet of EVA foam is formed around a slightly smaller template, this is done for both the front and back and trimmed at the seam line between the case shells

8

The EVA foam sheet is bonded to the inside of the PVC shells with contact adhesive

9

A zip is stitched into a loop with edges prepared so they join to case shells

10

The two halves of the case are stitched together with zip in the middle

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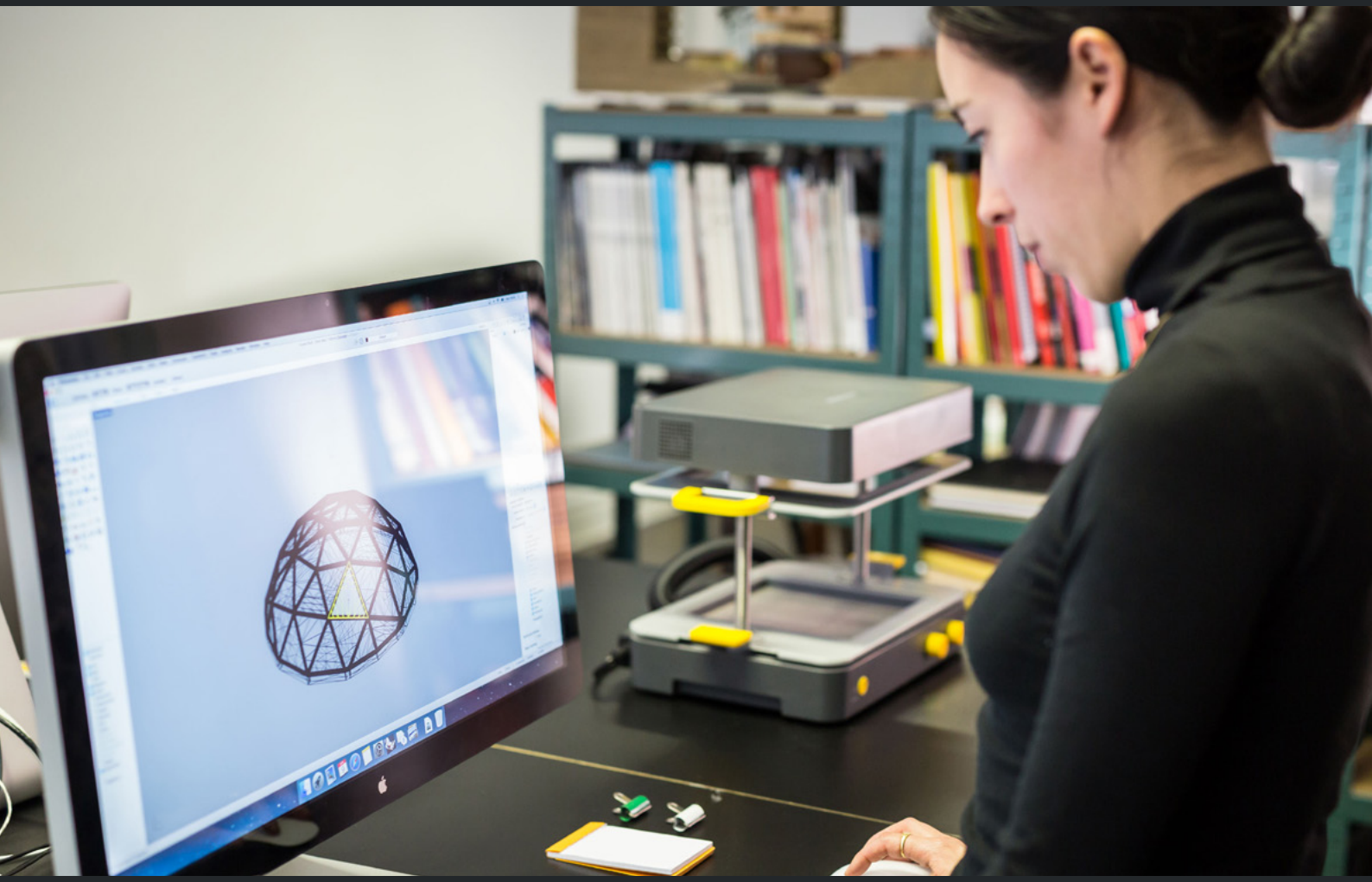
Design Considerations



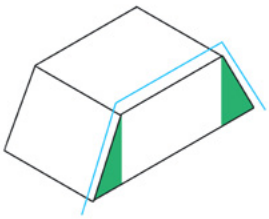
In this section you'll learn which materials and specifications work with the FormBox

Design	#01	Designing for the FormBox
Design	#02	Casting with FormBox molds
Design	#03	Processing parts made with the Formbox

Design #01

How to design for the FormBox

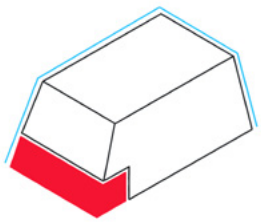
1



Working with draft angles

1. Draft angles of three degrees or more are recommended to ensure that templates and casts can be easily removed after forming.

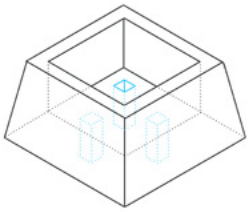
2



Working with undercuts

1. Undercuts should be avoided so that a formed sheet can be removed from the template.
2. Undercuts can be incorporated with multi-part templates.

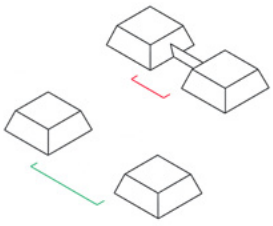
3



Working with ventilation holes

1. In order to avoid craters and crevices, where air can become trapped during the forming process, ventilation holes need to be added to the template. This ensures that the formed sheet can reach every part of the shape. These holes can be very small and discreet.

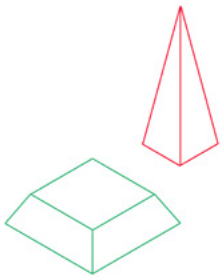
4



Avoid webbing

1. Webbing is when excess material folds over itself during forming — it is often due to items being placed too close to each other on the vacuum plate, overheating the sheet material, or a lack of draft angles on the template.

5



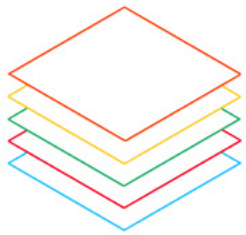
Working with volume and width-height ratios

1. Generally, vacuum formed objects should be wider than they are tall.
2. Choose a thicker sheet when forming larger items to ensure that the plastic does not stretch too thin.

Design #01

How to design for the FormBox

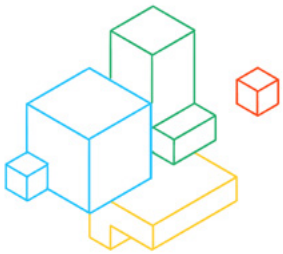
6



Compatible sheet materials

1. PET
2. HIPS
3. PLA
4. Polypropylene
5. Polycarbonate
6. PVC
7. Kydex
8. HDPE
9. LDPE
10. EVA foam
11. TPU
12. ABS

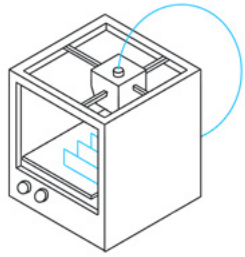
7



Compatible template materials

1. 3D-printed FDM PLA
2. 3D-printed FDM ABS
3. 3D-printed FDM Nylon
4. Most 3D-printed SLA materials
5. Most 3D-printed SLS materials
6. Wood
7. Milled and injection molded plastics such as ABS or nylon
8. Steel
9. Aluminium
10. Plaster
11. Polyurethane tooling foam
12. Hardened clays
13. Silicone
14. Paper and card
15. Toughened glass

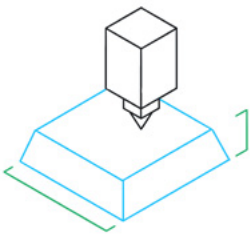
8



Appropriate template manufacture methods

1. 3D printing
2. Milling
3. Hand carving
4. Injection molding
5. Laser cutting

9



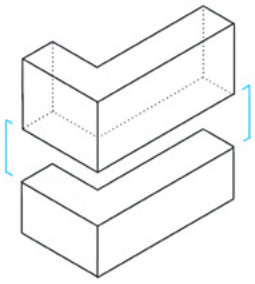
Tips for 3D printing templates for vacuum forming

1. FDM prints in any material benefit from three-layer plus wall thicknesses.
2. FDM prints in any material benefit from 40% plus infill.
3. FDM prints can be filled with plaster to create durable templates [leave out the bottom layer on the print].
4. SLA and SLS prints can be porous and can create tighter forms.

Design #01

How to design for the FormBox

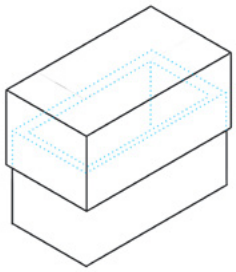
10



How to make a butt-joint

1. Trim the edge of two pieces so that they meet end-to-end.
2. This type of joint may require an internal brace or framework for stability.

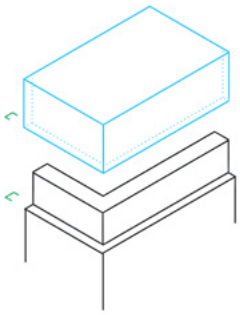
11



How to make a push-fit joint

1. Make one of the pieces slightly larger than the other at the point at which they join so that the parts hold themselves together with pressure alone.

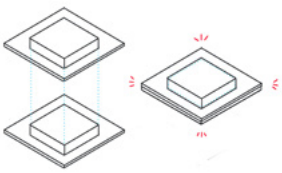
12



How to add a return for a lap joint

1. Add a step onto the border of one of the pieces to be joined.
2. The step should be the width of the sheet used on the part that it will be mated to.
3. If using a positive template this can be easily added with a skirt at the base of the form.
4. When using a negative template, a two-part template lip is required to create a return without getting the form trapped in the template.

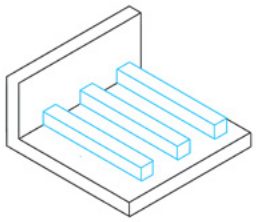
13



How to make snap-fit joints

1. Use deliberate undercuts to create clips that flex gently into matching pockets on the mating part.
2. These pockets will require venting holes in the template.

14



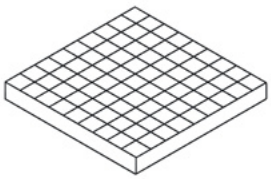
Adding ribs for stability

1. Generally, vacuum formed objects should be wider than they are tall.
2. Choose a thicker sheet when forming larger items to ensure that the plastic does not stretch too thin.

Design #01

How to design for the FormBox

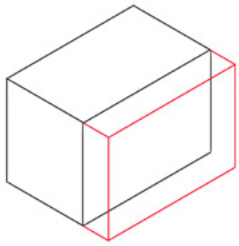
15



Adding texture to forms

1. Vacuum forming picks up fine detail on various natural and synthetic textures.
2. Sanding or sandblasting a template can transfer a matte finish to formed components.
3. Highly polished templates create glossy forms.

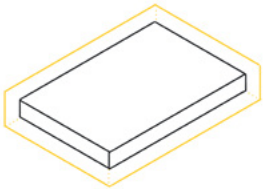
16



How to engineer tolerances

1. Always take into account the thickness of the thermoform sheet when engineering tolerances into designs.
2. Also consider any texture treatment for templates that may add or remove material from the original template dimensions, the same is true for final vacuum-formed parts.

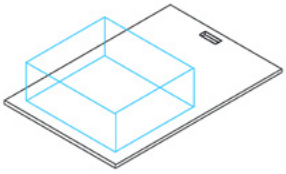
17



How to create electronically isolated and anti-static housings

1. Plastic casings are useful to isolate electronic parts.
2. Anti-static plastics can be used to shield components inside products or in transit.

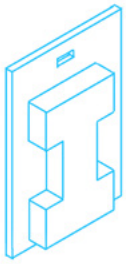
18



Obtaining a crystal clear finish

1. Transparent plastics such as PETg and Polycarbonate are fantastic at creating optically clear shells. Ensure templates are highly polished and blemish-free to obtain a crystal-clear finish.
2. Formed components can be sanded and polished.

19



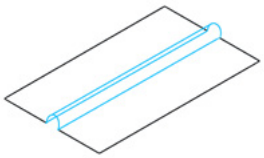
Making basic blister packaging

1. Simple packaging can be made by creating a clear plastic shell for a product —stapled, glued and folded around a card backing plate.

Design #01

How to design for the FormBox

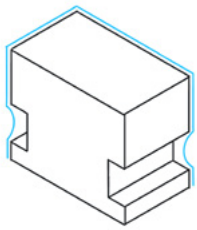
20



How to make living hinges

1. A wide T-shaped ridge can be added along the length of a packaging piece to create a folding hinge. PETg polypropylene are good materials for this application.

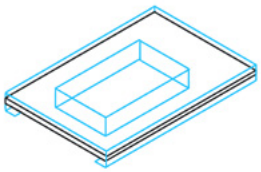
21



How to make snap-fit clips

1. Use deliberate undercuts to create clips that flex gently into matching pockets on the mating part.
2. These pockets require venting holes in the template.

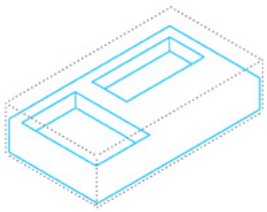
22



How to make clips for backing card

1. Use deliberate undercuts to make long grooves — creating a channel to slide a piece of card into.

23



How to make trays for boxes

1. It's easy to make custom product tray inserts for cardboard boxes. Ensure that you measure the cardboard box accurately and add tolerances for the thickness of the sheet.

24

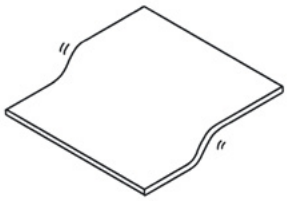
Working with EVA foam

1. EVA foam is good for creating soft shapes.
2. Due to its porosity, expect it to form more loosely at the base of templates, although it picks up fine detail depending on the cell size of the foam.

Design #01

How to design for the FormBox

25



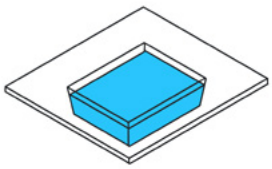
Working with PVC

1. PVC can be flexed and manipulated without cracking and splitting — unlike most other plastics — making it useful for flexible applications.
2. Be cautious of overheating PVC, its chlorine content can produce toxic fumes when overheated.

Design #02

How to cast with FormBox molds

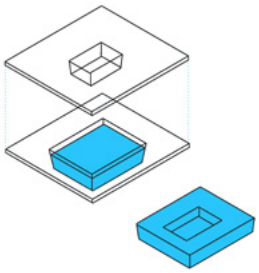
1



One-part molding

1. A wide variety of materials can be cast using molds made with vacuum forming.
2. One-part molding is the simplest method — using one template, one sheet and an exposed face for the cast piece.

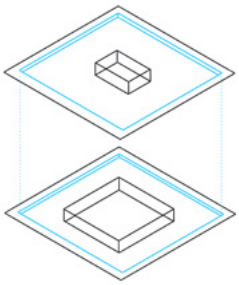
2



Basic two-part molding

1. Two [or more] sheets can be combined to create a molded part that is enclosed on all sides, allowing for more complex cast parts.

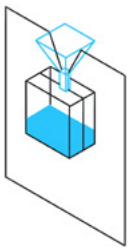
3



Two-part molding with a snap-fit skirt

1. A skirt can be added to the parts of the mold so that they join together securely, increasing stability, and reducing flash and leakage during the casting process.

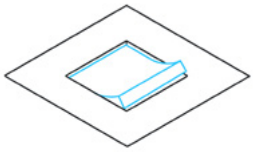
4



Using sprues

1. Sprue can be added to the design to improve the ease of pouring casting material into the mold.

5



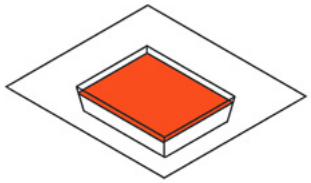
Working with silicone

1. Silicone has good non-stick properties with most plastics, including the sheets used for making vacuum-formed molds.These cast parts can add non-stick, food-grade heat- and chemical- resistant properties to various products.
2. Materials such as silicone and polyurethane are suitable for over-moulding to create items with structural integrity and good ergonomics.

Design #02

How to cast with FormBox molds

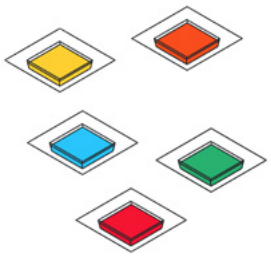
6



Working with resins

1. Resins are compatible with polypropylene and other sheets when used with a mold-release agent.
2. Resins can provide a wide range of finishes including crystal clear transparencies, tints, encapsulation and colour ranges.

7



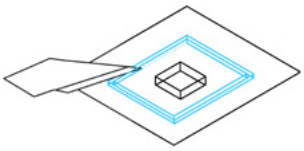
Compatible casting materials

1. Silicone
2. Polyurethane
3. Epoxy resin
4. Polyester resin
5. Gypsum
6. Resin-modified gypsum
7. Concrete
8. Foams
9. Edibles
10. Cosmetics

Design #03

How to post process FormBox parts

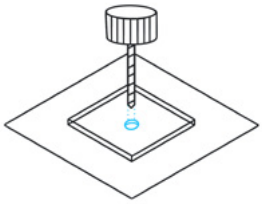
1



Cutting holes with a trim line

1. Create a gutter around the area you wish to cut
2. The vacuum form will pick this up and create a groove to run a scalpel along

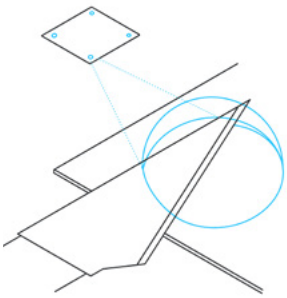
2



Cutting holes with a drill

1. Mark the centre point of the hole with a dent in the template
2. The vacuum form will pick this up and create a divot to guide a drill-bit

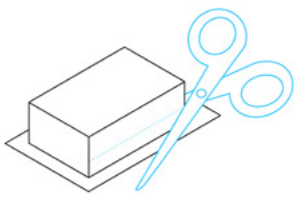
3



Cutting holes with a razor

1. Create a deep crater with a sharp perimeter where your hole needs to be
2. This will create a bubble where the hole should be
3. You can run a blade adjacent to the perimeter of the hole to slice off the hole opening

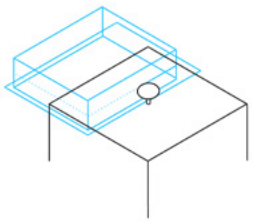
4



Trimming edges with a pair of scissors freehand

1. Use various guides to neatly trim thinner plastics with a sturdy pair of scissors by eye

5



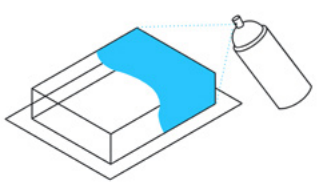
Trimming edges with a form cutter

1. Use a specialist form cutter machine to trim along the bottom of a form

Design #03

How to post process FormBox parts

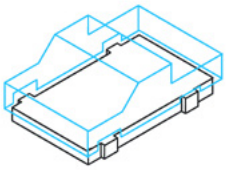
6



Adding colour to forms

1. Thermoform sheets are available in a variety of colours
2. Most plastics can be spray painted and airbrushed in custom colours
3. Some sheets can be dyed for custom tints
4. Vinyl graphics can be applied to sheets before and after forming
5. Inkjet printed transfer paper can be laminated onto sheets before forming

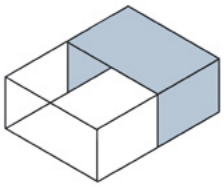
7



Joining vacuum-forms to other parts

1. Most adhesives are compatible with thermoform sheets. Stand-offs, brackets and trays can be easily added to product shells.
2. Snap-fit clips can also be used to click components into place. Use deliberate undercuts to create clips that flex gently into matching pockets on the mating part. These pockets will require venting holes in the template.

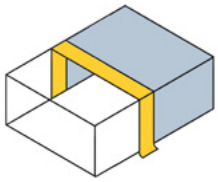
8



Obtaining a frosted finish

1. A frosted finish can be obtained by adding a fine texture to the template before forming: by sanding, sandblasting or brushing the surface.
2. A frosted finish can also be added to the component after form by sanding, sandblasting, brushing or spraying the item with a frosting spray.

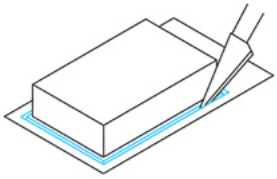
9



Masking transparent materials

1. Both crystal clear and frosted finishes can be combined by masking off specific areas with tape or vinyl graphics.

10



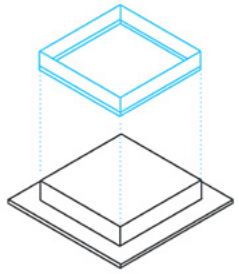
How to trim packaging with a trim line

1. Create a gutter along the trim line you wish to cut.
2. The vacuum form will pick this up and create a groove to run a scalpel along or trim with a pair of scissors.

Design #03

How to post process FormBox parts

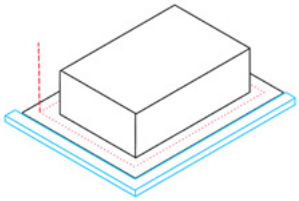
11



How to trim packaging with a die cutter

1. Large batches of packaging can be produced faster with a die cutter to trim the molds.
2. These tools usually require a flat area on which to cut.

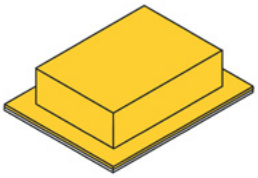
12



How to trim packaging with a laser cutter

1. A jig can be made to hold a vacuum-form in place inside of a laser cutter to allow rapid trimming around items.
2. Some plastics cut more cleanly than others: HIPS, PETg and acrylic are recommended.

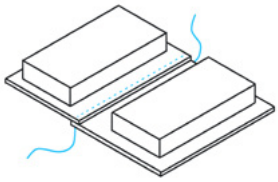
13



Laminating textiles and leather

1. Leathers, both synthetic and natural, can be laminated onto plastic sheets; sheets that are also flexible enable you to create embossed, debased and structural effects.
2. The same can be done with various textiles, however stretchy materials work best.

14



Stitching and embellishing flexible forms

1. Some softer plastics can be hand stitched or machine stitched, much like leather. This can be useful for fashion accessories and cosplay items in particular.

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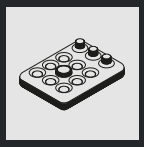
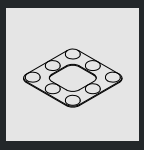
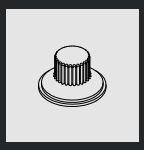
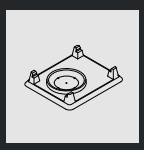
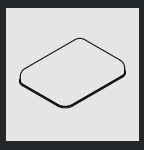
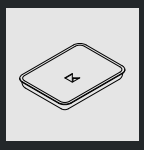
Numbers

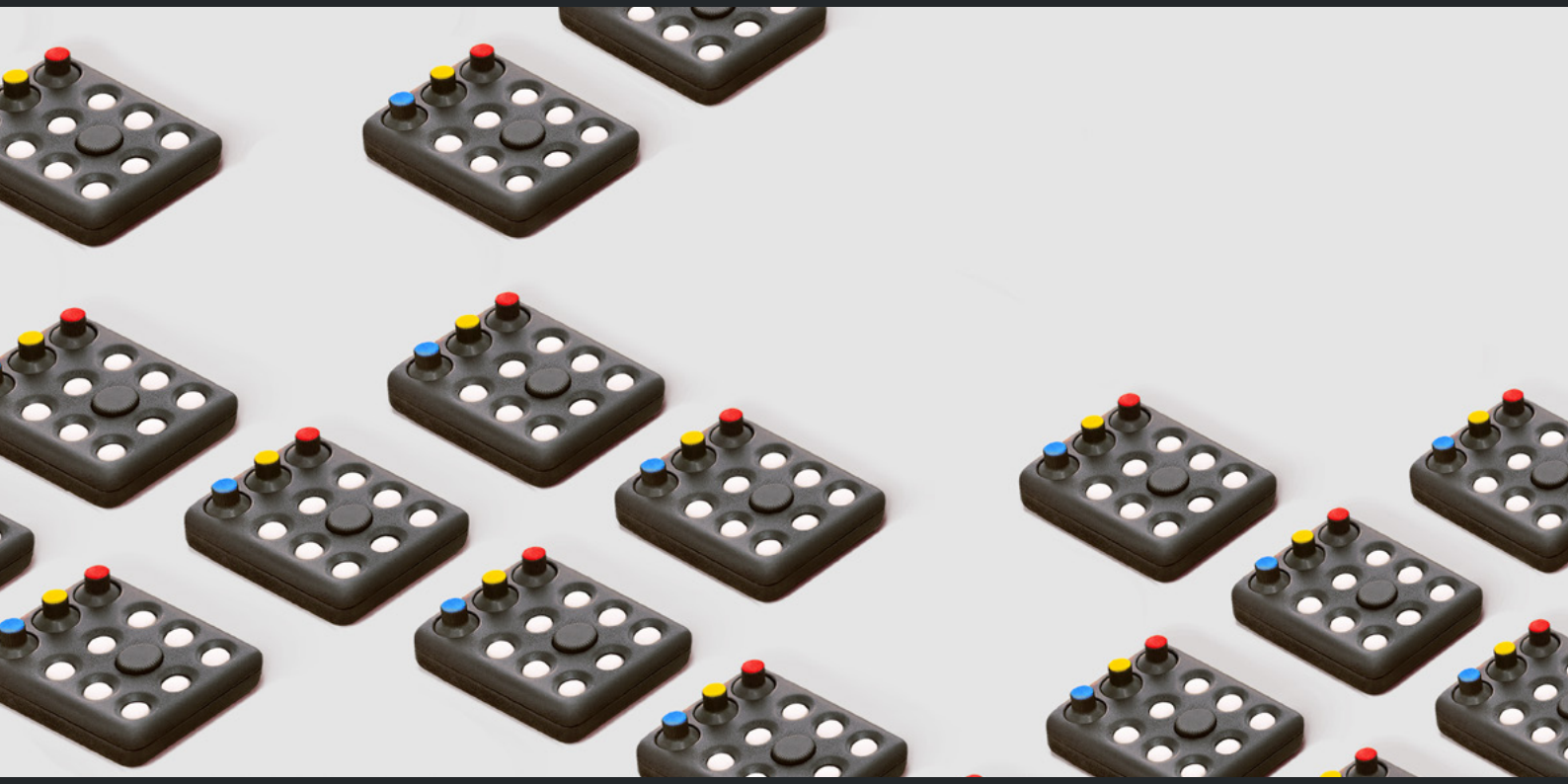
The proof is in the pudding — or in this case, the tables below.

		Cost per part	Production time	Cost savings	Time savings
	Total assembly	£15	3 days	£1000+	14 days
	Product casing	£1	60 mins	£100	3 days
	Silicone buttons	£2	1 day	£150	5 days
	Resin knobs	£0.50	60 mins	£50	5 days
	Electronics housing	£1	15 mins	£50	3 days
	Polycarbonate packaging lid	£1	20 mins	£50	5 days
	Packaging tray insert	£2	30 mins	£50	5 days
	PVC & Leather Case	£4	1 day	£200	7 days

Purchase a FormBox >

Your own tabletop factory

The Mayku FormBox brings the means for end-to-end product development to your desktop. This machine democratises the production process: makers can now create a variety of product parts in a plethora of materials, colours and finishes quicker than before. Owning the Mayku FormBox means you can bring a physical product to market with the minimum of time and expenditure.



Buy the machine

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