

Compactable USB plug Project log

CDT/Mona Sharma
Summer 2015

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design brief

Design a three-pin usb plug to fit in a pocket, for a promotional merchandising company.

It should be design so that the casing can be changed and then sold as different shapes/characters, e.g. a tortoise shell or ladybird.

Current users are faced with the issue of not being able to transport plugs in a compact manner due to the the three pins in a plug 'poking' them.

design specification

It must be able to be manipulated into a compact form, where the three pins are no longer of discomfort to the user when stowed away in a pocket/bag.

It must be a UK 3-pin plug, with a built-in USB port.

It should be a low value, high quality product.

existing 3-pin USB plugs



Apple USB adaptor plug/charger

Clean, minimal design.
Flush surfaces, minimal colour palette.

Contrasting finishes highlight user/non-user areas (white gloss/grey matte).

Currently the most compact design of non-folding plugs available.

An ideal form and structure to consider for promotional purposes.



Standard USB adaptor plug/charger

Bulky, large design.

Designed to fit standard, non-specialised fixings to achieve lower productions.

Fixings and split lines can be clearly seen - this increases its bulky appearance.

Standard black spark finish.



USB adaptor plug/charger

Ergonomical design.

More specialised fittings allow for a smoother design.

Curvature in the body allows for easier (un)plugging.

Black gloss finish.



Mu foldable USB plug adaptor

Original compactable design.

Specialised wiring as well as fittings allows for a fully compactable design to fit in a users' pockets.

Clever rotation of pins would ideally be applicable to the design brief, but not possible due to the design being heavily protected by patents.

White gloss finish.



Mu foldable USB plug adaptor - continued

Available in stackable and non-stackable versions. Allows for intelligent use of space - e.g. at least three USB plugs can be plugged into the space of one power source.



Vojo USB plug adaptor

Fun, slightly bulky, compactable design.

Although an international plug, the folding pins another possible solution to the brief.

Rounded bulges at the top and bottom add character and practicality (assemble of plug etc.).

Purple matte/white gloss finishes

regulations/standards

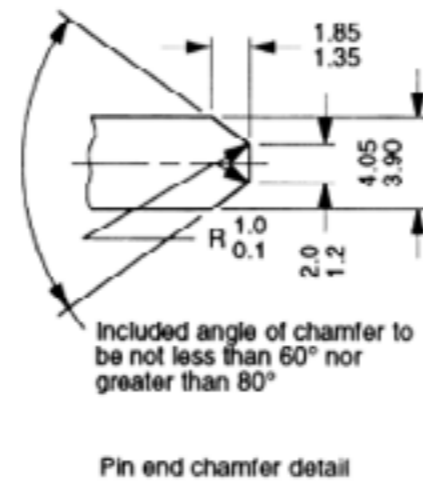
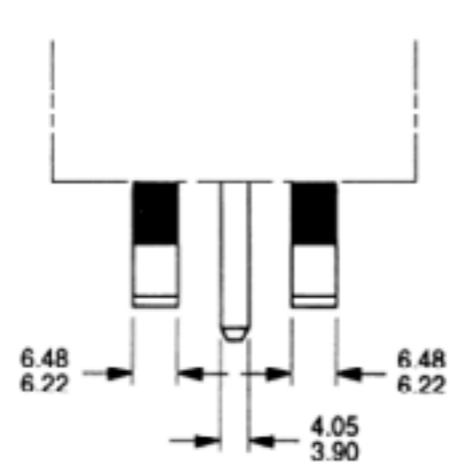
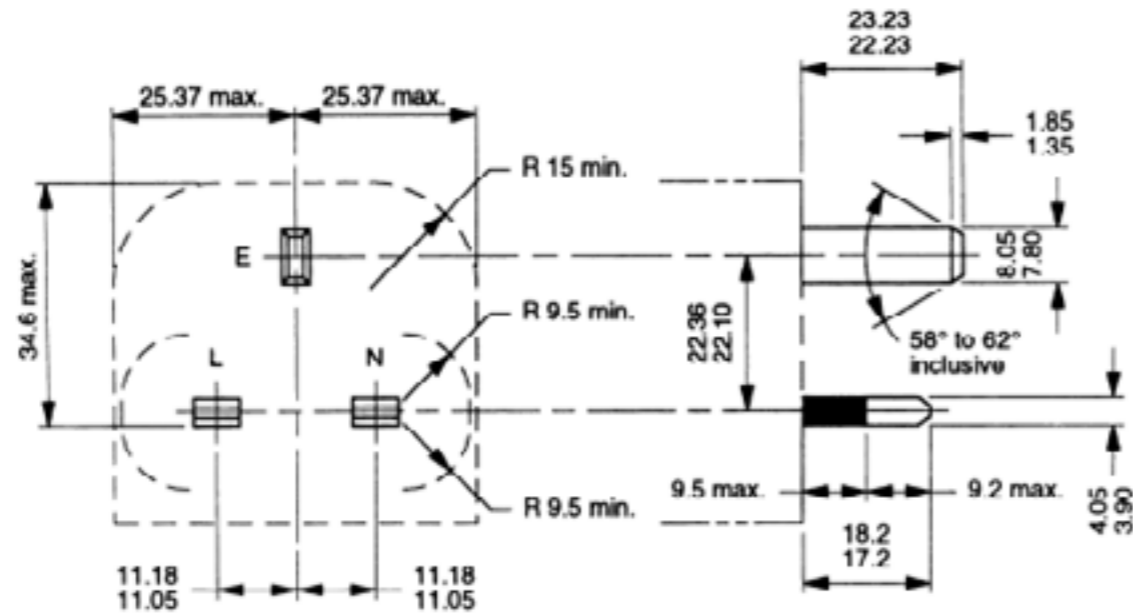
The UK plug is heavily regulated with strict standards, understandably.

Realistically, altering the arrangement of the pins and allowing the user to move them, too, would require rigorous testing, as there would be many safety implications for handling mains electricity.

Initially, it is ideal that the physical dimensions and limits are considered when working out pin arrangements and designing the form of the plug.

Fundamentally, the main safety concern when designing the plug would be minimising chances of the user making contact with any internal parts.

It is important that the design is durable and able to withstand the forces of pushing into/pulling out of the socket, without compromising on the functionality - such as the locking mechanism found in wall sockets.



inspiration

Finding methods and inspiration that could be applied to the brief:



Folding tools found in a Swiss army knife.

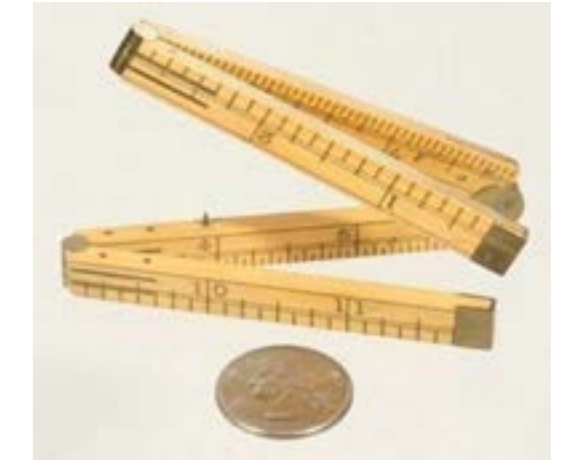
All tools fold into one body.

Accessibility to each tool is simplified by machining grooves to allow the user to 'pinch' them out.



Curvature found in the palm of a hand.

The internal curve of the hand could be translated onto the outside curvature of the plug, giving it an organic and ergonomic form.

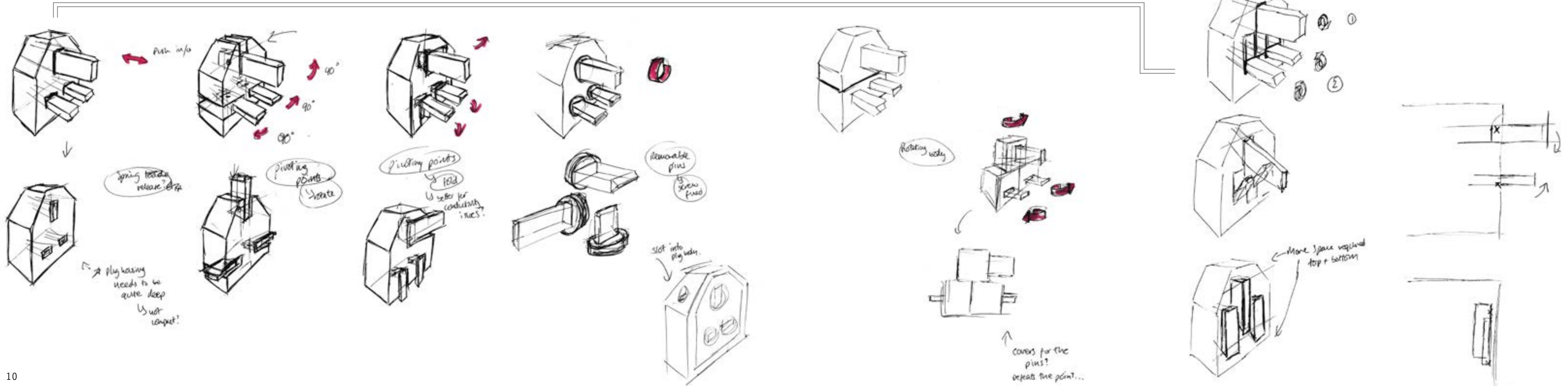


Folding ruler.

The way this ruler can fold in different directions could be applied to the plug - ideal for when dealing with the two different sizes of pins.

initial concepts

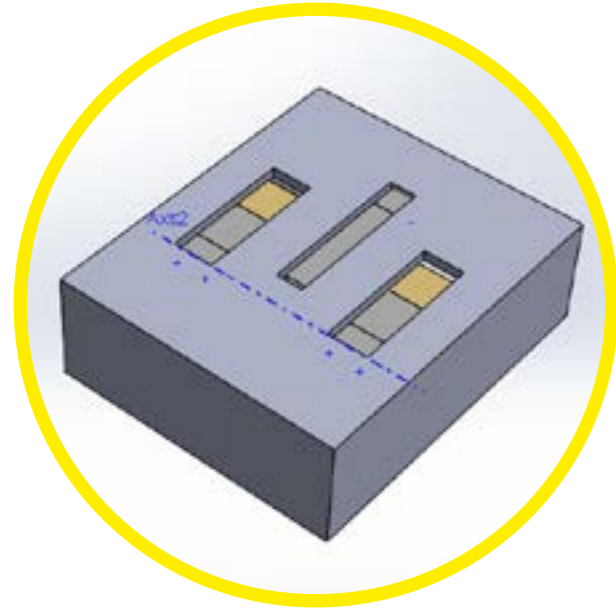
Following research, it was realised that the best form of compacting a plug would be some form of rotation of the pins. The various methods are explored as follows:



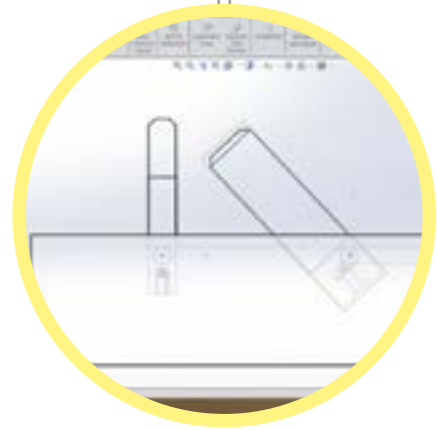
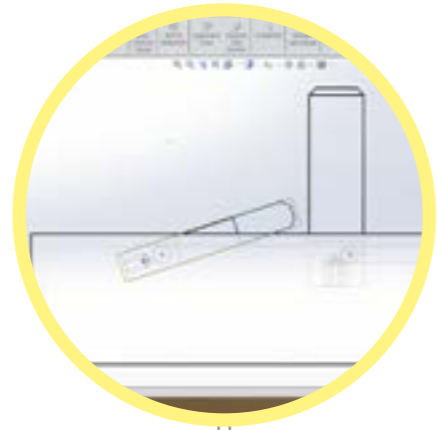
It was decided that the most effective form would be for the top pin to fold downwards into the body, and the two shorter pins to fold up into the body.

Having the pins fold into the body would mean that the user would not see/feel any protrusions from the pins. This would mean that the case would probably be larger than an average plug, but overall its footprint would be smaller.

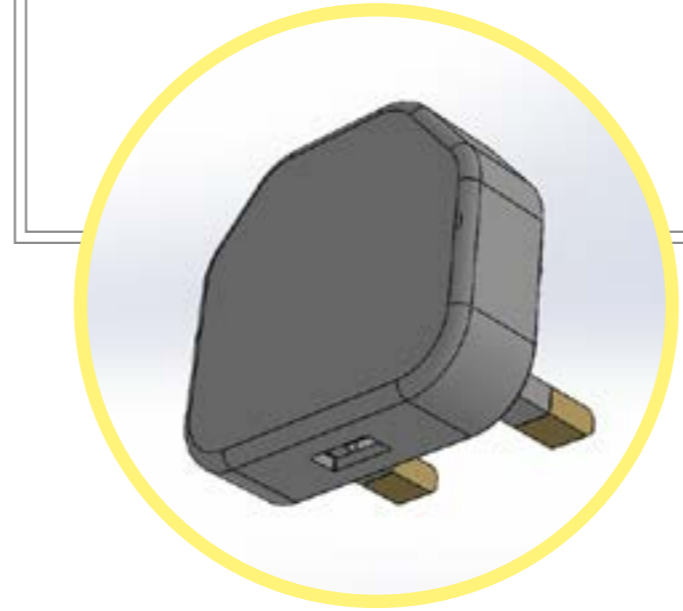
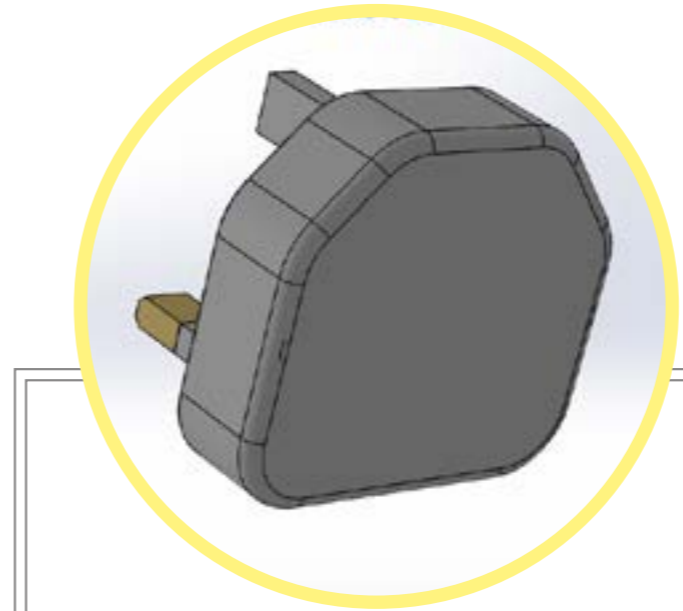
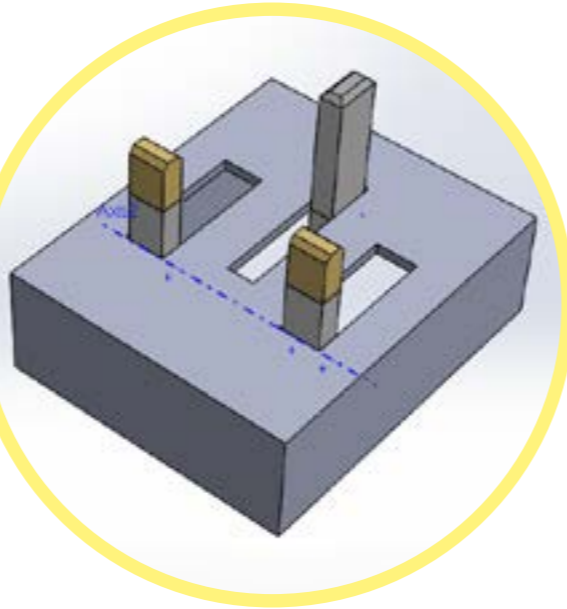
Locating pins



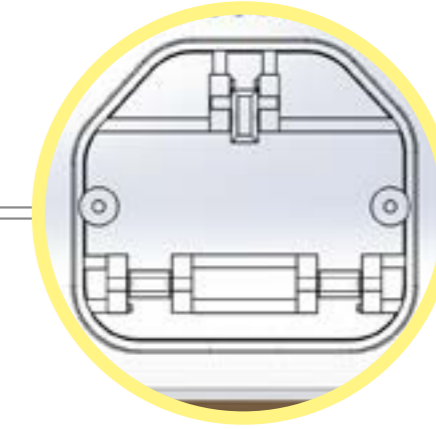
In order to help decide the overall form and size of the plug, a test rig was built in SolidWorks, where both the start and end positions were considered. It helped to define the minimum dimensions required for the pins to fold into the body.



Grooves and hinges were included for rapid prototyping purposes, although realistically similar features would be machined, meaning that this product would require specialised pins instead of standard bought in ones.

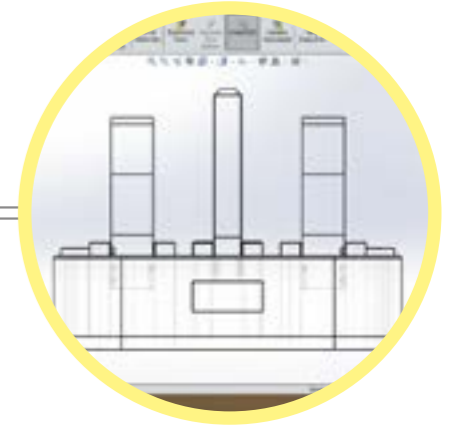


The initial test rig led to this straightforward design, made up of flat surfaces and heavily rounded corners, to fit around the folding pin mechanism.



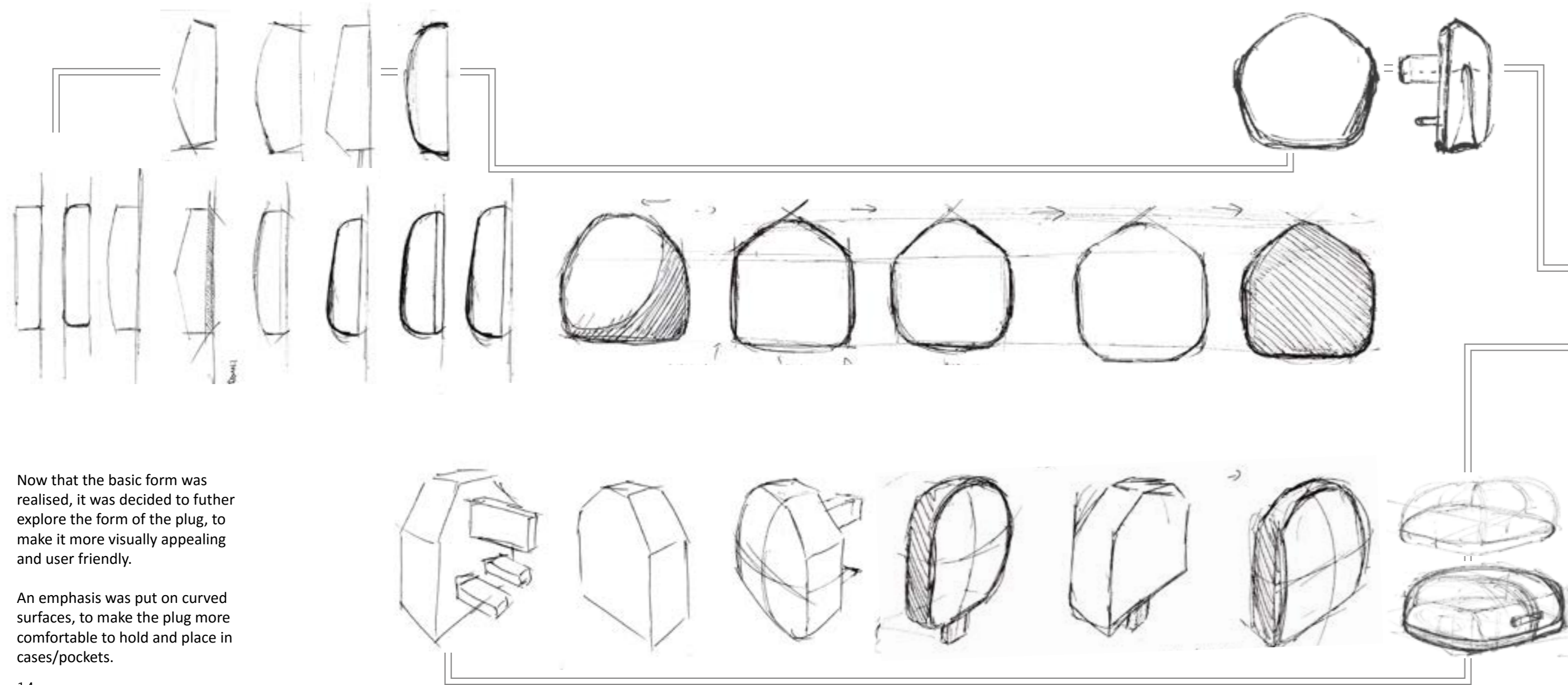
Screw bosses and ribs were included, as well as detents for the pins to lock into place when rapid prototyped.

The case has been given a thickness of 1.75mm, in order to withstand the forces of pulling/pushing plugs from/into wall sockets.



The internals are thicker than what they would be realistically be, but again this is to make for a more durable prototype.

form/ergonomics



Now that the basic form was realised, it was decided to further explore the form of the plug, to make it more visually appealing and user friendly.

An emphasis was put on curved surfaces, to make the plug more comfortable to hold and place in cases/pockets.

Refining forms in sketching narrowed down the shape to two pentagonal form models, in foam.

The soft pentagonal shape was chosen due to the form allowing for more internal space and the possibility of an easier, wider grip. It would also work if animal-shaped shells were designed for the plug - it allows even spacing of the head and legs etc.

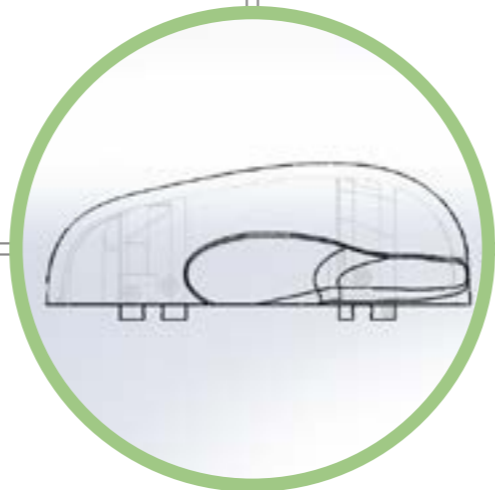
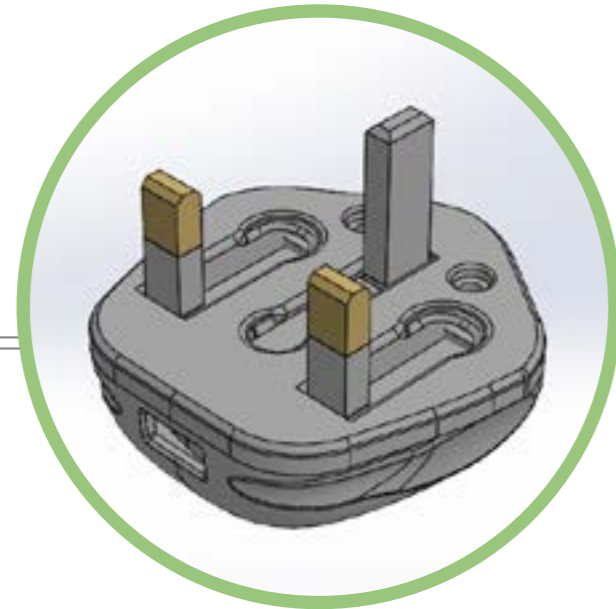
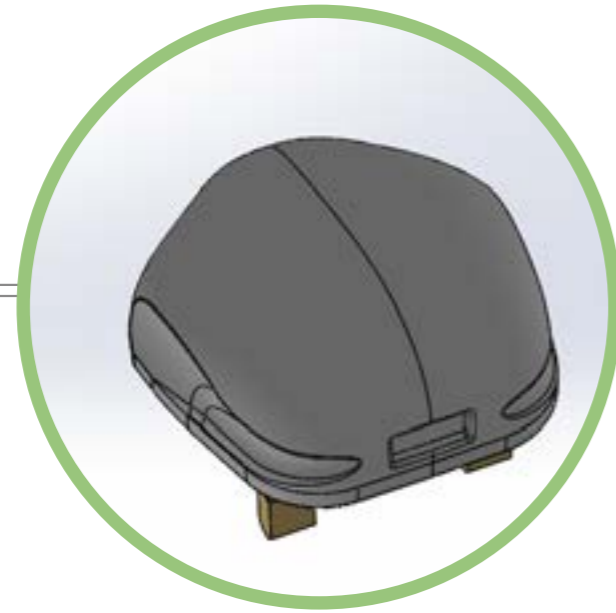
User testing helped to decide that model no.2 was most suitable.

The finger grooves fit well with the soft form of the plug, and an increased surface area for the user to hold onto, in comparison to model no. 1.

Practically, no. 2 is also more suited in terms of manufacturability as there are no undercuts, as opposed to no. 1.



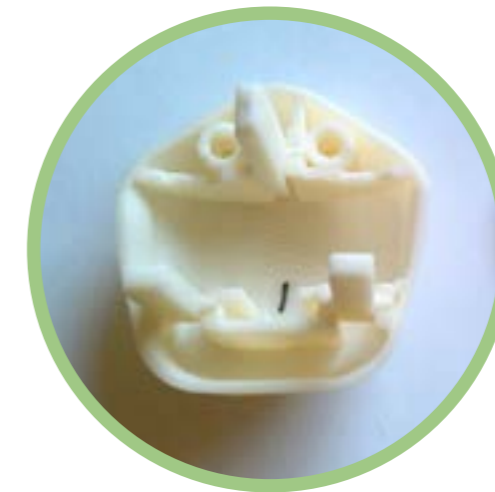
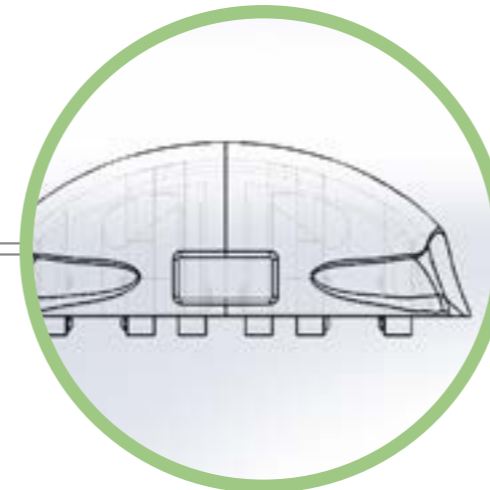
model no.1



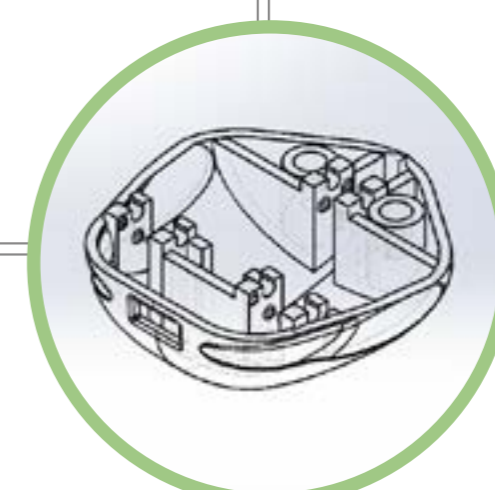
A flowing groove was cut into the shell of the pentagonal plug on both sides.

The pins would have to be machined specifically for the product, thus making it a higher quality product. The USB socket would be bought in, and the casing is only made up of two injection moulded parts, lowering manufacturing time and costs.

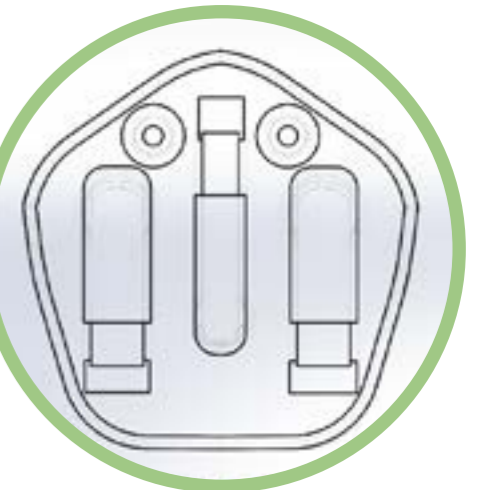
The groove follows into the USB socket, highlighting the purpose of the plug in a subtle way.



A casing for the pins was added to the inside of the top lid, protecting the user from making contact with electrical components.



The pin supports and detents were used from the previous design. As the shape was given priority in this design, the screw bosses were moved to the top, utilising free space in the casing.



model no.1 - modifications

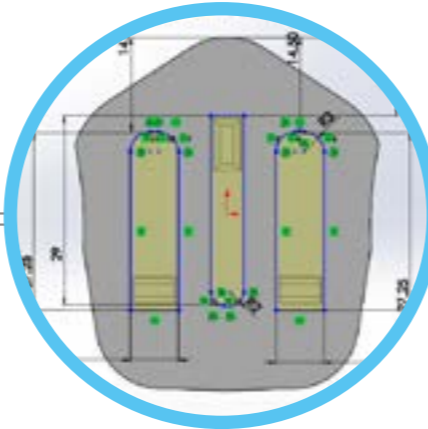
User testing of model no. 1 highlighted three main issues:



1. Access to the pins when lifting them was difficult, especially for users with larger fingers

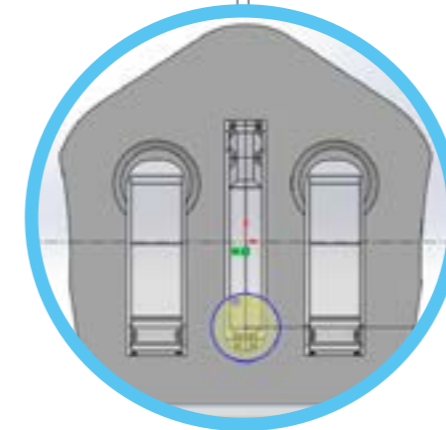
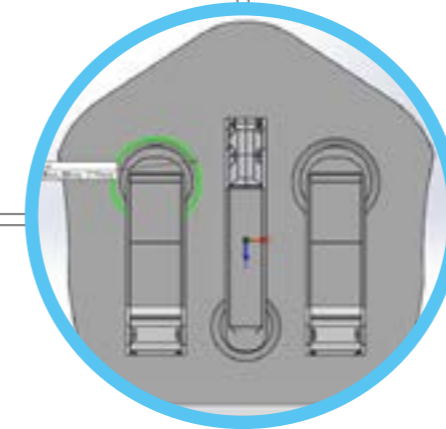
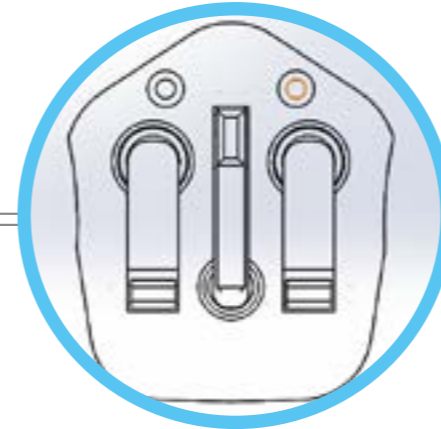
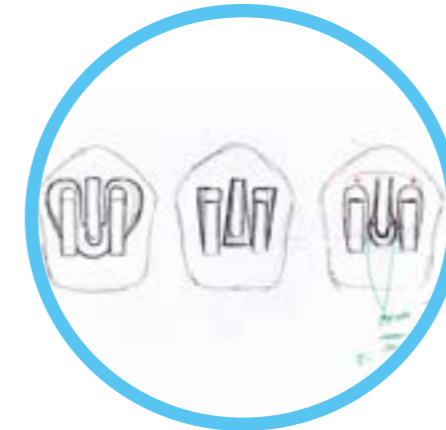


2. Access to the middle pin was even more difficult, due to lack of finger space - a compromise must be found between usability and internal space.

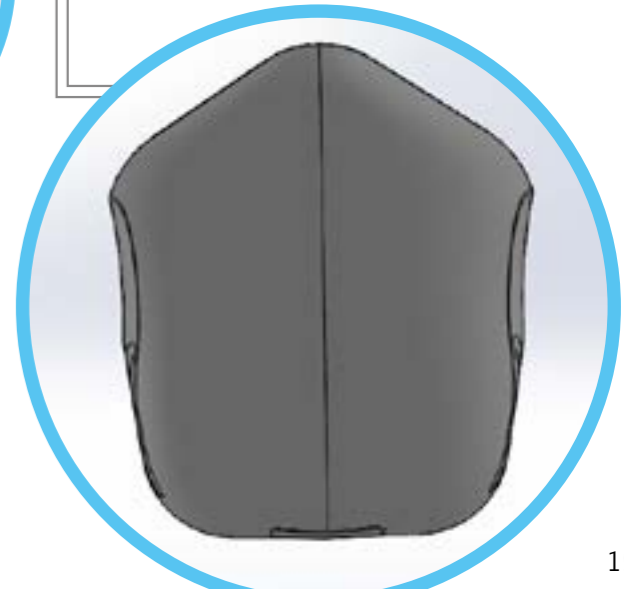
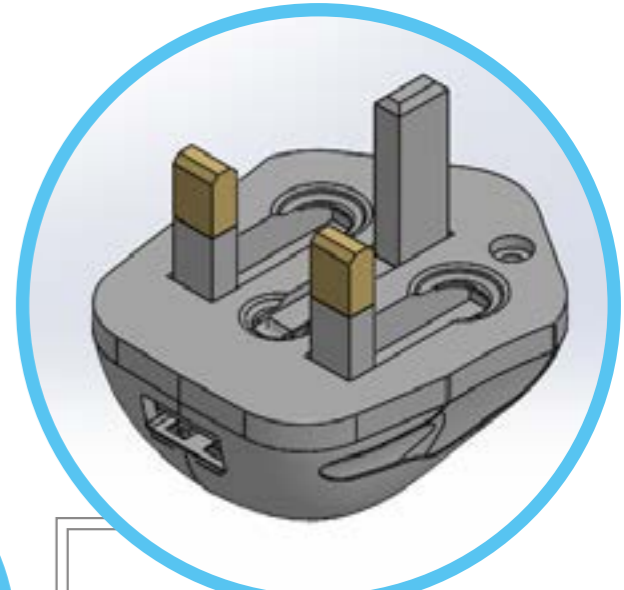
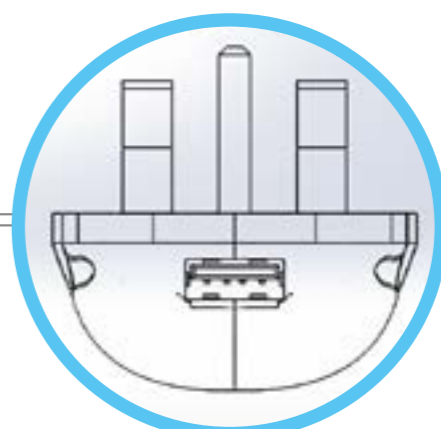


3. The pins are too far apart, and the plug is too wide - exceeding the limits approved by British Standards (50mm max.). A compromise between practicality and aesthetics must be found.

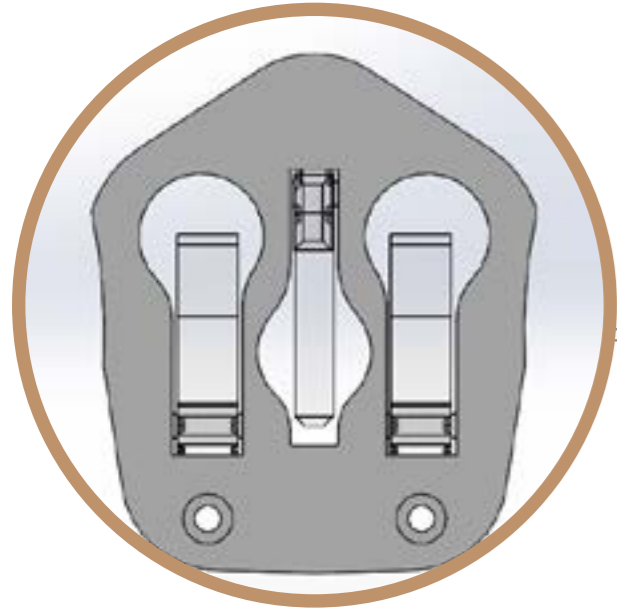
Extra space was added around the tips of the pins for easier access, with an effort to carry through the flowing curve aesthetic.



These modifications resulted in a slightly longer and smarter design, still carrying the smooth, curved aesthetic suitable for a pocket.



model no.2



Modifications of model no. 1 lead to changes to overall form and style, as previously mentioned.



Here, a space at either side of the middle pin has been included to allow the user to pull the pin up by holding both sides, maximising contact surface area (instead of space at just the tip, as found in for the shorter pins).

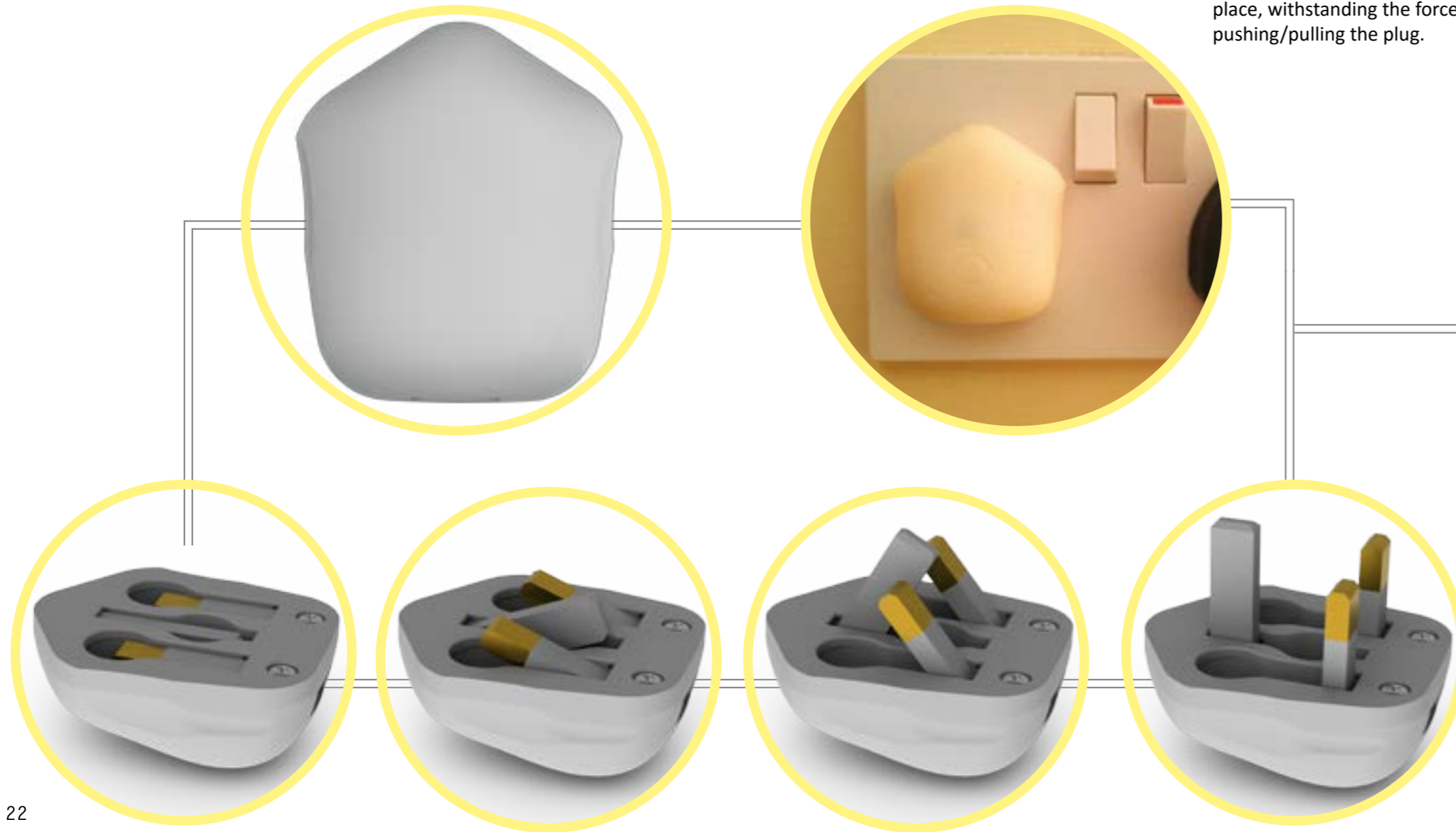
Although the size, pin spacing corrections and additional access space around the short tips seem to work, the middle pin was still difficult to pull out:



The change in shape also allowed for the screw bosses to move to the bottom of plug, also freeing up space for snap fittings in the top of the case, so that the top could fit into the body and stay in place when screwed in from the bottom.

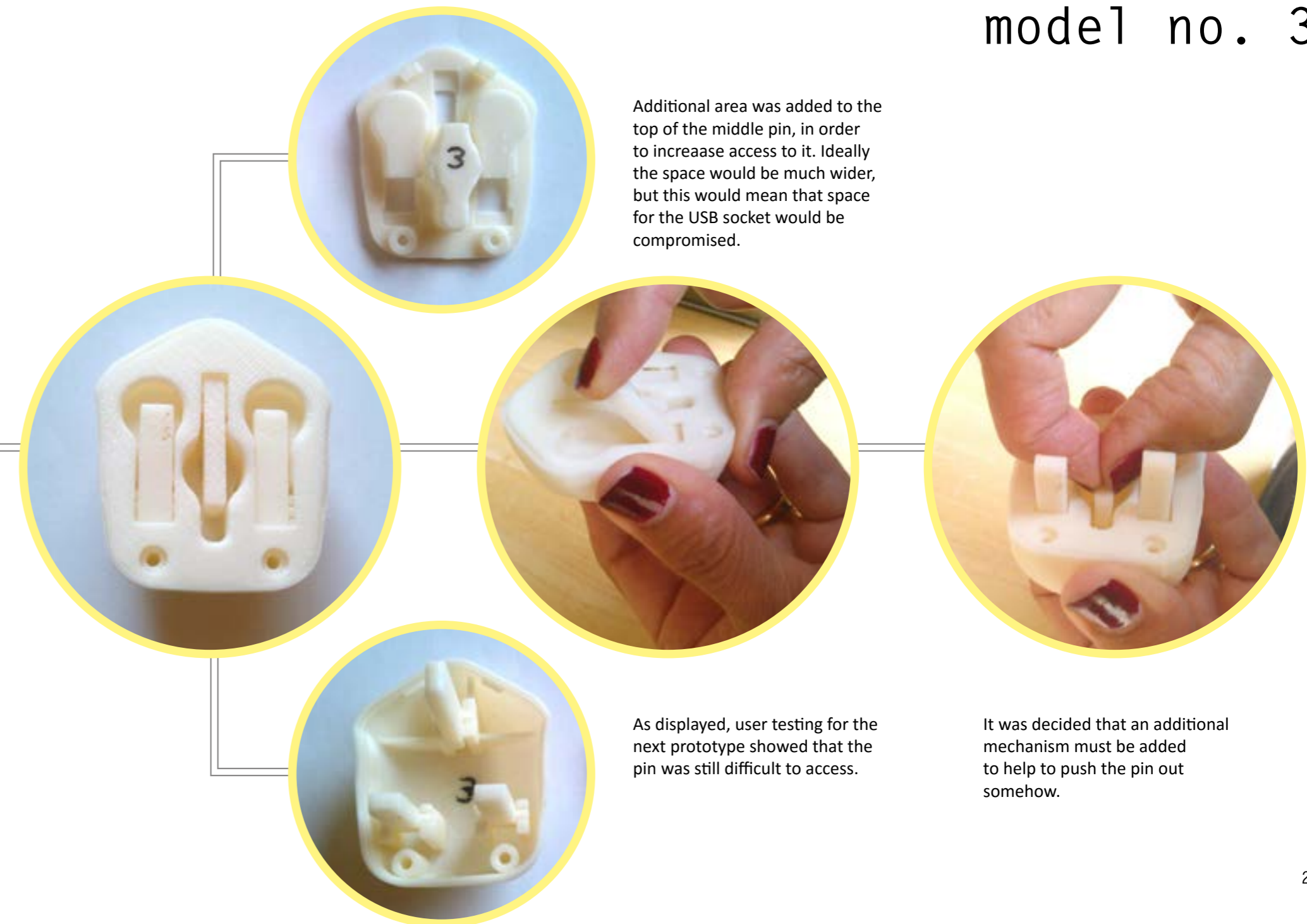
renders/context

Renders produced in Photoview 360 displaying the pins in action.



As shown, the snap fixings and screws allowed the pins to stay in place, withstanding the force of pushing/pulling the plug.

model no. 3



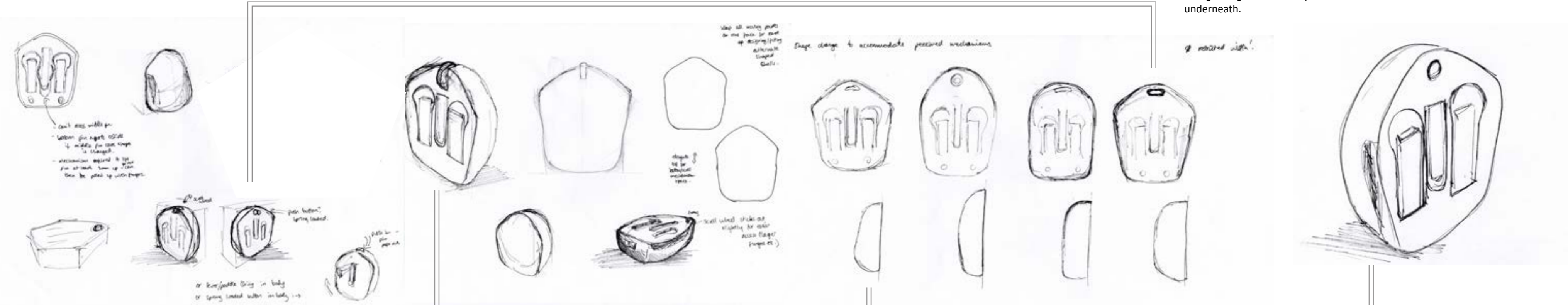
Additional area was added to the top of the middle pin, in order to increase access to it. Ideally the space would be much wider, but this would mean that space for the USB socket would be compromised.

As displayed, user testing for the next prototype showed that the pin was still difficult to access.

It was decided that an additional mechanism must be added to help to push the pin out somehow.

middle pin access

Further sketch generation exploring various ways of making the middle pin easier to access:



An additional mechanism would mean that more internal space would be required. It was decided that whatever the mechanism, its ideal placement would be at the top of the plug, due to the USB socket fitting taking most of the space underneath.

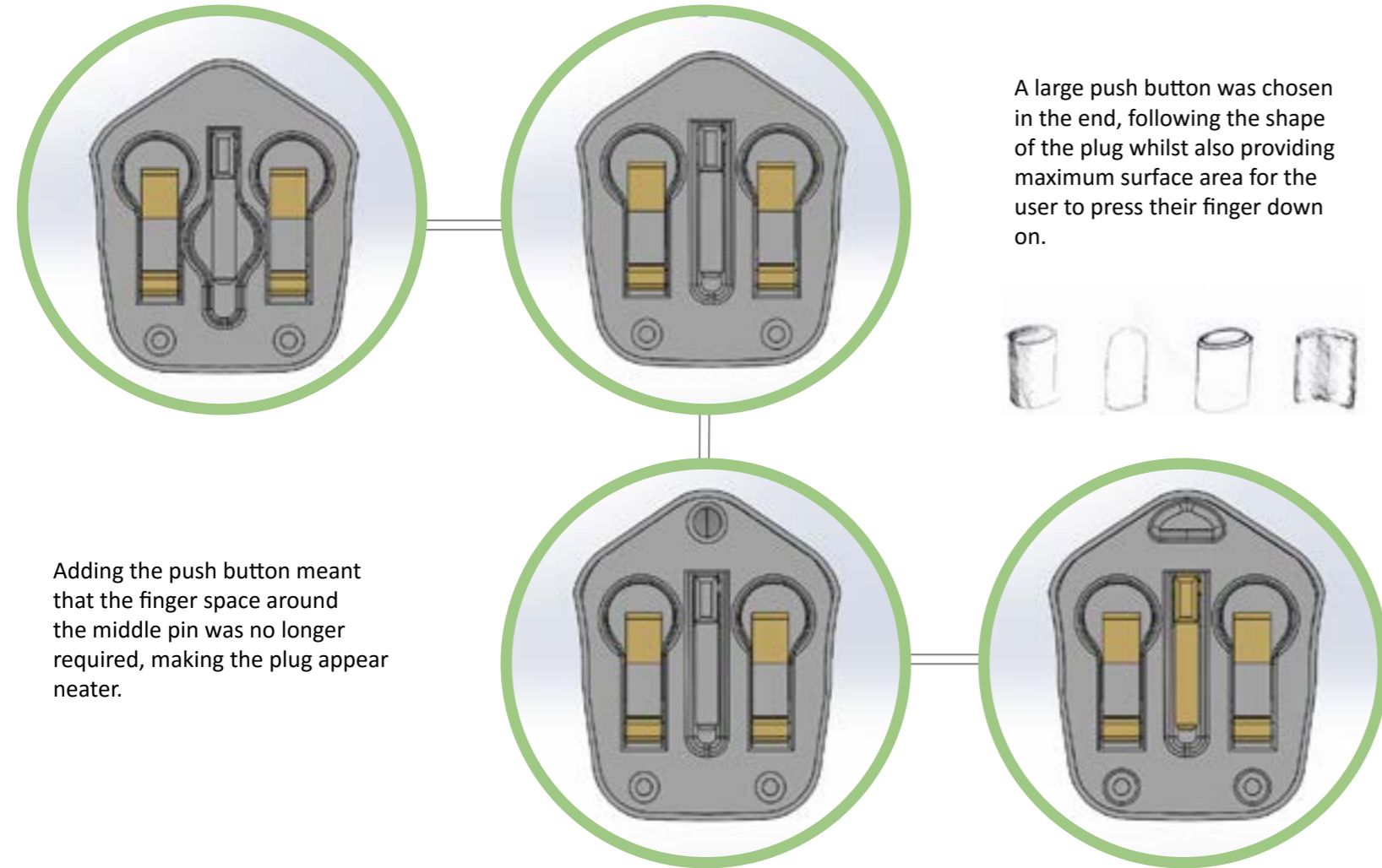
Furthermore, increasing space at the sides would mean that the plug would be wider and therefore exceed limits set by British Standards.

Ideas such as a scroll wheel, push buttons at the top or sides or a small lever were discussed, taking into consideration how the plug would feel in a users' pockets - would any small bumps in the plug be uncomfortable?

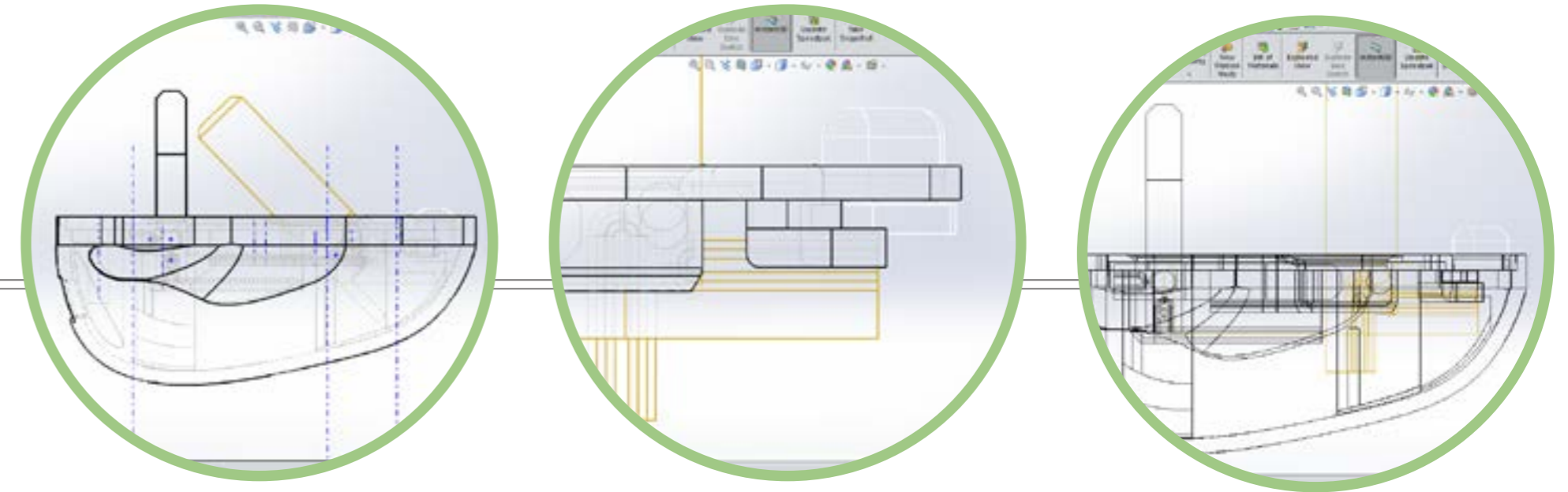
A fragment of plastic was attached to the previous prototype in different places, and put in trouser pockets to test.

It was decided that a push button would be placed at the top of the plug - and not at anywhere in the curved shell, as this complicates the manufacturing and assembly when different shapes/characters are applied.

push button modifications



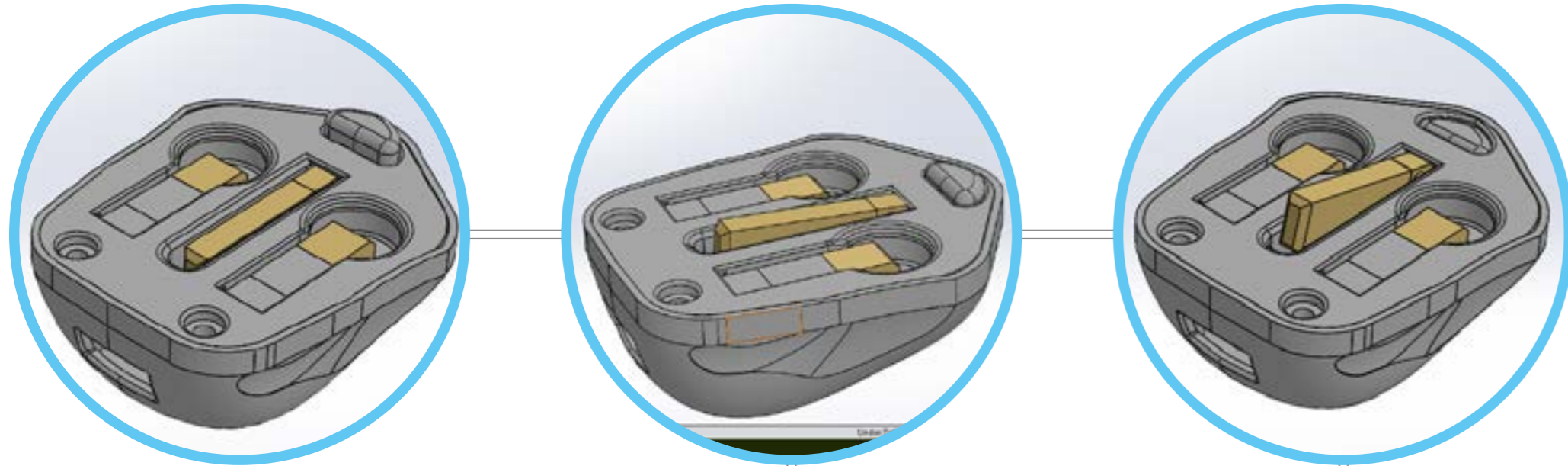
Adding the push button meant that the finger space around the middle pin was no longer required, making the plug appear neater.



The end of the middle pin and the top end of the body was extended to allow space for the pin to rotate and the push button to press down on it, lifting the pin by up to 5mm - this small leverage produces enough space for the user to pull the rest of the pin up with the fingers.

Ideally the button would be spring loaded, so that it sits flush with the surface of the top lid, and also sit against the wall when plugged in. Folding the pin back down would release the button back to its start position again.

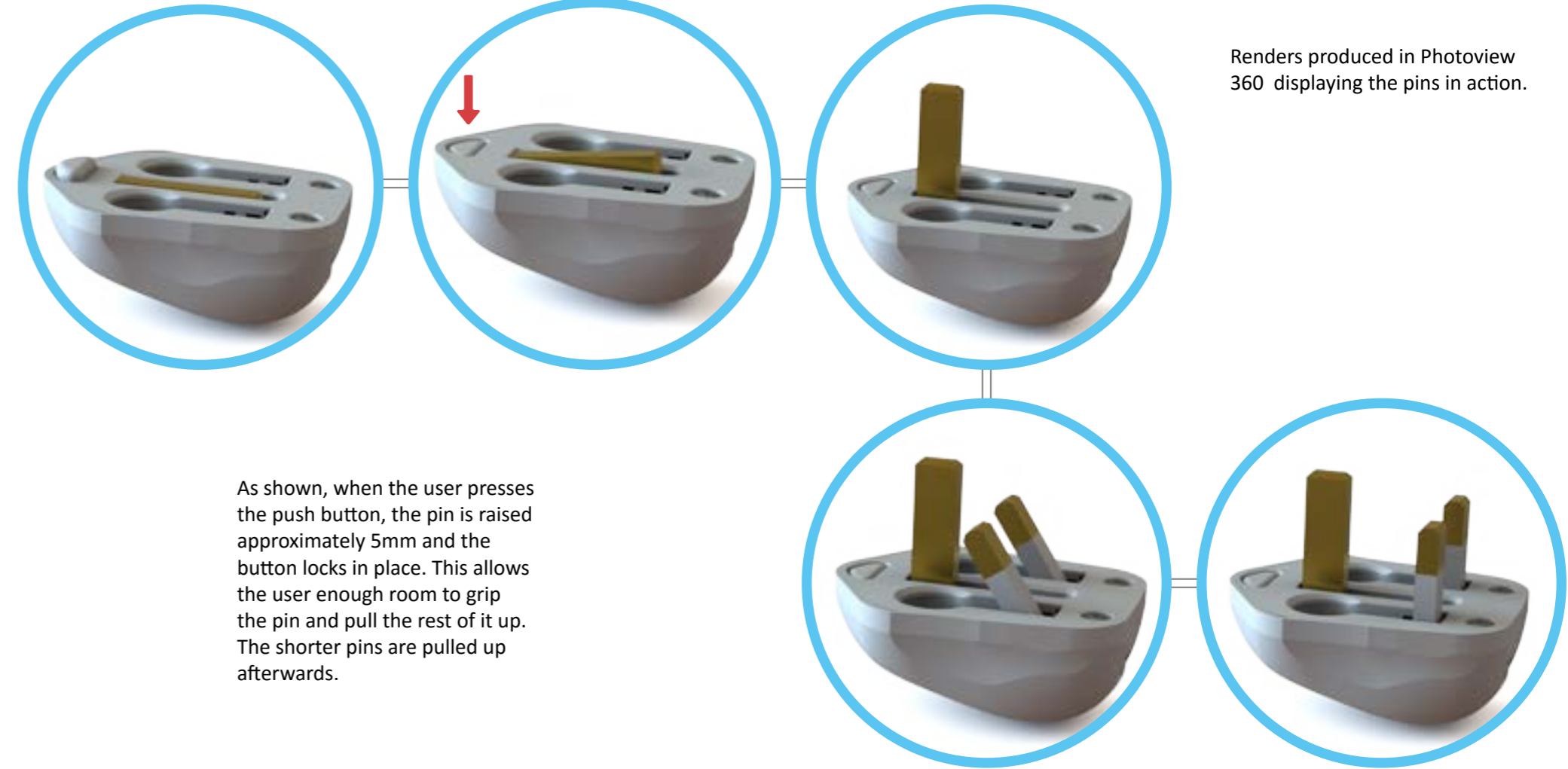
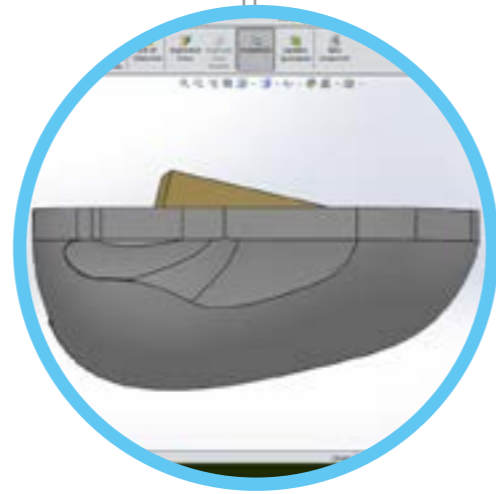
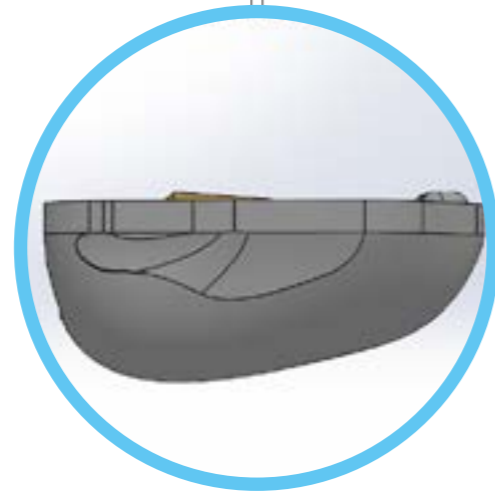
model no.4/final concept



The finalised concept. Further detail would be required in the push button mechanism before it can be rapid prototyped.

All injection moulded parts would be made of white high gloss ABS, with standard self tapping screws and snap fittings. The pins would be specially machined. Space has been left for internal wiring and pin cases.

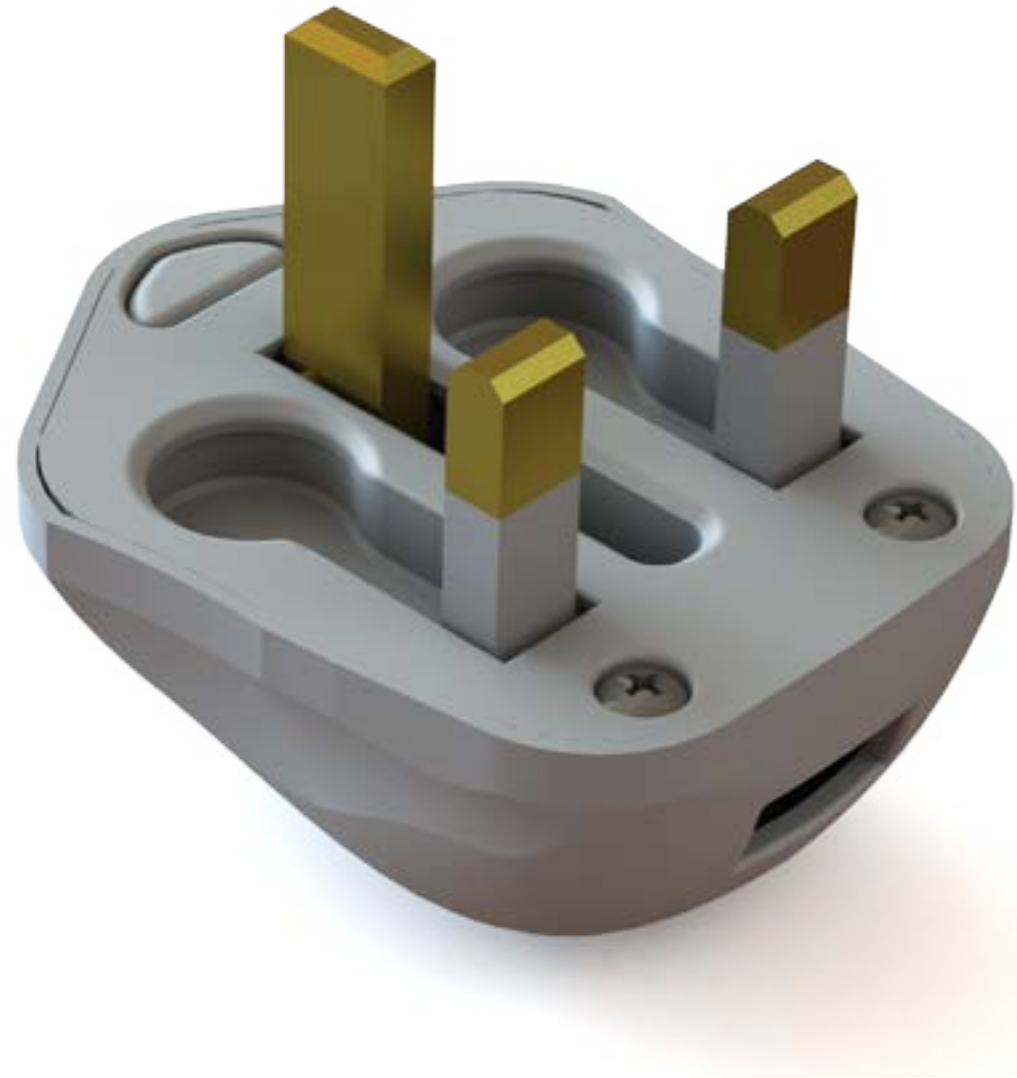
The inset lid and standard fittings mean that various shell designs can be produced, allowing for a greater product range as described in the brief.



As shown, when the user presses the push button, the pin is raised approximately 5mm and the button locks in place. This allows the user enough room to grip the pin and pull the rest of it up. The shorter pins are pulled up afterwards.

Renders produced in Photoview 360 displaying the pins in action.

final concept



The plug could come in several finishes or colours, such as bright colours to reflect their branding, or satin/gloss finishes. The changeable cover (assembled before sold) could be quite playful, such as tortoise shell or ladybird casings.

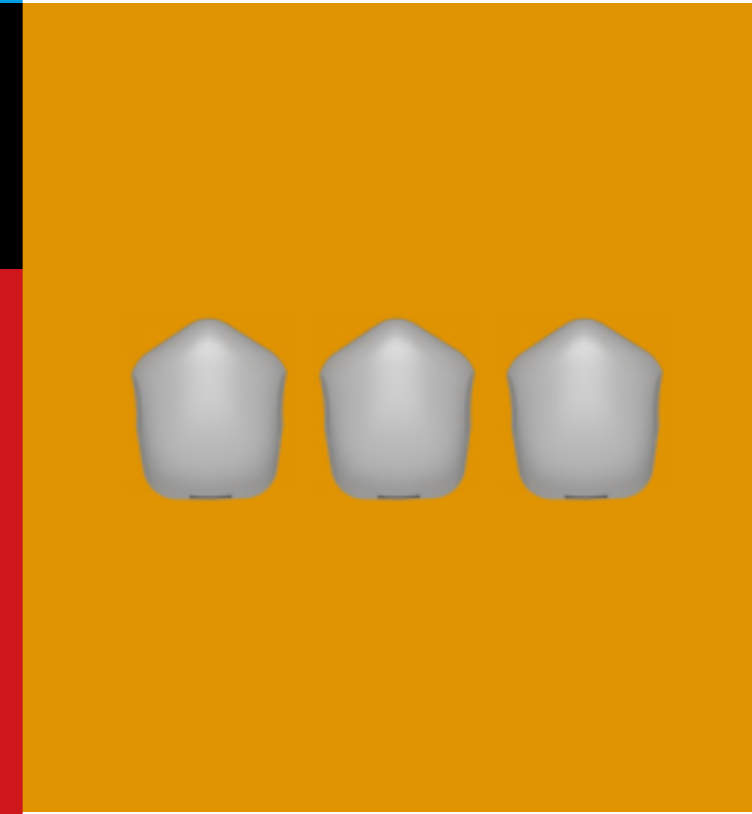
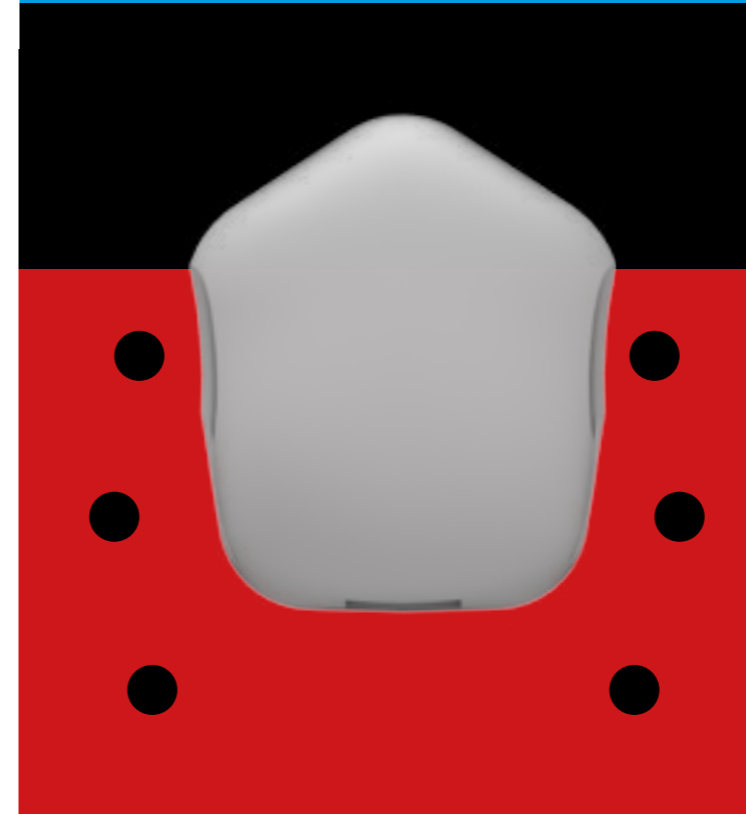


image references

1. http://www.advancetec.co.uk/media/catalog/product/cache/1/image/1250x1250/b65b7106e6199ae52d7f-08f5a5033ae0/a/p/apple_3_pin_usb_power_adapter_mains_charger_uk_wall_plug_for_iphone_5_ipod_nano_7_ipod_touch_5_-_md812b-a.jpg
2. http://ecx.images-amazon.com/images/I/51hQVgw6tIL._SX522_.jpg
3. http://ecx.images-amazon.com/images/I/51q0LNLzItL._SY300_.jpg
4. http://i.telegraph.co.uk/multimedia/archive/02142/mu_2142522b.jpg
5. http://www.wired.com/images_blogs/gadgetlab/2009/12/choi-folding-plug.jpg
6. http://i00.i.aliimg.com/wsphoto/v0/1610911468_1/Patent-Expansion-Socket-design-2-1A-Folding-AC-Plug-VoJo-Bone-Dual-USB-travel-Charger-for.jpg
7. BS 1363-1-1995+A4-2012--[2015-06-16--11-39-18 PM]
8. <http://www.swissarmy365.co.uk/images/products/zoom/1293640910-30044000.jpg>
9. http://i.istockimg.com/file_thumbview_approve/19820715/5/stock-illustration-19820715-hand-cupped.jpg
10. <http://www.jimbodetools.com/images/products/290674.jpg>