Protech Six

Group #6

Group Members:
Sebastian Baehr
Uriel Barragan
Josh DeWitt
Bradley Seamons
Caleb Wright

Comprehensive Overview

Roles

Team Roles were chosen during lab 4 and were not followed exactly as they were planned throughout the semester, however, our team did a good job staying organized, on task, and delegating the workload among team members.

- Task manager/Ops - Caleb
- Documentation - Josh
- Connector Design - Caleb & Josh
- Case Design - Sebastian, Bradley & Uriel
- Manufacture Lead - Sebastian

The roles of Task Manager/Ops and Manufacturing Lead were followed closely throughout the project, as Caleb set up the project tasklist and delegated tasks according to it and Sebastian took the lead on assembly drawings and the BOM. The Documentation, Connector Design, and Case Design roles were not served as strict positions, but rather as a series of tasks that were completed by all team members throughout the project. Overall, our team organizational structure and work delegation was satisfactory and led to a successful project.

Lab 4

During Lab 4, the team brainstormed ideas for the product, discussed a plan of action for the semester, and chose team roles. Josh played a large role taking notes and recording sketches of ideas during the brainstorming section which was helpful when later deciding which design we were going to pursue. The rest of the team worked on the lab report, answering 1-3 questions each.

Lab 6

In Lab 6, the team explored options for manufacturing the product and brainstormed the types of tolerances and fits that were necessary for the part to be manufactured to serve its function. As manufacturing lead, Sebastian took charge of the manufacturing processes section and led a productive discussion on the different ways our product could be manufactured, which ultimately led to the creation of a table noting the potential production processes for the product. Caleb, Uriel, and Bradley worked on drawing and tolerancing the phone case which was reviewed and revised heavily by Josh later that day.

Lab 8

In this lab, Caleb (Task Manager) took charge of creating the project schedule in a spreadsheet and assigned both short and long-term tasks to each member of the group. Tasks included specific detail drawing completion as well as documentation and prototyping The entire group filled out the lab report and agreed to meet to discuss project details and start prototyping.

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Drawings

All team members have been involved in the design and drawing for the product since the beginning of the project. Sebastian created the Exploded Isometric Assembly, Outline Assembly, and Bill of Materials almost entirely on his own by referencing the parts made by other team members.

Josh designed and created drawings for the phone case and API attachment which has served as the foundation for which all accessories could be made. This was instrumental because it allowed more team members to expand the design to include more accessories (Money Clip and Laser Attacher) and further distribution of work.

Bradley created the case attachment drawing. This part was foundational to our project since it is what allows all the accessories to interface with the phone, so the GD&T tolerancing and dimensioning specified are very important.

Caleb created the initial and final drawings for the money clip attachment, including GD&T tolerancing and dimensioning.

Uriel created the drawings for the laser pointer holder. This was our focus accessory, and it took several prints to get the size of the inside hole correct, so he adjusted the drawings accordingly.

Sebastian tied together all of the parts with the assembly drawing. This drawing shows the way that our group's case and attachments interface together. He also checked or approved the detail drawings of each part.

Prototyping:

Sebastian created the initial prototype on the phone case on the ultimaker with ABS plastic and also helped with the assembly of the case attachment,

Josh created the laser cut case attachment, versions 1 through 3. He coordinated printing of the flexible phone case, researching viability of using a personal FDM with flexible material, the

Carbon3D, and settling on the Objet. He also managed 3D prints for 332 Jacobs, primarily the money clip version 2 and the flexible phone case.

Bradley was in charge of an abs prototype of the phone case. It was not used because it was so stiff that the phone would not even fit inside of it.

Caleb created the initial prototype for the money clip attachment which did not end up serving as the final prototype. He worked with Josh to determine the best prototyping method and design for the final money clip prototype. Caleb also was heavily involved in the assembly of the case attachment mechanism prototype by acrylic cementing and gluing the laser cut acrylic and 3D printed plastic components of the assembly together (case attachment, spacer, magnet, rotating mechanism)

Uriel created the initial laser pointer holder design. It did not work at first because the inside was too small, so he took the lead on fixing it. Rather than relying on the manufacture dimensions, he measure the actual laser pointers to make sure the new print would work.

Report Writing:
Sebastian researched and documented the differentiation of our solution to other solutions, the process selection of the phone case (part 1), and part of the reflection.

Josh drafted the first section of the Fits and Tolerance section focused on the fits and tolerances between the phone case and the case attachment, process selection parts 2 and 3.

Bradley drafted the Scaled-Up Production Plan and Market Need sections by going through course material and researching independently. He also served as an editor for the whole report document. He edited the sections written by all team members to ensure consistency in voice.

Caleb served a copy editor for the entire report document. He revised and edited the sections written by all team members to ensure consistent content, structure, and writing conventions.

Uriel also served a report document editor. He reviewed and edited the sections written by all team members to ensure correct use of writing conventions and consistent information throughout.

Presentation:
Sebastian focused on the assembly drawing throughout the project, so he could explain how the parts fit together when setting up the phone case.

Josh took the lead when it came to manufacturing the case after our first failures, so he could speak to our rationale to use the objet printer.

Bradley could speak to the first failed case, and why pure pla plastic was not a good idea for a case.

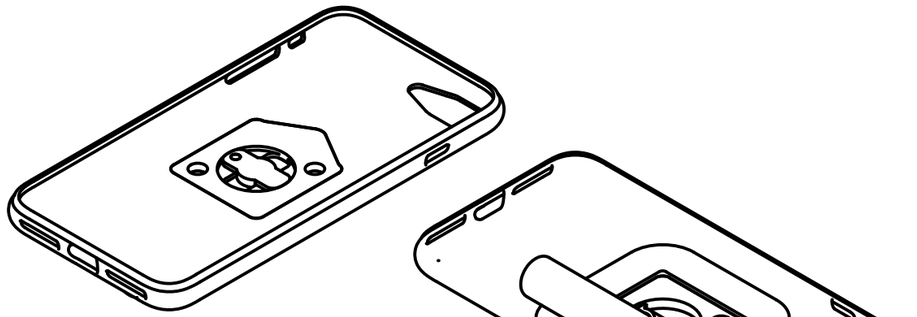
Caleb will not be able to attend the Jacobs Design Showcase until 2:30pm on Thursday, November 6, but is prepared to talk about the design, prototyping, and tolerancing processes with the general public once he arrives.

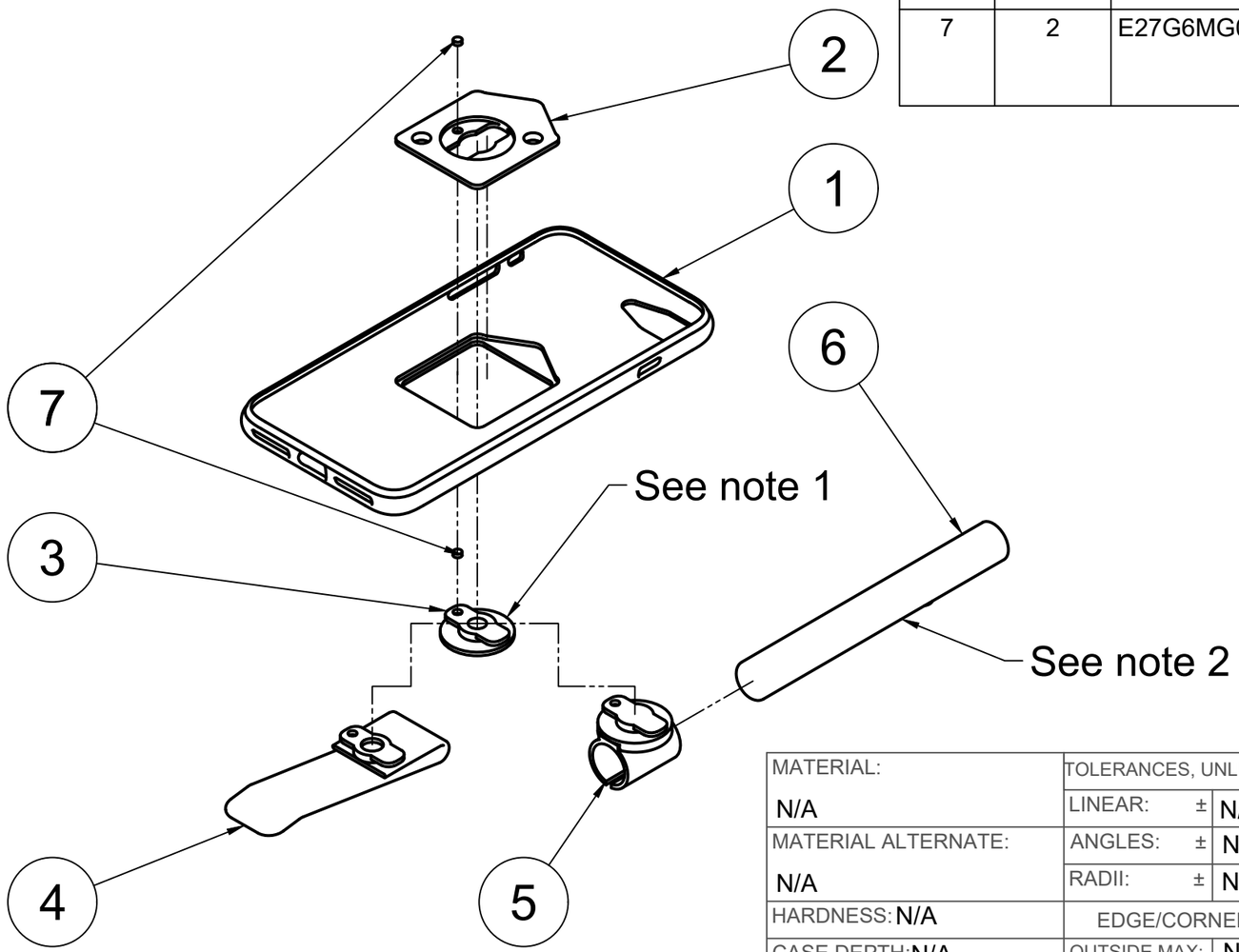
Uriel is prepared to talk about his main focus, the laser pointer holder. He also helped a lot with the drawings so he is prepared to talk about that as well.

Final Prototype Pictures

Laser Pointer on Phone

API Expander on Phone





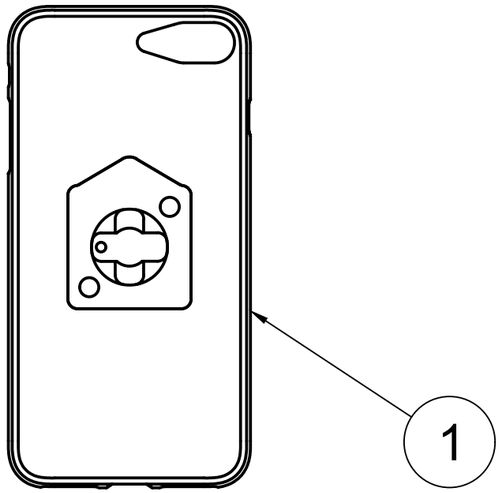
PARTS LIST					
ITEM	QTY	PART NUMBER	PART NAME	DESCRIPTION	MATERIAL
1	1	E27G6CS02	CASE	CASE WITH ADAPTER MOUNT	THERMOPLASTIC RESIN
2	1	E27G6CA02	CASE ATTACHMENT	ATTACHMENT TO BOTH CASE AND ACCESSORY	ACRYLIC
3	1	E27G6API02	API EXPANDER	BADE FOR HOW TO CONNECT ACCESSORY ATTACHMENTS	ACRYLIC
4	1	E27G6MC02	MONEY CLIP	ACCESSORY ATTACHMENT TO HOLD MONEY	ABS PLASTIC
5	1	E27G6LH02	LASER POINTER HOLDER	ACCESSORY ATTACHMENT TO HOLD LASER POINTER	ABS PLASTIC
6	1	E27G6LP02	LASER POINTER	LASER POINTER SOURCED FROM INNOZON LASER CAT TOY	MULTI- MATERIAL
7	2	E27G6MG01	MAGNET	MAGNET TO ALIGN AFTER INSERTION AND TURN. SOURCED FROM K&J MAGNETICS	IRON, GRAY

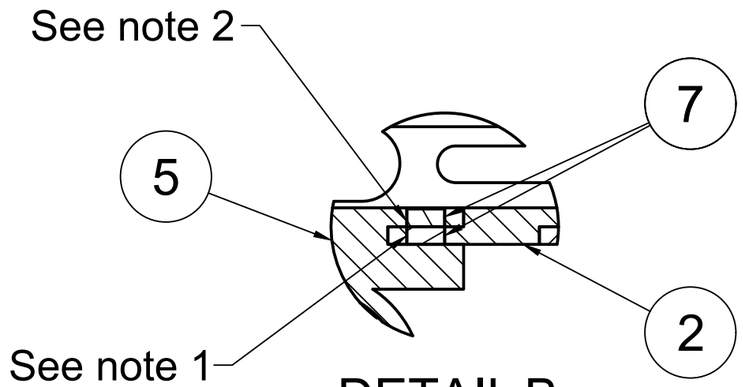
Notes

1. Part 3 is basis for how the accessory attachments will attach to the case attachment and is to be replaced with the differentt accessory attachments such as part 4 or 5. (shown in isometric views)
2. Laser pointer only to be included when accessory attachment for laser pointeris in use.

MATERIAL: N/A	TOLERANCES, UNLESS NOTED		UNITS: IN	SCALE: 1:2	PART NO E27G6ASM02 / GROUP 6
MATERIAL ALTERNATE: N/A	LINEAR: ± N/A		US IMPERIAL US:B	THIRD ANGLE PROJECTION	PART NAME: PHONE CASE ASSEMBLY
HARDNESS: N/A	ANGLES: ± N/A				PAGE # 1/2 Company: PROTECH SIX
CASE DEPTH: N/A	RADII: ± N/A				DRAWN BY: SEBASTIAN B. DATE: 12/3/18
SURFACE TREATMENT: N/A	EDGE/CORNER BREAKS		PERFORMANCE OF WORK FOR E27 PROTECTED SIX, OR ENGINEERING HOMEWORK. ALL QUESTIONS MUST BE REFERRED TO E27 GROUP 6.		CHECKED BY: Josh DeWitt DATE: 12/4/18
	OUTSIDE MAX:	N/A			APPROVED BY: Bradley Seamons DATE: 12/4/18
	INSIDE MAX:	N/A			INTERPRET GD&T TO: ASME Y14.5
	RADII, UNLESS NOTED: N/A				

PART NUMBER; E27G6ASM02
NEXT ASM: N/A





DETAIL B
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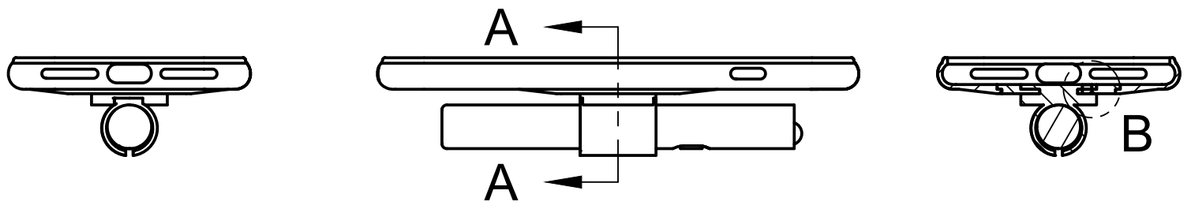
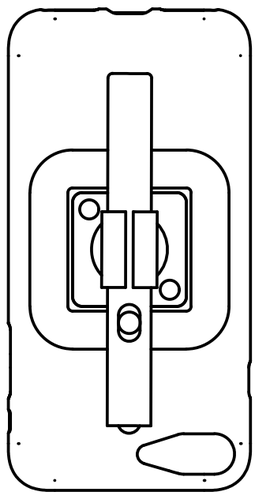


SECTION A-A
SCALE 1:2

NOTES

1. The sides of Part 5 (Magnet) should be super glued to the sides of the hole in part 2
2. The sides of Part 5 (magnet should be super glued to the sides of the hoe in Part 8



MATERIAL: N/A	TOLERANCES, UNLESS NOTED		UNITS: IN	SCALE: 1:2	PART NO E27G6ASM02 / GROUP 6
MATERIAL ALTERNATE: N/A	LINEAR: ±	N/A	US IMPERIAL US:B	THIRD ANGLE PROJECTION	PART NAME: PHONE CASE ASSEMBLY
HARDNESS: N/A	ANGLES: ±	N/A			PAGE # 2/2 / Company: PROTECT SIX
CASE DEPTH: N/A	RADII: ±	N/A			DRAWN BY: SEBASTIAN B. / DATE: 12/3/18
SURFACE TREATMENT: N/A	EDGE/CORNER BREAKS				CHECKED BY: Josh DeWitt / DATE: 12/4/18
	OUTSIDE MAX:	N/A			APPROVED BY: Bradley Seamons / DATE: 12/4/18
	INSIDE MAX:	N/A			INTERPRET GD&T TO: ASME Y14.5
	RADII, UNLESS NOTED: N/A				

PERFORMANCE OF WORK FOR E27 PROTECTED SIX, OR ENGINEERING HOMEWORK. ALL QUESTIONS MUST BE REFERRED TO E27 GROUP 6.

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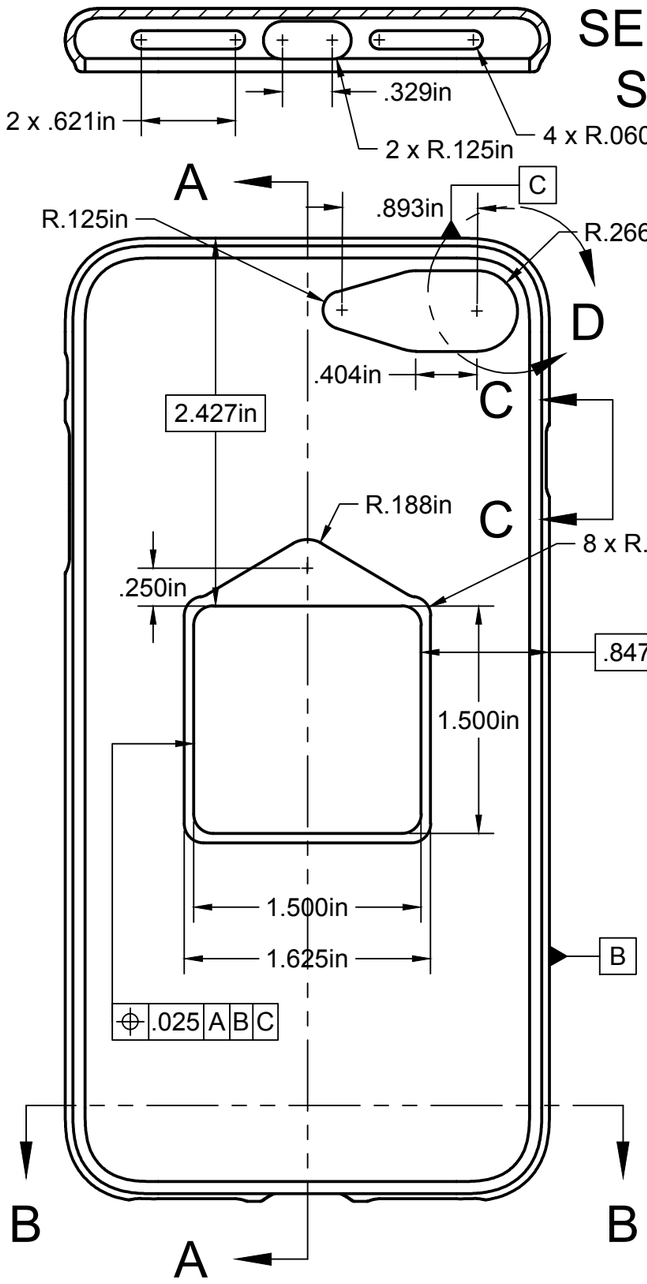
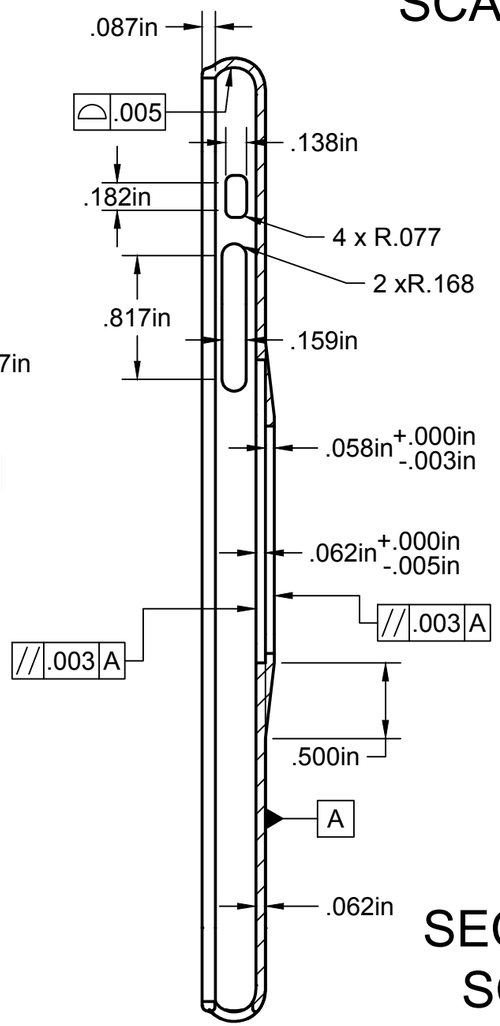
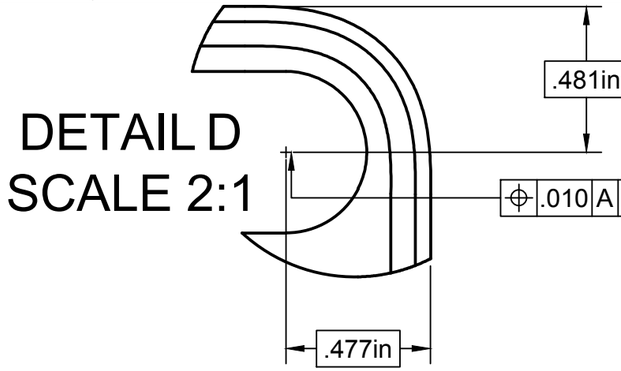
Next Assem: E27G6ASM02



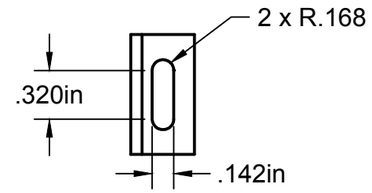
SECTION B-B
SCALE 1:1



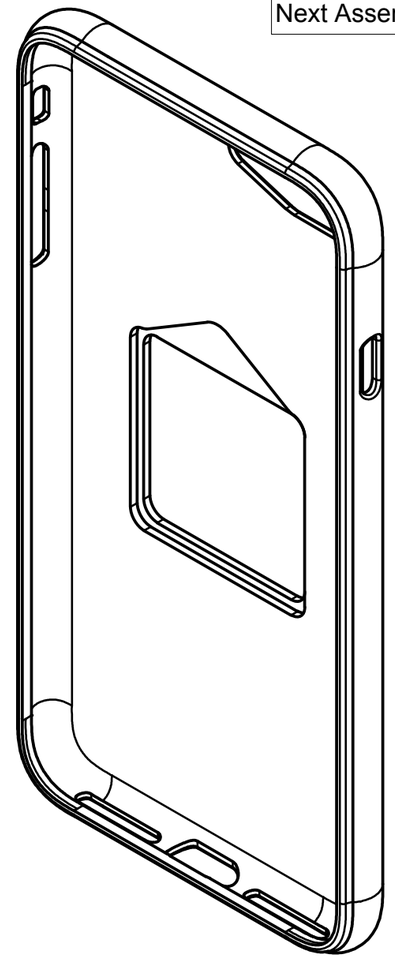
SECTION A-A
SCALE 1:1



DETAIL D
SCALE 2:1



SECTION C-C
SCALE 1:1



Notes:

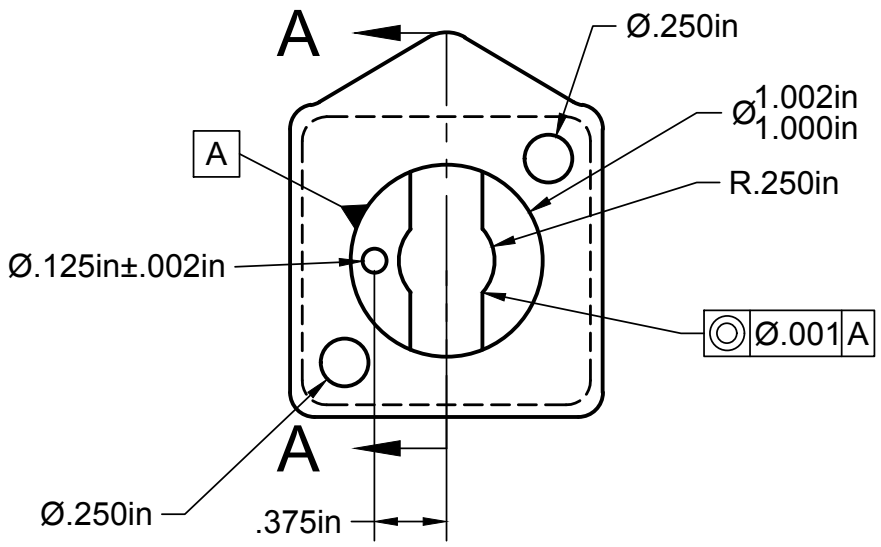
- Control Spline defines inner and outer case curve. See Apple release docs for control points.
- Case thickness is constant throughout shell.

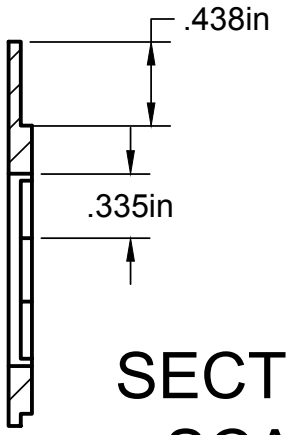
MATERIAL: RGD8340 - Resin	TOLERANCES, UNLESS NOTED	UNITS: IN	SCALE: 1:1
MATERIAL ALTERNATE: EPU60	LINEAR: ± .005	US IMPERIAL US:B	THIRD ANGLE PROJECTION
HARDNESS: N/A	ANGLES: ± 2		
CASE DEPTH: N/A	RADII: ± .003		
SURFACE TREATMENT: Waterjet cleaned	EDGE/CORNER BREAKS		
	OUTSIDE MAX: .010		
	INSIDE MAX: .003		
	RADII, UNLESS NOTED: .063		

PERFORMANCE OF WORK FOR E27 PROTECTED SIX, OR ENGINEERING HOMEWORK. ALL QUESTIONS MUST BE REFERRED TO E27 GROUP 6.

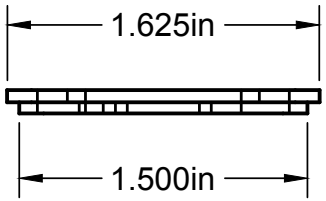
PART NO E27G6CS02		GROUP 6
PART NAME: CASE		
PAGE # 1/1	Company: PROTECH SIX	
DRAWN BY: Josh DeWitt		DATE: 12/3/18
CHECKED BY: Sebastian Baehr		DATE: 12/4/18
APPROVED BY: Bradley Seamons		DATE: 12/4/18
INTERPRET GD&T TO:		ASME Y14.5

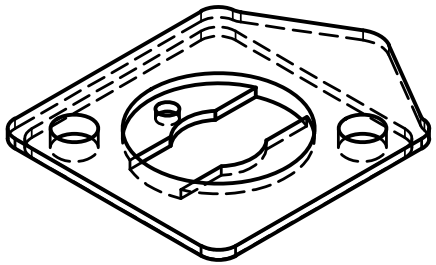
Part No:	E27G6CA02
Next Assem:	E27G6ASM02





SECTION A-A
SCALE 1:1





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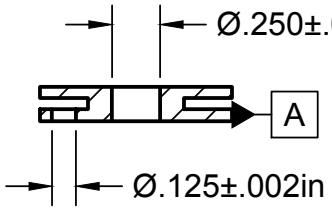
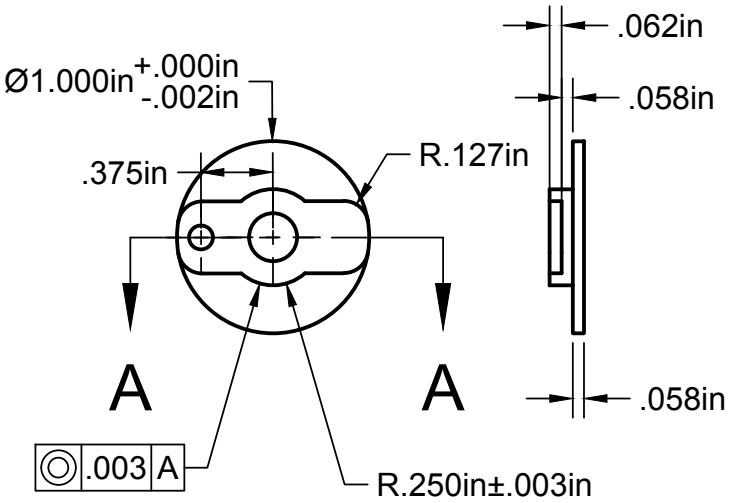
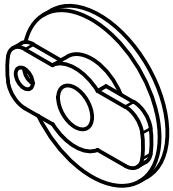
MATERIAL ALTERNATE: Rigid Plastic	LINEAR: ±	.005	US IMPERIAL US:A	THIRD ANGLE PROJECTION	PART NAME: CASE ATTACHMENT
HARDNESS: N/A	ANGLES: ±	.1			PAGE # 1/1 — Company: PROTECH SIX
CASE DEPTH: N/A	RADII: ±	.0625			DRAWN BY: Bradley Seamons — DATE: 12/3/18
SURFACE TREATMENT: Glossy	EDGE/CORNER BREAKS				CHECKED BY: Sebastian Baehr — DATE: 12/4/18
	OUTSIDE MAX:	.010			APPROVED BY: Josh DeWitt — DATE: 12/4/18
	INSIDE MAX:	.002	PERFORMANCE OF WORK FOR E27 PROTECTED SIX, OR ENGINEERING HOMEWORK. ALL QUESTIONS MUST BE REFERRED TO E27 GROUP 6.		INTERPRET GD&T TO: ASME Y14.5
	RADII, UNLESS NOTED:	.063			

Part No:	E27G6API02
Next Assem:	E27G6ASM02



SECTION A-A
SCALE 1:1





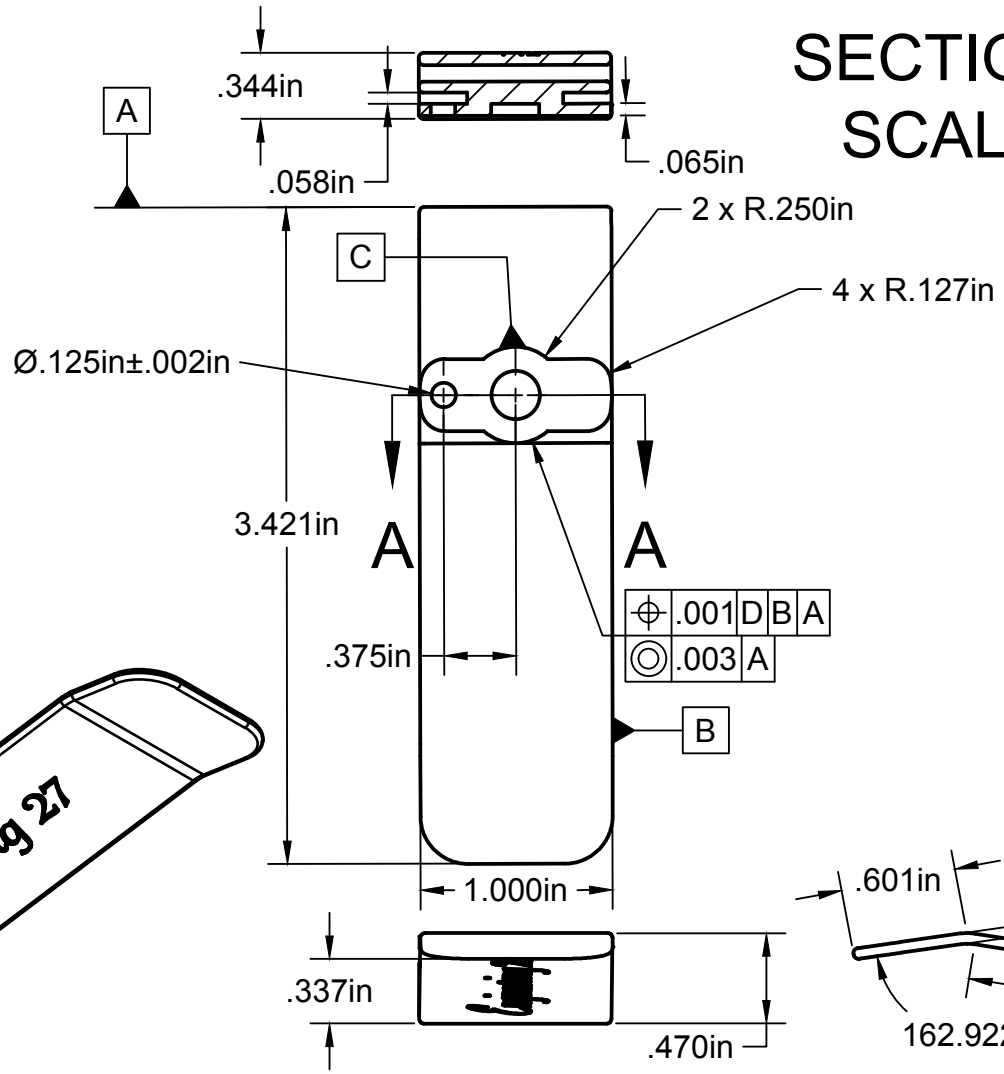
Notes:

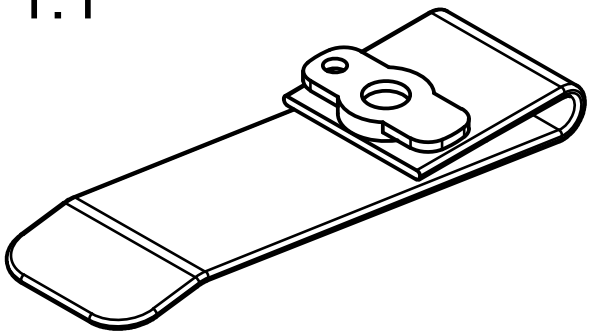
- API for developing new hardware attachments.
- Center hole for alignment - use .25in dowel pin
- Thickness is optimized for 1/16in acrylic layered together with acrylic cement
- Hole for magnet

MATERIAL: Rigid Plastic	TOLERANCES, UNLESS NOTED		UNITS: IN	SCALE: 1:1	PART NO E27G6API02 / GROUP 6
MATERIAL ALTERNATE: Cast Acrylic	LINEAR: ±	.005	US IMPERIAL US:A	THIRD ANGLE PROJECTION	PART NAME: API EXPANDER
HARDNESS: N/A	ANGLES: ±	.1			PAGE # 1/1 — Company: PROTECH SIX
CASE DEPTH: N/A	RADII: ±	.03125			DRAWN BY: Josh DeWitt — DATE: 12/3/18
SURFACE TREATMENT: Glossy	EDGE/CORNER BREAKS				CHECKED BY: Sebastian Baehr — DATE: 12/4/18
	OUTSIDE MAX:	.010			APPROVED BY: Bradley Seamon — DATE: 12/4/18
	INSIDE MAX:	.002	PERFORMANCE OF WORK FOR E27 PROTECTED SIX, OR ENGINEERING HOMEWORK. ALL QUESTIONS MUST BE REFERRED TO E27 GROUP 6.		INTERPRET GD&T TO: ASME Y14.5
	RADII, UNLESS NOTED:	.063			

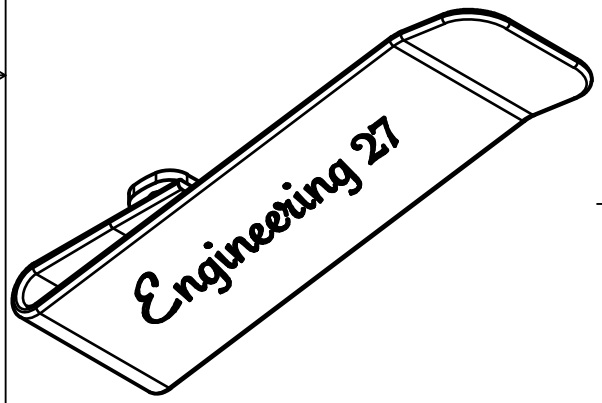
Part No: E27G6MC02
Next Assem: E27G6ASM02

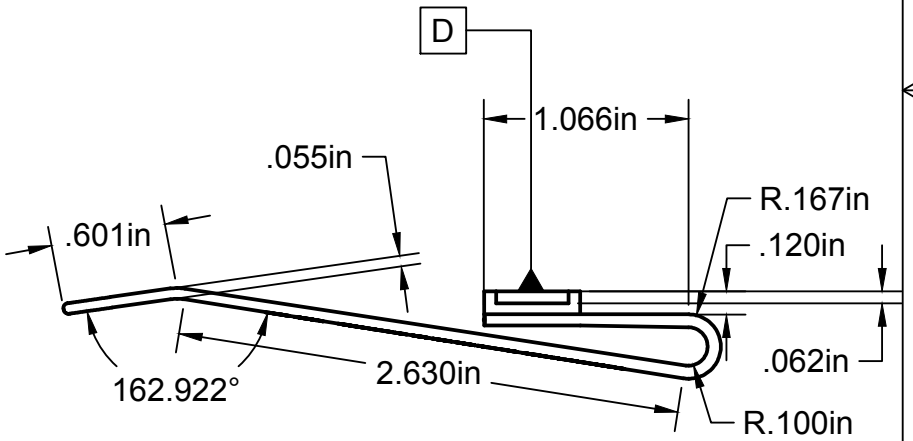
SECTION A-A
SCALE 1:1





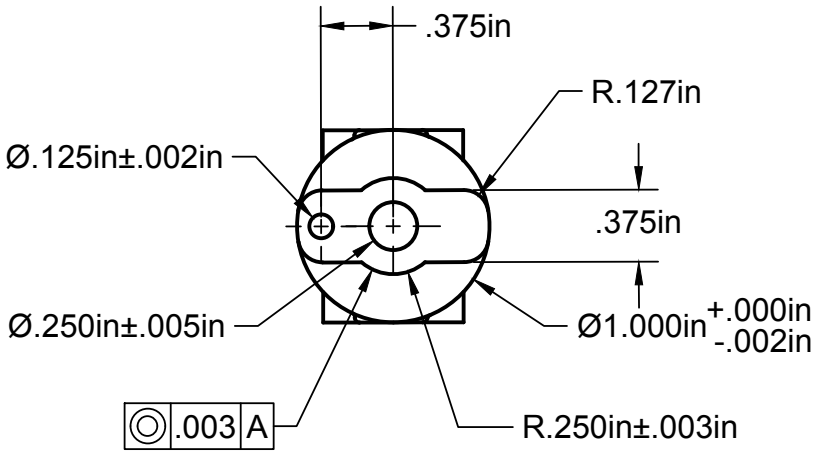
Notes:
- Text is in Savoye LET, size .375in

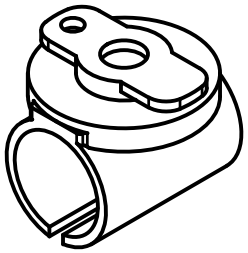


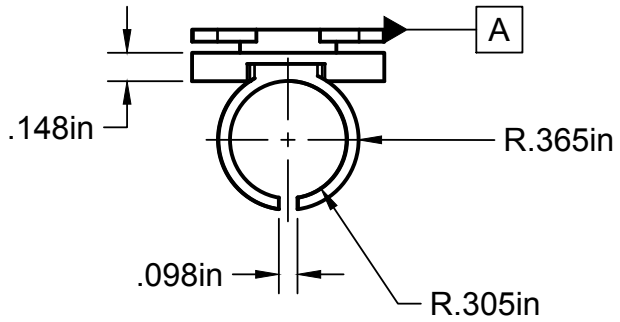


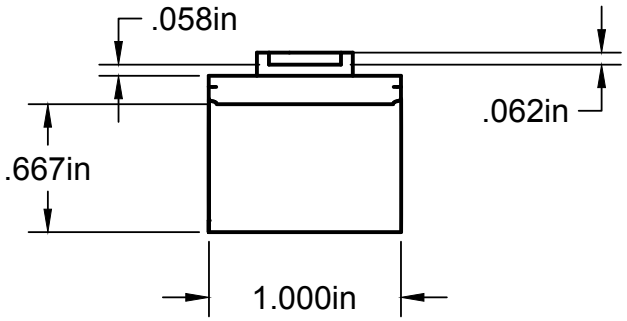
MATERIAL: RGD8345 Resin	TOLERANCES, UNLESS NOTED	UNITS: IN	SCALE: 1:1	PART NO E27G6MC02	GROUP 6
MATERIAL ALTERNATE: PLA Plastic	LINEAR: ± .005	US IMPERIAL US:A	THIRD ANGLE PROJECTION	PART NAME: MONEY CLIP	
HARDNESS: N/A	ANGLES: ± .1			PAGE # 1/1	Company: PROTECH SIX
CASE DEPTH: N/A	RADII: ± .03125			DRAWN BY: CALEB WRIGHT	DATE: 12/3/18
SURFACE TREATMENT: Waterjet cleaned	EDGE/CORNER BREAKS			CHECKED BY: Josh DeWitt	DATE: 12/4/18
	OUTSIDE MAX: .010			APPROVED BY: S P Baehr	DATE: 12/4/18
	INSIDE MAX: .002	PERFORMANCE OF WORK FOR E27 PROTECTED SIX, OR ENGINEERING HOMEWORK. ALL QUESTIONS MUST BE REFERRED TO E27 GROUP 6.		INTERPRET GD&T TO:	ASME Y14.5
	RADII, UNLESS NOTED: .025				

Part No:	E27G6LH02
Next Assem:	E27G6ASM02









MATERIAL: ABS plastic	TOLERANCES, UNLESS NOTED		UNITS: IN	SCALE: 1:1	PART NO E27G6LH02 / GROUP 6
MATERIAL ALTERNATE: Acrylic and PLA	LINEAR: ±	.005	US IMPERIAL US:A	THIRD ANGLE PROJECTION	PART NAME: LASER POINTER HOLDER
HARDNESS: N/A	ANGLES: ±	.1			PAGE # 1/1 — Company: PROTECH SIX
CASE DEPTH: N/A	RADII: ±	.03125			DRAWN BY: Uriel Barragan — DATE: 12/3/18
SURFACE TREATMENT: Sanded clean	EDGE/CORNER BREAKS				CHECKED BY: Josh DeWitt — DATE: 12/4/18
	OUTSIDE MAX:	.010			APPROVED BY: SP Baehr — DATE: 12/4/18
	INSIDE MAX:	.002			INTERPRET GD&T TO: ASME Y14.5
	RADII, UNLESS NOTED:	.025			

PERFORMANCE OF WORK FOR E27 PROTECTED SIX, OR ENGINEERING HOMEWORK. ALL QUESTIONS MUST BE REFERRED TO E27 GROUP 6.

Market Need

Fig 1: Case and Attachment Mechanism

There are many different phone accessories: lenses that go over the camera, popsockets, and mini wallets. However, one of the biggest problems with phone accessories is that they are often not compatible with each other. Lenses often come mounted on cases, popsockets often come with a sticky side that can only be added onto one case, and mini wallets often come on the back of a case. We wanted to standardize the attachment of phone accessories by creating an interface that allows you to add and exchange different accessories on your phone quickly and easily. Our solution is a phone case that contains a female slot that a universal male attachment plug can fit into and rotate into a locked position. The male plug is meant to be universal adapter that can serve as the foundation for any type of phone accessory, allowing designers to use our attachment mechanism to create their own phone accessory. (Fig 1)

We decided to prototype two accessories using the universal attachment mechanism (API) to showcase the different applications enabled by our product. The first is a laser pointer attacher. (Fig 2) During powerpoint presentations it is often nice for presenters to have a laser pointer to highlight important points on their slides to the audience. People can use their phones as presentation remotes using various mobile applications that wirelessly link to their computer, and having a laser pointer attached to their phone would transform the phone into an all in one presentation device.

Figure 2: Laser Pointer Attacher with Laser Pointer Installed

Our second accessory is a money clip (Fig 3). Many people have wallets that are unorganized and full of cards or other various information that is difficult to sort through quickly when trying to get cash to make a purchase. By attaching a money clip accessory to the attachment enabled phone case, users will be able to store all of their cash on the back of their phone, where it is convenient and easy to access.

Figure 3: Money Clip Attachment

Overall, we plan to market our phone case with the built in attachment mechanism directly to users and encourage both users and product designers to create additional accessories to be attached to the standard phone case system through the use of our attachment API foundation.

Differentiation

Currently, designers and companies address individual user needs by creating either a phone case with a specific purpose (Ztylus Camera kit that improves iPhone camera quality but restrict's a user to their case [1]) or a specific accessory that can attach to any phone or phone case (Gecko adhesive phone wallet allows you to add a wallet to your case, but if you ever want to change cases, you can not.). This is problematic because it restricts the user to one accessory on their phone at a time, and getting another accessory would require purchasing an entire new case or rendering an adhesive based accessory as useless. This is expensive and frustrating for the user.

Our phone case differs because it offers a universal accessory attachment system that can be used seamlessly between a wide range of accessory functions such as laser pointer attachments,

money clips, tripods, creative emblems, belt clips, etc. This approach is beneficial for both phone users who seek to get multiple functions out of their phone and designers who are looking for a way to reach users with their phone accessory products.

Fits and Tolerances

There are two primary areas of fits: between the case and attachment device, and between the attachment device and the end accessory.

1. Between the case and the attacher, there is no mechanical fastener; it is the case's geometry itself must keep the parts connected. This keeps the assembly simpler, but requires specific fits with the case. A lip creates an overhang on the case which keeps the attacher against the phone in the Z direction. This lip also constrains the attacher transversely in the XY plane of the phone. Because the material of the case is slightly elastic, the fit can be transition, utilizing the flex of the case designed to absorb shock to use a looser tolerance to decrease production costs. There need to be two parts because the attachment device needs to be rigid to interface well with the moving parts of the end accessories, while the case needs to be flexible to fit over the phone with a full wraparound border and absorb shock in case of drops. This criteria requires a tight fit so that the two parts fit together and act as a single piece. During the prototyping process, the thickness of the acrylic plates dictated the case's dimension, and the printing processes layer height determined the case tolerance. Therefore, following the flexible logic of the case, we designed the case to have a slight interference fit so that the case pushes the attachment device into the phone, keeping it in place. The top triangular region gives the attachment device a definable orientation in combination with the magnet in the attacher. This feature follows the same tolerancing style of transition because of the flexible case material, keeping the same general tolerance. Having an orientation allows end accessories to have more options in that they can be repeatedly inserted the same way with less user error. While the two parts do not need exacting tolerances to define their fit, but they do require intentional design and good fits to ensure their function.
2. The attachment device and end accessory require tight tolerances in order to fit together and operate properly. The attachment device hole and end accessory shaft feature must have a clearance tolerance in order for a given accessory to fit within the hole. Unlike the attachment device to case fit, this fit involves two acrylic (prototype) or hard plastic (manufactured) material features with low elasticity and room for error. A position tolerance must be applied to both the end accessory shaft feature and attachment device hole in order to establish a tolerance zone that can be used in manufacturing the assembly. While a clearance fit is essential for allowing the assembly to fit together, too

much clearance of this assembly will lead to an accessory that is free to wiggle around while mounted on the phone case, which will reduce functionality and possibly dissatisfy users that want a firm, locking feel when they have an accessory attached to their phone. While the magnet interface will help counter any discrepancies in manufacturing, tight tolerances will ensure the assembly is user-friendly and effective.

Process Selection

1. **Phone Case**
   We decided to use PolyJet additive manufacturing to print out the phone case. We used an Objet260 Connex3 printer with 50% TangoBlackPlus and 50% VeroWhite. We chose this process because it would provide an accurate print job which would allow the case to be within tolerance. We also needed a printer that could print in an elastic/flexible material so that the phone could fit snugly in the case. Polyjet technology allowed us to print a semi-flexible material. Our first case was printed on the Ultimakers, and while it was dimensionally accurate, it was too stiff to put the phone into. We then moved too far in the other direction, printing a case that was too flexible and did not hold its shape well enough to function as a case. Therefore, we settled on the 50-50 mix to find the Goldilocks zone of case flexibility so that the phone fits and the case can absorb shock.

2. **Case Attachment**
   In our initial prototyping run, we decided to use laser cut and layered acrylic. This would be faster than 3D printing and would allow for more consistency in the Z direction, as the acrylic has a consistent thickness while 3D printers have less resolution in Z than in X and Y. The other concern is overhangs, in that there is no orientation of the part to completely avoid overhangs in one way or the other that make mating surfaces less clean and ideal. A rough surface on the side of the rotating accessory means it would be difficult to use the end accessory, while a rough surface on the mating lip with the case would make it difficult for the attachment to be held in its proper location.

3. **Accessory mounts**
   We created a standardized API to fit our end accessories onto for the prototyping phase. We did one test print of the money clip where the entire part was on the 3D printer, but we had trouble removing support material from around the accessory mount itself. Therefore, we decided to use layered acrylic in a negative of the accessory mount to standardize our fit. One major advantage of this was that the acrylic had a consistent thickness, so the very exacting tolerance in the Z direction was more easily achieved.

The other advantage was that by creating a standardized fit, it is easier to develop new end accessories that can be more easily mounted with an alignment hole in the center and a flat surface to glue to the acrylic. One issue with laser cutting is the kerf, the thickness of the laser as it cuts through the material. Because the laser cutters travel along the center of the path, there is a slight amount of material that is burned away from both sides, meaning that parts are not their true dimensions. We worked to measure the kerf and correct for it so that our cuts would be exactly to tolerance, and we would have a smooth and consistent fit between the end accessory mount and the case attachment.

Scaled-Up Production Plan

If we scaled up production of our phone case and attacher, we would want to be able to produce the attacher and housing for it in one step. In our current prototype, we laser cut the three layers on acrylic for the attacher and two for the housing (Fig 4). We then tediously removed the paper and glued the layers together. It was a very slow and oddly difficult process, so that is definitely the first thing we would address to make sure the process can be scaled up. The next thing we would want to address is the case. We printed our prototype using 50% PLA and 50% flexible material. 3D printing is rather slow, so to mass produce the case we would want to injection mold it using a slightly flexible plastic such as Flexible Polyvinyl Chloride (PVC). A mix of 50% straight PLA and 50% flexible plasticizers would work perfectly. As for the laser pointer holder, we can injection mold this out of PLA since it does not need to be flexible. The money clip does need a slight bit of flexibility so it does not snap when in use. For this reason, we would likely injection mold it using a Flexible Polyvinyl Chloride (PVC) with a mix of 80% PLA and 20 % flexible plasticisers. By injection molding and reducing the acrylic work, we make the process of making the phone case and attachments much more efficient.

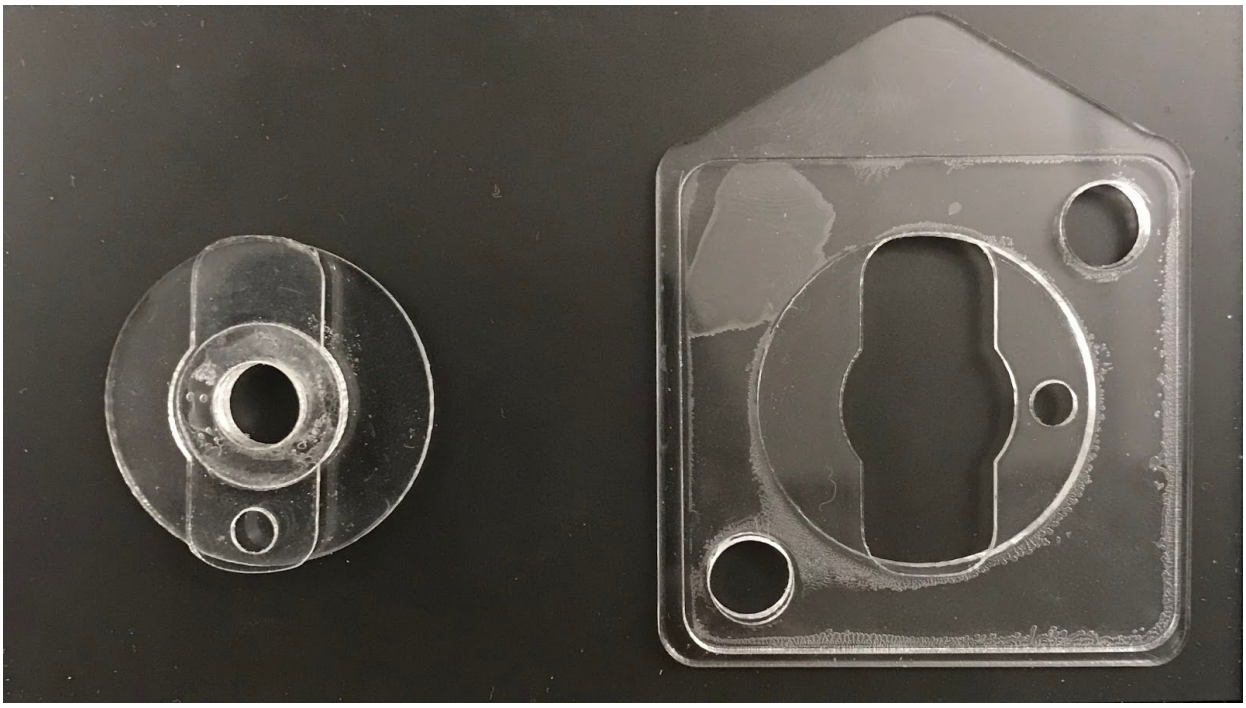


Figure 4: Prototyped acrylic attacher (left) and prototyped acrylic housing (right).

Reflection

Failing early is always better than failing later; by failing early, we were able to redesign the failed components and retest them to ensure that the components were working as intended. Additionally, failing early allowed us to have enough time to redesign components in a calm, efficient manner.

Being able to make drawings that accurately represent the assembly of our product is very important. Our drawings/components are designed for mass production; if the manufacturer/s cannot tell which part goes where without ease, production time slows down which means more money is spent. With that being said, we implemented any feedback that we received from our assembly drawings to make the assembly of our products as easy as possible.

Working on a team requires a lot of responsibility; everybody needs to get their parts done in order for the project to come together. One of the hardest parts of working on a team is being able to meet up in person. Since everyone has their own schedule, it can be very difficult to come up with a time to meet that works for everybody. Luckily, our group started a group chat at the

beginning of the semester that we were able to use to coordinate meetings. This leads us to communication. Communication was the key factor that brought all of this project together. We assigned roles in our task list at the beginning of the semester, so we were able to begin the prototyping phase as soon as possible. We updated each other on the iterations of each part using the group chat to make sure we were all on the same phase. The importance of communication is without a doubt one of the most important lessons we learned during the semester.

If we could redo this project, we would definitely begin prototyping the case earlier. The prototyping phase is one of the most important phases because it provides immediate feedback to the designers. We had the most trouble with the case, so we could have avoided stress by nailing down the tolerances and material blend for the case.

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