JACOBS INSTITUTE FOR DESIGN INNOVATION
COLLEGE OF ENGINEERING, UC BERKELEY

CalCase: the Card and Key Holding Phone Case

Wednesday Lab: Shruti Aggarwal, Max Boutry, Dana Lansigan

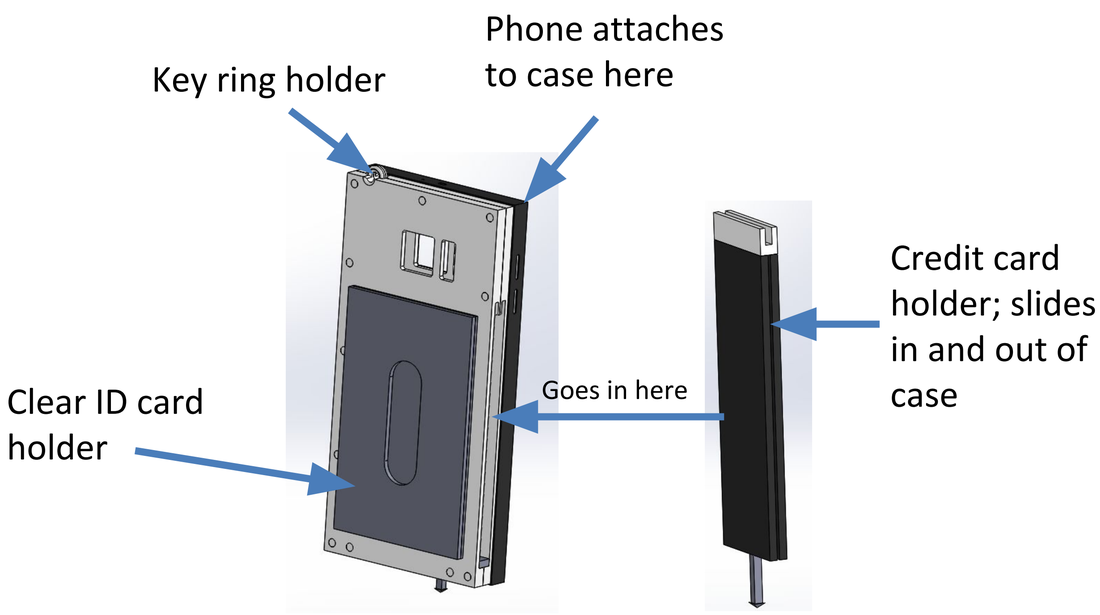
Problem

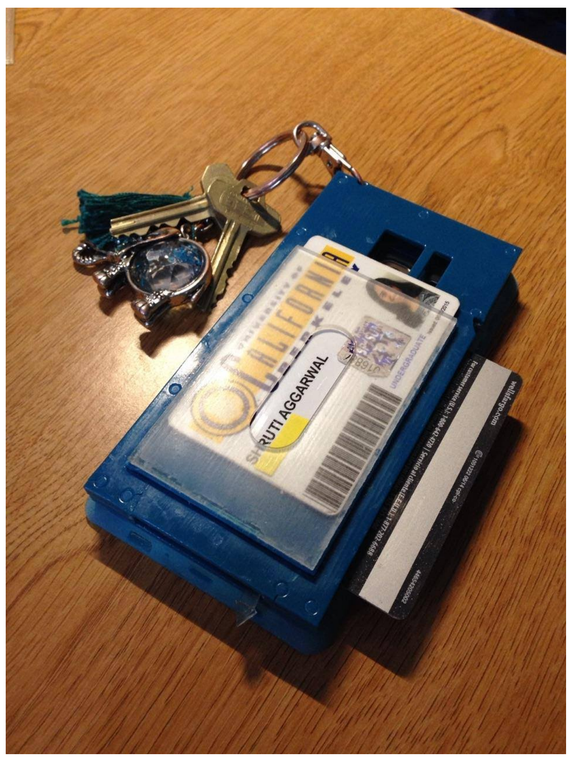
A common problem we saw among college students was that they would lose their keys or their ID cards because they did not have a convenient place to keep them. Students use their ID cards many times over the day to get into their dormitories, pay for their food, and access different buildings on the campus. Similarly, students often use their keys to get into their rooms in between classes. It quickly becomes a hassle to have to pull these items out then put them away over and over again. Oftentimes, especially when students are in a rush, these loose items get misplaced or forgotten. In fact, this is a problem many people—not only students—seem to face, so we saw a need to find a unique solution to this.

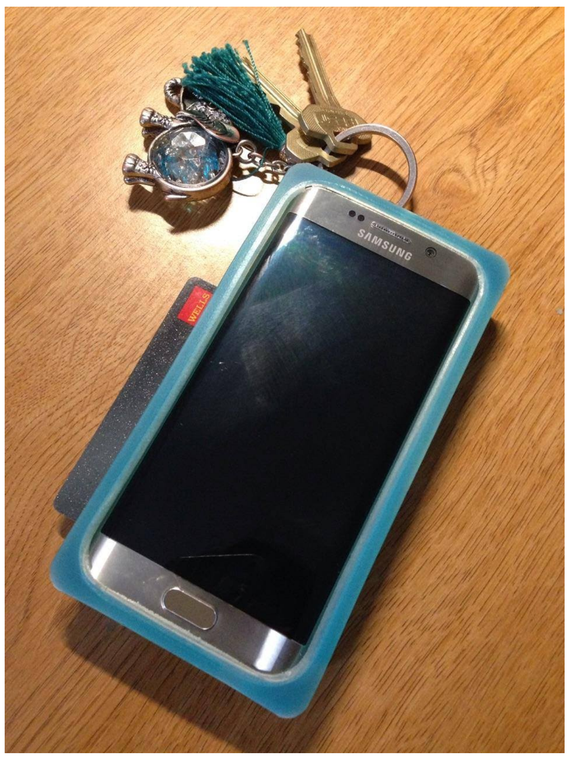
Solution

Currently, people carry around a wallet and their keys in their pockets or bag separately. In an effort to make it more convenient to carry all these things at the same time and decrease the chance of losing them, we created a cell phone case that carries credit cards, student IDs and keys, all while protecting the phone. Everything is easily accessible but at the same time difficult to lose since everything is attached to the cell phone, which most people have on themselves at all times. Pushing the slider peg at the bottom of the case exposes the magnetic band of the credit card to allow for quick and easy swiping. This function lessens the chance of losing the card as well as saves time since the user does not have to remove the card from the case. An advanced version of the case would only allow the credit card to slide out if the user unlocks it with his or her fingerprint using the smartphone's fingerprint sensor. A transparent pocket on the back of the phone allows for an ID to be easily read or scanned in without having to remove it from the case as well. The case protects both the phone and its contents: stealing a credit card or ID from the case would be difficult since the ID card is held in a tight rubber pocket and the credit card is concealed in the case. Applications that can input credit cards are also available but can be vulnerable to cyber theft. These apps also do not solve the problem of losing loose keys, which is simply accomplished by a key ring holder at the top of the CalCase.

Design







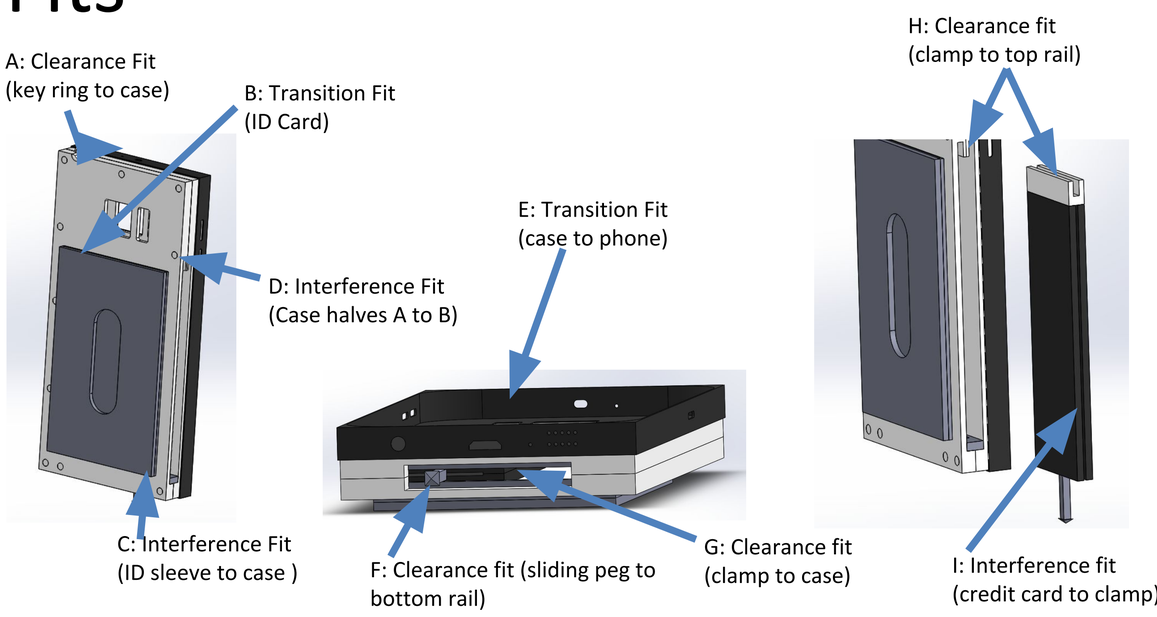
Materials and Manufacturing

We used the Objet printer in Jacobs because we needed to print multiple materials for the case. For sturdiness and inexpensiveness, we used plastic for the case halves. The ID sleeve and the part of the case that attaches to the phone were made with the Objet printer's rubber-like material to allow for some elasticity so that it would not be too difficult to slide the ID card and the phone into the respective parts; at the same time, the rubber-like material would form around the objects and prevent them from falling out too easily. The credit card clamp was made from both rubber and plastic: the sliding peg and the part of the clamp that slides on the top rail are plastic for rigidity, while the center of the clamp where the credit card fits is made from the Objet's rubber-like material for the same reasons as the ID card sleeve.

Production Plan

On a larger scale we would expect to use injection molding to produce a large volume of cases very rapidly. We could injection mold different pieces separately, based on their material and shape and then assemble them by machine. We would need to press fit the different halves and then use an adhesive to glue other parts such as the ID holder together. There is no stage of assembly that is too difficult for a machine to do and requires human assembly, so the production of this would be quick, efficient and cost-effective.

Fits



A: A clearance fit was used to allow the key ring to move freely in the hole.
B: A transition fit was used because if the fit were slightly too tight, the rubber could be stretched to slide the card in. If the fit were slightly too loose, the card would still remain in the pocket due to high friction between the rubber and the card. This more forgiving tolerance is also less expensive to manufacture.
C: An interference fit was used to ensure the ID sleeve remains attached to the case.
D: An interference fit was used to ensure the case cannot be taken apart after assembly.
E: A transition fit was used because if the fit were slightly too tight, the rubber could be stretched to place the phone in the case. If the fit were slightly too loose, the rubber would still grip onto the phone pretty well. This more forgiving tolerance is also less expensive to manufacture.
F: A clearance fit was used to allow the sliding peg to slide back and forth along the rail.
G: A clearance fit was used to allow the clamp to slide back and forth somewhat easily inside the case.
H: A clearance fit was used to allow the clamp to slide back and forth along the rail.
I: An interference fit was used to ensure the credit card will not slide out of the clamp.

Reflection

Through this project, we were able to apply our knowledge of manufacturing processes and tolerancing that we learned in class. During the design process, we learned that many factors must be considered, including the desired strength and elasticity of a component, how small a component needs to be, how to best achieve a certain function, and how each component should move relative to each other. These all affected what manufacturing process we used (3D printing) and which fits we chose for each part. Working with the Objet was an enriching learning experience. Since we were all inexperienced with 3D printing, we went through several trial runs due to difficulties we encountered with fits and deformities from the printing process. We learned that the more elastic materials tend to shrink, which we had to account for in our design. We also realized that when printing pegs or holes, it is better to not use support material as there is a very thin layer that is difficult to remove, no matter how many times you water jet or scrape it and this will make the holes smaller and the pegs thicker, resulting in an even tighter interference fit. Our biggest surprise came in how much the manufacturing process comes down to trial and error and not to calculations. We had calculated every piece and the tolerance it should have to give it the desired fit, but even so, pieces still needed to be redesigned. While the machinist's handbook was useful in giving us a good idea of what fits to use, we found that some of the theoretical tolerances would not achieve our desired fits. In effect, we had to figure out some tolerances ourselves through experiment. This readjustment period between our first print and the finalization of our product was essential, since during this time we figured out more effective ways to produce the part. Overall, this project gave us a better understanding of the process of creating a product, from design to manufacturing, and the numerous challenges manufacturers may encounter in each step of the process.