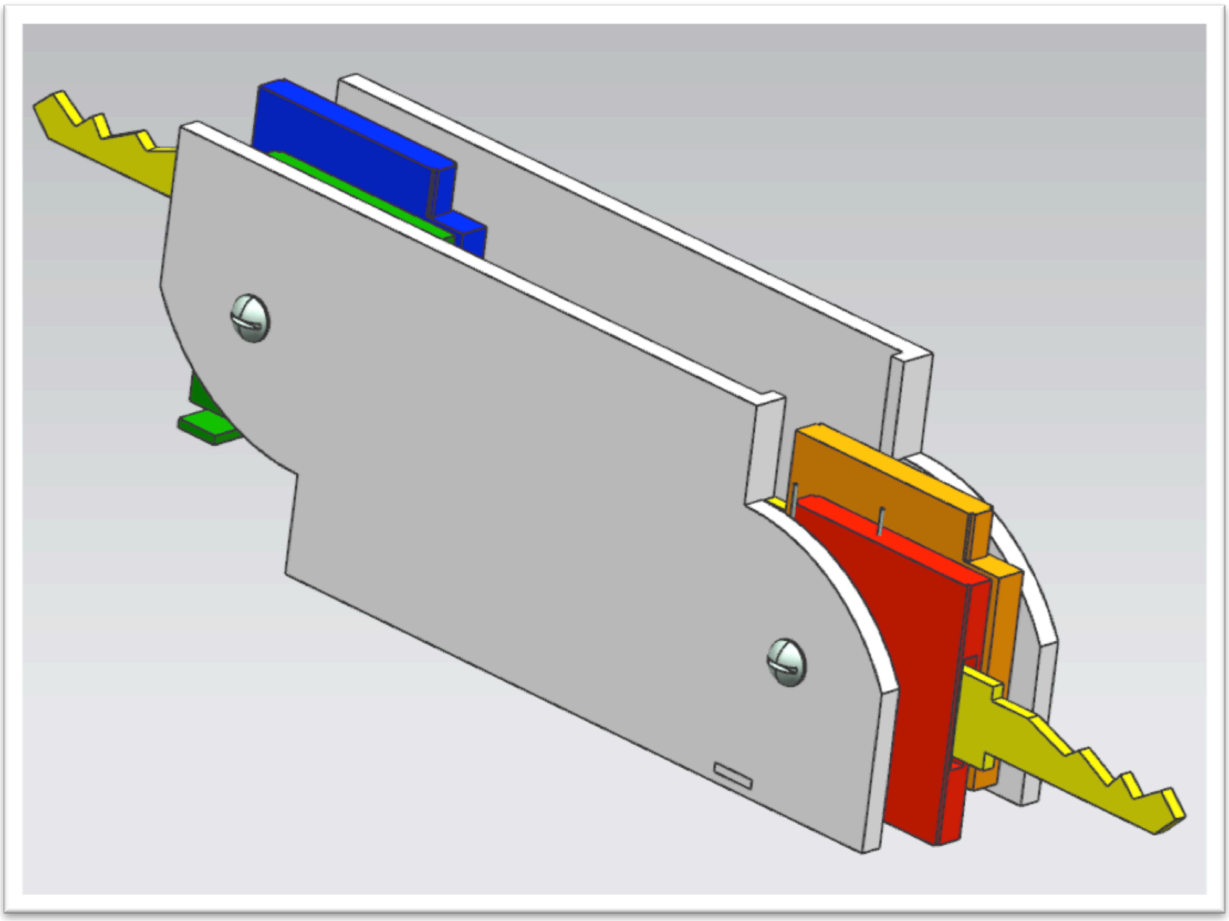
KeySaber

ME 350 Design Project



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To: Professor Bruce Flachsbart

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Section 1: The Need

Everyone carries keys, and most of them use key rings because key rings allow consumers to store a large number of keys. However, the design of key rings also creates several problems:

1. Key rings don't give the user an effective way of organizing their keys. As a result, people are forced to closely examine all their keys just to open one door.
2. Key rings leave keys loosely hanging. They often make annoying noises from the simple act of walking. In quieter settings, like an office or a concert, such a cacophony will often embarrass the person carrying the keys and distract everyone else in the vicinity.
3. Since the keys are loose, keys often get tangled in the pockets or purses in which they are being held. They become difficult to remove and they sometimes dislodge other items in your pocket or your purse.
4. Keys tend to scratch items they come into contact with. Since key rings don't protect the keys, this often results in the keys damaging other items placed on pockets or purses. Commonly scratched items include cell phones and MP3 players.

Key rings make keys difficult to handle and fail to protect other important items from your keys. We believe that our design can solve these problems.

Section 2: The Design

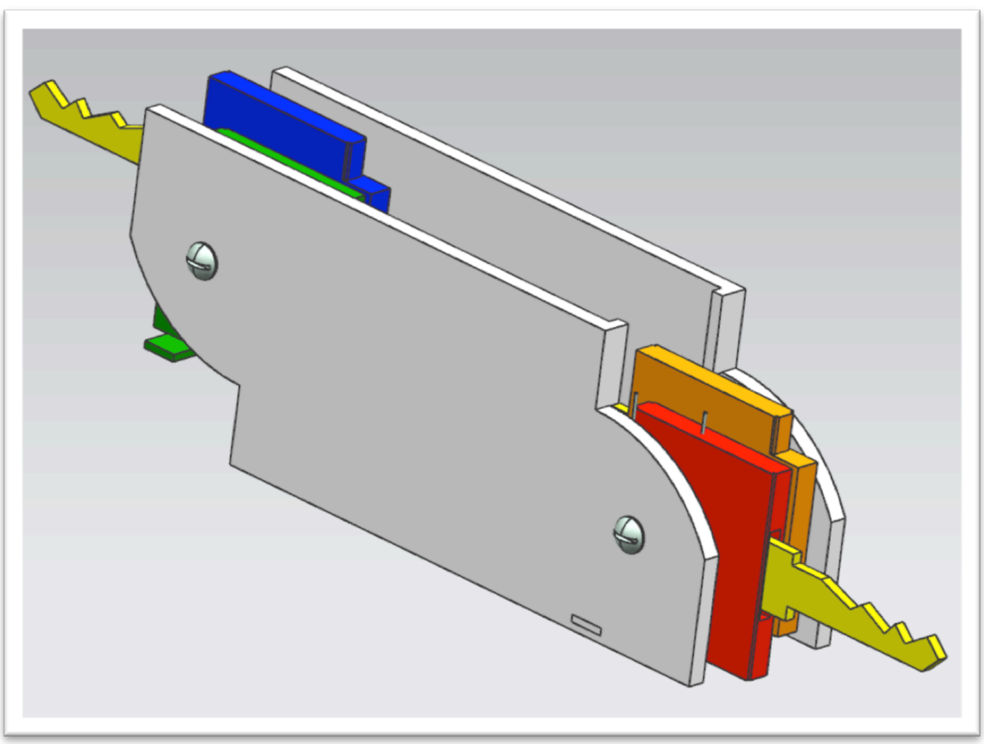

Figure 1. Concept model of KeySaber

Our design allows keys to be organized and accessed easier, while simultaneously protecting keys from damaging other items. The key to the design is that our keys can alternate between a “stored” position and an “active” position. In the stored position, the keys are neatly folded between the outer plates of the KeySaber and the KeySaber takes on a simple rectangular shape. In this position, the KeySaber becomes very easy to store and remove from a pocket or a purse. Also, because the surface of the keys is protected from coming into contact with foreign objects, keys stored in the KeySaber will not damage other items. In the active position, the key flips out of the casing and the KeySaber takes on a shape similar to that of figure 1. From this position, it is possible to use the key to open the relevant lock.

A major advantage of our design is the simplicity with which a key switches from the stored position to the active position. All the user needs to do is flick the tab of the key they wish to use (the tab can be seen on the green key head in figure 1) and tiny torsion springs mounted in the key cause the key to automatically flip open. Since each of the key heads is its own color, it is very easy to discern which key is required, so no searching through all your keys is necessary.

Our current design supports 4 keys, but the design can easily be expanded to house more keys. Our design also allows for the user to use their own keys through use of “universal heads” which we provide with the KeySaber. The universal heads open through use of a living hinge, and then the user can put their own key in the head. The head then snaps closed, securing the key in place.

Section 3: The Current Market

There are a few other products in the market (other than the key ring) that attempt to find a more ergonomic way to carry keys. There are two we think are of particular significance:

3.1 Keyport

The Keyport, as shown in figure 2, also uses the idea of a “stored” versus “active” key position to make keys easier to carry and access. However, there are some serious flaws in this product that our product addresses. First, the Keyport requires the customer to send their keys to the manufacturer. Many people can’t last for even a single day without important keys (e.g. your apartment key), let alone three or four. In our design, the user is able to easily assemble the KeySaber themselves.


Figure 2. The Keyport

The Keyport also destroys the key heads in order to fit their key into the mechanism. For people who are renting apartments, destroying or even duplicating keys is not an option. Due to our universal head, our customers can use their keys with needing to duplicate or destroy them. Also, the keys that are stored within the KeySaber can easily be changed, so if a college student is moving to a different apartment, they can still use our product. In order to use the Keyport, this same college student would have to send the Keyport back to the manufacturer in order to swap out keys.

3.2 Keysmart

The Keysmart uses a Swiss-Army knife concept to store and access their keys. In this design, the keys are exposed at all times. As a result, the keys can scratch other items in your pocket or purse. The design requires that you have an equal width of keys on each side. It is not possible to load an odd number of keys to Keysmart; the symmetric design requires an even number of paired keys that must share a common width.

Figure 3. Keysmart

Provided the consumer is able to load an even number of perfectly consistent keys, they will soon find that the design also wears their keys. Every time the device is opened, the keys must abrade against one another. The rough surfaces of keys will quickly degrade softer materials. Yet another disadvantage of the Keysmart is the difficulty in selecting a particular key. In order to find a key on the Keysmart, you need to pull out and look through all the keys you added until you find the key you need. In our design, colored tabs and dedicated switches make identifying and selecting the required key very easy.

Section 4: Target Demographic and Manufacturing Analysis

4.1 Demographic

The major demographics this product is geared towards includes college students and people living in urban areas. Both groups tend to use walking, biking, and public transportation as their primary form of transportation. This works well for our product because our universal head does not support car keys. Also, these groups of people tend to rent apartments and move frequently. This makes our competitors, such as the Keyport, less viable alternatives.

4.2 Manufacturing Analysis of Universal Head

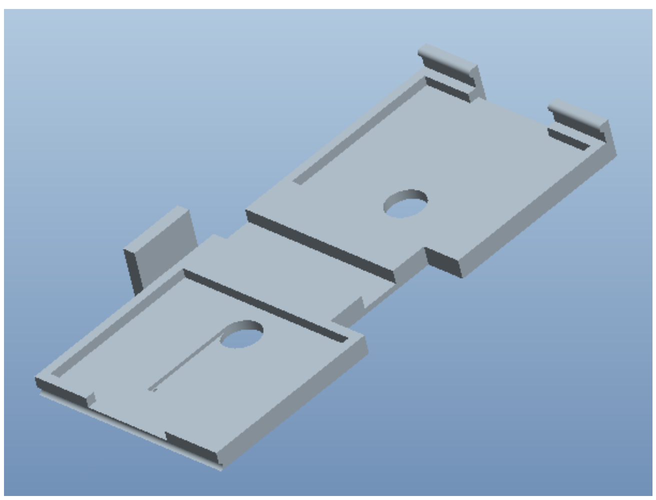

Figure 4. ProEngineer Model of the Universal Head

Figure 6. Living hinge on a TicTac using polypropylene

Figure 4 depicts the shape of the universal head. The geometry of the universal head is highly irregular, specifically designed to accomplish its multi-role task. It must hold firmly onto a variety of keys, secure the torsion spring that opens the key, and hold the mechanism that keeps the device closed. These tasks each have complex geometry associated with them that did not allow simplification. One such key feature of the universal head is its living hinge, already a minimalist approach to securing the key in a monolithic structure. Constrained by the living hinge, we decided that the universal head should be made out of polypropylene. Polypropylene is the industry standard material for living hinges because of its high fatigue resistance. An example, TicTac lids (Figure 6) are made from polypropylene). Choosing polypropylene also solves the issue of complex geometry. While the part would be difficult to mill, the design lends itself very well to injection molding using polypropylene. We can see evidence of the feasibility of this approach with the very wide manufacture of TicTac lids referenced above.

4.2 Manufacturing Analysis of Outer Casing

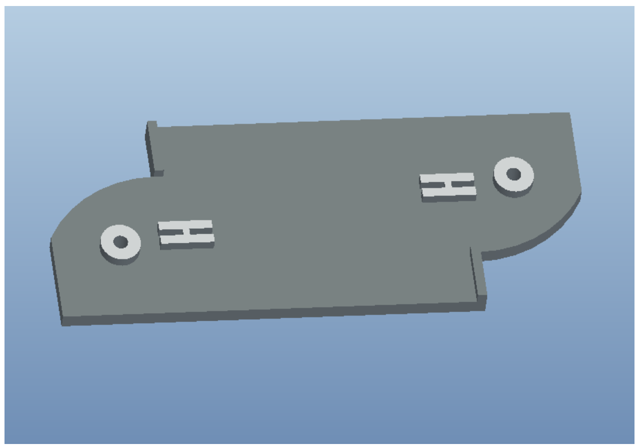

Figure 5. Pro-Engineer Model for Top and Bottom Plates

Figure 5 depicts the plates that encase the keys. We have elected to produce them from 6061-T6 Aluminum. Making the plates from 6061 Aluminum, a tough and lightweight grade, allows the part to be very thin while retaining a high amount of strength and stiffness. The thinness allows for a more visually appealing and ergonomic product, as we believe that most consumers will strongly prefer a thinner final product. The current design of the casing does not allow for it to be manufactured easily using aluminum sheet metal. A minor modification may be made to the to accomplish this. The slight circular rises around the holes in the casing are accomplished by dimpling the punched holes to form those same rises. The spring holding structures are replaced by a simple filing operation to insert a channel in the dimple along the length of the casing and facing the inside of the KeySaber. To accomplish durability and longevity, the casing will be anodized, covering the exterior with a very thick layer of oxidized aluminum, a material that, as a consequence of its hardness, is highly scratch resistant. As a result of these choices, the casing will be tough and long lasting, but highly affordable, a major selling point of our product.

Figure 7. Dimpling of sheet aluminum will replace molded ring structure

4.3 Assembly Analysis
One of the unique features of our product is that its user assembled. Upon purchasing the product, the user will receive 4 universal heads, 4 torsion springs, 2 plates, 2 screws (with paired nuts), and an instruction manual detailing how to put the KeySaber together. The simplicity of the design and assembly eliminates all concern of consumer confusion. As a result, there is no cost of assembly for this product.

Section 5: Cost Analysis

The primary tool used in our choice of materials and manufacturing processes was aPriori, a cost estimating software that allows the user to input the component as a CAD file and material. The software then recommends several standard manufacturing options, which the user may manipulate to optimize the output.

5.1 Manufacturing Analysis of the Universal Head

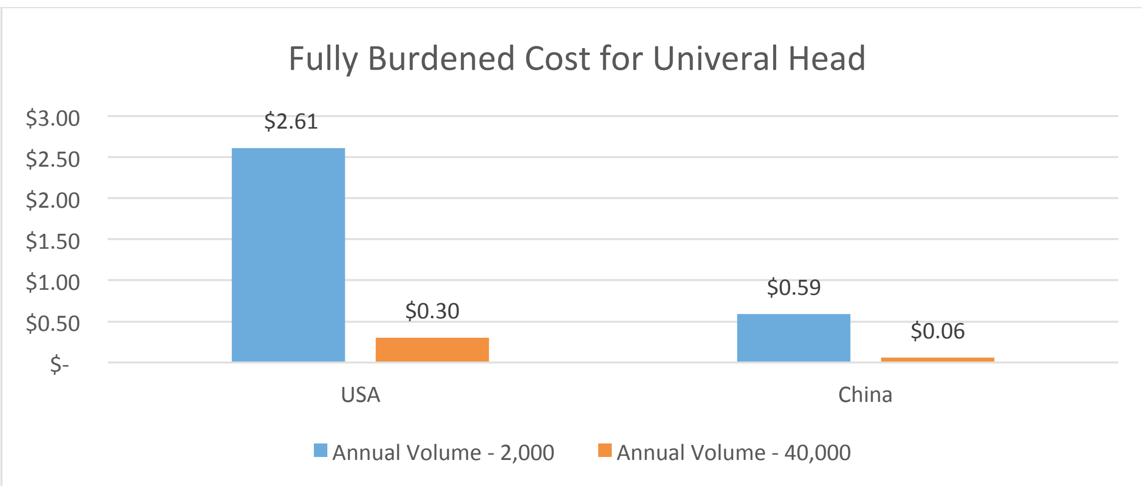

Figure 8. Cost of producing universal head at varying locations and annual volumes

Pictured in Figure 8 are the derived manufacturing estimates given from the software aPriori concerning the universal head. The estimates were given using injection molding and polypropylene. Our universal head requires very little cost of raw materials (such as polypropylene). The majority of the cost will be derived from the labor and tooling cost. The labor intensive manufacturing processes required to fabricate our components causes the price of fabrication to be largely dependent on the cost of labor. Labor is drastically cheaper outside of the United States, and cheapest in China. As a result of this, the universal head is cheaper by more than an order of magnitude to produce in China. We will certainly be choosing to follow that work.

Unsurprisingly, due to the relatively small fixed cost of materials, the cost of the universal head also drastically decreases as production volume is scaled up. The cost of tooling (independent of production volume) remains the same for producing 500 units or producing $10,000. So while the material and labor costs of the higher production volume would be largely the same, the price per unit deceases significantly.

5.2 Manufacturing Analysis of Outer Plates

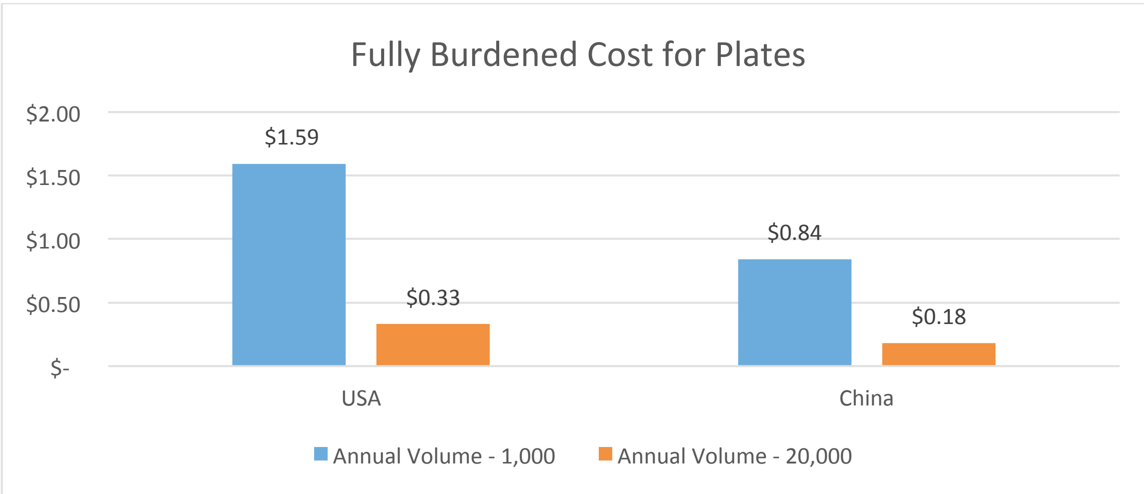

Figure 9. Cost of producing the outer casings at varying locations and annual volumes

Figure 9 illustrates the aPriori estimates for high vs. low volume production of our products exterior casing plate. These estimates are calculated for fabrication from 6061 Aluminum using a turret press on raw sheet. The ratio of material to labor cost is higher than the universal head. However, there remains a definitive advantage to producing the product in China rather than the United States. The tooling cost for manipulating sheet aluminum is very low. No unique tools are required to fabricate the plates as we have designed them. However, economies of scale hold true as the price halves when the production rate is scaled upward.

5.3 Final Production Estimations

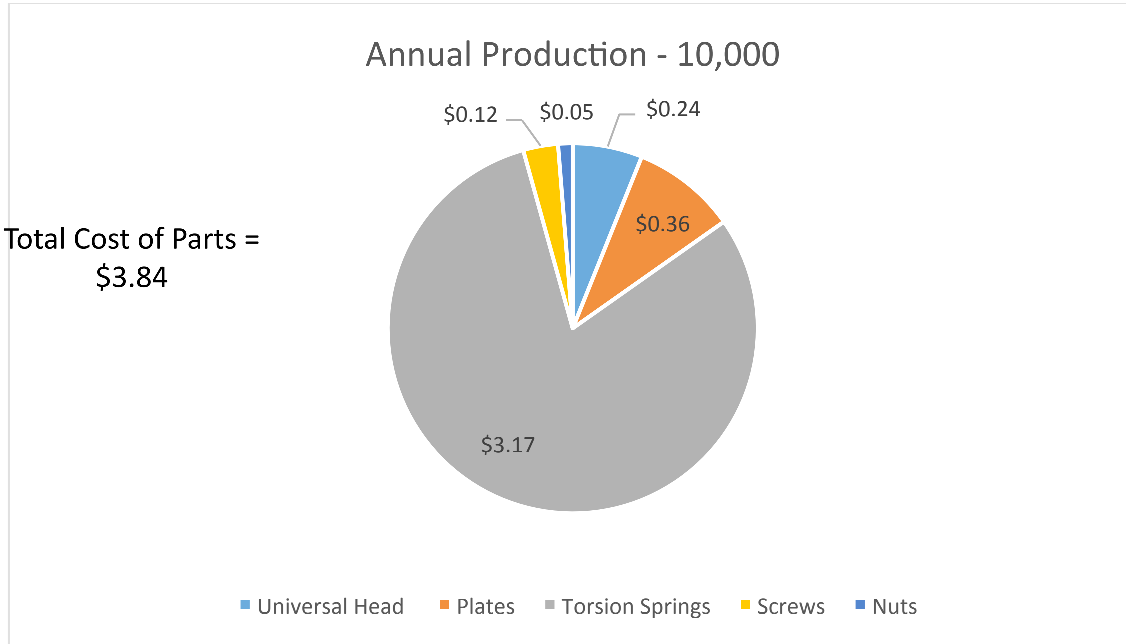

Figure 10. Cost of the final product at high production volume

The final product, at a production volume of 10,000 units, could be moved to retail at very wide margins while remaining affordable. The design of the components allowed the cost of all non-stock parts (when manufactured in high volume) to remain very low. The largest drivers of cost, the torsion springs, were estimated using stock prices from McMaster-Carr, without the advantage of large scale (40,000 units).