



The Snap Key

Team: Major Key

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Executive Summary

Running with a house key adds needless frustration when runners do not have pockets on their athletic clothing. Many workarounds for this problem exist, but these generally impede the use of the key and are reported as being uncomfortable. A number of products exist to alleviate the problem of carrying a single key while running, but these tend to be bulky and more expensive than users are willing to spend on a product. Hence, a whitespace exists to create a product that can successfully hold a single key while running, is low effort, intuitive to use, and secure/comfortable (See Appendix A).

The Snap Key, as shown in Figure 1, is a result of identifying where gaps in the market exists to solve an issue that a diverse group of users experience (See Appendix B). Brainstorming sessions identified a wide range of problems, and came up with three potential problems to pursue: how to carry a key while running, how to clean a French Press coffee maker, and how to avoid getting hair tangled in sunglasses nose pads. After feedback from peers was collected and interviews with potential users were conducted, it was determined that the issue of carrying a key while running is something that the team could successfully address and was a project they felt passionate about pursing (See Appendix C).



Figure 1: The Snap Key

The Snap Key is a compact device that fits over the top portion of keys snuggly that can be clipped on and off keychains with ease, while then being able to be clipped easily on a user's body for the duration of their runs. The Snap Key design successfully,

- Holds a single key
- Enables key use
- Is inexpensive
- Is comfortable
- Is not bulky
- Is stable, secure
- Requires low effort
- Is resistant to various weather conditions

One major limitation of the Snap Key was its ability to be perfectly manufactured in the 10 weeks developing this project. As a result, the Snap Key prototype is weaker than intended and not fully functional (See Appendix D). The design was temporarily manufactured using rapid prototyping, and while this project is being pursued further as a business opportunity, more sophisticated and effective processes will be explored (See Appendix E).

Introduction

Runners need a way to transport their house key when going for a run. Through conducting casual interviews with potential users, runners described issues with being able to easily carry their key on their person. They described that their current methods may impede their movements, adds unnecessary bulkiness to their body, and it is relatively high effort to remove their key from their keychain, attach to their person, and remove from their person again in order to enable key use post-workout.

Currently, users employ a number of workarounds to successfully carry their key while they go for a run. Some of these workarounds include, but are not limited to, tying keys to their short drawstrings, looping their key into a hair tie, tying the key to their wrist, or lacing their key into their shoe during the run. Additionally, there are products on the market that were discovered during market research, such as bracelets to store keys, small zip-pockets in sport bras, a key ring, a belt to store items, and a shoe pocket (See Concept Proposal section). The team did not have an opportunity to talk directly to users of these products, but upon reading buyer reviews it was found that these devices were generally expensive, bulky, and required higher effort than desired.

The Snap Key is a compact device that would remain as an attachment to the user's key while running and for everyday use. The cap fits snuggly over the top of the key and can be easily clipped on and off keychains with ease, while then being able to be attached to a person's body for the duration of their runs as shown in Figure 2. This fulfills user requirements for a device that is inconspicuous, stable/secure, is low effort, and performs under various weather conditions.



Figure 2: Snap key attached to user body

This report discusses users and requirements, specifications for requested design, detailed explanation of the design process, design rationale, and outlines sophisticated processes to manufacture the Snap Key. The purpose of this report is to explain how a whitespace in the market was identified and how the Snap Key addresses the issues where the current products are not as successful to fill this whitespace.

Users and Requirements

User Persona

Personas like the following were created in order to better understand the needs of the users, as well as foster a more empathetic perception of the problem statement. This user persona was created using the data collected from surveys, interviews, and personal insights (See Appendices F and G).



Figure 3: Dorothy, the user persona for this problem.

Meet Dorothy. She is:

- 20 years old
- 5'5"

Dorothy is a Junior at Northwestern studying Economics. She lives in Evanston, IL with her roommates, Maria and Rafid. Dorothy loves playing sports and exercising but does not get a chance to do so often because of her hectic schedule. Fortunately, Dorothy finds time to go on runs when she is stressed or when she has 30 minutes free. When Dorothy goes on a run, she does not like to carry much; she says the jingling of her keys on her keychain is especially annoying. Her roommate Rafid showed her several ways to carry her single apartment key while she runs, but she feels uncomfortable because she always has to check to see if it is there. Dorothy's other roommate Maria says that since women's athletic wear seldom has pockets, she just puts her key in her bra. Despite this Maria often complains that her key is irritating during her runs.

Dorothy needs a way to store a single key while she goes on a run.

Dorothy would benefit from a product solution to the problem that is also compatible with her keychain.

Requirements

The following requirements outlined in Table 1 were assessed based on data from surveys and interviews (See Appendices F and G), as well as product and patent research (See Appendix H).

Table 1—Requirements for a device to solve the issue of holding a key while running

Requirements	Specifications	Rationale
Hold a single key	Fit a standard key size of 1 X $\frac{3}{4}$ " & $1\frac{1}{4}$ X $\frac{7}{8}$ "	The majority of keys are cut in one of the two sizes, thus a solution should accommodate one or both
Enable key use	90% of users will be able to open their door on 1st attempt	The product solution should not inhibit the functioning of the key, as the problem statement targets <i>carrying</i> the key
Be inexpensive	(\$3-\$7)	Due to the commonality of the problem, the solution should be widely accessible, thus cheap
Be comfortable	60% of users will present no red friction symptoms from usage on their skin	The product solution should not be a hindrance to user comfort or harm the user in any way
Not be bulky	The device will not stick out more than 1.0 inches on the person's body	When going on a run, users do not want to add any protruding or cumbersome devices to their person
Be stable, secure	10,000-55,000 steps	Running can be a dynamic exercise, thus the product must be stable and secure in order to withstand a multitude of movements
Be low effort	90% of users will be able to unlock the door in 15-seconds	The product solution should not impede upon the functioning of the key
Be weather resistant	Withstand being submerged under water for 4 hours and heat of 120V, 60Hz, 10W	People go on runs in all kinds of weather conditions, a product solution must perform within reason

Concept Proposal

Everyday presents itself with a multitude of design opportunities. In looking at daily routines, general areas of annoyance, and conducting user interviews (See Appendix B), three problems were chosen to explore as possible projects for the Spring 2016 quarter of the Human Centered Product Design course before narrowing down the scope of the project.

These three potential project areas were:

- How to carry keys on a person while running or exercising
- How to effectively clean a French press coffee maker
- How to avoid getting hair tangled in toggled-nose-pads on sunglasses

After carefully considering the three potential projects, it was decided to focus on and move forward with the first project area: how to carry keys on a person while running or exercising. This potential project area was narrowed down even further to specifically relate to how to carry a single key while running or exercising based on survey data (See Appendix F).

This concept proposal outlines the methods of ideation and the potential project areas of interest in detail. It is discussed why it was decided to move forward with the issue of holding keys while exercising and important data/information gathered from a user survey, observations, and interviews are outlined as well.

Project Proposal #1

The problem: “When I go on a run, I do not know where to securely store my key!”

The users: The main users targeted with this concept are people who run or exercise while carrying keys.

- Anybody traveling with keys
- People who run or exercise

This type of solution would also be applicable to anybody who wishes to carry their keys while traveling and does not want to carry a bag, keychain, or other storage mechanism for keys.

The market: There is great variety among the product solutions that attempt to address the problem of where to store one's key while running. Most of the designs adapt an aspect of a commonly used product in order to fulfill the needs of the user (e.g. A belt with a clip and pocket or a key ring). Of the products on the market looked at, most found ways to successfully address the problem, yet have not become widely used. This may be due to the generally expensive prices, or perhaps the limited approach of the product designs themselves.

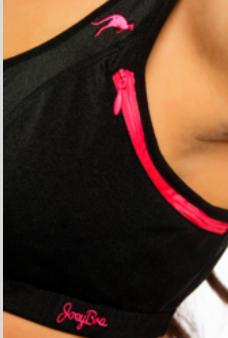
There are numerous workarounds to this problem, and those are described in Table 2 on the following page along with how the workarounds address the issues of holding a single key, being inexpensive, comfortable, stable/secure, and requiring low effort in various ways.

Table 2—Alternatives Matrix for Workarounds for Concept #1

Product	Description	Hold a single key?	Price (<\$10)?	Comfortable?	Stable/secure?	Low effort?
Tie to waistband	Tie key to drawstring on a pair of shorts for duration of run	+	+	-	-	+
Tie to hairband	Loop key into hair tie and wear during run	+	+	+	-	+
Tie to wristband	Tie key onto hair band or string and wear on wrist during run	+	+	-	-	+
Tie to shoelace	Lace key into shoe laces during run	+	+	+	-	-

In addition to the workarounds, there are numerous examples of current solutions on the market. In evaluating these solutions and their effectiveness at solving the issue of having a product that holds a single key at minimum, is cost effective, comfortable, stable/secure, and requires low effort, an alternatives matrix was created as shown in Table 3 below.

Table 3—Alternatives Matrix for Concept #1 for Products

Product	Image	Hold a single key?	Price (<\$10)?	Comfortable?	Stable/secure?	Low effort?
GoKey		+	-	+	+/-	+
JoeyBra Sport		+	-	+	+	+/-

Keon V1		+	-	+/-	+	+
FlipBelt		+	-	+/-	+	+/-
Jogalite Shoe		+	+	+/-	+/-	+/-

Patent research has provided relevant methods in addressing how to store a key when on a run. Particularly, it has indicated the relevance of pocket-type storage and clip-based storage. These methods incorporate features like accessibility, security, discreteness, and low effort interaction (See Appendix A).

In addition to providing interpretations of how to utilize design strengths, the patents also provide guidelines as to how to ineffectively address the problem statement. The patents researched were especially useful in highlighting the importance of compatibility with other methods of key storages, such as key rings. This became apparent in an analysis of the patents against feedback and requirements. Moreover, patents such as the Athletic Key Clasp and Pocket for Athletic Shoe in Figures 4 and 5 on the following page (See Appendix H) demonstrate very fundamental and direct solutions to a multi-faceted problem.

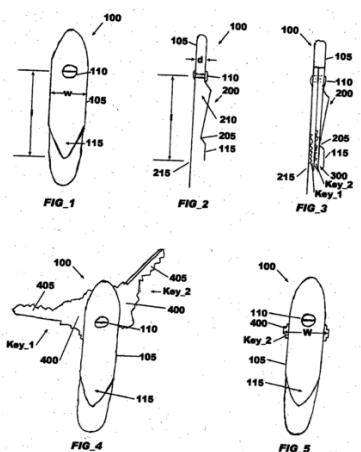


Figure 4: Athletic Key Clasp

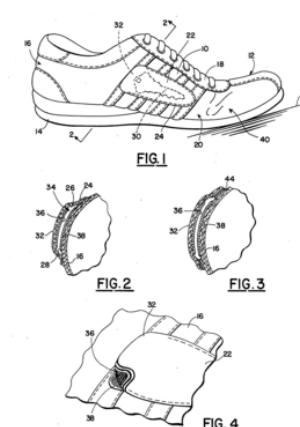


Figure 5: Pocket for Athletic Shoe

Not having a suitable way to store one's key while running or exercising can create annoyance, panic if key is lost, and interruption to one's workout. A solution to address this problem requires a way to hold at least a single key on one's person in a comfortable and secure way. The solution should also minimize the effort needed to transfer from storing the key while running to using the key to unlock something.

Project Proposal #2

The problem: “Cleaning my French press before I make coffee takes too long and wastes water!”

The users: The main users targeted with this solution are people who use a French press to make coffee.

- Anybody who uses a French press to make coffee
- Anybody who cleans their coffee devices

It would be an added bonus if a solution also appealed to users that clean other coffee devices.

The market: The market for products that aid in the cleaning of French coffee presses is relatively limited to filters and removable plates/grounds catching devices. The majority of the products that address this problem are relatively expensive and are not universally compatible with all French press styles. Perhaps the limited product solutions highlight the fact that the problem targets a small niche within the coffee consumption market, such as individuals who use a French press often enough that the problem causes significant annoyance to their lives.

After interviewing French press users, a few common solutions for removing grounds appeared. Most of these included repetitive combinations of scooping and rinsing to fully remove all the grounds and remaining coffee. None of the processes seemed adequate to fully remove and clean a French press, however, some of the products addressing the problem seem to fully address it. In evaluating these workarounds against the requirements of cleaning a French press in one action, taking less 30 seconds, and being a solution that can fit comfortably in the kitchen, the following alternatives matrix was created as shown in Table 4.

Table 4— Alternatives Matrix for Workarounds for Concept #2

Solution	Description	Cleans in one fell swoop?	Takes less than 30 seconds?	Small to fit comfortably in kitchen?
Drip Filters	Users put drip coffee filters in the French press to catch grounds	+/-	-	+
Clean with water	Users rinse multiple times with water to remove all grounds	-	-	+
Scoops	Users use a spoon or other utensils to scoop out coffee grounds from the French press	-	-	+

In evaluating current products and their effectiveness at solving the issue of having a device that successfully cleans a French press in one fell swoop, takes less than 30 seconds to use, and is small enough to fit comfortably in the kitchen, an alternatives matrix was created as shown in Table 5.

Table 5—Alternatives Matrix for Products for Concept #2

Product	Image	Cleans in	Takes less	Small to fit
---------	-------	-----------	------------	--------------

		one fell swoop?	than 30 seconds?	comfortably in kitchen?
Reusable filter for French press		+/-	+	+
OXO Good Grips French press		+/-	+	-
Coffee Catcher		+/-	+	+

Patent research has provided particularly relevant approaches to effectively and efficiently cleaning one's French coffee press after use. Further, an analysis of patents has indicated the importance of solutions to remain compatible, modular and not adding excess steps to the unassisted cleaning process (See Appendix H).

The patents that upheld this standard generally involved a collecting-plate with rod or removable filter. The identification of this trend in patent styles provides an array of ways to uphold the aforementioned standard, as well as an indication of what would be required to address the problem more thoroughly. Furthermore, particular patents such as the Disposable Beverage Filter and Brewing Accessory shown in Figures 6 and 7 below (See Appendix H) establish a baseline of advantages and disadvantages to the most popular approaches.

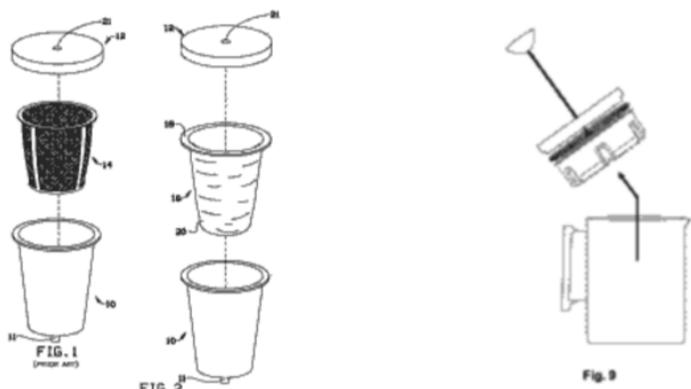


Figure 6: Disposable Beverage Filter **Figure 7:** Brewing Accessory

Cleaning a French press is both time and energy consuming, and not always efficient. A solution to address this would provide a way to remove the leftover grounds in practically one action, drastically reducing the time it takes to clean a French press without the assistance of a product. Additionally, moreover the solution would ideally be compatible with most if not all sizes and styles of French coffee presses.

Project Proposal #3

The problem: “My sunglasses get stuck in my hair when I take them off the top of my head.”

The users: The main users targeted with this solution are anybody who uses sunglasses with the toggled nose pad.

- Anyone who owns sunglasses
- Anyone who has long(er) hair

Toggled-nose pads are sunglasses, as shown in Figure 8 on the following page, that have nose pads that move and are common to certain sunglasses styles such as aviator sunglasses.



Figure 8: Sunglasses with toggled-nose-pads that get easily caught and tangled in hair

The market: The market for products addressing the above problem is extremely limited. There are no attachment-like products for this problem. Further, a solution is presented by buying a pair of sunglasses

without pivoting nose pads, or has solid, plastic-injection-molded frames as shown in Figure 9 below. This requires a sometimes expensive purchase, and limits the styles available to the user.



Figure 9: Sunglasses without toggled-nose-pads

There is also the option to customize frames or get current frames serviced so that the toggled-nose-pads are no longer a feature of the frame. This option is effective, but can be very expensive and it is unknown if the integrity of frames will be compromised by servicers who alter the frames.

After searching blog and beauty forums, there were suggestions about how to nicely place the toggled-nose-padded sunglasses on your head, and nicely lift them up to avoid the issue of having them get stuck in your hair. Additionally, other solutions obtained from the blogs were how to style one's hair appropriately to avoid getting glasses snagged in them. Despite all these suggestions, none of them are truly effective at avoiding getting one's hair caught in the nose pads of the glasses.

The solutions are evaluated in Table 6 on the following page for their effectiveness at solving the issue of avoiding getting hair stuck in its nose pads, how expensive the solution is, if the solution securely attaches to all styles of glasses, is comfortable, and does not change the aesthetic appeal of the sunglasses. In contrast to Project Proposals #1 and #2, there really is no clear line between product solutions and workarounds, so a single matrix evaluation was created below.

Table 6—Alternatives Matrix for Concept #3

Product	Avoids getting stuck in hair?	Inexpensive?	Secure attachment to all styles?	Comfortable?	Does not alter aesthetic of glasses?
Solid, plastic frame sunglasses	+	+/-	-	+	+
Customize frames	+	-	-	+	+/-
Placing glasses nicely on head	-	+	-	+	+
Styling hair appropriately	-	+	-	+	+

Interestingly, there are no additive products that present a viable solution to hair getting stuck in glasses nose pads. Despite this there are several patents that present methods by which a solution could be designed. Oakley, a major sunglasses brand, filed a patent for a Nose pad connector for eyewear as shown in Figure 10 below (See Appendix H) that aims to solve the exact problem statement. This association implies that the problem itself is widespread, but only recently getting the design attention it needs.

Overall, patent research informed the need and methods by which a solution should remain unobtrusive, secure and compatible with different styles of sunglasses.

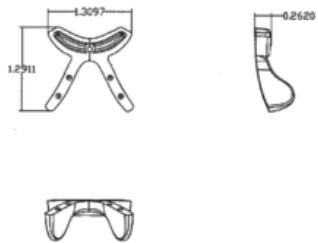


Figure 10: Nose pad connector

The problem of getting one's hair stuck in the nose pads of eyeglasses or shades causes extreme annoyance and discomfort to users. An ideal solution would involve a product attachment compatible with most eye-glasses and shades that have pivoting nose pads. Said product would bridge the nose-pads in a comfortable way so that they do not tangle with hair, all while not inhibiting the purpose of the nose pads.

Project Rationale

During an in-class opportunities evaluation, the three concepts were presented and scored on a scale of 1-5 (1 being the worst and 5 being the best score) in various categories (See Appendix C). The highest total score that could be achieved was a 75, and the three concepts scored as follows:

Table 7—Averaged total scores for three proposed project ideas

	Concept #1	Concept #2	Concept #3
Total	69.4	69.3	71.6

As can be seen, Concept #3, the issue of getting hair stuck in toggled-nose-pads on sunglasses, scored overall the highest on average, with the other two concepts at almost identical scores. As a whole, the group did not find the scores of the group feedback that helpful because no single concept evidently stood out from the rest. Although Concept #3 had the highest score, it was not significantly higher, or outscored the others that it was the evident choice in pursuing for the project.

The feedback from the class varied in the quality and extent that people were detailed in their scores and comments. For example, some feedback was only filled out for the first concept and then incomplete towards the end of the third concept, or some people skipped scoring categories altogether. At a maximum, there was only eleven people who gave scores at all, which is generally not enough of a sample size to make a statistically significant conclusion (See complete score breakdowns in Appendix C for each concept).

Because the numerical class feedback did not prove that helpful, it was determined that an online survey would be sent to people to aid in the decision. In the one question survey, it was asked which of the three concepts did the participant most relate to or see as an evident problem to address. As shown in Figure 11 on the following page, 66% of the 132 that people that responded, said that Concept #1 how to carry keys while running or exercising, should be pursued further.

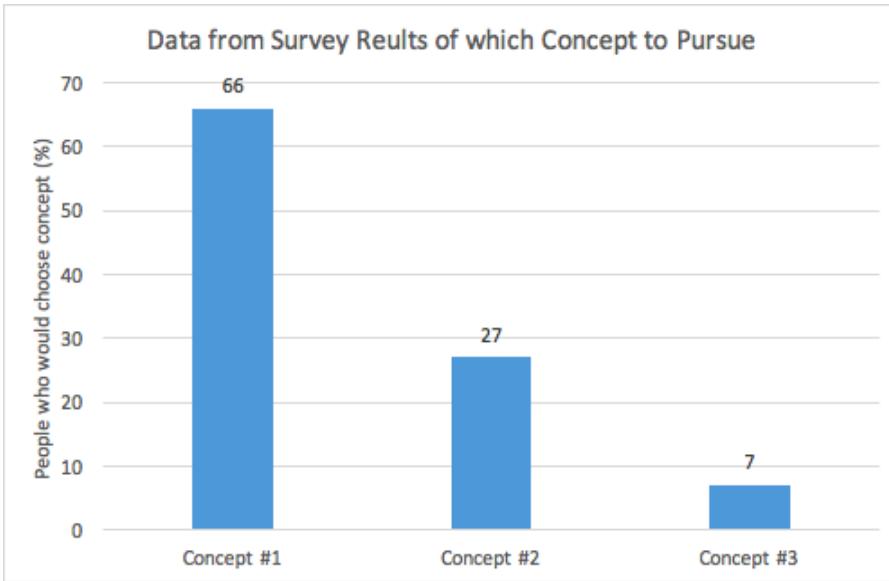


Figure 11: Survey results concerning which concept people most relate to or saw as an evident problem to address.

This data collected was the main deciding factor in choosing to pursue Concept #1, the issue of carrying keys while running or exercising, for the final project.

Possible Solutions

This section outlines three possible design solutions to address the issue of carrying a single key while running. The ideas were created during team brainstorming sessions and detailed sketches, as well as initial mockups, are included for all three designs.

Possible Design #1

Name: Snap Key

Description: The Snap Key is a malleable cap that fits a single key (Figures 12 and 13). The cap consists of a snap piece that doubles as a reinforced clip. In this, the Snap Key affords for the attached key to either snap on to a keychain or clip on to any flat material (Figure 14).

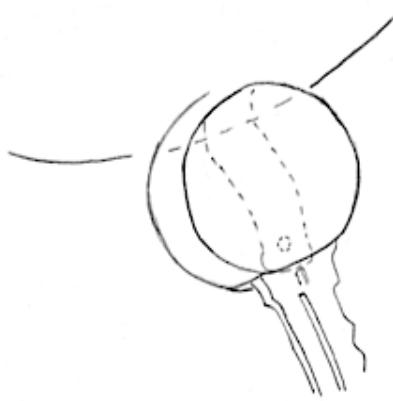


Figure 12: Snap Key front view



Figure 13: Snap Key back view

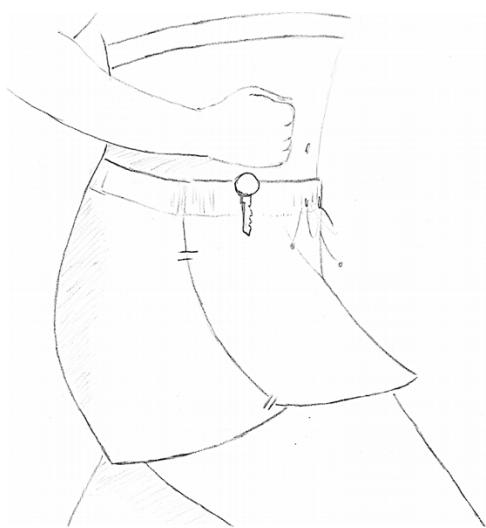


Figure 14: Snap Key can be slipped into flat materials, such as the waistband of shorts

Preliminary Mockup: The initial mockup of the snap key was made using a rubber key cap and a security badge extension clip (Figure 15 and 16). The clip was removed from the security badge extender and a slot was cut into the top of the key cap (See Appendix E).



Figure 15: Snap Key mockup front view

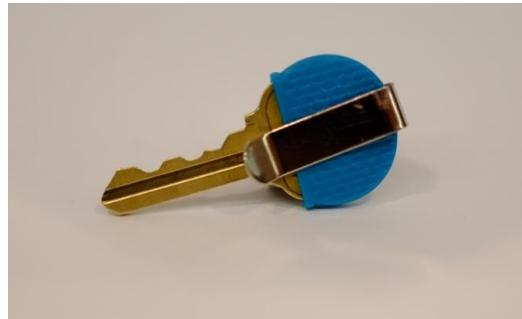


Figure 16: Snap Key mockup back view

Once a key was inserted into the keycap the clip could be slid into the slot. The key provides rigid support for the clip. This mockup was limited in its lack of ability to truly snap closed, but it still fastened to clothing (Figure 17). Furthermore, the rubber key cap did not provide much support for the clip. Finally, the clip was able to slip out of the key cap.

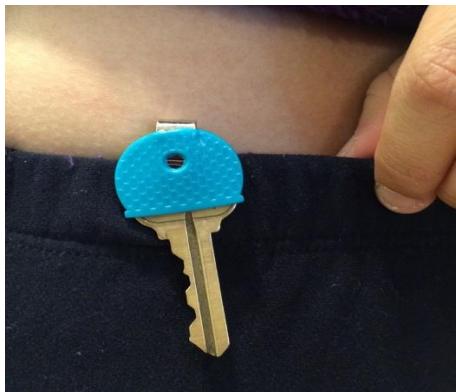


Figure 17: Snap Key mockup can be slipped into flat materials, such as the waistband of leggings despite the lack of snap ability currently

Potential Strengths: The advantages of the Snap Key design were that it was small and much less conspicuous than other potential designs. The design was generally low effort and easily snapped on and off the user's clothing, and had the flexibility to be stored wherever on the user's body they desired.

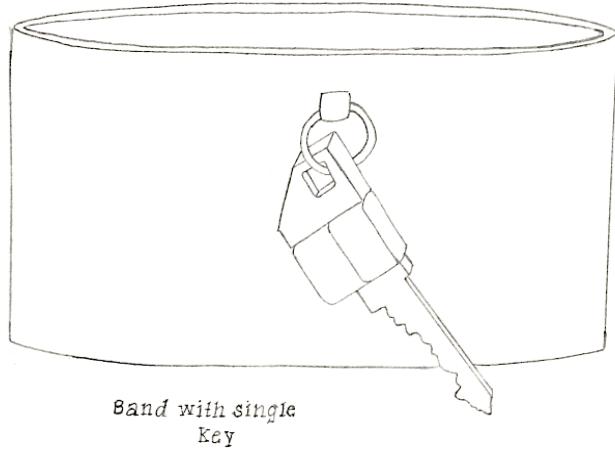
One unique feature this design offered was the potential opportunity to color code or differentiate keys from each other by purchasing Snap Keys of different colors.

Potential Pitfalls: One main concern for the Snap Key design was that it was unclear how secure this design solution was. Testing conducted (See Appendix D) proved that the design could withstand loads over 20 lbs., perform under dynamic conditions, and perform under various weather conditions.

Possible Design #2

Name: Reversible Keychain

Description: As shown in Figures 18 and 19, the Reversible Keychain consists of two main parts: the band with house key attachment and the carabineer clip with other item attachment option.



*Band with single
key*

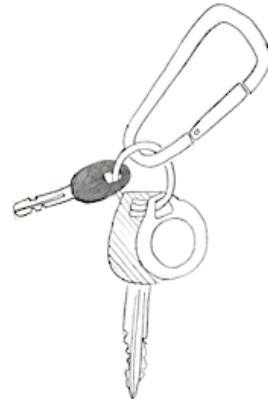


Figure 19: Carabineer clip with keys

For everyday use, the band would be used as a short, soft cloth keychain where all keys, fobs, etc. would be stored (Figure 20). On the band there was a small metal ring where a house key would be attached at all times, and then a carabineer clip and metal ring, where all other items were stored.

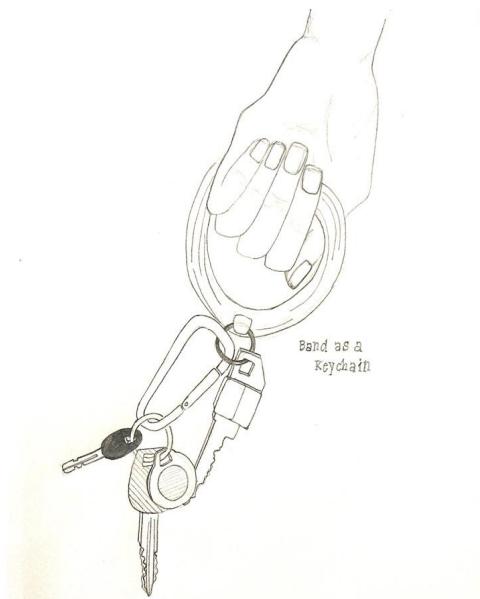


Figure 20: Reversible Keychain in everyday use

When the user desired to go on a run, they would be able to easily unclip the carabineer from the band, and all that would be left would be the band and single house key (Figure 30). The band could then be turned inside out, hence the name “Reversible Keychain,” and slipped onto the body during the run so

that the single house key would be securely fastened on the body and protected from jingling around by being covered by the band. The band could be slipped on the user's arm (Figure 21), wrist, ankle, shoe, etc. during their workout.

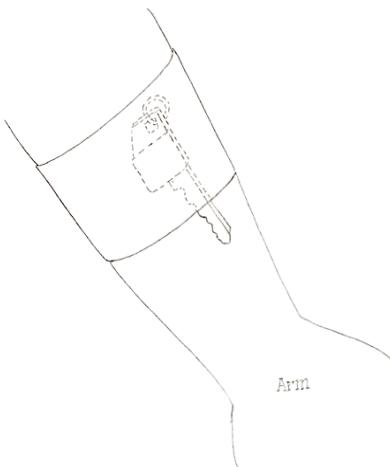


Figure 21: Storing single key on body during run

Preliminary Mockup: The mockup was constructed from an old t-shirt that cut and glued in a band shape (See Appendix E). A metal ring was glued to the band permanently for holding the single house key, and a carabineer clip was used for clipping onto the band and holding other keys (Figure 22).



Figure 22: Reversible Keychain mockup

This mockup was crude in that the material did not necessarily mimic the desired functions of the band, but generally still fit the user's arm and snuggly held a key to the user's body (Figures 23 and 24).



Figure 23: Reversible Keychain mockup band with single key



Figure 24: Reversible Keychain mockup on arm

Potential Strengths: Some of the clear advantages to the Reversible Keychain would be its ability for diverse use in that it can be used as an everyday keychain and also to hold a single key during a workout. It would generally be low effort for the user and secure to the body.

This design also affords the opportunity to personalize the band and make it aesthetically pleasing for potential buyers.

Potential Pitfalls: It is unclear how comfortable the Reversible Keychain would be for users, and it poses the safety hazard of having the key exposed to the skin for durations of time. Additionally, there is a potential for wear and tear and having the fabric of the band stretching out and no longer serving its purpose of securely holding the key to one's body. Many of these pitfalls could potentially be avoided by choosing the right materials for this design.

Possible Design #3

Name: Shoe Tag

Description: The Shoe Tag features a housing made of a malleable fabric as well as two oppositely attached stretchable tags (Figure 25).

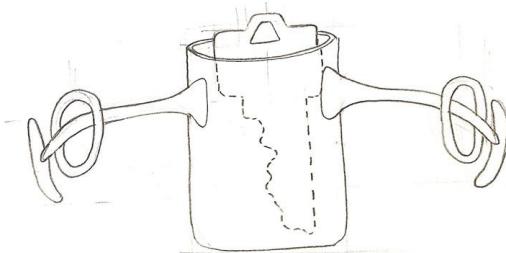


Figure 25: Shoe Tag with stretchy tags to insert into shoelace holes

Solid bars attached to the stretchable tags facilitate the secure holding of the housing to the shoe by way of the shoelace holes shown in Figure 26.

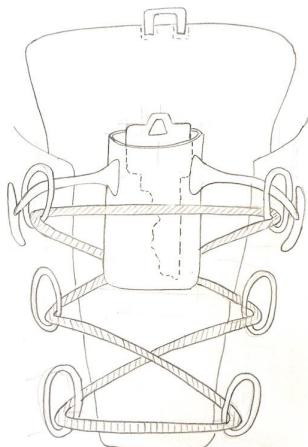


Figure 26: Shoe Tag inserted on top face of shoe

Preliminary Mockup: The initial mockup of the shoe tag was made using Ziploc bag pouch, a name tag elastic band with toggles and two metal washers (See Appendix E). Figure 27 depicts the initial name tag clip mockup variation, and a later alligator clip mockup iteration. The name tag elastic band was removed from the name tag and the elastic tag cut to fit the baggie size. Once the Ziploc bag pouch was made at an appropriate size, the washers were attached to the baggie securing both the elastic tag handles and the key holder.

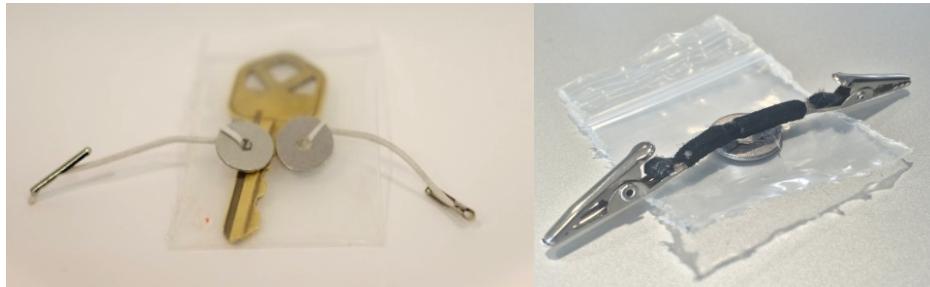


Figure 27: Shoe Tag mockups with name tag clips and alligator clips

This mockup was limited in its lack of ability to truly snap fit into the shoe holes, but could still be laced in as shown in Figures 28 and 29 on the following page. Furthermore, the plastic key bag did not provide much security for the key and the elastic band was not as secure as desired.



Figure 28: Shoe Tag mockup on shoe



Figure 29: Side view of Shoe Tag mockup on shoe

Potential Strengths: The Shoe Tag had strengths in its secure attachment and also its ability to be a semi-permanent fixture to the user's shoe they desire to workout or run in. It would generally be low effort, not inhibitive to the user's body, and would have the ability to be adjustable and adapt to many types and sizes of shoes.

Potential Pitfalls: The Shoe Tag may be uncomfortable for users to wear and there is also the potential for the stretchy tags to become overstretched and no longer serve their purpose of being adjustable and snuggly securing the key to the user's shoe.

Summary of Possible Solutions

In looking for potential for solutions to the issue of carrying a single key while running or exercising, three design concepts were generated to address this issue:

1. Snap Key snaps onto the user's clothing to hold a single key.
2. Reversible Keychain doubles as a keychain for everyday use and can be reversed and slipped onto the extremities of the body to protect and secure the key to the body.
3. Shoe Tag holds a single key in a small pocket that is inserted and held securely by stretchy tags that are inserted into the shoe laces of running shoes.

Table 8 below outlines how each potential design addressed the initial design requirements for the product to hold a single key, be inexpensive, be flexible and comfortable for the user while securely storing the key and be low effort.

Table 8—Alternatives Matrix for all three possible solutions

Requirements	Snap Key	Reversible Keychain	Shoe Tag
Single Key	+	+	+
Enables key use	+	+	-
Inexpensive	+	+	+
Flexible, comfortable	+/-*	+/-*	+/-*
Not bulky	+	-	+/-
Stable, secure	+/-*	+/-*	+/-*
Low effort	+	+	+/-*

Ultimately, the three design solutions presented encompass a variety of solution types from keychain accessories to key additions and to shoe ability, promising significant potential for appealing to the needs of users who travel with one key and have problems finding where to store it.

Design Concept

Concept Rationale

The possible solutions created to solve the issue of carrying a key while running were:

1. Snap Key
2. Reversible Keychain
3. Shoe Tag

When choosing which of the three designs to initially eliminate, it was determined that the Reversible Keychain would not satisfy user needs like the other two concepts would. The Reversible Keychain will not satisfy the requirements of being comfortable or secure as it was unknown whether the band could be made tight enough to securely hold the key, but loose enough so as not to cause discomfort to the user's arms or legs. Additionally, the exposed teeth and key-skin contact poses a potential safety hazard.

Throughout the process, neither the Snap Key nor the Shoe Tag were completely eliminated. Table 9 below demonstrates how the two designs compared to each other in terms of user requirements. A score of 0 correlates to the design not fulfilling the requirement, a 1 correlates to the design minimally fulfilling the requirement, and a 2 correlates to the product completely fulfilling the requirement.

Table 9—Choosing a final design, with 14 as the highest possible score

Product	Holds one key?	Enables key use?	Is comfortable?	Is not bulky?	Is stable and secure?	Is low effort?	Performs in various weather conditions?	Total score
Snap Key	2	2	1	2	2	2	2	13
Shoe Tag	2	0	2	1	2	1	1	9

As shown by the scores given in the table above, the Snap Key was noticeably higher scoring than the Shoe Tag. This was supported from class feedback and user testing (See Appendices C and G), as this design proved to be simpler and more intuitive for users. The aesthetic concerns of the Shoe Tag were also prominent in user feedback. From all of this, it was decided to pursue the Snap Key as the final design solution.

Overview

The Snap Key is a device that allows users to carry a single key when they are running or exercising. The key is inserted into a key cap that holds it securely, which becomes a relatively permanent attachment to the key that can be used for the duration of runs or for everyday use (hung on keychains, stored in wallets, etc.). On the backside of the keycap is a clip that can be used to easily attach and detach from key chains, and then attached to the user's person for running. The Snap Key secures to the person in a variety of fashions, such as, but are not limited to, clipping onto a sports bra, sliding onto the lip of the user's pants, and clipping onto a user's laces.

Due to limitations in manufacturing processes for the scope of the 10-week project, the prototype was constructed of rigid and flexible plastic using rapid prototyping methods. A more sophisticated process (See Limitations and Future Plans section) would produce the Snap Key comprised of two different materials, but the 3D-printed prototype presented in this report is a unified component constructed of rigid plastic via 3D printing. CAD views of the assembly can be seen in Figure 30.

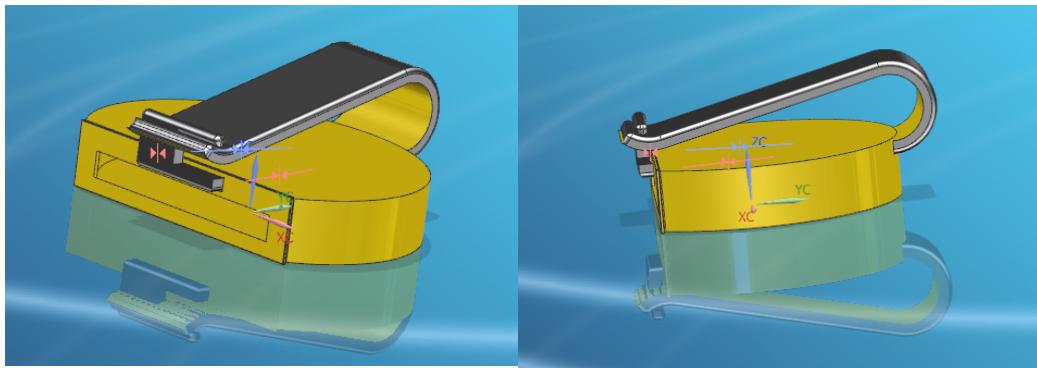


Figure 30: CAD views of the Snap Key

Key Cap

The prototype constructed in the ten weeks of this project is constructed of rigid and flexible plastic using rapid prototyping methods. The key cap was first constructed using NX, as shown in Figure 31.

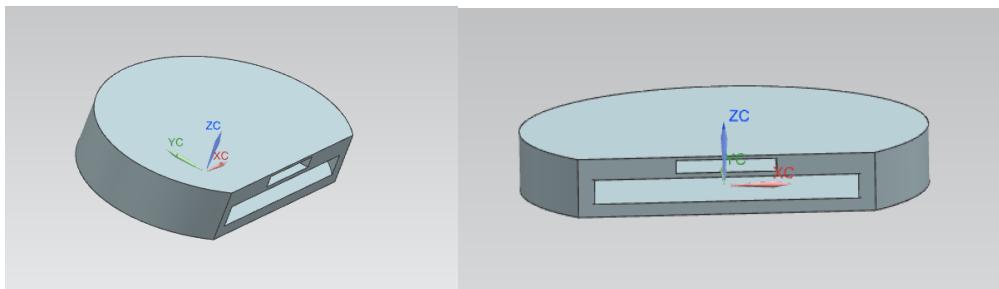


Figure 31: CAD views of the Snap Key keycap

Due to the limitations of manufacturing processes, the key cap could not be constructed of a flexible, silicone to fit various sizes of keys as initially desired, but more sophisticated manufacturing plans include this as an aspect of the design (See Limitations and Future Plans section). A standard key of 1"x 3/4" and 1 1/4" x 7/8" fits comfortably in the key cap, as shown in Figure 32 and 33 below.



Figure 32: Key cap made of flexible plastic

Figure 33: Key cap with a key inserted

Clip

On the back face of the keycap is a clip mechanism. The clip mechanism allows the user to attach and detach their key from their keychain and clip the Snap Key onto their person. The clip extends from the top of the key cap with a small loop in order to hang comfortably on a user's keychain. The loop then continues to the bottom of the key where it can be pushed to the side and allowed to spring out for use. To close the device, the clip can be pushed down and pushed to the side again to lock into place. This locking mechanism is a small notch to catch the clip, preventing it from springing out.

The clip was first constructed using NX, as shown in Figure 34.

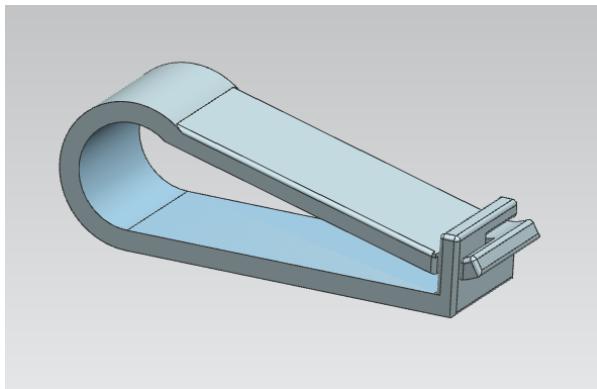


Figure 34: CAD views of the Snap Key clip

Similar to the keycap, due to the limitations of manufacturing processes, the clip could not be constructed of strong, spring steel as initially desired, but more sophisticated manufacturing plans include this as an aspect of the design (See Limitations and Future Plans section). The clip prototype can be seen in Figures 35 and 36 below.



Figure 35: Clip made of rigid plastic



Figure 36: Clip used on keychain

Design Rationale

The Snap Key is a compact device that fits over the top portion of keys snugly that can be snapped on and off keychains with ease, while then being able to be clipped easily on a user's body for the duration of their runs. The Snap Key design successfully fulfills all of the design requirements:

- Holds a single key
- Enables key use
- Is inexpensive
- Is comfortable
- Is not bulky
- Requires low effort

Key Cap

The prototype constructed during the ten weeks of this project is constructed using rapid prototyping methods. The key cap was first constructed using NX, as shown in Figure 36 with corresponding dimensions (See Appendix E). This prototype fulfills our project definition to simplifying the process of securing your key while on your run. This device allows users to attach the key to their person securely while being comfortable, not bulky and requiring low effort to attach to the person or to detach from the key chain.

The key cap itself is shown in Figure 37 with dimensions as labeled. These dimensions were intentionally chosen to allow for any standard house key size to fit into the design and widen the audience of the product. During user testing, users expressed the desire to fit many different types of keys including a house key and a residential house key or even a fob. Ultimately, the cap was dimensioned to create a tight snug between the key and the device while being lightweight and comfortable on the user.

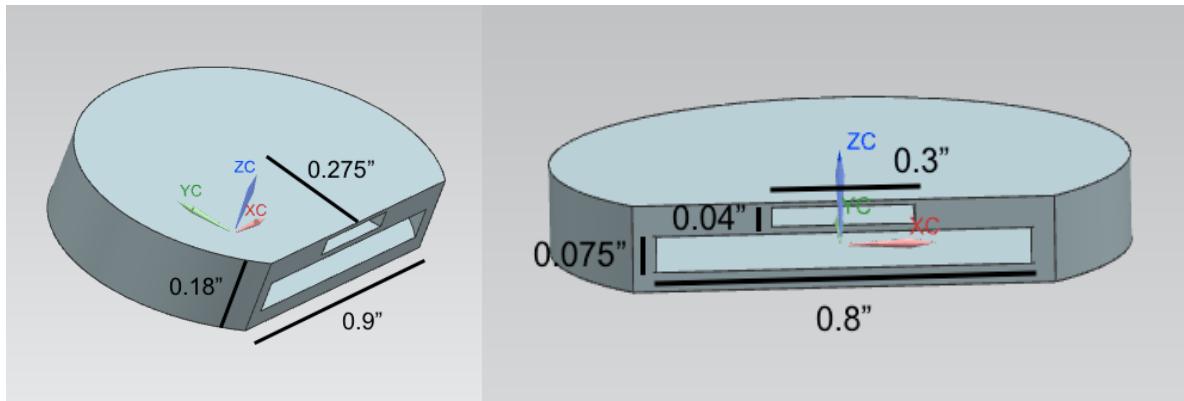


Figure 37: Dimensions of key cap

The manufacturing of the key will provide the option to change the colors of the key cap to personalize which key the user chooses to carry. This design concept was chosen to allow users to personalize the device color they want to identify their various key usages, maybe one key cap can be red to indicate the front door and one key cap can be blue to indicate the back door. This allows users to integrate this design into their everyday lives and effortlessly carry their key on their person while they run.

Clip

On the back face of the keycap is a clip mechanism. The clip mechanism as shown in Figure 38 with labeled dimensions allows the user to attach and detach their key from their keychain and clip the Snap Key onto their person. The clip extends from the top of the key cap with a small loop in order to hang comfortably on a user's keychain. The intention behind this design concept was to allow the user to feel confident in the fact that the snap key will be secure while being low effort to clip on and off from the body but also from the key chain. This unique feature of the device allows the user to clip the Snap Key off of their keys without having to use their fingernails to take the key out of the key ring and to clip on to their person securely.

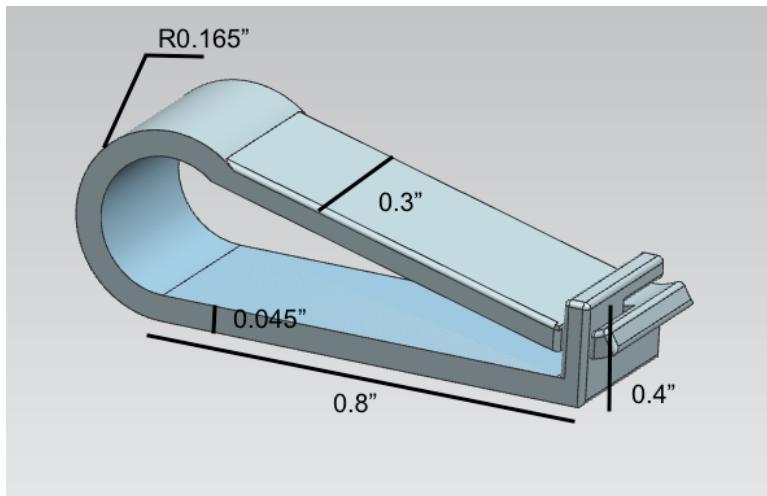


Figure 38: CAD views of Snap Key clip with dimensions

The loop then continues to the bottom of the key where it can be pushed to the side and allowed to spring out for use. To close the device, the clip can be pushed down and pushed to the side again to lock into place. This locking mechanism is a small notch to catch the clip, preventing it from springing out. The intention behind creating a spring back mechanism in the Snap Key was to allow users to easily apply force using their thumb to unclip, insert into their keys or their person and then the device goes back to snapping in (See Appendix E).

Limitations and Conclusions

The Snap Key does not fulfill the following requirements according to their specifications (See Appendix A and Users and Requirements section):

- Is stable, secure
- Can withstand various weather conditions

Following performance testing (See Appendix D), it was determined the 3D printed prototype could only withstand a load of 2 lbs. and the integrity of the device was compromised when subjected to extreme heats. Therefore, the prototype presented in this report is not a working prototype, but rather a look-a-like, and more sophisticated manufacturing processes are necessary to produce a working prototype (See Limitations and Future Plans section).

Limitations and Future Plans

Limitations

The Snap Key is a compact device designed to allow users to securely carry their key while running. The Snap Key can be easily clipped on to a user's body for the entire duration of their run without being cumbersome while maintaining key use. In order to advance the design, the following limitations must be addressed.

The Snap Key requires more sophisticated manufacturing.

Key features of the snap key require tooling and machinery that is not available to us in the Ford shop. A major limitation is the ability to perfectly manufacture our product given the 10-week project timeline. As a result, the Snap Key we are presenting is not as strong (See Appendix D) as intended and may not withstand a major concept life. This design demands better equipment that will create a fully functional device, as explained in the Manufacturing Plan section below.

This prototype was manufactured with rapid prototyping (See Appendix E and Design Concept and Rationale sections) and once an appropriate shop is identified with access to sophisticated and effective processes, it is recommended that this project be further pursued as a business opportunity.

The Snap Key requires more testing.

Through user testing of a variety of mockups and alternative solutions (See Appendix G), users suggested multiple changes to the design to best fit their needs. No single solution was found to be entirely successful for the wide range of demographics of users who run and need a place to store their key. The key feature of the Snap Key is that it maintains key use while simplifying the process of having to remove the device from your keychain when going on a run while staying comfortable and stable on the user. Overall, the Snap Key was found to be the most effective design to meet as many as our user requirements as possible but it is recommended further testing to ensure a design that accomplishes the task of carrying your key on your run and meets all the needs.

The Snap Key should be redesigned in accordance with testing.

After more user testing (See Appendix G), sophisticated performance testing (See Appendix D) and continued use, it should become clear to the user what specific limitations exist with the Snap Key. Once these issues have been identified, it is recommended that the Snap Key be redesigned to address them. Below in Figure 39 are some examples of future iterations that would be pursued with a longer timeline to address some of the limitations of this design of the clip mechanism.



Figure 39: Examples of future clip iterations

Manufacturing Plan

In order to manufacture a production snap key spring steel should be used as the clip to provide the most spring back and rigidity. In order to create this sheet steel should be used initially. It would then be stamped to create the initial shape of the specialized clip shape shown in Figure 40 below.

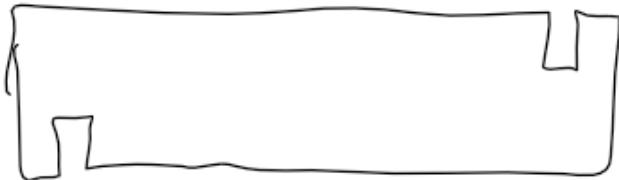


Figure 40: Stamped spring steel

Once stamped out of sheet steel the clips would be heated to improve their workability. Once heated the clips would be formed using a large press. The press would initially clamp the base down and then a roller would pass over the steel to create our shape. The clip would then be annealed to ensure that the clip would always return to the closed position. A possible forming tool is shown in Figure 41 below.

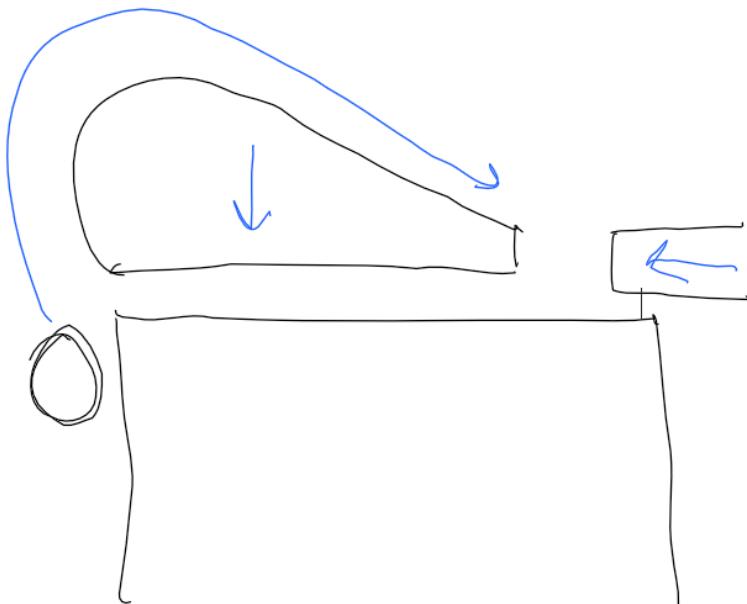


Figure 41: Possible forming tool

The cap would be easier to manufacture in comparison to the clip mechanism. It would simply be injection molded of silicon material as shown in Figure 42. To ensure the specialized features were produced in this operation, there would have to be a horizontal CAM action as well as the two vertical mold components. There would be a lollipop-like fixture that the cap would stick to once injection molded. This would require the silicon to be taken off of it once the injection molding process was complete. The blue arrows denote the movements of each of the parts of a hypothetical mold.

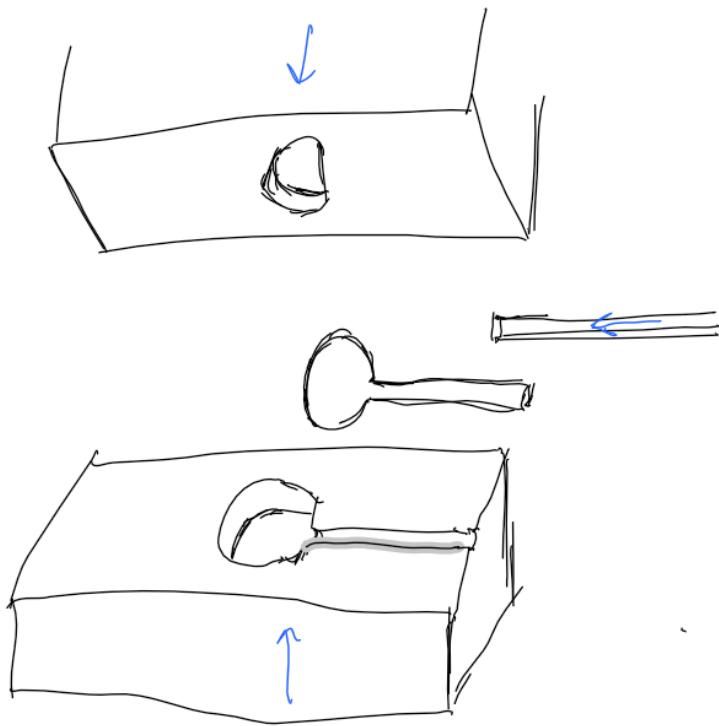


Figure 42: Mold for injection molding the cap, with blue arrows indicating the movements of each part of the mold.

Finally, the clip and the cap would have to be assembled. In order to do this, the clip would be unlatched and the top side slid through the hole in the cap. Once the clip was fully inserted it could be re latched and assembly would be complete. The manufacturing and assembly of this product, done in these three steps would generate high value for Snap Key working prototype.

Conclusion

This final project was a result observational and brainstorming methods (See Appendix D). Through these methods, various white spaces in the market were identified. From three main concepts (See Concept Proposal section), it was identified that solving the issue of carrying a key while running was the one the team would pursue.

Once it was decided to pursue the issue of carrying a key while running, three possible solutions were created: The Snap Key, the reversible keychain, and the Shoe Tag. Following user testing (See Appendix G) and talking to potential users, it was decided to pursue the Snap Key.

In summation, the Snap Key design addresses the white space that exists in the market for products that are aimed at carrying a key while running. The Snap Key design includes:

- A key cap to attach the device to the key
- A clip to attach and detach the key for everyday use and onto the user's person while running

This product is aimed at users who need a way to carry a key while running or exercising. This includes a broad spectrum of users with no limit on age, gender, ethnic group, and overall lifestyle (See Users and Requirements section). An added bonus to the Snap Key design is, that although the product is focused on runners looking for a method to store their key, it has other applications such as, but are not limited to, making it easier to attach and detach keys from keychains, differentiate keys being used, and allowing anybody traveling on foot to conveniently carry a single key.

While in theory the Snap Key fulfills all user requirements based on the specifications outlined in this report (see Users and Requirements section), there were manufacturing limitations based on the material and equipment available to the design team. Because of these limitations the team created a final look alike prototype to exact size specifications that doubles as a working prototype that is not capable of withstanding the loads that a more sophisticated model would be able to. In future manufacturing processes, the product would be composed of a flexible, silicone key cap and spring-steel clip (See Limitations and Future Plans section).

Overall the team was better able to understand identifying whitespace within the market and executing the design process to successfully ideate, brainstorm, test, and create a solution for users looking for a way to carry their key while running. This was all accomplished by maintaining team standards and equally contributing to the project (See Appendix I).

Appendix A: Project Definition

Project Name: Snap Key

Team Members: Freesoul El Shabazz-Thompson, Christina Lundgren, Wendy Roldan, and William White

Course: Spring 2016 Design 308: Human-centered Product Design

Instructor: Professor David Gatchell

Date: 06.06.2016

Mission Statement: To design and manufacture a device that allows for users to carry a single key on their person while running that is simple in design, encourages security, and requires low effort.

Project Deliverables: A conceptual design that will carry a single key on a person's body while running or exercising was developed throughout the ten weeks of this course. Sketches, CAD, and a prototype were constructed to help users understand how the finalized product will impact their ability to carry a key while running. Plans for more sophisticated manufacturing processes were also described.

Users/Stakeholders:

- Anybody traveling with one key
- People who run or exercise often

Requirements for the project with specifications are included in Table 10 below (See Users and Requirements section).

Table 10—Requirements and specifications for project definition

Requirements	Specifications
Hold a single key	Fit a standard key size of 1 X ¾" & 1¼ X ⅞"
Enable key use	90% of users will be able to open their door on 1st attempt
Be inexpensive	(\$3-\$7)
Be comfortable	60% of users will present no red friction symptoms from usage on their skin
Not be bulky	The device will not stick out more than 1.0in on the person's body
Be stable, secure	10,000-55,000 steps
Be low effort	90% of users will be able to unlock the door in 15-seconds
Be weather resistant	Withstand being submerged under water for 4 hours and heat of 120V, 60Hz, 10W

Appendix B: Determining Opportunities

In beginning the ideation phase of the project, each team member was responsible for doing some individual brainstorming on their own. This ranged from keeping observations of their own routines and making notes of what were annoyances or challenges they faced each day to simply asking peers what kind of problems they would like to see design solutions for.

As part of a class assignment, AEIOU observations were conducted to get started in thinking about humans in various situations as users for a potential product. Each team member was required to conduct an hour long observational study of a large group of people. This method requires the observer to consider the activities going on, the environment where the study is being conducted, the interactions of the users, the objects involved in the space, and the users themselves.

Although, none of the three project ideas generated for this concept proposal were a result of the AEIOU activity, this still opened up the notion of observing humans interacting with the world in order to derive potential project opportunities and identify real world problems. Overall, the AEIOU observation was a relevant tool provided through the course that can be utilized in future iterations for other opportunities or even user observation testing in later stages of this project.

Once team members were given the opportunity to observe and think about areas for potential design solutions, the team met for brainstorming sessions. These two sessions were conducted at the weekly team meeting and there was a 60-minute time limit on each one. These 60 minutes were also utilized to conduct other team responsibilities, so the brainstorming process was given less than 60 minutes each time.

The idea of the brainstorming process was to be given a relatively open, judge-free opportunity to offer ideas and describe project opportunities observed during the week. These ideas were recorded in a team document, as provided below.

April 5, 2016

- I. Keys
 - a. Difficult to hold key while running
 - b. Annoying to tie and untie laces to use key
 - c. Keys are small and can get lost easily
- II. Coffee
 - a. Difficult to judge how much milk/creamer being put in
 - b. Difficult to clean tall mugs and French press makers
- III. Brita water filters
 - a. Difficult/sometimes impossible to fill up in the sink

April 6, 2016

- I. Wallets
 - a. Uncomfortable to sit on when in back pocket
- II. Water bottles
 - a. Difficult to carry in hand/without a bag
- III. Shower
 - a. Soap plate
 - i. Griminess
 - b. Rack on shower head
 - i. Unstable
 - ii. Ineffectively stores/organizes items
- IV. Sunglasses
 - a. Get caught in hair
 - b. Uncomfortable on nose
- V. Lotion
 - a. Pumping mechanism does not get all of product

The list is an abbreviated version of lengthy lists generated during this ideation phase. An abbreviated version is provided to give a general idea of the types of things considered for various topics. Team members then discussed which of the project areas would be beneficial to explore further for finding a design solution. In deciding on the final three potential projects opportunities, a few different questions were considered:

- Is this a problem that a wide, diverse group of users experience?
- Is this a user-centered problem, and not experience focused?
- Is this project directly observable?
- Is this a project that we have interest in and would have a passion for finding a solution for?

Seven ideas from the two open brainstorming sessions were defined into short problem topics that were evaluated, shown in Table 11 below, using the four questions outlined above.

Table 11—Evaluating topics from brainstorming sessions

Problem Topic	Wide, diverse group of users?	User-centered (and not experience focused) problem?	Directly observable?	Interest and passion for?
Holding keys while running	+	+	+	+
Cleaning French press	+/-	+	+	+
Filling up Brita	+	+	+	-
Carrying water bottle	+	+	+	-
Organizing shower items	+	+	+	-
Sunglasses caught in hair	+	+	+	+
Pumping lotion	+	+	+	-

As can be seen in Table 11, many of the problem topics satisfied the first three questions of consideration. The fact that most of the ideas addressed wide, diverse groups of users, user-centered issues, and were directly observable further exemplified the quality of ideas that were generated during brainstorming and generally made the decision more difficult for which projects to pursue further.

Because all seven of the ideas chosen for further exploration as potential projects were generally equal in how applicable they were to a course focused on human-centered product design, the three concepts that were narrowed down to were chosen mostly on a basis on how passionate the team members were about the project. As can be seen in the last column of Table 1, there were three potential projects out of the seven ideas that the team felt strongly about pursuing. The topics the team were most interested in are:

1. Holding keys while running or exercising
2. Cleaning a French press coffee maker
3. Sunglasses getting caught in hair

These three concepts were then explored further (See Concept Proposal section) as a part of an opportunity evaluation conducted in class, and ultimately the issue of how to carry a key while running was addressed.

Appendix C: Class Feedback Data

Table 12 below outlines the averaged data collected from class feedback during the opportunity and concept evaluation as provided by the instructor. The concepts correspond and refer to the following:

1. How to carry keys on a person while running or exercising
2. How to effectively clean a French press coffee maker
3. How to avoid getting hair tangled in toggled-nose-pads on sunglasses

Table 12—Average values from class feedback collected during concept proposal evaluation. Each category was evaluated on a scale of 1-5, 1 being the worst score and 5 being the best score. The maximum total score for each concept is 75.

	Concept #1	Concept #2	Concept #3
What is the problem?	4.8	4.8	4.8
For whom?	4.2	4.3	4.6
Current solutions?	5	4.5	3.9
Where do current solutions fail?	4.6	4.6	4.7
How are we different?	4.1	4.4	4.3
Realistic access to the user group	5	4.5	4.9
Problem/task/context is directly observable	4.7	4.6	4.9
Must be object focused (not space, process, or experience focused)	4.7	4.9	4.9
Must be local	5	5	5
Must be timely	5	5	4.9
The need for the product must be greater than the potential cost of the product to the user (in either money or individual change)	4	4	4.7
Team members have an interest in this problem	4.8	4.8	5
Prototyping materials can be easily accessed through the shop	5	4.6	4.7
Should allow team to test/prototype easily	5	4.8	4.9
A solution better than that presented does not exist	5	4	4.8
Total	69.4	69.3	71.6

This data was used in conjunction with comments provided from the class feedback to narrow down to Concept #1 for a final project to pursue.

Table 13 on the following page provides comments from the in-class opportunities evaluation feedback sheets that had a larger impact on which concept to pursue.

Table 13—Summarized and abbreviated comments from class feedback for each concept in consideration

	Concept #1	Concept #2	Concept #3
Advantages	<p>Lots of existing products that exemplify a need for users</p> <p>Large, available group of users who could be passionate about a solution</p> <p>Will be easy to prototype</p> <p>Large area of solutions to work with and be inspired by</p>	<p>No current solutions, large market need</p> <p>Big opportunity for white space</p> <p>Large group of potential users</p>	<p>Very relatable</p> <p>Very real problem, unique/interesting</p> <p>Very large white space in the market</p>
Disadvantages	<p>Potentially a saturated market</p> <p>Single key limits versatility</p> <p>May be difficult to justify cost of any product</p> <p>Workarounds and current solutions may already be sufficient</p>	<p>May be difficult to test or create a working prototype</p> <p>Can post-cleaning process really be eliminated by a solution?</p> <p>How much time does it actually take to clean ground? Is this even worth pursuing?</p>	<p>May be difficult to create an add-on product instead of redesigning sunglasses all together</p> <p>May be hard to prototype and build</p> <p>Requirements are too specific, and may be unrealistic</p> <p>Maybe should not pursue further</p>

Appendix D: Performance Testing Report

Purpose of Testing: The purpose of testing the Snap Key and design are to explore how the design maintains its integrity and durability under various different testing conditions to ensure that it will fulfill the following design requirements:

- Hold a single key at minimum
- Be stable, secure
- Be able to withstand various weather conditions

In alignment with the design requirements are as aforementioned, the goal of performance testing is determine how the design holds up under extreme conditions. The areas of testing are:

- Weight: In performance testing, one goal is to determine how much weight the device would be capable of holding. This would provide specific data in terms of weight (lbs.) that the devices can handle before failing.
- Durability and Stability: In testing durability and stability, the goal is to determine how stable the devices are when attached to a user's body. In this area of testing, the team will explore what movements and load types compromise the integrity of the device's stability.
- Weather Performance: The goal of testing weather performance will be to test the devices under various weather conditions (i.e. rain, snow, cold, heat, etc.). It will be determined how the devices maintain its condition under extreme weather duress.

Methodology: These procedures will be conducted for the Snap Key (mockup and look-a-like prototype) and the results are described in the next section of this paper.

Weight:

1. Add various weights to the device in controlled amounts.
2. Once the device fails (cracks, breaks, rips, slips, etc.), the last successful load without failing will be the device's weight bearing capacity.

Weather Performance:

1. The devices will be subjected to various weather condition simulations.
2. The device will be put into water to test if the device is waterproof.
3. The device will be put into a freezer to determine if it can maintain its integrity under cold temperatures.
4. The device device will be put under a heat lamp to determine if it can maintain its integrity under hot temperatures and remain safe for the user to use.

All results are as follows in Tables 14-17 on the subsequent pages.

Results for Snap Key Mockup:

Table 14—Weight Results for Snap Key Mockup

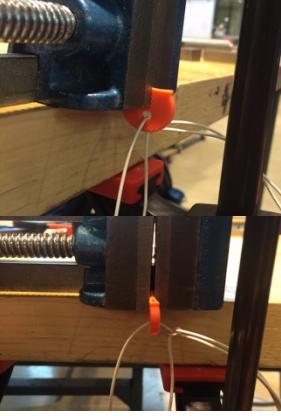
Component	Images	Plastic Deformation	Failure
Metal Clip		The clip began to bend at a load of 7 lb. 8 oz. http://i.giphy.com/3oAt1WWbLXAipieZ44.gif	The clip fractured and fell out of the load cell 
Key cap		The key cap began to stretch and plastically deform at 2 lb. 13.8 oz. http://i.giphy.com/JSeMvRWQBr3gs.gif	The key cap completely failed and ripped at 39 lb. 4.3 oz. 

Table 15—Weather Results for Snap Key Mockup

Description of element tested	Images	Results
Snap Key mockup and attached key were submerged underwater for 10 minutes. The device was removed to observe whether or not the design was waterproof.	N/A	Snap Key and device, while still having some droplets of water on its surface when first removed, was determined to be waterproof as no water was absorbed by the device.
Snap Key mockup and attached key were put into an ice box (32 degrees F) for 10 minutes.	N/A	Snap Key felt cold to the touch, but the integrity of the device, its surface, and detailed features were not altered.
Snap Key was subjected to a heat lamp (150 degrees Fahrenheit) for 10 minutes.	N/A	Snap key felt warm to the touch, but the integrity of the device, its surface, and detailed features were not altered.

Snap Key keycap was exposed directly to the heat from a hot glue gun for 2 minutes. Hot glue specs are 120V, 60Hz, 10W.		The plastic of the key cap melted from subjection to the heat from the hot glue gun tip. 
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Results for Snap Key Prototype:

Table 16—Weight results for Snap Key Prototype

Component	Images	Plastic Deformation	Failure
Plastic clip		The clip began to bend with slight force by hand.	The clip cracked at a testing load of <2 lbs. Clip was subjected to 2 lb. hand weight and immediately cracked.

Table 17—Weather results for Snap Key Prototype

Description of element tested	Images	Result
Snap Key prototype and attached key were submerged underwater for 10 minutes. The device was removed to observe whether or not the design was waterproof.	N/A	Snap Key device and key, while still having some droplets of water on its surface when first removed, was determined to be waterproof as no water was absorbed by the device.
Snap Key prototype and attached key were put into an ice box (32 degrees F) for 10 minutes.	N/A	Snap Key felt cold to the touch, but the integrity of the device, its surface, and detailed features were not altered.
Snap Key prototype was subjected to a heat lamp (150 degrees Fahrenheit) for 10 minutes.	N/A	Snap Key felt warm to the touch, and the plastic a little more malleable, but the integrity of the device was not altered
Snap Key keycap was exposed directly to the heat from a hot glue gun. Hot glue specs are 120V, 60Hz, 10W.		Glue gun burned a hole right through the keycap.

Conclusions and Limitations

From the observations and data collected during performance testing, it can be concluded for the mockup that:

- The Snap Key mockup can withstand a minimum weight of 21 lbs. 2.16 oz. before failure. This meets the user requirement that the device be lightweight but stable and secure while under conditions of stress like running.

- The Snap Key can withstand a total temperature range of at least 32 to 150 degrees Fahrenheit. The Snap Key can be submerged in water for an indefinite amount of time and maintain its integrity. This meets the user requirement of being resistant to various weather conditions which users might encounter during their run.

From the observations and data collected during performance testing, it can be concluded for the mockup that:

- The Snap Key 3D printed prototype withstands less than 2 lbs. before failure. This does not meet the user requirement that the device be lightweight but stable and secure while under conditions of stress like running, and hold a load of at least 20 lbs. (See Appendix A). Therefore, the device is not a working prototype.
- The Snap Key cannot withstand extreme temperature conditions in a range of at least 32 to 150 degrees Fahrenheit, further making it a look-a-like-prototype rather than a working one. The Snap Key can be submerged in water and subjected to cold conditions for an indefinite amount of time and maintain its integrity. This meets the user requirement of being resistant to various weather conditions which users might encounter during their run.
- More sophisticated manufacturing processes are required in order to produce a working prototype for the Snap Key (See Limitations and Future Plans section).

Appendix E: Instructions for Construction

Shoe Tag Mockup Instructions

Name Tag Clips Mockup

These instructions represent the process of safely and efficiently constructing the Shoe Tag (name tag clip variation as shown in Figure 43), so it can be used for carrying a single key while the user is running.



Figure 43: Name tag clips mockup for Shoe Tag

Materials and Equipment

In order to create a single alligator clip variation Shoe Tag one must first gather the following materials: **(One)** name tag lanyard with the side clips as shown, **(One)** plastic bag 4.5cm x 4.5cm with zip top, **(Two)** flat washers of smaller size than the plastic bag

Additionally, the following equipment is necessary for the construction of the Shoe Tag: hot glue gun, scissors.

Directions

1. Using the scissors, cut the name tag lanyard into a two strands approximately 4cm long with each strand having an end of the name tag clip.
2. Using the hot glue gun, secure the flat washer to the midpoint of the elastic band with name tag clip.
3. Using the hot glue gun, apply glue to the bottom side of the flat washer and press to the plastic bag.
4. Construction is now complete and can be inserted in shoe.

Alligator Clips Mockup

These instructions represent the process of safely and efficiently constructing the Shoe Tag (alligator clip variation as shown in Figure 44 on the following page), so it can be used for carrying a single key while the user is running.



Figure 44: Alligator clips mockup for Shoe Tag

Materials and Equipment

In order to create a single alligator clip variation Shoe Tag one must first gather the following materials: **(One)** elastic hair band, **(One)** plastic bag 4.5cm x 4.5cm, **(One)** flat washer of smaller size than the plastic bag, **(Two)** alligator clips without rubber backings.

Additionally, the following equipment is necessary for the construction of the Shoe Tag: hot glue gun, wire cutter, pliers.

Table 18—Directions for assembling the alligator clips mockup

Direction	Image
Using the wire cutters, cut the elastic hair band into a single strand approximately 4 cm long.	
Using the pliers, bend open the end of the alligator clip intended to secure the wire so that it can secure the end (~.5cm) of the elastic band. Place the elastic band into the opening. Once the elastic band is in place, use the pliers to bend the metal ends over one another, securing the band to the alligator clip. Repeat this process for the other side of the elastic band.	
Using the hot glue gun, secure the flat washer to the midpoint of the elastic band with alligator clips. Using the hot glue gun, apply glue to the bottom side of the flat washer and press to the plastic bag. Construction is now complete and can be inserted into shoe as shown.	

Snap Key Instructions

Mockup

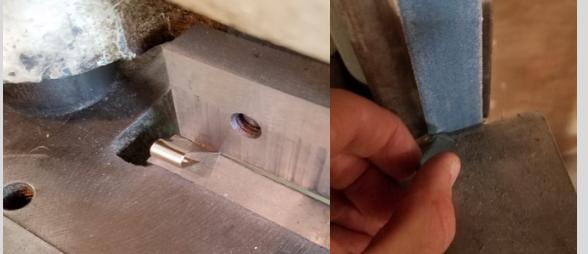
These instructions represent the process of safely and efficiently constructing the Snap Key Mockup, so it can be used for carrying a single key while the user is running.

Materials and Equipment

In order to create a Snap Key mockup one must first gather the following materials: **(One)** silicon standard size key cap, **(One)** spring steel badge clip.

Additionally, the following equipment is necessary for the construction of the Shoe Tag: razor or other cutting utensil, band saw, and metal sander.

Table 19—Directions for assembling the Snap Key mockup

Direction	Image
First a hole is cut in the top of the cap. A razor is able to slice through the rubber very easily and precisely.	
The clip required more post processing. To ensure the functionality of the mockup with a key the initial clip had to be sheared and sanded.	
Finally the clip is inserted into the hole at the top of the cap. If the hole is cut correctly it should be a very snug press fit. This ensures that the clip will stay on the cap of the mockup.	

3D Printing

The final prototype of the snap key was 3D printed in the RP lab at northwestern. It was constructed using the Stratasys Connex 350. The cap was made with flexible rubber and rigid opaque plastic was used for the clip. The Connex was chosen because it can print multiple materials at one time with high accuracy. Renders of the CAD files are included in Figure 45 and 3D printed parts are shown in Figure 46 on the following page as well.

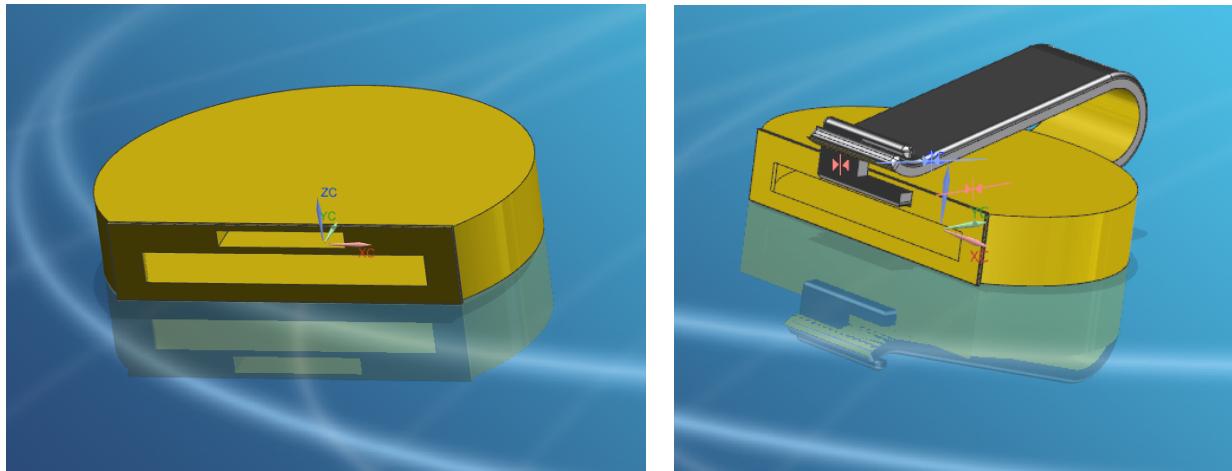


Figure 45: CAD renders of prototype



Figure 46: 3D printed Snap Key prototype

Conventional Manufacturing

The manufacturing and assembly of the final snap key product would primarily use injection molding and sheet metal forming. The clip would be formed from heated spring steel which would enable it to maintain elasticity and always return to its final shape. The cap would be injection molded from silicone using a fairly complex mold apparatus including a horizontal moving bar as well as a lollipop like insert. Once the component parts were complete they would be assembled by sliding the metal clip through the provided hole in the cap (See Limitations and Future Plans section).

Appendix F: Survey Results

To better understand the market for the chosen solution a survey was created. This survey initially collected demographic information on users such as age and gender. Then participants were inquired how often they went running. Based on how they answered their run frequency question, the participants were presented with different pages. If they indicated that they ran rarely/never, they were sent to the final page which asked them to rate how often their everyday clothing had pockets on a scale of one to five. If they indicated that they did run a few times a week or more, they were asked about their running preferences before being sent to the final question.

Three hundred and twenty-nine people responded to the survey, which is enough data to draw statistically significant conclusions. There were 105 men, 221 women, 3 users who identified as other. Of these responses the average age was 23-years old. However, as shown in Figure 47, this data was not normally distributed and instead it seemed to be composed of two unique subgroups.

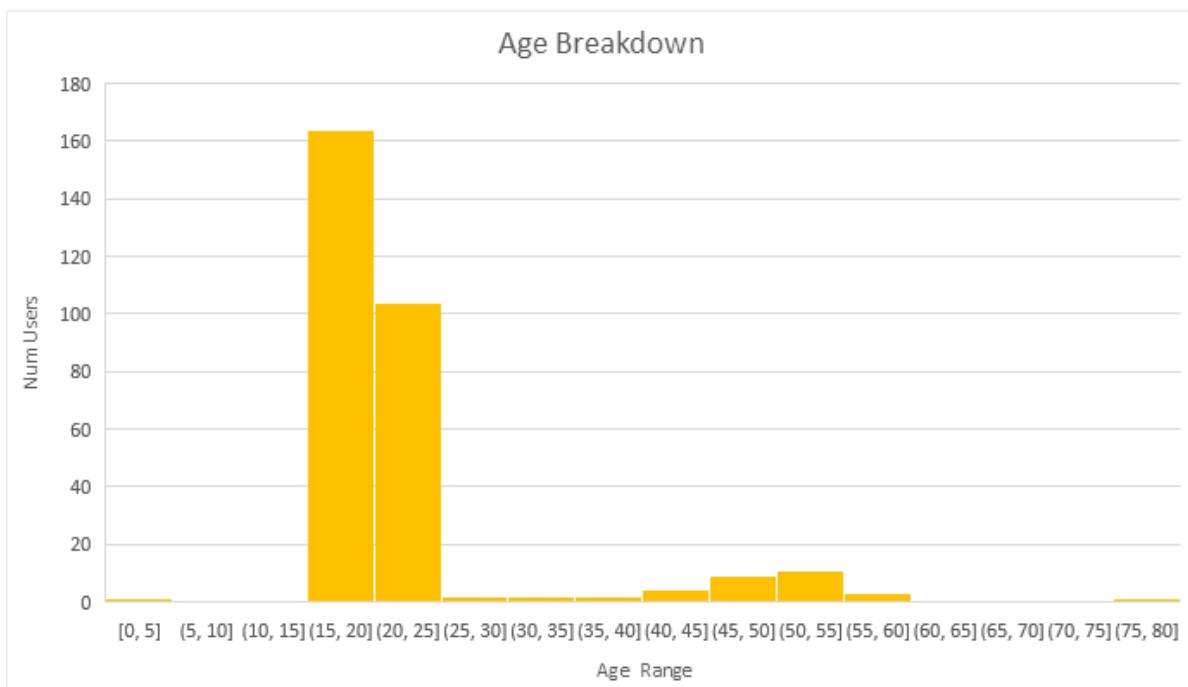


Figure 47: Age distribution of users

The majority of survey participants were made up of people in or approaching their early 20s, and the other group is in their 50s. This provided interesting contrasts between people who have stable lives and those who are in a transitional period in their lives such as college.

In order to better understand the market that was chosen, the survey asked how frequently participants ran. This was on a scale from daily to rarely. For the market to be viable a majority of users should be running at least every week. The frequency that survey participants ran can be seen in Figure 48 on the following page.

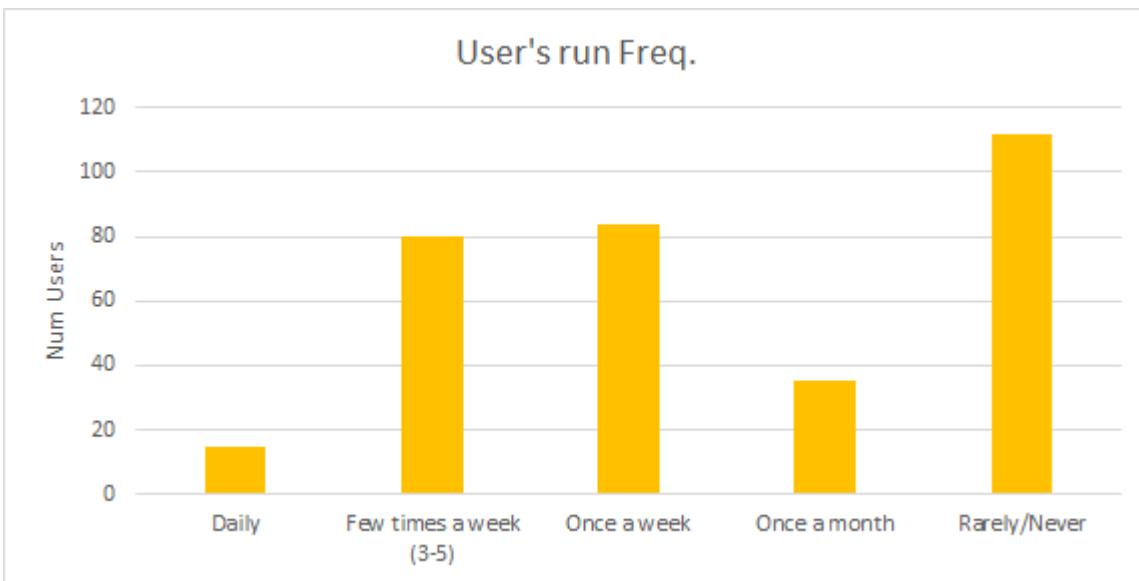


Figure 48: Running frequency

Figure 48 indicates that the largest group rarely or never ran. However, a majority of responders, almost half, indicated that they ran once or more per week. A main concern in the survey was to determine what users deemed valuable to have on their person while running, and results can be seen in Figure 49.

What do you carry on your run? Select all that apply (212 responses)

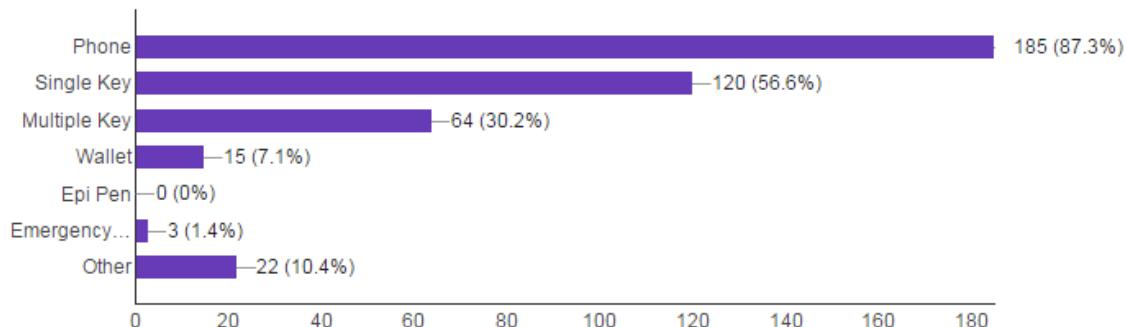


Figure 49: Individual item breakdown

As seen above in Figure 49, users overwhelmingly seemed to want to have their phone on them while running (87.3%), which is closely followed by a single house key (56.6%). Furthermore, of those who responded to the survey, 70% simply had a normal house key instead of a key FOB or key card, and key type is further broken down in Figure 50 on the following page.

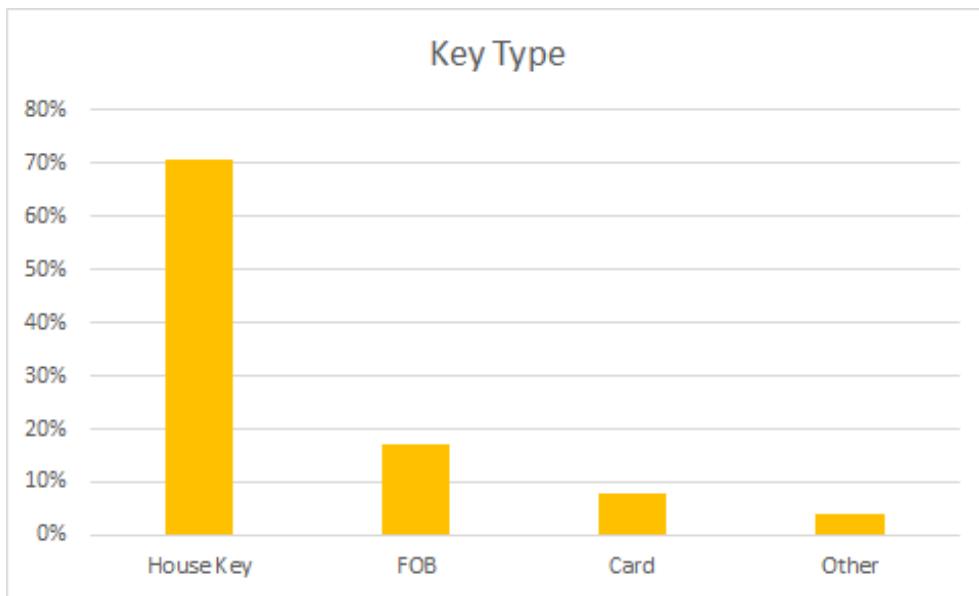


Figure 50: Item combination popularity

As indicated in Figure 50 the majority of keys, 70% are standard metal keys instead of FOBS or cards.

Appendix G: User Testing Report

User Testing Guide: This following testing guide will be used in conjunction with various subjects as they perform runs with the two designs: the Snap Key and the Shoe Tag.

The goals of this user testing are to learn:

- How intuitive the design is for users
- How the user would attach the device
- What the users like and dislike about each of the designs
- Which of the two designs to pursue based on user feedback and how well each fulfill the design requirements

Introduction: As part of the Northwestern Human Centered Product Design course, our team has been tasked with the project of designing a product that fills a white space existing in the market. After exploring various potential project areas, our team decided to pursue the issue of carrying a single key while going for a run. This device would theoretically provide a method for users to securely carry their key while going for runs while being comfortable and requiring low effort to be used. We will ask that you use this device today on your normal workout run and provide us with feedback on the intuitiveness of the design and what you like or dislike about it. The mockups we are providing you with are generally high fidelity and functioning, but may not simulate the final product in terms of materials, appearance, etc. However, your interaction with the device will provide us with valuable information and allow us to move forward with our design. Please feel free to ask questions and comment at any time.

Methodology:

- 1) Record the user's age, name (if desired), gender, and any other relevant information concerning the demographics of the user.
- 2) Hand the device to the runner. This runner would ideally be someone who identifies as normally running with a key, as this is an intended user for this product. Be sure to record qualitative observations.
 - i) What are the user's first impressions of the design? Where does their intuition lead them to believe, say, and do?
 - ii) What does the user initially like about the design?
 - iii) What concerns does the user have about the design?
- 3) Ask the runner to attach the device to their person.
 - i) For the Snap Key, record where the user attached the key. Ask the user why they attached the device there.
 - i) For the Shoe Tag, observe how the user first responds to the device and note how they would attach the device. If necessary, provide further instruction to tell the user that the Shoe Tag will be attached the face of the user's shoe.
- 4) Have the runner complete their run with the mockup in use. Record the runner's distance and time for their run. Record any unusual conditions for the run (i.e. Weather, injury, etc.).
 - i) Post-run, what did the user like about the design?
 - ii) Post-run, what did the user not like about the design?

Snap Key User Testing

User Testing Report for Snap Key: The purpose of the user testing was to determine how users would interact with the Snap Key design. It was desired to learn how intuitive the device was, how the user would attach the device with no instruction, and what the user liked and disliked about the design.

Test Methodology: One team member took the Snap Key mockup as shown in Figure X below to three different Evanston Running Club practices. The device was presented to four runners at each practice (twelve users tested overall) and the testing procedure outlined in Appendix X was followed.

These testing procedures were conducted for four mile long run practices. The runs started in the Norris Student Center on Northwestern University's campus in Evanston, IL, running south along Sheridan Rd. and looping back to end in Norris. Testing procedures lasted no longer than an hour each session, including the run as running times varied from 24:16 to 41:00 for four miles.

The users included in these user testing sessions ranged from ages 21 to 56 years old and there were 5 females and 7 males who volunteered to be a part of this user testing. All users included in this testing identified as being runners who normally carried a key with them during their workout.

Table 20—User Demographics for Snap Key Testing

User #	Age	Gender	Time for 4 miles
1	22	Female	40:12
2	21	Male	39:58
3	34	Female	34:16
4	56	Female	33:24
5	21	Male	28:16
6	27	Male	31:40
7	44	Female	31:40
8	43	Male	38:24
9	50	Female	41:00
10	22	Male	24:16
11	21	Male	24:54
12	34	Male	29:51

Results:

Table 21—Information gathered from users prior to their run for Snap Key mockup (these are not direct quotes and instead are synthesized versions of their responses)

User	Likes	Dislikes
1	Small, doesn't seem like it will burden me while running	It doesn't seem like it'll be super secure, I'm worried that it could potentially slip off without me noticing
2	Like how simple it is, and how nobody would really be able to notice it. Like the idea that I could take it on and off my keychain easily	Nothing I can really tell right now. With this model, the key is so small, I wonder if there is a cap that would comfortably fit on dorm key/fob though
3	Colorful and provides versatility of where the device can go on my body. Can go on my pants, my shirt, my armband, my bra!	So small and no real method of making sure that it securely snaps. The name is a bit deceiving right now.

4	I like the color and how it's very small.	I don't really see much a use for it because I don't carry a keychain and always wear athletic clothing with small pockets in them to carry my stuff.
5	Super small and totally makes sense. I like that this would make it super easy to come on and off my keychain because my nails are short and I always hate doing that transfer of key from keychain in order to go for a run.	I'm only just worried that it might slip off during a run. I go decently fast, and while movements are generally constant, it could be a problem. I'm also worried I'll be able to feel the metal during the run and it will annoy me.
6	The clip is such a great idea! It's really small and seems pretty durable too.	It seems fine to me. I definitely want to see if it will stay on the entire time during my run.
7	Ah, so cool! It's so small and you can even still use the key without having to take the key out of the blue thing.	It feels pretty strong, but hopefully it can stay on the entire time without slipping off.
8	Definitely small, which makes it a very sleek design. I like how it can go on my key clip too.	I'm doubtful that it will be secure enough, but I guess we'll see!
9	This is so easy to be able to pull on and off my keychain. It always hurts my fingers and ruins my nails when I try to slide it off my ring. The color is a nice touch. I feel like there is some advantage there.	I think a lot of people would probably like how small it is, but it actually concerns me that it's so small because I feel like it might not be noticeable and get lost very easily.
10	The blue is great; aesthetics are always important, right? I think the clip is a pretty nice idea and seems really simple.	My only worry is if it will come loose or slip off during my run.
11	I see how this works! Pretty simple and cool. I like that it has the metal clip-thing, and I could this being used for many different things and in different places.	I'd be a little worried about losing it when it's either not on my shoe, or not on my keychain.
12	I like how it's not super noticeable. The clip is a nice touch.	I don't see how this would work for different types of keys other than this standard house one.

Table 22—Placement of the Snap Key and justifications

User	Where attached	Why
1	Lip of pants	Seemed like the most obvious place, wasn't really sure how secure it would be on other parts of the body
2	Top of shoe	I usually tie my key to my shoe anyway and just seemed like the most obvious place
3	Back of bra strap	At first I wanted to put it on my front strap because normally I put my key in my sports bra, but it fit really nice on the back strap and laid flat against my back.
4	Small pocket in shorts	I always wear clothing with small pockets in them, so it just makes sense to use the small pocket and put the key there like I usually do.
5	Lip of shorts	If weather is nice I usually run shirtless, so this really is the only place the key can reasonably go using the clip.
6	Shoe	I usually tie my key on my shoe, which is why I chose to put it there, and the clip made it super easy to slip it onto my laces.
7	Sports bra strap	It just seemed like the easiest place to slip the clip onto.
8	Shoe	I always put my key on my shoe, and this felt like the most natural place

		for it.
9	Sports bra	It slides very easily over the fabric and I know that I'll be able to feel the key to some extent at all times, which means I know if I lose it or not.
10	Lips of shorts	Fits really well on the fabric and grips everything tight enough that it makes me less worried about it falling off.
11	Shoe	I always run with my key on my shoe and I don't really feel like going outside of the box here.
12	Armband	I run with an armband to hold my phone and listen to music while I run. It can go on the strap pretty easily.

Table 23—Information gathered from users after their run for Snap Key mockup

User	Likes	Dislikes
1	Stayed on the entire time and I hardly noticed it	Don't know if I would want this on my pants every time I go for a run, wonder where else I could put it that it's still secure
2	Stayed on my shoe, felt stable, and I could see that it was there the entire time because of the colorful cap.	Could feel the key poking at the top of my foot a bit, but that's no different than from when I normally tie it to my shoe
3	Stayed on the entire time and I was never worried about it falling off.	I could feel the clip rubbing on my skin during the run and it was a relief to take it off at the end. I didn't like having the key be almost directly on my skin. This may be combated by putting it somewhere else on my body, or on my shoe like a lot of other people.
4	I definitely see why this would be helpful for a lot of people who run with keys. It didn't feel any different than when I normally run with a single key, so it's definitely not an annoying addition to the key itself.	I didn't really have a use for it because I am pretty happy with the way that I run with my key. Maybe in future uses, I would find a different way to carry my key since I would have the clip option.
5	I liked how small it was and I didn't feel it once during the run, which is something I was worried about. It was also secure and didn't fall off, so that's good!	I was paranoid that the key would slip off during the run, so I kept touching it to make sure it was still there. I imagine it's something I could get used to, but that sort of bugged me.
6	Like I said before, it was so easy to slip onto my shoe! I liked that I didn't have to tie and untie my shoelaces to use it.	There were some times I found myself looking down to make sure it was still there. The smallness of it was worrying, but the color of the key thing was great because I could see it easily.
7	It was so easy to clip on and it stayed put the entire time. I like how it's so small and not bulky at all; you couldn't even see it poking out from under my shirt.	I could feel the clip poking my skin a little bit, but it mostly lifted the key away from my body. It wasn't perfectly comfortable, but perfectly fine.
8	I liked how easy it was to use; definitely an advantage to the design. It also was surprising how stable it was, and it never fell off my shoe which is great.	I noticed at one point the key shifted, so it was sort of poking the top of my foot, which was kind of annoying.
9	I liked that it was stable and secure, and being able to slightly feel it was good	It wasn't 100% comfortable, but I feel like it's something that a person can get used to. If there was

	for me, so I wasn't worried that it was gone.	a way to make it flatter, I think that would be great.
10	I didn't even notice it during my run, which is great! Stayed on the whole time and I would definitely buy something like this if it were super cheap.	Honestly, don't have any dislikes. It seems like a pretty good thing/design.
11	This was definitely easier than tying and untying my shoes to lace my key through. I was never worried that it would completely fall off my shoe during the run, which is good.	I could feel the key poking, but that's pretty much the same as when I run with my key on my shoe all the time. I'm still worried about potentially losing it.
12	It's small and could be great for a lot of people looking for a way to slyly store their key while running.	It was definitely rubbing my skin a bit. The armband was a good separation between my skin and key.

Limitations and Conclusions: One major limitation to this procedure of testing was that it was impossible to see how the user interacted with the key during the run. Because of this limitation, it was not known if the user fidgeted or altered the location/security of the device at any point. It could not be determined how often they looked at, touched, or thought about the device.

The ability to test a large number of users was limited by the number of mockups available for each session. For future projects and iterations, it should be considered to test a higher number of mockups to get more feedback from a greater number of users.

Generally, the feedback from the various users concerning the Snap Key was pretty consistent. Users liked that the design was small and not very noticeable. The design was very simple and could easily be communicated without much instruction. During the run, users reported that the mockup felt secure, and many had little or no concern that it would fall off. Additionally, it was reported to be comfortable and not hinder the user's ability to run.

Frequency coding based on user testing feedback can be viewed at the following links:

<https://drive.google.com/a/u.northwestern.edu/file/d/0BwZz4RuvQP1Wa2RQOGdoUktqRIE/view?usp=sharing>

<https://drive.google.com/a/u.northwestern.edu/file/d/0BwZz4RuvQP1WMTJyREd5T2FwVDQ/view?usp=sharing>

Still, there were some concerns about the design to consider when moving forward. Some users reported that they could feel the device and key to some extent on their body. A few worried that it was too small, and sometimes worried that the design would fall off without the user noticing. It was also communicated that users were concerned that the design would not fit a wide variety of keys, limiting the design to very specific niche of users with a very specific type of house key.

User Testing for Shoe Tag

User Testing Report for Shoe Tag: The purpose of the user testing was to determine how users would interact with two different versions of the Shoe Tag design. It was desired to learn how intuitive the device was, how the user would attach the device with no instruction, and what the user liked and disliked about the design.

Test Methodology: Another team member took the Shoe Tag mockup with the name tag clips to various age groups, genders and levels of running to her close friends and family. The device was presented to eight runners total and the testing procedure was followed. A separate team member took the Shoe Tag mockups with alligator clips for testing following the same testing procedures.

These testing procedures were conducted for varying levels of distances for casual runs. The runs took place in Chicago city sidewalks, on Sheridan up into Winnetka and around the lakefill on Northwestern University campus. Testing procedures lasted no longer than an hour each session.

The users included in these user testing sessions ranged from ages 12 to 24 years old and there were 4 females and 3 males who volunteered to be a part of this user testing. All users included in this testing identified as being runners who normally carried a key with them during their workout.

Table 24—User demographics for name tag clips mockup user testing

User #	Name	Age	Gender	Test	Time
1	Giovanny	24	Male	Jog around Chicago neighborhood	6:32
2	Edgar	22	Male	Jog around Chicago neighborhood	7:24
3	Fabiely	13	Female	Jog around Chicago neighborhood	7:49
4	Miles	21	Male	Jog around the lakefill	6:23
5	Amy	12	Female	Jog around Chicago neighborhood	8:13
6	Allison	21	Female	Run into Winnetka	45:23
7	Diana	18	Female	Jog up Sheridan	15:23

Table 25—User demographics for alligator clips mockup user testing

User #	Name	Age	Gender	Test	Time
1	Simeon	18	Male	Jog around lakefill	6:57
2	Elias	19	Male	Jog around lakefill	7:24
3	Ahlaam	19	Female	Walk around Annenberg	4:13
4	Matthew	21	Male	Jog around block	3:27
5	Sehmon	19	Male	Walk around sorority quad	6:00
6	Teah	19	Female	Walk around sorority quad	5:22

Results:

Table 26—Information gathered from users prior to their run for name tag clips mockup

User	Initial reaction	Likes	Concerns
1	“Is this bag big enough to fit my key? Seems a bit small”	“I have one pair of running shoes I can see this as a permanent solution for me”	At first glance couldn’t figure it out where to attach it on his shoe
2	“I really like how it’s clear and you know the key is still in there. But if the product works the way it’s supposed to then I shouldn’t have a need to look down anyways”	“I like that it’s clear”	“My feet are skinnier but the little bands seem to be a bit long. Maybe they could be shorter?”
3	“Oh this looks easy to put on my running shoes. I wonder how it will affect my cleats that I wear for softball”	“I like that it’s in a secure bag”	“It looks kinda funny. I wonder if my teammates would ask me about it”

4	"This is cool, I like that it won't ruin my running shoes but still is semi-fixated"	"I like how easy it is to attach to my shoe"	"I still worry about the security of this top zip thing. I'd have to run with it and see but that risks potentially losing a key. Can you test that for me?"
5	"Is this strong enough for me to put it on? I worry it's too flimsy I don't want to break it"	"I like that it's the exact size for my key"	"But a bigger bag would be nice cause what if I have difficulty putting it in/out"
6	"I'd love to try this on my run! I never know where to put my key"	"I like how low-key it is. I can go on a run and I think no one will notice unless I point it out"	"I hope this stays on safely for the entirety of my run!"
7	"This is cool I want to try it on my jog. Is there a reason why the bag is clear?"	"It fits my running shoes! I am a size 6 so I was worried my feet would be too small"	"Is there another way I can snap this shut just to be extra careful so that it doesn't fall off? Kinda scared to lose it"

Table 27— Information gathered from users prior to their run for alligator clips mockup

User	Initial reaction	Likes	Concerns
1	"Clips obviously, strange that you always need to clip it on to something"	Clips on to shoe	Not being secure while running especially in certain places
2	"Yo this is smart... seems like you can put it anywhere"	That the clips will work everywhere	Durability, clip might hurt, appearance isn't great, clip might not be tight enough
3	"Can clip on to my pants, seems efficient"	n/a	Not big enough, might not notice when it's gone, if I kick something it might fall off
4	"Put it on my hip? Pocket maybe?"	Small	Stability, might fall apart
5	"Clips make me think it can go on anything, little flimsy though...two clips throws me off not sure where to put it"	Small	Seal very close to key, square shape, might not be able to feel it
6	"Key fits, wonder if another (type) key would not fit...looks like something I'd clip on to my body...point of key might hurt?....two clips must be between something"	Doesn't take up much space	Secureness, clips strong enough if i'm doing something that's a lot of activity

Table 28— Information gathered from users after their run for name tag clips mockup

User	Likes	Concerns
1	"I like that I can put it in my first shoe lace hole and didn't have to put it in a	"I hadn't untied these shoes since I bought them! Do I always need to untie my shoe if I decide to

	specific hole”	use this device?” “The bag is too flimsy maybe better quality would be nice”
2	“I like that it’s clear and you can still see the key in there”	“My feet are skinnier so the bands seem a little too long. Is there a way you could shorten the length of the bands and make it more necessary to stretch the bands? I feel like it’d make it more secure”
3	“It took me 2 minutes to put it on and I think I can manage that. It was pretty easy to attach to my shoe and I think my friends could figure it out too”	“I probably wouldn’t leave it on permanently cause during softball games when I slide it could hurt” “Maybe something better to lock would be helpful”
4	“It’s secure, I couldn’t even notice it on my run and it didn’t bother me. No one would ever suspect it was there”	“The bag is too flimsy maybe better quality would be nice” “Also I know you’re only focusing on one house key size but have you specified which type of shoe you’re targeting? I think my running shoes have different hole sizes, maybe just something to look into”
5	“I was in a rush to go on my run and I liked that it took me less than 30s to secure it to my running shoes”	“I’d really like to have a zipper like the Ziploc bags with the square thing.”
6	“Attaching the key was intuitive and I would definitely use this on my runs!” “It stayed on during my entire run. When I turned around I looked down to make sure it was still there cause I was nervous but other than that seemed like I wasn’t carrying anything”	“I think definitely something stronger as an attachment method would make me less worried. The name tag elasticity just seems a bit flimsy now and I was worried about the actual attachment mechanism not so much the plastic bag”
7	“I like how adaptable it was to my two running shoes I was considering using when going on this run. One has my special insoles”	“The little disk things can fall off if I’m attaching it and pull too hard. Is there a way to not have those washers there?”

Table 29— Information gathered from users after their run for alligator clips mockup

User	Likes	Concerns
1	Didn’t jiggle as much as I thought it would, I kept checking to see	If I was running in the woods or more seriously I feel like it could have snagged on something
2	Didn’t fall off, I could see the key	Kind of hard to put on, felt tight across my foot
3	Thought it was going to fall off but it didn’t	Didn’t like how it looked and didn’t fit evenly on my shoe
4	I could see the key	It broke, other than that it wasn’t bothering me
5	I felt it around my foot, reassuring	Looks aren’t the best, had to be put under my laces because it stuck out when it wasn’t
6	Was secure, nicely over my shoelaces	n/a

Limitations and Conclusions: One major limitation to this procedure of testing was that it was impossible to see how the user interacted with the key during the run. Because of this limitation, it was not known if the user fidgeted or altered the location/security of the device at any point although one long

distance user did comment on how she looked down halfway through to make sure it was still secure. It could not be determined how often they looked at, touched, or thought about the device while on their jog or run.

The ability to test a large number of users was limited by the number of mockups available for each session. For future projects and iterations, it should be considered to test a higher number of mockups to get more feedback from a greater number of users with varying running distances and speeds.

The feedback from the various users concerning the Shoe Tag can be categorized across three areas; locking mechanism of the plastic bag, security of the name tag material and the low-effort attachment. Users liked that the design was clear and not noticeable once on the shoe. The design was very simple and could easily be communicated without much instruction thanks to the signifiers in the shoe tag. During the run, users reported that the mockup felt secure, but a couple had concerns about the locking mechanism in the baggie top and a couple about the security of the name tag on the shoelace hole. Additionally, it was reported to be comfortable and not hinder the user's ability to run, staying low-key and stable, i.e. not jiggling while on their run.

Frequency coding based on user testing feedback can be viewed at the following links:

<https://drive.google.com/file/d/0BwZz4RuvQP1WMXN5UVB4UjQ4bms/view?usp=sharing>

<https://drive.google.com/a/u.northwestern.edu/file/d/0BwZz4RuvQP1WMmJFWUM1MU5IVDA/view?usp=sharing>

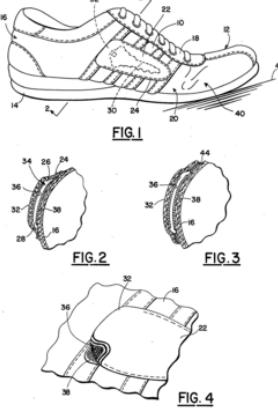
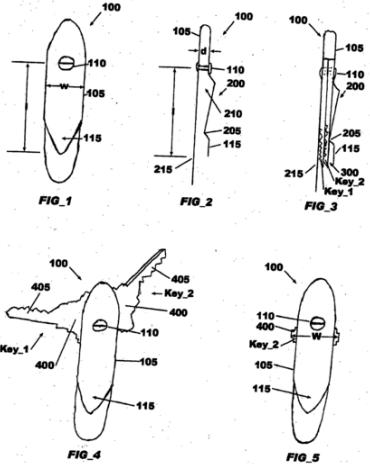
Moving forward, the major areas that need to be focused on based on this set of users is the locking mechanism of the plastic bag to secure the key is stable inside and the security of the attaching mechanism to design if alligator clips or name tag clips would give users more trust in their key not being lost.

Appendix H: Patent Research

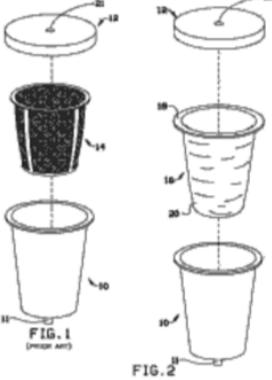
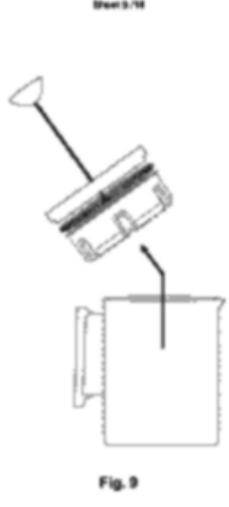
Project Proposal #1

Table 30 outlines relevant patents with descriptions for how to carry a single key on a person while running or exercising.

Table 30—Relevant Patents for Concept #1

Patent	Description
	<p>Pocket for athletic shoe (patent # US4280287) (publication date 1981-07-28)</p> <p>The pocket is created using a “flat sheet of material” attached to the outside of the shoe. The material has within it a “closure flap” to allow the easy storage and removal of small items.</p> <p>Advantages: easier to access than if items were stored in a bag, secures one small item, visible i.e. user will not forget where the key is,</p> <p>Disadvantages: harder to access than if items were stored on hip e.g. pocket or fanny pack, only has the potential to secure one item, interrupts the design of the shoe/ may not be aesthetically pleasing, the feature is only useable with a pair of shoes that has the design i.e. in order to use the feature on all pairs of shoes, all of the shoes must have the pocket</p> <p>Notes: the Pocket for athletic shoe is interesting because it meets several of the requirements users detailed in the interviews and survey. The pocket is secure as well as somewhat accessible. The design is not obtrusive or uncomfortable for the user because of its position.</p>
	<p>Athletic Key Clasp System (patent #US20060000250A1) (publication date</p> <p>The System is comprised of two parts; the clasp which allows attachment to anything relatively flat, and the key holding mechanism which holds up to two keys. Because the keys are connected at the head portion, this allows for the mobility of the “shank portion coupled to the head portion.”</p> <p>Advantages: holds multiple keys discreetly, can be clasped to most articles of clothing, improved accessibility due to clasp, low effort</p> <p>Disadvantages: slightly cumbersome, requires keys to always attach within clasp system, not easily compatible with other key storage methods e.g. keychain ring</p> <p>Notes: The clasp system is particularly interesting, as it allows for the key to be placed on a variety of clothing pieces. Additionally, being able to hold multiple keys in a discreet</p>

2006-01-05)	fashion is also attractive.
<img alt="Technical drawings of a flexible shoe pocket. Fig. 1 shows a side view of a shoe with a pocket attached to the laces. Fig. 2 is a front view of the pocket with labels for various parts like 10, 102, 23, 28, 42, 100, 22, 23, 24, 34, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180, 182, 184, 186, 188, 190, 192, 194, 196, 198, 200, 202, 204, 206, 208, 210, 212, 214, 216, 218, 220, 222, 224, 226, 228, 230, 232, 234, 236, 238, 240, 242, 244, 246, 248, 250, 252, 254, 256, 258, 260, 262, 264, 266, 268, 270, 272, 274, 276, 278, 280, 282, 284, 286, 288, 290, 292, 294, 296, 298, 300, 302, 304, 306, 308, 310, 312, 314, 316, 318, 320, 322, 324, 326, 328, 330, 332, 334, 336, 338, 340, 342, 344, 346, 348, 350, 352, 354, 356, 358, 360, 362, 364, 366, 368, 370, 372, 374, 376, 378, 380, 382, 384, 386, 388, 390, 392, 394, 396, 398, 400, 402, 404, 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<p>Patent Application Publication Oct. 29, 2015 Sheet 1 of 4 US 20150307267 A1</p>  <p>FIG. 1 (prior art)</p> <p>FIG. 2</p> <p>10 12 14 16 18 20</p>	<p>Features a basket-like section made from a liquid permeable material. “The disposable filter is removed immediately after use and discarded without mess.”</p> <p>Advantages: removes grinds at one time, compact</p> <p>Disadvantages: compatibility with different French Presses, may not help with coffee stains</p> <p>Notes: The design is attractive because it removes whatever it filters at one time, additionally it is a small compact size</p>
<p>Disposable Beverage Filter (Permeable Disposable Filter and Beverage System) (patent #US20150307267A1) (publication date 2015-10-29)</p>  <p>Fig. 9</p> <p>Sheet 3/16</p> <p>WO2011005542A2</p>	<p>Features an insert with compartments for holding coffee or tea. The insert is removable thus allowing easy removal of the grinds that are pressed into the insert</p> <p>Advantages: removed at one time</p> <p>Disadvantages: may not be easier to clean, may not be compatible with different size presses, may take longer than desired</p> <p>Notes: The design is interesting because it doesn't interrupt the natural cycle of the brewing process (no additional steps added)</p>

Device and Method for Cleaning a French or Coffee Press (patent #US8074561B2) (publication date 2011-12-13)

Features a screw-like ramp platform that rotates from the floor of the press, up and out to a point where any grounds can be removed.

Advantages: Does not interrupt the integrity of the press mechanism

Disadvantages: potential inefficient removal of grounds

Notes: Another simple way to remove grounds that does not add an extra step to the process

Project Proposal #3

Table 32 outlines relevant patents with descriptions for how to avoid getting hair stuck in the toggled-nose-pads of sunglasses.

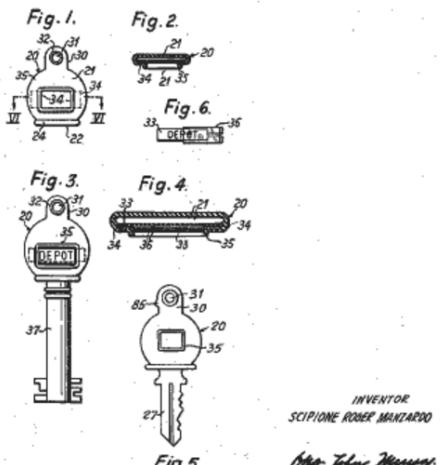
Table 32—Relevant Patents for Concept #3

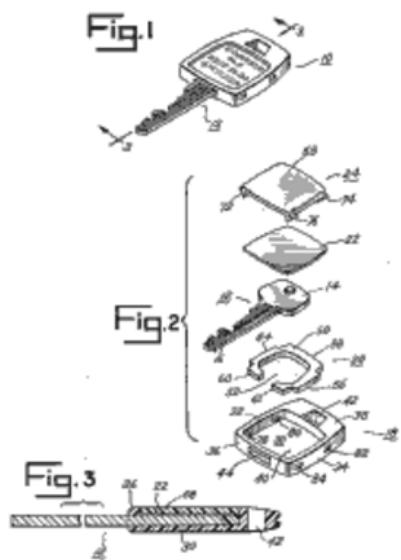
Patent	Description
 Eyewear with Stabilization Nosepiece (attachment) (patent #US20110317122A1) (publication date 2011-12-29)	<p>Acts as an attachment for technical eyewear. Comprised of a platform that stabilizes the bridge of the glasses and fits snugly to the nose of user.</p> <p>Advantages: more stability, use of non-pivoting nose-pads</p> <p>Disadvantages: compatibility, interrupts aesthetic of glasses</p> <p>Notes: An attachment piece that fits eyewear gives a good general outline as to functioning designs that could be made more discreet</p>
	<p>The design involves using several “struts” that would allow a connecting piece to slide on to the pads along with a portion of the frame in order to “reduce snagging or catching of foreign objects between the pad and the pad support.”</p> <p>Advantages: not obtrusive, secure, compatibility</p> <p>Disadvantages: may alter aesthetic</p>

Nosepad Connector for Eyewear (nosepiece for eyewear) (patent #EP2614401B1)(publication date 2016-04-06)	depending on glasses, several small part and must use compatible pads in glasses Notes: The design aims to solve our exact problem and provides a detailed attempt at doing so
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Snap Key Design Relevant Patents

Table 33—Relevant patents to support novelty of Snap Key design

Patent	Description
 <p>KEY IDENTIFICATION AND FILING MEANS Patent #US2932107A publication date 1960-04-12</p>	<p>This patent describes a key-identification means, and receiving means comprising a resilient removable snap-on cover-envelope for at least the handle part. Extending in the plane of the cover is a projection serving key-attaching purposes.</p> <p>Advantages: way to attach key to keychain, identify key by color</p> <p>Disadvantages: only clips onto keychain and no other methods of attachment</p>
 <p>Key Cover (patent #US1868563A) (publication date 1932-07-26)</p>	<p>The Key Cover is made of a “resilient material to fit a correspondingly shaped head of a key and adapted to be removable fitted there over.”</p> <p>Advantages: give better grip to the key, universal with many different key styles</p> <p>Disadvantages: no way to secure directly to person</p> <p>Notes: The key cover is interesting because it is the most fundamental improvement to a key, in that it fits the exact shape of the key. This cover is a potential building block for a design that address this problem.</p>



The key and the bottom of the recess is comprised of a layer of malleable material in the recess in which the head of the key is embedded, or a layer of material in the recess having a high coefficient of friction against which the head of the key is held under pressure.

Advantages: holds key very snugly

Disadvantages: many more pieces than necessary

Appendix I: Team Charter

Members: Freesoul El Shabazz-Thompson, Christina Lundgren, Wendy Roldan, and William White

Mission: To design and manufacture a device that allows for users to carry a single key on their person while running that is simple in design, encourages security, and requires low effort.

Performance Goals:

- By week four, have three full-fledged design idea concepts (with mockups) and have answers to the opportunity questions for each design.
- By week five, have narrowed down to one design idea concept and produce a team project proposal.
- By week six, have design alternatives for project.
- By week six, have a full concept sketch with a contextual research plan, in addition to an advanced mockup.
- By week seven, have conducted testing and organized results.
- By week eight, have a working prototype.
- By week nine, have a business plan and first rough draft of final report.
- By week ten, have a final draft of report.

Methods of communication:

- Main method of communication will be via groupme
 - Reply to groupme texts in a timely manner
- Utilize GoogleDrive for documenting work and communicating ideas to fellow team members

Team member responsibilities and roles:

- Identify and take advantage of each team member's strengths
 - Christina: sketching, organizing, CAD, has access to North Shore residents, report writing, sewing/knitting
 - Wendy: Has access to Chicago users and wide range of demographic groups, CAD, shop experience with CNC, injection molding, experience with design process in research lab
 - Bill: Building, creating, CNC milling, injection molding, CAD, statistics
 - Freesoul: sketching, shop experience, communication/presentation (video, audio, photo)
- Divide and conquer approach
 - Each team member knows their responsibilities clearly
 - Each member is accountable and reliable to complete their work to a high quality and on time

Decision making:

- At least 75% of members need to be present to make a final design decision.
- For the definition of the problem statement and the final design concept, each team member needs to be on board.
- Need to make timely decisions. This means being decisive, but also respectful of the ever-changing process

Respect and trust: It is important that each member of the team is respectful of the process and of each other's ideas and ways of approaching the process. It's also important to trust each member to have their work complete and that they will be accountable to their responsibilities. Everyone needs to be understanding of exceptions, but also not take advantage of them and work hard for each other.

Handling conflict: The team does not like conflict, so each member will do their best to address problems as they arise in the moments or in a timely manner. It is important to be honest with each other and listen to each other.

Celebrating success: The team will be generous giving team members credit for their hard work. The team plans to get together for a fun dinner out at the end of the quarter.