TimTech

KeyGen

Group 18

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Executive Summary

1. **Who we are?**
   a. We are a medium-sized technology company called TimTech. We were established on the 4th of October, 2018. We are composed of five different, talented individuals, each with our own strengths and weaknesses. We came together and discussed issues that are emerging in today's technological society. A big issue we noticed was the safety of people and their homes. A recent study[1] shows that in 2017 there was an average of 1.4 million homes being broken into. With that, we decided to take action and address this issue by coming up with a solution of our own, the KeyGen. We based off our product similar to that of Lockitron's product.

2. **Why is the project being undertaken?**
   a. We saw an opportunity for our medium-sized company to grow by creating a product that everyone can use. The KeyGen is designed to protect people's' homes from being invaded and robbed. This will give them a sense of security and relief because KeyGen will notify them via realtime if their homes are being broken into. No one deserves all their hard work to be taken away by someone who wants to make profit out of them. KeyGen can protect one's home and have a more secured lock/door.

3. **Vision Statement**
   a. Provide people with easier access to their own living space and a sense of security

4. **Mission Statement**
   a. We are committed to help keep people safe and secure where they live, visit and work. Even though mechanical hardware is the foundation of our business and will be the core of what we do, we acknowledge that the future of the security industry lies within the needs of an increasingly connected world. That is why our core strength in mechanical security, when combined with digital, mobile, and interconnected electronic devices, makes us a leader in our markets.

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[1] Property crime in the U.S.: *https://www.statista.com/topics/1751/property-crime-in-the-us/*
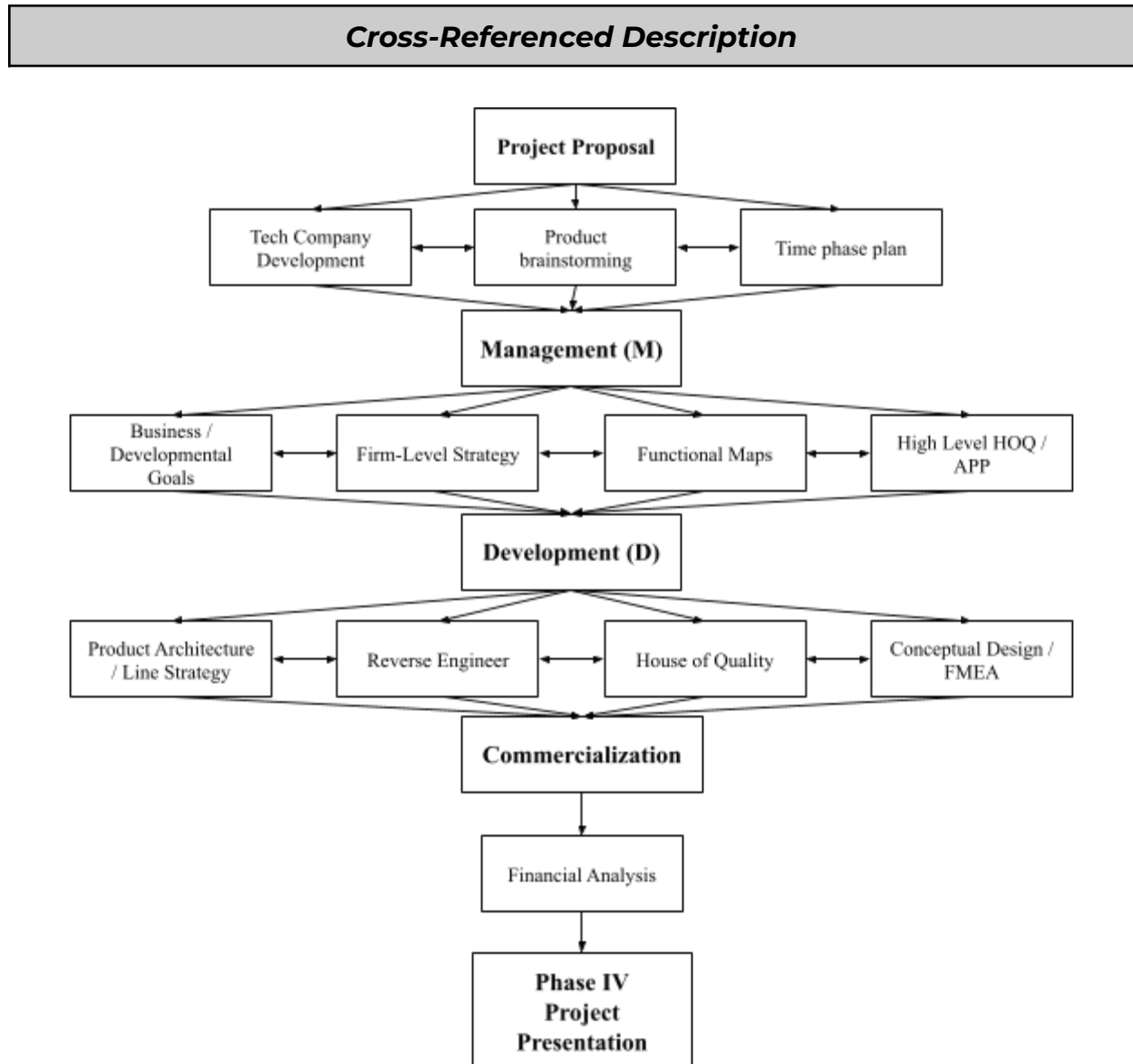
Cross-Referenced Description

Figure 1, Functional Structure of everything

The above block diagram, similar to a "function-structure" shows how all the parts of the report (e.g., HOQ, APP, Conceptual Design) are connected to each other. Each section depends on their on the previous section. If one section is not yet finished, then we cant move on to next section and if we do it would be wrong. Our professor told us that we need to finish a previous task in order to complete the next task because that task will have relevant information from the previous task. "If it's not usable, then it's not useful." - Subhas Desa. Our team made sure to finish any work that hasn't been done yet in order for us to be able to move on. The "function-structure" is kind of like the Waterfall methodology, were everything trickles down. Each task is dependent on the previous task.

It first starts off with the "Project Proposal." Without a proposal, we don't have a product and we can't move onto the next tasks. In this section, we brainstormed possible products that will help society as a

whole. We identified current problems in today's society and we created a product based off of those problems. We created a product that helped solve those issues. We did a lot of brainstorming because there were a lot of problems we could have also fixed, but security and safety was our number one. Once we identified our product and solution, we based our company (TimTech) off a similar company that creates Smart Keys. From there, we were able to move onto the next section with all the relevant brainstorming we had done.

It moves onto the next section, "Management." This section is the basis of why we were established. It cincluse sub-sections such as, business goals, developmental goals, firm-level strategy. Our business goals and developmental goals are the foundation of TimTech. We use those goals to help us stay on track and make sure we are fulfilling our mission/vision statement. Our firm-level strategies (technology, product/market strategy) helps us reach our goals. Those strategies are help us visualize how TimTech will be in the future. It also gives us an insight as to what our strategies will be and how we will go about finishing them. The inclusion of functional maps helps us identify what products TimTech has to offer. These time-phased maps help us stay on track with our products to make sure we release them to the market in time. It also includes our Market analysis and Customer needs analysis in which we identify the problem in today's society and create a product that fulfill those needs (relating to the project proposal, why we were established).

Then it moves onto the "Developmental" section. This section was the engineering section. This was were we started to develop our product(s). We had to concurrently engineer those sub-sections together. Those subsections also relied on the previous section because the product had to be related to what the problem we had originally found. We had to do a HOQ of our product which is related to the first section because we had to find problems/customer needs. We defined those customer needs in the HOQ and determined how the customer needs are correlated to the technical etrics. Then we moved to reverse engineering similar products. This was an important subsection because it allowed us to see what our competitors were creating and what their product contained. It also gave us an insight as what to add to our product that their product didn't have, which relates to our technology strategy to stay technologically advanced. We then created various concept designs to see which one of our product will be successful in the targeted markets. Within selection of the concept, we created an FMEA analysis to help us determine possible failures of that product and how to combat them.

Then it moves to the "Commercialization" section. This section was also important because it tells us if we will make a positive NPV without product. Hence, why we created various concept designs to see if one is better than the other and will generate profit. This section strongly depends on the "Development" and "Management" section because it determines how long our product will stay in the markets for. It also gives us an idea at how much to put a price in our product by still making revenue.

Lastly, it moves onto the last section "Phase IV." Phase IV is the presentation aspect. This section depended heavily on all of the sections. If we didn't identify a problem, we couldn't create a product, and without a product there wouldn't be a presentation. The presentation consisted of why TimTech was established and the solutions we found to the problems found in the brainstorming subsection. We had to

make sure everything was correct, neatly organized, and everything made sense before presentation our product to the instructor.

All in all, each section, subsection, strongly depended on one another. With a subsection being completed, we wouldn't be able to move onto the next section because that subsection has information that can be used in the next section. It was important for us to make sure that we completed everything in a timely manner to be able to present our product.

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Management (M)

1. Firm-Level Strategy

1.1. Competitive Analysis

Purpose: The Competitive Analysis addresses the competitive strategy available to TimTech in order to achieve a strong competitive position. We will be utilizing Porter's Five (Six) framework which includes the following terms: industry, market, competitors, new entrants, substitutes, buy ers, and seller.

Define:

1. Perform a thorough and specific competitive analysis of the industry/market landscape for the KeyGen identify: competitors, suppliers, buyers, etc.
2. Are we a new entrant?
3. Are we creating a substitute product*?*

Plan:

1. Use Porter's Five (Six) Forces to determine where TimTech stands
2. Analyze TimTech against other competitors

Execute

1. Specific Company Analysis (Structural Analysis)
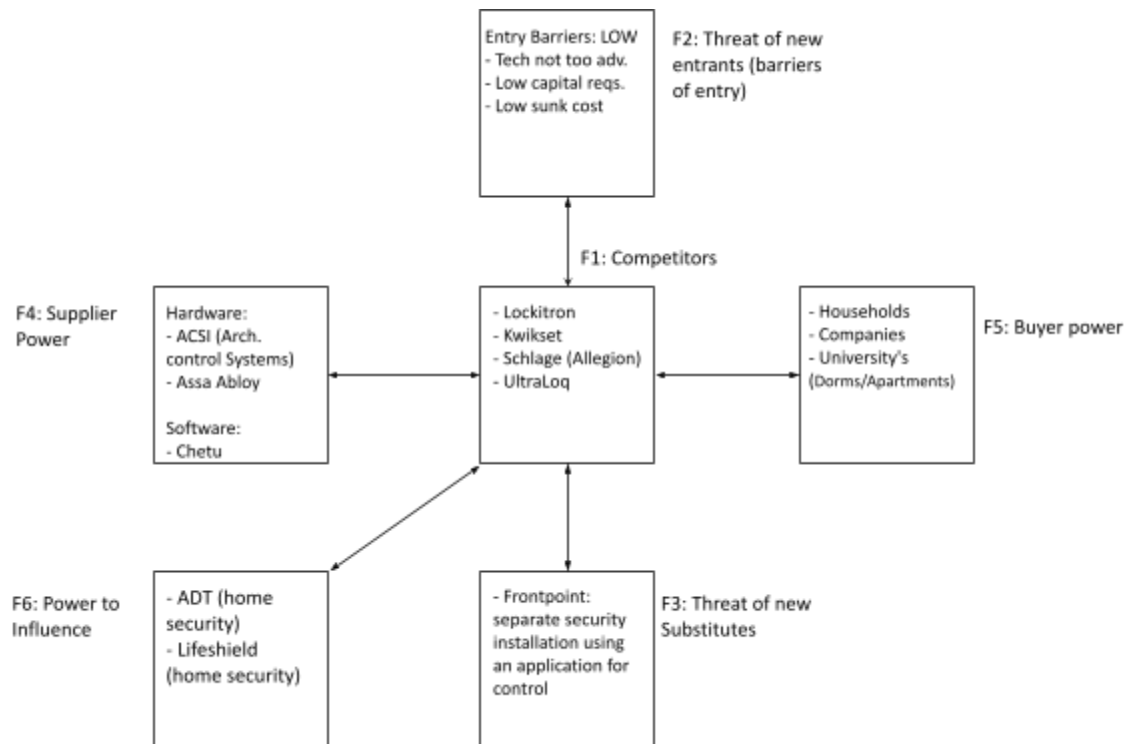
Structural Analysis:

Figure 1.1.1, Porter's Five (Six) Forces Model

Force	Analysis
Rivalry between competitors	- Schlage had 8.5% market share - Lockitron had 5% market share - Kwikset had 3-5% market share - UltraLoq has 1-3% market share
Barrier to entry	- Technology not too advanced - Low capital reqs. - Low sunk cost
Threat of new substitutes	- Frontpoint → separate security installation - August → Smart Lock 3rd Generation
Supplier power	- ACSI for the hardware components - Software companies for software aspects
Buyer power	- Households - Companies with offices
Power to influence (complementors)	- ADT (home security) - Lifeshield

Figure 1.1.2, Porter's Five (Six) Forces Analysis

Competitive Analysis:

Force	Key Determinants	Analysis	Intensity of Force	Actions
Rivalry between competitors	- Concentration - Size	- Four players: Lockitron, Kwikset, Schlage, UltraLoq - Schlage, Kwikset dominant players	Medium - high	Develop a differentiated product line
Barrier to entry	- Brand identity - Economies of scale - Capital requirements	Difficult for a company to develop products to compete	Medium	Use emerging technology to stay ahead in the game
Threat of new substitutes	- Switching costs - Price/performance	Frontpoint → separate security installation	Medium - high	Make the company grow exponentially
Supplier power	- Supplier size - Supplier concentration	Have various suppliers to speed development	Low - medium	Update current software to make it more powerful
Buyer power	- Buyer size (volume) - Buyer concentration	Create products for various consumers	High	Maintain market control and good relationships with tech giants
Power to influence	- Brand identity - Complementors size	Help stabilize current products	Low - medium	Have various complementors

Figure 1.1.3, Competitive Analysis of TimTech

Check Work

We made sure that we included everything that was asked for in analyzing TimTech's competitive analysis. We also made sure to include everything the instructor wanted us to include.

Learn and Generalize

TimTech is not a new entrant, it is a medium-sized company that entered the Smart Key markets and there has been various competitors. The entry barriers are low because the technology is not too advanced for a Smart Key. Additionally, we will not be creating a substitute product. We will be creating our own product that fits within the customers needs.

1.2. Competitive Strategy

Purpose: Including a Competitive Strategy will allow us to differentiate ourselves from our competitors and a different approach. It will determine how competitive we will be in the market and how are strategy will work.

Define

1. How will we differentiate ourselves from our competitors?

Plan:

1. Identify key components that make TimTech different from other companies
2. How is our product different from our competitors product?

Execute

1. **Competitive Strategy**
   a. Differentiation Focus
      i. We strive to differentiate ourselves from our competitors and keep our target customers narrow
   b. Pull in the customers on the border of segments who are looking for specific aspects of the key/lock product
   c. Difficult to sustain, but we plan to put heavy emphasis on customer service
      i. Listening and improving on most customer feedback
   d. Important for us to invest in research and development to create new products that are substantially better than our competitors and should focus on:
      i. Technical capabilities
      ii. Staying ahead of our competitors
      iii. Use emerging technology to develop better products

Check Work

We made sure that our work is correct and that it makes sense. We also made sure to combine it with some of our goals and developmental goals.

Learn and Generalize

We were able to understand what our Competitive Strategy was and how we are different from our competitors. We tried to combine it with some of our strategies to make us stand out even more.

1.3. Technology Strategy

Purpose: The purpose of including a Technology Strategy is to see how technological advance we are from our competitors. Including this strategy will allow us to visualize how we want to approach the technological aspect of our product and it will determine how advanced we are as a company.

Define:

1. What are core technology that give our company (TimTech) a technological advantage over our competitors?
2. What is TimTech's approach to Product and Technology Development?

Plan:

1. Define TimTech's core technology and how we have a technological advantage
2. Define our approach to Product and Technology Development

Execute

1. **Core Technology**
   a. Create a key that can function like an old-fashioned key (Ex. key with ridges)
   b. Key is stainless steel to keep it hygenic and resistant to corrosion/heat/water damage
   c. Key can signal the door to open automatically (with fingerprint recognition)
      i. Useful for when user has no hands free to open the door
   d. Create an app on mobile device/laptop/other devices that can keep user aware of key's/lock's situation
2. **TimTech's Approach**
   a. We will be using a differentiated approach
      i. Different than our competitors
      ii. Listening to what the customers want
   b. Identify the main problem in today's world and create a product based off of that problem
      i. Have a solution to the problem

Check Work

We made sure that our approach was reasonable and correct. We also made sure to answer the questions that the instructor wanted us to answer.

Learn and Generalize

We were able to identify TimTech's core technology and how that gives a technological advantage over our competitors. We also defined our approach and how it will help us out in the long run and how it will make us stay ahead of our competitors.

1.4. Product/Market Strategy

Purpose: The Product/Market Strategy will allow us to determine which market(s) to target with our product. It will also help us differentiate ourselves from our competitors and how we will be successful.

Define
1. What differentiates TimTech's products from our competitors?
2. What market segments does TimTech serve?

Plan:
1. Identify various market segments that TimTech can go into

Execute
1. **TimTech's Differentiation**
   a. Differentiation Focus
      i. We strive to differentiate ourselves from our competitors and keep our target customers narrow
   b. Pull in the customers on the border of segments who are looking for specific aspects of the key/lock product
   c. Difficult to sustain, but we plan to put heavy emphasis on customer service
      i. Listening and improving on most customer feedback
   d. Important for us to invest in research and development to create new products that are substantially better than our competitors and should focus on:
      i. Technical capabilities
      ii. Staying ahead of our competitors
      iii. Use emerging technology to develop better products
2. **Market Segments**
   a. Primary Market:
      i. Home Owners
      ii. Enterprises
      iii. Office departments

Check Work

We made sure that our work was correct and that our market segments were closely related to with what are product is. We also made sure that our differentiation strategy was different and actually made sense

Learn and Generalize

We were able to identify TimTech's differentiation and how we are different from our competitors. We were also able to identify the main primary markets that we should target, that we think may bring in revenue from our product.

2. Business Goals / Objectives

Purpose: Having Business Goals/Objectives will make TimTech stay ahead of the game. We will use our goals as milestones and check on them every-now-and-then to see if we are completing those objectives in a timely manner.

Define:

1. Establish the business goals and objectives (ROI, %market share, revenue, and growth aspirations).

Plan:

1. Identify tangible goals/objectives for TimTech

Execute

1. Business Goals / Objectives

Business Goals / Objectives	Value
Revenue ($)	$275 M
Growth (%)	10%
Market Share (%)	15%
Profit Margin (%) = (income) / (revenue)	15%

Figure 2.1, Business / Objectives of TimTech in 2018

Objectives

1. Create a product that will benefit the customers and generate revenue for the company
2. Develop different products that can also be used

Check Work

Our work should be correct in every aspect, and we made sure that the goals were tangible.

Learn and Generalize

TimTech's goals and objectives aren't too big or too small. We will be able to reach those goals/objectives once we have developed our product. We know it will take some time to achieve them, but as long as we complete them within a time-frame, we should still be ahead of the game.

3. Developmental Goals

Purpose: The Developmental Goals refer to concrete technology, product, and market goals. They need to be consistent with the company's technology, product/market, and competitive strategy. Having developmental goals will allow us to achieve TimTech's business goals.

Define:

1. Define the overall development goals to align business goals, competitive strategy, technology strategy, and market strategy.

Plan:

1. Come up with certain developmental goals that will help TimTech in the long run and make sure they are aligned to our strategies

Execute

1. **Developmental Goals**
   a. Pay attention to customer needs, market trends, and patterns, especially in terms of their customers
   b. Develop products before our competitors can develop them
   c. Being technically advanced than our competitors
   d. Solely focus on being a "utility" company

Check Work

We made sure to double check our work to see if it is correct. Each team member revised it to see if we all agree with what we had finished.

Learn and Generalize

We were able to identify TimTech's overall developmental goals and how they will help us stay in the Smart Key industry. It gave us insight was to how we should approach everything.

4. Functional Maps

Purpose: Having a time-based evolutionary map of one or more key metrics will allow us to determine the span of all our products. Additionally including a time map of our competitor's products will let us know how many products they released within a time frame.

Define:

1. Create functional maps (time-based evolutionary maps for engineering, manufacturing, and marketing in order to rationally decide which technologies and products to develop

2. A revenue map based on product/market segmentation is crucial for the selection of the appropriate target markets

Plan:

1. Develop time-based maps of TimTech's products over time
2. Have a revenue map based on product/market segmentation

Execute

1. Time-Based Evolutionary Maps

Evolution of TimTech:

1. Normal Key/Lock
2. Keycard/Lock
3. Smartkey/Electronic Lock
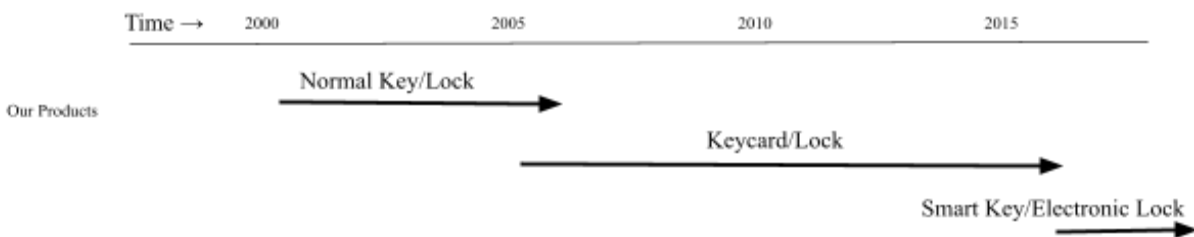
Figure 4.1.1, Evolutionary Functional Map

Technology/Products Similar To Ours:

Since our entrance to the smart key market, we've noticed quite some competition. We strive to be above all these companies but it will be difficult to compete with other companies with similar products. These products include:

Company	Product	Release Year
Schlage	BE479 V CEN 619 Sense	June 3, 2015
August	Smart Lock 2nd Generation	October 14, 2015
UltraLoq	UL3 BT Smart Lock	July 16, 2016
Lockitron	TRON200QS Bolt	July 31, 2017

Figure 4.1.2[2], similar products to ours

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[2] HighTech: *https://10hightech.com/best-smart-lock/#L1*
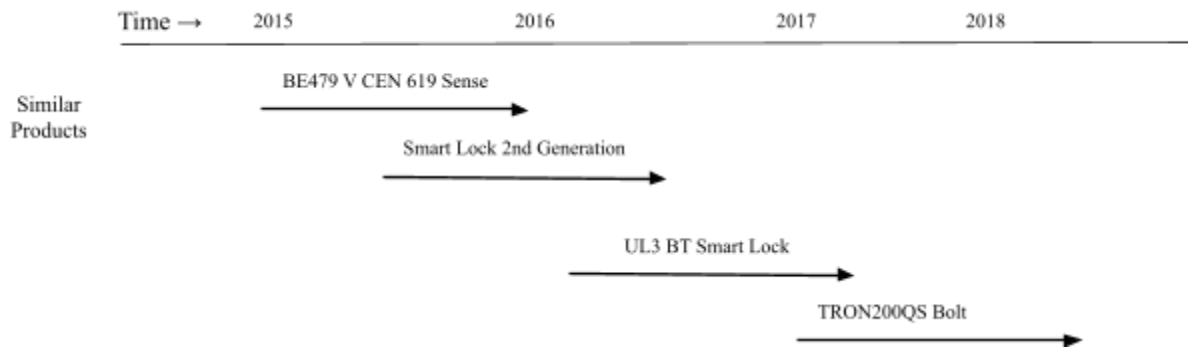
Figure 4.1.3, evolutionary time map of similar products

2.   Revenue Map / Market (Customer) Needs Analysis
2.1.   Revenue Map

	Normal Key/Lock	Keycard/Lock	Smartkey/Electronic Lock
Enterprises	sales revenue: $10 M growth: 0.5%	sales revenue: $100 M growth: 5%	est. sales revenue: $50 M growth: N/A
Institutions	sales revenue: $35 M growth: 1%	sales revenue: $54 M growth: 3.5%	est. sales revenue: $27 M growth: N/A
Households	sales revenue: $75 M growth: 3%	sales revenue: $1 M growth: 0.2%	est. sales revenue: $0.5 M growth: N/A

Figure 4.2.1, Revenue Map

2.2.   Market (Customer) Needs Analysis
What are the customer needs?
1. Households
   a. Safety/security
      i. Protection of valuables
      ii. Protection of family, housemate, pets, etc…
   b. Ease of use
      i. For people with their hands full
      ii. Ex: person carry groceries wants to be able to get into the house without having to put down groceries to open door
2. Institutions (universities, hospitals, etc…)
   a. Safety/security
      i. Protection of information
      ii. Protection of employees
      iii. Protection of customers

      b.   Ease of use
          i.   For people with disabilities

3. Enterprises
      a.   Safety/security
          i.   Protection of information
          ii.   Protection of employees
      b.   Ease of use
          i.   For people with disabilities
          ii.   For people with their hands full

How can we fulfill customer needs?

4. Create a lock that only opens on a signal
      a.   Signal will be scrambled so hackers can't hack open the door
      b.   Ensure only certain keys can open certain locks
5. Include a mechanism similar to doors that open when a button is pushed
      a.   Except our mechanism opens the door when a key is near

Check Work

We made sure to double check our work to see if it is correct. Each team member revised it to see if we all agree with what we had finished.

Learn and Generalize

We were able to create various maps that will help TimTech reach its goals. We were also able to establish a revenue map and a market needs customer analysis that will help us identify certain customer needs.

5. **High-Level HOQ**

Purpose: Including a High-Level HOQ will allow us to be able to determine the what the customers want and how important they are, and the technical metrics they would like to see in the product and how important they are as well.

Define:

1. Identify customer needs and translate these needs into high-level technical requirements (for the technology, products, and projects to be developed)

Plan:

1. Determine customer needs that will be important
2. Determine technical metrics that will be crucial to our product

Execute

Step 1: *Create a structured and prioritized list of the Customer Needs for the intended product based on market research and assess the importance of each need using a convenience scale*

Customer Needs	Importance
Easy to use	9/10
Affordable	8/10
Durable/Quality	7/10
Small size	7/10
Security	10/10

Figure 5.1, Customer Needs

Step 2: *Make a list of the technical metrics and asses the importance of each metric using a convenient scale*

Technical Metric	Units
Price	8/10
Number of buttons	7/10
Frequency response	7/10
Weight	5/10
Dimensions	5/10
Set-up Time	4/10

Figure 5.2, Technical Matrix

Check Work

We made sure to double check our work to see if it is correct. Each team member revised it to see if we all agree with what we had finished.

Learn and Generalize

Identifying the customer needs and technical metrics if our product will definitely allow us to know what the customer really needs. It'll give us insight on what to add in our conceptual design. It also helps us understand how important each need is.

6. Aggregate Project Plan

Purpose: The Aggregate Project Plan (APP) will help us determine which projects we should further develop. It'll give us the maximized EMV of each project we want to create and see which one will give us that high EMV.

Define:

1. Use probabilistic decision analysis to develop an initial Aggregate Project Plan, which is the mix of products to be developed:
    a. Research & Advanced Development
    b. Breakthrough
    c. Platform
    d. Incremental (Enhancements, derivatives, hybrids)
    e. Alliance, or partnered projects

Plan:

1. Have a set of three projects and do the decision analysis
2. Check in with team to see if they agree with what project we should select

Execute

The "Potential Project" landscape is shown below:
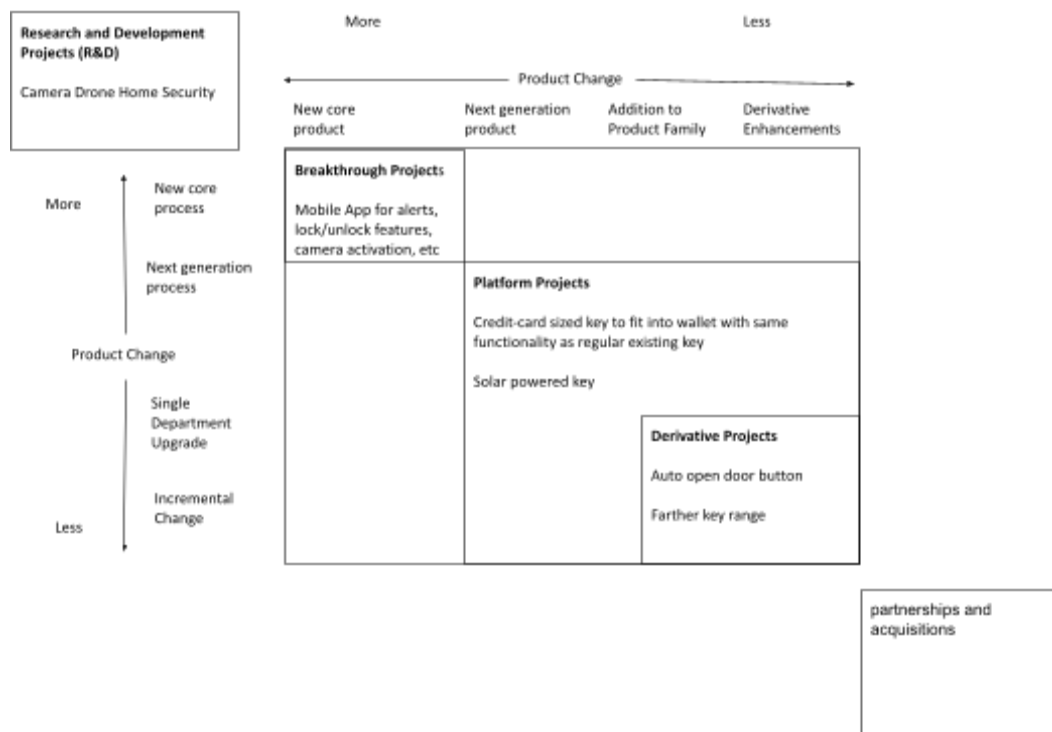
Figure 6.1, R&D Mix

Step 1: *Identify a set of n (in this case, 3) potential projects*
1. P1: Smart Key
2. P2: R&D for Keycard/Lock
3. P3: Safe (vault)

Step 2: *For each project, Pi*
1. Estimate the cost of each project

Project	Predicted Cost ($ Millions)	Predicted Revenue ($ Millions)
P1: Smart Key	$0.25M	$3.0M
P2: Keycard/lock	$1.5 M	$10 M
P3: Safe (vault)	$0.8 M	$7.0 M

Figure 6.2, Estimated cost, EMV

2. Use the 6-step Decision Analysis process to compute the payoff

Step 1: *List all the (raw) building blocks relevant to the particular problem of interest, with all the associated branches*

Figure 6.3, Raw building blocks

Step 2: *Create an Influence Diagram, which is a high-level chronological view (left-right) of the relationship between the blocks*

Figure 6.4, Influence diagram

Step 3: *Convert the Influence Diagram into a Decision Tree by including all the appropriate branches for the decision and uncertain event blocks*
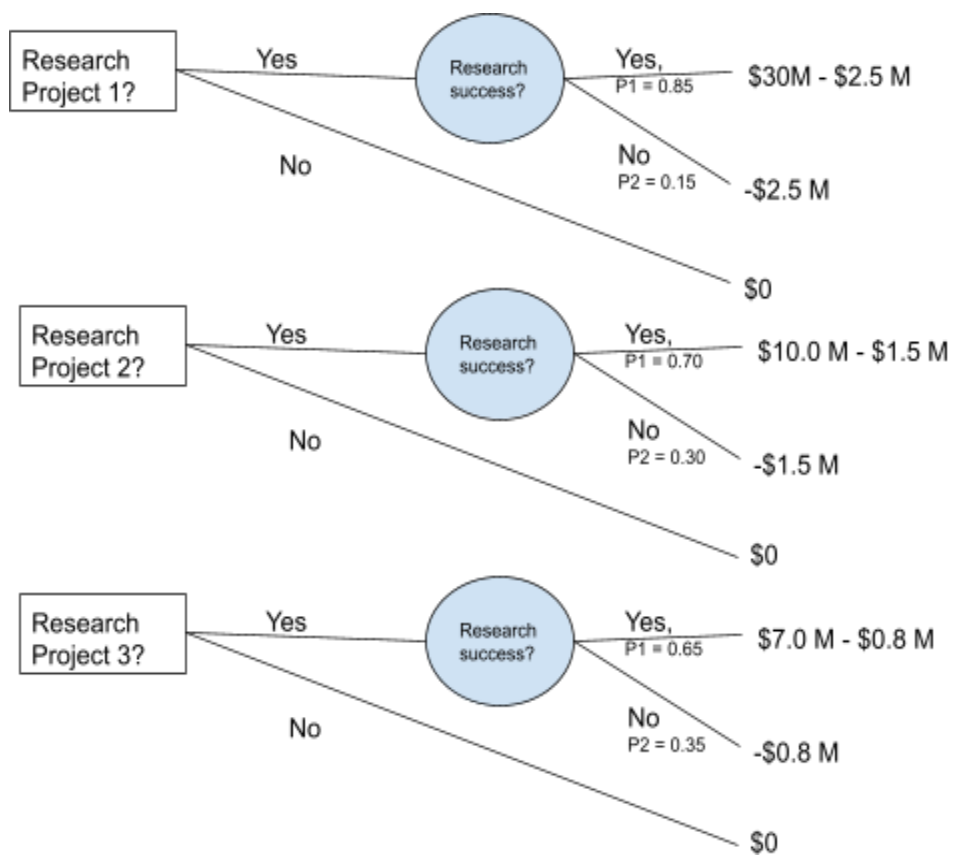
Figure 6.5, Decision Tree

Step 4: *Fold back the Decision Tree to obtain the payoffs associated with each choice in the decision blocks*
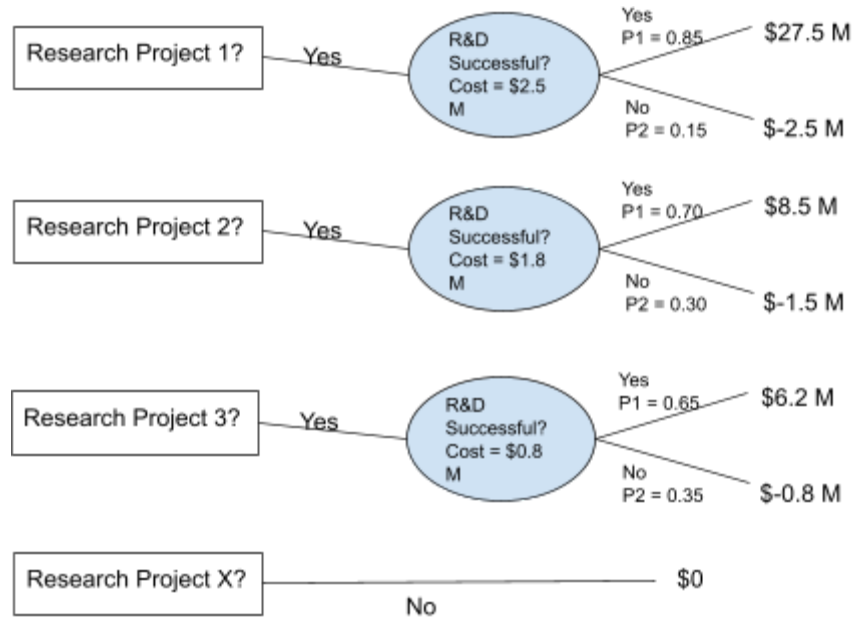
Figure 6.6, Payoffs associated with each project

Step 5: *Choose the option which maximizes payoff*

What maximizes payoff:

Given Project budget: **$30 M**
Project 1: EMV calculation
$\quad$ 0.85($30 M) + 0.15($-0.25 M) = $12.5 M - $0.0375 M = $12.4625 M $\quad$ ⇐ Fund project
Project 2: EMV calculation
$\quad$ 0.70($8.5 M) + (0.30)($-1.5 M) = $5.95 M - $0.45 M = $5.5 M $\quad\quad$ ⇐ Don't fund project
Project 3: EMV calculation
$\quad$ 0.65($7.0 M) + (0.35)(-0.8 M) = 45.5 - 2.8 = $4.27 M $\quad\quad$ ⇐ Don't fund project

Step 6: *Perform a Sensitivity Analysis to determine the "robustness" of our decision with respect to changes in the nominal value of the input parameters*

Project 1:
$\quad$ **(a)** 10% change in probability
$\quad\quad$ (i) $\quad$ Decision 1: P_{nom} = $nominal\ probability$ = $0.85 \rightarrow$ fund the project
$\quad\quad$ (ii) $\quad$ Decision 2: $P_{nom} + 0.1P_{nom}$ = $0.85 + (0.1)(0.85)$ = 0.935

$$(0.935)(\$30\ M)\ +\ (0.065)(\$-2.5\ M)\ =\ \$\ 27.888\ M \rightarrow \text{fund the}$$
project

   (iii)   Decision 3: $P_{nom}\ -\ 0.1P_{nom}\ =\ 0.85\ -\ (0.1)(0.85)\ =\ 0.765$

$$(0.765)(\$30\ M)\ +\ (0.235)(\$-2.5\ M)\ =\ \$\ 22.363\ M \rightarrow \text{fund the}$$
project

(b) 20% change in probability

   (i)   Decision 1: $P_{nom}\ =\ nominal\ probability\ =\ 0.85 \rightarrow \text{fund the project}$

   (ii)   Decision 2: $P_{nom}\ +\ 0.2P_{nom}\ =\ 0.85\ +\ (0.2)(0.85)\ =\ 1.02$

$$(1.02)(\$30\ M)\ +\ (NAN)(\$-25\ M) \rightarrow \text{invalid}$$

   (iii)   Decision 3: $P_{nom}\ -\ 0.2P_{nom}\ =\ 0.85\ -\ (0.2)(0.85)\ =\ 0.86$

$$(0.86)(30\ M)\ +\ (0.14)(\$-2.5\ M)\ =\ \$25.45M \rightarrow \text{fund the project}$$

Conclusion: Project 1 is robust.

Project 2:

(a) 10% change in probability

   (i)   Decision 1: $P_{nom}\ =\ nominal\ probability\ =\ 0.7 \rightarrow \text{fund the project}$

   (ii)   Decision 2: $P_{nom}\ +\ 0.1P_{nom}\ =\ 0.7\ +\ (0.1)(0.7)\ =\ 0.77$

$$(0.77)(\$85\ M)\ +\ (0.23)(\$-15\ M)\ =\ \$62M \rightarrow \text{fund the project}$$

   (iii)   Decision 3: $P_{nom}\ -\ 0.1P_{nom}\ =\ 0.7\ -\ (0.1)(0.7)\ =\ 0.63$

$$(0.63)(\$85\ M)\ +\ (0.37)(\$-15\ M)\ =\ \$48M \rightarrow \text{fund the project}$$

(b) 20% change in probability

   (i)   Decision 1: $P_{nom}\ =\ nominal\ probability\ =\ 0.7 \rightarrow \text{fund the project}$

   (ii)   Decision 2: $P_{nom}\ +\ 0.2P_{nom}\ =\ 0.7\ +\ (0.2)(0.7)\ =\ 0.84$

$$(0.84)(\$85\ M)\ +\ (0.16)(\$-15\ M)\ =\ \$69M \rightarrow \text{fund the project}$$

   (iii)   Decision 3: $P_{nom}\ -\ 0.2P_{nom}\ =\ 0.7\ -\ (0.2)(0.7)\ =\ 0.56$

$$(0.56)(\$85\ M)\ +\ (0.44)(\$-15\ M)\ =\ \$41M \rightarrow \text{fund the project}$$

(c) 30% change in probability

   (i)   Decision 1: $P_{nom}\ =\ nominal\ probability\ =\ 0.7 \rightarrow \text{fund the project}$

   (ii)   Decision 2: $P_{nom}\ +\ 0.3P_{nom}\ =\ 0.7\ +\ (0.3)(0.7)\ =\ 0.91$

$$(0.91)(\$85\ M)\ +\ (0.09)(\$-15\ M)\ =\ \$76M \rightarrow \text{fund the project}$$

   (iii)   Decision 3: $P_{nom}\ -\ 0.3P_{nom}\ =\ 0.7\ -\ (0.3)(0.7)\ =\ 0.49$

$$(0.49)(\$85\ M)\ +\ (0.51)(\$-15\ M)\ =\ \$34M \rightarrow \text{fund the project}$$

Conclusion: Project 2 is robust.

Project 3:

(a) 10% change in probability

   (i)   Decision 1: $P_{nom}\ =\ nominal\ probability\ =\ 0.65 \rightarrow \text{fund the project}$

   (ii)   Decision 2: $P_{nom}\ +\ 0.1P_{nom}\ =\ 0.65\ +\ (0.1)(0.65)\ =\ 0.715$

$$(0.715)(\$70\ M)\ +\ (0.285)(-\ 8\ M)\ =\ \$47.77M \rightarrow \text{fund the project}$$

    (iii)   Decision 3: $P_{nom}\ -\ 0.1P_{nom}\ =\ 0.65\ -\ (0.1)(0.65)\ =\ 0.585$

$$(0.585)(\$70\ M)\ +\ (0.415)(-\ 8\ M)\ =\ \$37.63M \rightarrow \text{fund the project}$$

(b) 20% change in probability

    (i)   Decision 1: $P_{nom}\ =\ nominal\ probability\ =\ 0.65 \rightarrow \text{fund the project}$

    (ii)   Decision 2: $P_{nom}\ +\ 0.2P_{nom}\ =\ 0.65\ +\ (0.2)(0.65)\ =\ 0.78$

$$(0.78)(\$70\ M)\ +\ (0.22)(-\ 8\ M)\ =\ \$52.84M \rightarrow \text{fund the project}$$

    (iii)   Decision 3: $P_{nom}\ -\ 0.2P_{nom}\ =\ 0.65\ -\ (0.2)(0.65)\ =\ 0.52$

$$(0.52)(\$70\ M)\ +\ (0.48)(-\ 8\ M)\ =\ \$32.56M \rightarrow \text{fund the project}$$

(c) 30% change in probability

    (i)   Decision 1: $P_{nom}\ =\ nominal\ probability\ =\ 0.65 \rightarrow \text{fund the project}$

    (ii)   Decision 2: $P_{nom}\ +\ 0.3P_{nom}\ =\ 0.65\ +\ (0.3)(0.65)\ =\ 0.854$

$$(0.845)(\$70\ M)\ +\ (0.155)(-\ 8\ M)\ =\ \$57.91M \rightarrow \text{fund the project}$$

    (iii)   Decision 3: $P_{nom}\ -\ 0.3P_{nom}\ =\ 0.65\ -\ (0.3)(0.65)\ =\ 0.455$

$$(0.455)(\$70\ M)\ +\ (0.545)(-\ 8\ M)\ =\ \$27.49M \rightarrow \text{fund the project}$$

Conclusion: Project 3 is robust.

Step 3: *Introduce a project selection decision variable for Project Pi, define a binary*)

Variable	Definition	Value (if applicable)
N	Number of projects	N = 3
2^N	Combinations	8 Combinations
α	Integer for project	
C	Cost	
V	EMV	
$\Delta i\ =\ 1$	Perform the project	
$\Delta i\ =\ 0$	Reject the project	

Figure 6.7, projection selection variables

Variables:

P1→ α1, C1, V1

P2→ α2, C2, V2

P3→ α3, C3, V3

Total Cost = (α1*C1) + (α2*C2) + (α3*C3)

Total EMV = (α1*V1) + (α2*V2) + (α3*V3)

Step 4: *Calculate the cumulative (total cost), Ct, of performing the projects*

Ct = Δ2.5 + Δ15 + Δ8 = **$25.5**

Step 5: *Calculate the cumulative (total EMV), Vt*

Vt = Δ225.75 + Δ55 + Δ42.7 = **$323.45M**

Step 6: *Introduce the capital budget constraint*

Cb ≈ $150 Million, maximized total EMV in regards to total cost must be less than or equal to the budget constraint.

Step 7: *Pose the optimization problem (the capital budgeting problem; Integer-Programming problem)*

Maximize the cumulative EMV:

$$Vt = \sum_{i=1}^{n} \Delta i V i$$

Subject to the capital budget constraint

$$Ct = \sum_{i=1}^{n} \Delta i C i \leq Cb$$

Use table lookup to solve the optimization problem:

Project Mix   Project Cost   Project EMV

P1	P2	P3	C1	C2	C3	V1	V2	V3	Cum. Cost	Cum. EMV
0	0	0	$2.5 M	$1.5 M	$.8 M	$12.6M	$5.5 M	$4.27 M	$0	$0
0	0	1	$2.5 M	$1.5 M	$.8 M	$12.6M	$5.5 M	$4.27 M	$.8 M	$4.27 M
0	1	0	$2.5 M	$1.5 M	$.8 M	$12.6M	$5.5 M	$4.27 M	$1.5 M	$5.5 M
0	1	1	$2.5 M	$1.5 M	$.8 M	$12.6M	$5.5 M	$4.27 M	$2.3 M	$9.77 M

1	0	0	$2.5 M	$1.5 M	$.8 M	$12.6M	$5.5 M	$4.27 M	$2.5 M	$22.575 M
1	0	1	$2.5 M	$1.5 M	$.8 M	$12.6M	$5.5 M	$4.27 M	$3.3 M	$26.845 M
1	1	0	$2.5 M	$1.5 M	$.8 M	$12.6M	$5.5 M	$4.27 M	$4.0 M	$28.075 M
1	1	1	$2.5 M	$1.5 M	$.8 M	$12.6M	$5.5 M	$4.27 M	$4.8 M	$32.345 M

Figure 6.8, Project Mix Analysis

Conclusion

With a dedicated budget of $30 million, we have decided that it would be best for the company to invest in dedicating resources to only project 1: the smartkey. Project 1 (the smartkey) has a higher chance of success in development and has the highest EMV that is under the dedicated budget. The costs and risks from developing the project is lower than the other two projects because the technology is advanced in this industry as compared to project 2 (keycard/lock) and project 3 (vault) because there is more research being done in this (smartkey) field.

Check Work

We made sure to double check our work to see if it is correct. Each team member revised it to see if we all agree with what we had finished.

Learn and Generalize

We were able to pick the top project that maximized our EMV. We had to make sure that the projects were related with our company. We also held a team meeting to see if everyone agreed with the numbers.

7. Project Planning

Purpose: Project Planning will help us out in the long-run. It establishes everything that we need to compete within a certain time period. It includes Gantt charts, PERT charts, etc., that will help us stay ahead in a timely manner.

Define:
1. Establish a cross-functional team for each technology/product development project
2. Develop a project plan using the design/development structure matrix, GANTT, PERT, and CPM charts

Plan:
1. Develop Gantt, Pert charts
2. Have an activities matrix

Execute

Description of Grouped Tasks:
- Independent Tasks: **A, B, C, L**
- Sequential Tasks: **D, E, F, G, H, I, J, K**
- Coupled Tasks: **I, J, K, L**

Tasks	Subtasks

Tasks: (corresponding to the figure below)
  1. **A:** Firm-up Project Proposal
  2. **B:** Business Model
  3. **C:** Overall Supply Chain Strategy
  4. **D:** High-Level Structure
  5. **E:** Time-Phased Plan
  6. **F:** Demand Forecasting
  7. **G:** MIT Beer Game
  8. **H:** Software Platform
  9. **I:** Cycle Inventory
  10. **J:** Software Automation
  11. **K:** Benchmarking
  12. **L:** SCM Integration
	I. **Phase 0** (1 week)
	    A. Project Proposal
	    B. Company Development
	    C. Product/Service brainstorming
	II. **Phase 1** (2 weeks) *1 WEEK OVERLAP INTO PHASE 2
	    A. Firm-up Project Proposal
	    B. Project Planning
	    C. Business Model
	    D. Supply Chain Strategy
	III. **Phase 2** (3 weeks) *1 WEEK OVERLAP INTO PHASE 3
	    A. Demand Forecasting
	    B. MIT Beer Game
	    C. Software Platform
	IV. **Phase 3** (2 weeks)
	    A. Cycle Inventory
	    B. Software Automation
	    C. Benchmarking
	V. **Phase 4** (1 week)
	    A. SCM Integration
	    B. Final Report

Figure 7.1, Tasks and Subtasks

Activities Matrix:

	A	B	C	D	E	F	G	H	I	J	K	L
A	A											

B	B										
C	X	C									
D			D								
E			X	E							
F				X	F						
G			X	X	X	G					
H				X	X	X	H				
I						X	X	I			
J							X	X	J		
K							X	X		K	
L											L

Figure 7.2, Activities Matrix

PERT Chart:
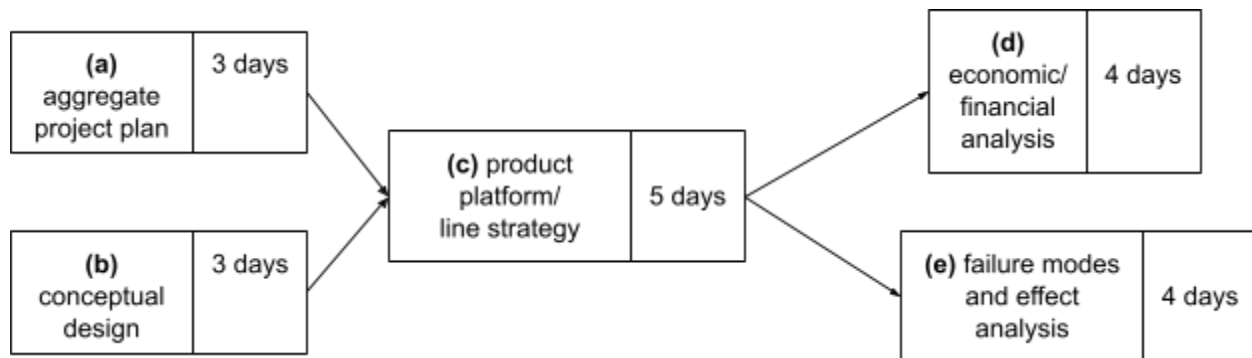
Figure 7.3, PERT Chart

Gantt Chart:
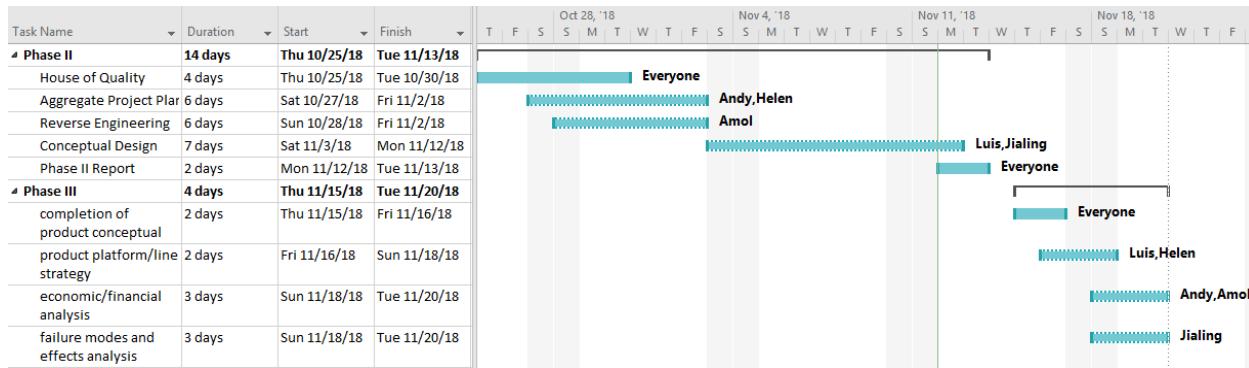
Figure 7.3, Gantt Chart

CPM Chart:
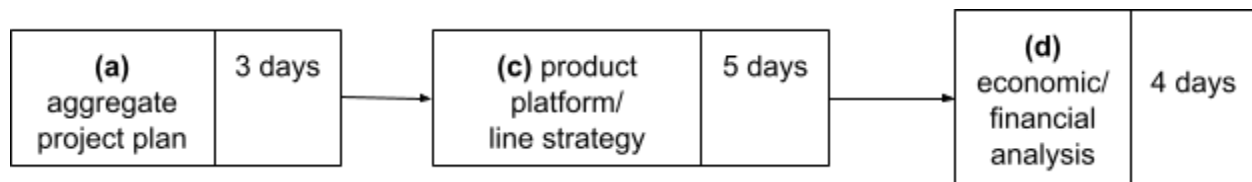
Figure 7.4, Critical Path

Check Work

We made sure to double check our work to see if it is correct. Each team member revised it to see if we all agree with what we had finished.

Learn and Generalize

We learned a lot about time management and how important it is for TIM 105. Having all these charts really helped the team stay on track and get things done a timely manner before all the deadlines.

Development (D)

1. Quality Function Deployment

Purpose: The QFD will allow us to fully benchmark/rate our product(s) in relation to customer needs and technical metrics. This process will let us know what to include in our final product because it will be benchmarked and have everything we will need.

Define:

1. Develop a comprehensive House of Quality (HOQ) to correlate customer needs to technical metrics and specifications

Plan:

1. Gather customer needs and technical metrics from high-level HOQ
2. Create a Morphological Matrix to show their correlation

Execute

   ### 1. House of Quality

Step 1: *Create a structured and prioritized list of the Customer Needs for the intended product based on market research and assess the importance of each need using a convenience scale*

Customer Needs	Importance
Easy to use	9/10
Affordable	8/10
Durable/Quality	7/10
Small size	7/10
Security	10/10

Figure 8.1, Customer Needs

Step 2: *Make a list of the technical metrics and asses the importance of each metric using a convenient scale*

Technical Metric	Units
Price	8/10
Number of buttons	7/10
Frequency response	7/10
Weight	5/10
Dimensions	5/10
Set-up Time	4/10

Figure 8.2, Technical Metrics

Step 3: *Correlate customer needs and the technical metrics (engineering requirements) using a convenient scale (combined with step 4 below)*

Step 4: (Combination with Step 5 below)

1. *There are dependencies between the technical metrics. Correlate the technical metrics to each other using a convenient scale*
2. *Place "half" of the matrix on top of the matrix*

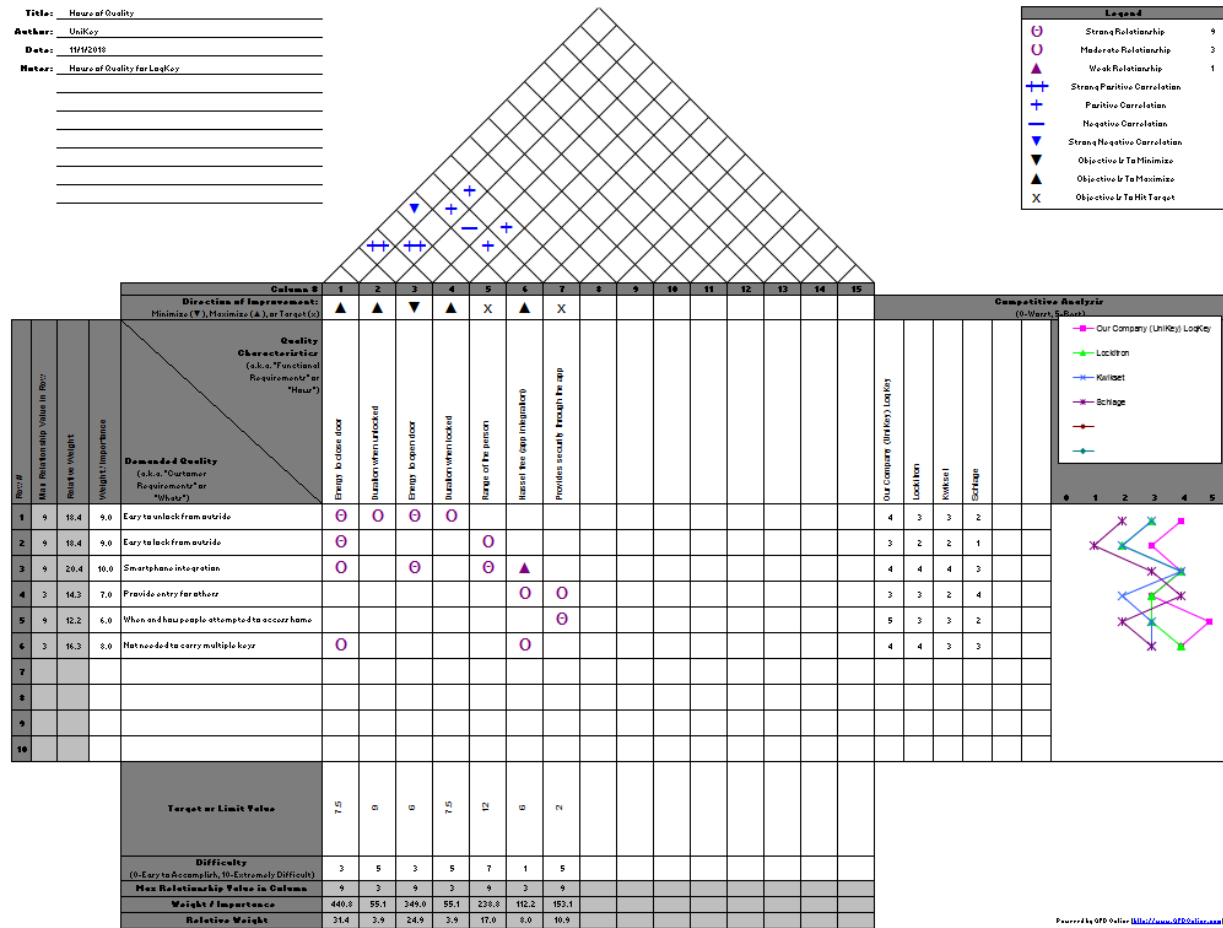|				**Column #**	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15					
				Direction of Improvement: Minimize (▼), Maximize (▲), or Target (x)	▲	▲	▼	▲	X	▲	X													
Row #	Max Relationship Value in Row	Relative Weight	Weight / Importance	Demanded Quality (a.k.a. "Customer Requirements" or "Whats")	Energy to close door	Duration when unlocked	Energy to open door	Duration when locked	Range of the person	Needs the app (mandatory)	Provides security through the app									Our Company (UniKey) LockKey	LockItron	Kwikset	Schlage
1	9	18.4	9.0	Easy to unlock from outside	Θ	Ο	Θ	Ο													4	3	3	2
2	9	18.4	9.0	Easy to lock from outside	Θ			Ο													3	2	2	1
3	9	20.4	10.0	Smartphone integration	Ο		Θ	Θ		▲											4	4	4	3
4	3	14.3	7.0	Provide entry for others						Ο	Ο										3	3	2	4
5	9	12.2	6.0	When and how people attempted to access home							Θ										5	3	3	2
6	3	16.3	8.0	Not needed to carry multiple keys	Ο					Ο											4	4	3	3
7																								
8																								
9																								
10																								
				Target or Limit Value	7.5	8	6	7.5	12	6	2												
				Difficulty (0=Easy to Accomplish, 10=Extremely Difficult)	3	5	3	5	7	1	5												
				Max Relationship Value in Column	9	3	9	3	9	3	9												
				Weight / Importance	440.8	55.1	349.0	55.1	238.8	112.2	153.1												
				Relative Weight	31.4	3.9	24.9	3.9	17.0	8.0	10.9												

Legend: Θ Strong Relationship (9), Ο Moderate Relationship (3), ▲ Weak Relationship (1), ┼┼ Strong Positive Correlation, ┼ Positive Correlation, — Negative Correlation, ▼ Strong Negative Correlation, ▼ Objective Is To Minimize, ▲ Objective Is To Maximize, X Objective Is To Hit Target

Title: House of Quality *Author:* UniKey *Date:* 11/1/2018 *Notes:* House of Quality for LogKey

Figure 8.2, Correlation Matrix

Step 5: *Assess a set of competing products from the viewpoint of the customer and from a technical viewpoint, using a convenient scale for customer benchmarking and engineering units of measurements for the technical benchmark*

Customer Benchmark:

Target Customer Specifications	Smartkey
Affordability	7/10
Ease of use	8/10
Security	8/10
Compatibility	8/10
Reliability	9/10

Figure 8.3, Customer Benchmarking

Technical Benchmark:

Target Technical Specifications	Smartkey
Price ($)	~ $200
Dimensions (in x in)	1 in x 2 in by 0.5 in
Buttons (Buttons)	1
Frequency Response (kHz)	125 kHz
Set-up Time (Min)	1 hour
Weight (Grams)	100 Grams

Figure 8.3, Technical Benchmarking

Step 6: *Set targets for customer needs and technical metrics for a new product(s)*
Target customer specifications for the smartkey for buildings:

Target Customer Specifications	Smartkey
Affordability	8/10
Ease of use	8/10
Security	10/10
Compatibility	6/10
Reliability	9/10

Figure 8.3, target customer specifications

Target Technical Specifications for the smartkey for buildings:

Target Technical Specifications	Smartkey
Price ($)	~ $200
Dimensions (in x in)	1 in x 2 in by 0.5 in
Buttons (Buttons)	1
Frequency Response (kHz)	125 kHz
Set-up Time (Min)	1 hour
Weight (Grams)	100 Grams

Figure 8.4, target technical specifications

Conclusion

Our smartkey will be very similar to the BMW car key dissected in this section. Although the designs are almost the same (same customer needs, same technical metrics), we will be focusing more on the reliability and security aspects of the customer needs. We really want to emphasize to our customers that our product is all about safety and reliability; after all, our product is created to secure the personal and work spaces of all buildings using our keys and locks. We will be using these results in the House-of-Quality section to produce our conceptual design in the concept design section (the section after the reverse engineering section).

Check Work

We made sure to double check our work to see if it is correct. Each team member revised it to see if we all agree with what we had finished.

Learn and Generalize

This problem taught us a lot about the house of quality and how to implement it in certain products. This technique can be so useful to any company that utilizes it. It focuses mainly on the customers and technical side. They will get an insight on how they need to spend or how much time they to invest in order for them to develop a product that will survive in the market.

2. Reverse Engineering

Purpose: Having a Reverse Engineering section will allow us to determine what our competitors products' have and be able to implement them into our product. It will also allow us to add new technology that hasn't been added to our competitors product.

Define:
1. Dissect existing products which are similar to the proposed new product using the Function Analysis Systems Technique (FAST)

Plan:
1. Identify different similar products to ours
2. Reverse Engineer them using FAST

Execute

There are 6-steps and we will be dissecting two similar products.

Company	Product
Schlage	BE479 V CEN 619 Sense
August	Smart Lock 2nd Generation

Figure 9.1, similar products

Product 1: BE479 V CEN 619 Sense

Step 1: *Understand how the product works*
The Schlage Sense Deadbolt uses an access code in the touchscreen to unlock the door. The lock can be paired with any smartphone. It allows access with trusted friends and family so there aren't any spare keys.

Step 2 & 3: *Make a list of all the important subsystems that are relevant to the FAST diagram / Make a list of the main (primary) function and sub functions of the product*

System: - lock	Function: - control entry access to a building
Subsystems: - keypad - keyhole - battery - alarm	Subfunction: - to input (in)correct number sequence - to insert key - to power lock (in case of power outage) - to alert people when broken

Figure 9.2, system and functions of BE479 V CEN 619 Sense

Step 4: *Write down the main function of the system on the extreme right of the diagram (below)*
Step 5: *Organize the diagram with the "whys" to the right and "hows" to the left (below)*
Step 6: *Creating a Fast Diagram for a complex product is a "Trial-Error process" to minimize Trial and error" work for both ends of the diagram*
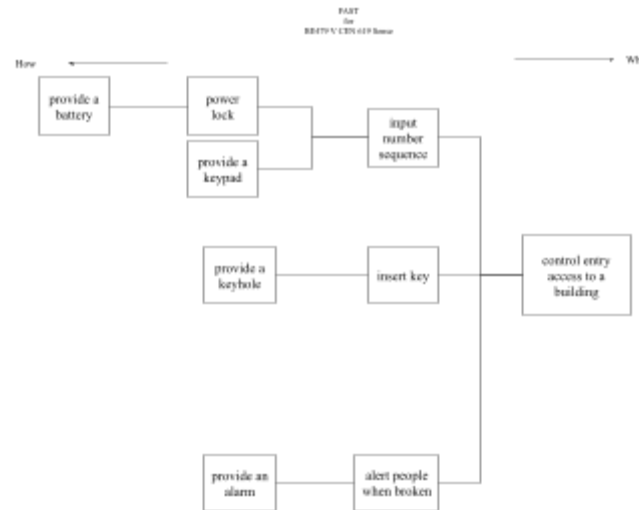
Figure 9.3, FAST for Schlage product

Product 2: Smart Lock 2nd Generation

Step 1: *Understand how the product works*
Secure, keyless entry for your smart home. Lock and unlock your door, control keyless access and keep track of who comes and goes, all from your phone. Keep your existing lock and keys. Easily attaches to your existing deadbolt, so everyone can still use their keys.

Step 2 & 3: *Make a list of all the important subsystems that are relevant to the FAST diagram. Make a list of the main (primary) function and sub functions of the product*

System: - lock	Function: - control entry access to a building
Subsystems: - sensor - battery - mechanism	Subfunction: - to calculate location of lock from phone - to power lock - to open lock automatically

Figure 9.4, system and functions of Smart Lock 2nd Generation

Step 4: *Write down the main function of the system on the extreme right of the diagram (below)*
Step 5: *Organize the diagram with the "whys" to the right and "hows" to the left (below)*
Step 6: *Creating a Fast Diagram for a complex product is a "Trial-Error process" to minimize Trial and error" work for both ends of the diagram*

FAST
for
Smart Lock 2nd Generation

How ← → Why

provide a sensor → calculate location of lock from phone

provide a battery → power lock → open lock automatically → control entry access to a building
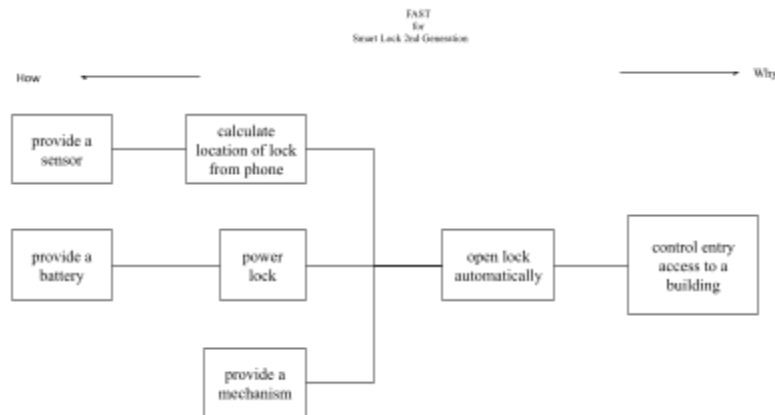
provide a mechanism

Figure 9.5, FAST for August product

Conclusion

By reverse engineering the Smart Lock 2nd Generation (an August product) and the BE479 V CEN 619 Sense (a Schlage product), we were able to understand a smart key's systems and functions better. Both products needed a way to lock and unlock doors (the Smart Lock used a sensor to lock/unlock doors while the BE479 used a keypad to lock/unlock doors) and a way to power the lock. However, they both had unique ways to lock/unlock doors that differentiates themselves with the rest of the products in key/lock market. With this knowledge, we will be able to start brainstorming about our smartkey product's systems and functions.

Check Work

We made sure to double check our work to see if it is correct. Each team member revised it to see if we all agree with what we had finished.

Learn and Generalize

We were able to fully understand how other products work. What they include and how they work. It gave us an insight as to what we can add in our product. It will also let us know how technological advance we are from our competitors.

3.   Conceptual Design

Purpose: The Conceptual Design will allow us to have various concept designs. Once we create those concept designs, we will create a Morphological Matrix that will allow us to determine which concept we should select into further development.

Define:

1. Create a function structure (FS) for your product, and use this
2. FS to generate a morphological matrix (MM)
3. Use the MM to generate several design concepts

4. Select one (or more) concepts using a utility function, which is based on an appropriate set of weighted selection criteria

Plan:
1. Use previous work to help establish conceptual design
2. Create a morphological matrix to help us determine product concepts

Execute

Step 1: *Establish customer needs and technical metrics (specifications) for the intended product*

Customer Needs:

Customer Needs	Importance
Easy to use	9/10
Affordable	8/10
Durable/Quality	7/10
Small size	7/10
Security	10/10

Figure 10.1, Customer Needs

Technical Metrics:

Technical Metric	Units
Price	8/10
Number of buttons	7/10
Frequency response	7/10
Weight	5/10
Dimensions	5/10
Set-up Time	4/10

Figure 10.2, Technical Metrics

Step 2: *Identify the main function or primary function of the product (the product intent reason)*

System:	Primary Function:
- Lock	- Control entry access to a building

Figure 10.3, Main function of the Smart Key

Step 3: *Identify one or more related products and Reverse Engineer these products (dissect) using FAST technique*

Product: BE479 V CEN 619 Sense

    Step 1: *Understand how the product works*

The Schlage Sense Deadbolt uses an access code in the touchscreen to unlock the door. The lock can be paired with any smartphone. It allows access with trusted friends and family so there aren't any spare keys.

    Step 2 & 3: *Make a list of all the important subsystems that are relevant to the FAST diagram / Make a list of the main (primary) function and sub functions of the product*

System:	Function:
- lock	- control entry access to a building
Subsystems:	Subfunction:
- keypad - keyhole - battery - alarm	- to input (in)correct number sequence - to insert key - to power lock (in case of power outage) - to alert people when broken

Figure 10.4, system and functions of BE479 V CEN 619 Sense

    Step 4: *Write down the main function of the system on the extreme right of the diagram (below)*
    Step 5: *Organize the diagram with the "whys" to the right and "hows" to the left (below)*
    Step 6: *Creating a Fast Diagram for a complex product is a "Trial-Error process" to minimize Trial and error" work for both ends of the diagram*
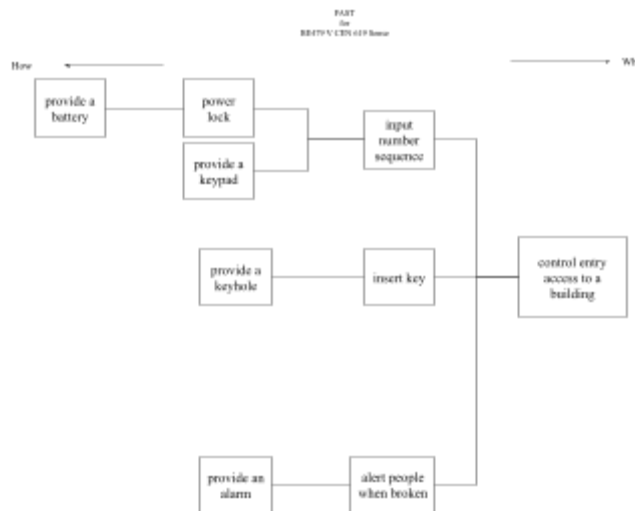

Figure 10.5, FAST for Schlage product

Step 4: *Create an abstract functional representation of the (intended) product, called the Function Structure*
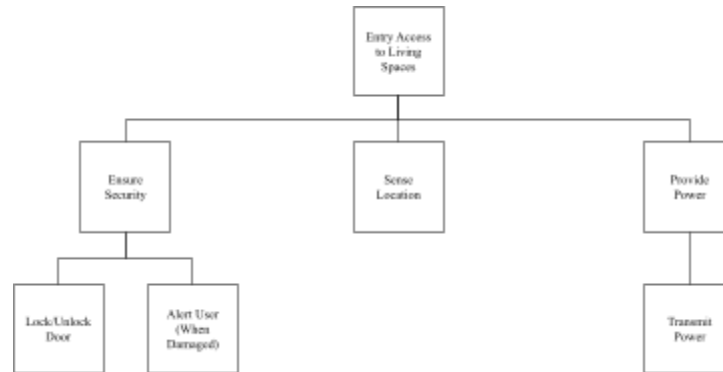

Figure 10.6, Function Structure

Step 5: *For each sub-function generate alternative solution principles for realizing that sub-function. Then we organize the solution principles into a Morphological Matrix*

Solution Principles / Sub Functions	Solution Principle 1 (SP 1)	Solution Principle 2 (SP 2)	Solution Principle 3 (SP 3)	Solution Principle 4 (SP 4)
SF 1: Lock/ Unlock Door	Regular/Standard Lock	Keycard Lock	Electronic Lock	Biometric Lock
SF 2: Alert User (When Damaged)	Alarm (sound)	App Option	Call	
SF 3: Transmit Power	Gearbox	Pneumatic	Hydraulic	
SF 4: Sense Location	Real Time Locating Systems (WiFi)	Real Time Locating Systems (4g/LTE)	Close Range	
SF 5: Provide Power	Electricity	Solar Power	Wind	

Figure 10.7, Morphological Matrix

Step 6: *We then generate 6-10 alternative concepts by suitably combining the solution principles in the Morphological Matrix*

Solution Concept: SC 1
Explanation: (SP1, SF1), (SP1,SF2), (SP1,SF3), (SP2,SF4)
- Regular/Standard lock, Smartphone Integration, Simple unlock/lock doors, Close Range, Electricity

Solution Principles / Sub Functions	Solution Principle 1 (SP 1)	Solution Principle 2 (SP 2)	Solution Principle 3 (SP 3)	Solution Principle 4 (SP 4)
SF 1: Lock/ Unlock Door	Regular/Standard Lock	Keycard Lock	Electronic Lock	Biometric Lock
SF 2: Integrate App	Smartphone Integration	Laptop Integration	Web-Browser Integration	
SF 3: Tracking	Simple unlock/lock doors	Track who enters home	List of who can enter	
SF 4: Sense Location	Real Time Locating Systems (WiFi)	Real Time Locating Systems (4g/LTE)	Close Range	
SF 5: Provide Power	Electricity	Solar Power	Wind	

SC 1

Figure 10.8, Concept 1

Solution Concept: SC 2
Explanation: (SP1,SF1), (SP2,SF2), (SP2,SF3), (SP3,SF4)
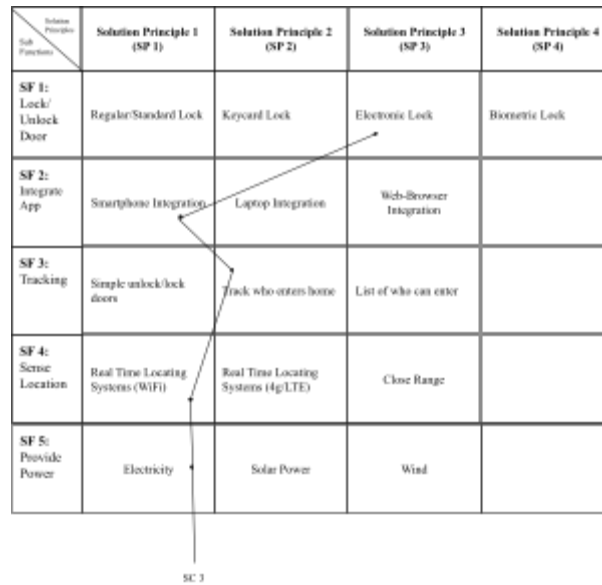- Keycard lock, Smartphone Integration, Track who enters home, Close Range, Wind

Solution Principles / Sub-Functions	Solution Principle 1 (SP 1)	Solution Principle 2 (SP 2)	Solution Principle 3 (SP 3)	Solution Principle 4 (SP 4)
SF 1: Lock/ Unlock Door	Regular/Standard Lock	Keycard Lock	Electronic Lock	Biometric Lock
SF 2: Integrate App	Smartphone Integration	Laptop Integration	Web-Browser Integration	
SF 3: Tracking	Simple unlock/lock doors	Track who enters home	List of who can enter	
SF 4: Sense Location	Real Time Locating Systems (WiFi)	Real Time Locating Systems (4g/LTE)	Close Range	
SF 5: Provide Power	Electricity	Solar Power	Wind	

SC 2

Figure 10.9, Concept 2

Solution Concept: SC 3
Explanation: (SP3,SF1), (SP1,SF2), (SP2,SF3), (SP1,SF4)
- Electronic lock, Smartphone Integration, Track who enters home, Real-time Locating systems (WIFI), Electricity
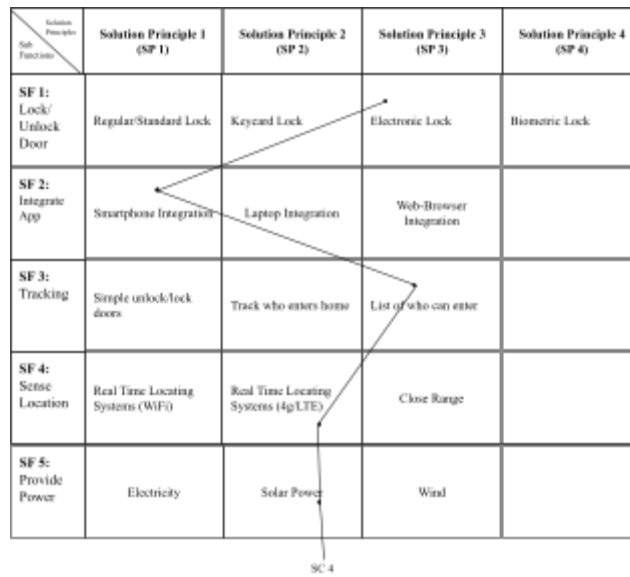

Figure 10.10, Concept 3

Solution Concept: SC 4
Explanation: (SP3,SF1), (SP1,SF2), (SP2,SF3), (SP1,SF4)
- Electronic lock, Smartphone Integration, List of who can enter, Real-time Locating system (4G/LTE), Solar Power

Figure 10.11, Concept 4

Solution Concept: SC 5

Explanation: (SP4,SF1), (SP2,SF2), (SP1,SF3), (SP3,SF4)
- Biometric lock, Smartphone Integration, Simple unlock/lock doors, Close Range, Electricity

Solution Principle / Sub Functions	Solution Principle 1 (SP 1)	Solution Principle 2 (SP 2)	Solution Principle 3 (SP 3)	Solution Principle 4 (SP 4)
SF 1: Lock/ Unlock Door	Regular/Standard Lock	Keycard Lock	Electronic Lock	Biometric Lock
SF 2: Integrate App	Smartphone Integration	Laptop Integration	Web-Browser Integration	
SF 3: Tracking	Simple unlock/lock doors	Track who enters home	List of who can enter	
SF 4: Sense Location	Real Time Locating Systems (WiFi)	Real Time Locating Systems (4g/LTE)	Close Range	
SF 5: Provide Power	Electricity	Solar Power	Wind	

SC 5

Figure 10.12, Concept 5

Solution Concept: SC 6

Explanation: (SP4,SF1), (SP3,SF2), (SP1,SF3), (SP1,SF4)
- Biometric Lock, Web-Browser Integration, Simple unlock/lock doors, Real-time Locating system (WIFI), Solar Power

Solution Principle / Sub Functions	Solution Principle 1 (SP 1)	Solution Principle 2 (SP 2)	Solution Principle 3 (SP 3)	Solution Principle 4 (SP 4)
SF 1: Lock/ Unlock Door	Regular/Standard Lock	Keycard Lock	Electronic Lock	Biometric Lock
SF 2: Integrate App	Smartphone Integration	Laptop Integration	Web-Browser Integration	
SF 3: Tracking	Simple unlock/lock doors	Track who enters home	List of who can enter	
SF 4: Sense Location	Real Time Locating Systems (WiFi)	Real Time Locating Systems (4g/LTE)	Close Range	
SF 5: Provide Power	Electricity	Solar Power	Wind	

SC 6

Figure 10.13, Concept 6

Step 7: *Identify an appropriate set of selection criteria to assess and compare alternatives (from step 6) and use these criteria to create a Utility Function. This will be used to compare, rank, and selse the best alternatives*
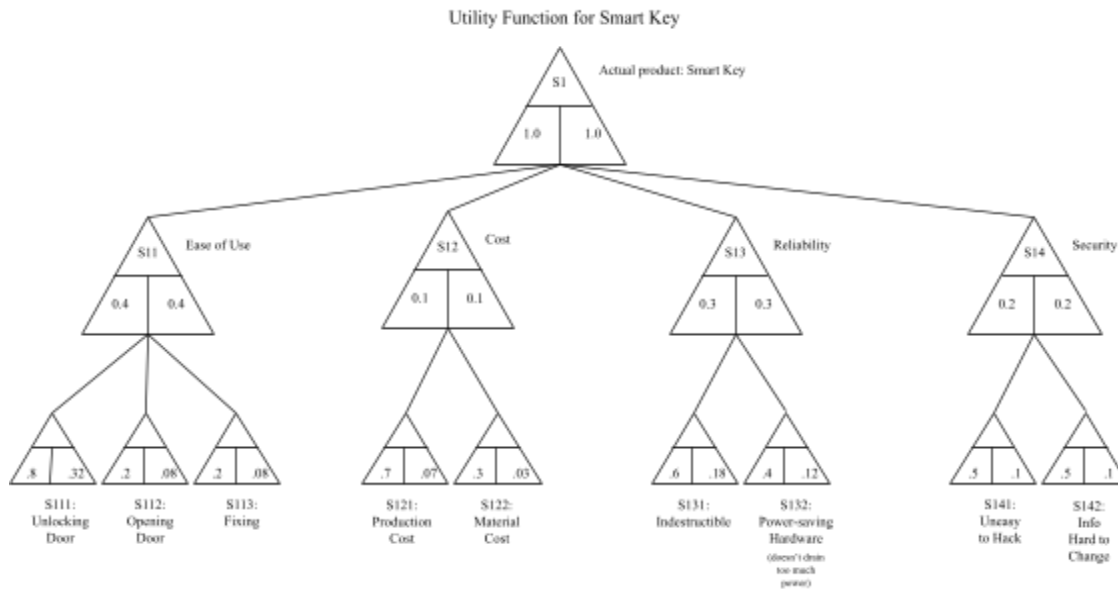

Figure 10.14, Utility Function

Step 8: *Use the Utility Function to compare the alternatives and select one (or two) feasible concepts for further development*

Selection Criteria	Absolute Weight	Concept 1		Concept 2		Concept 3		Concept 4		Concept 5		Concept 6	
		Concept Rating	Utility	Concept Rating	Utility	Concept Rating	Utility	Concept Rating	Utility	Concept Rating	Utility	Concept Rating	Utility
S111	0.32	5	1.6	4	1.28	5	1.6	5	1.6	5	1.6	5	1.6
S112	0.08	3	0.24	5	0.40	3	0.24	3	0.24	4	0.32	3	0.24
S113	0.08	3	0.24	3	0.24	4	0.32	3	0.24	4	0.32	4	0.32
S121	0.07	4	0.28	3	0.21	3	0.21	4	0.28	4	0.28	4	0.28
S122	0.03	4	0.12	3	0.09	4	0.12	3	0.09	3	0.09	4	0.12
S131	0.18	3	0.54	4	0.72	4	0.72	4	0.72	4	0.72	4	0.72
S132	0.12	3	0.36	3	0.36	3	0.42	3	0.36	5	0.60	3	0.36
S141	0.10	4	0.40	3	0.30	3	0.30	4	0.40	4	0.40	4	0.4
S142	0.10	3	0.30	4	0.40	4	0.40	3	0.30	4	0.40	4	0.4
Σ			4.08		4.0		4.33		4.23		**4.73**		4.44

Figure 10.15, Comparison of different concepts

Conclusion

Concept 5 has the highest cumulative utility with concept 6 being the backup with the second highest cumulative utility. With the conceptual design, we now know that the best concept for our product is to use: a biometric lock, smartphone integration, simple unlock/lock doors, close range, and an electric key. Our best backup would be a biometric lock, web-browser integration, simple unlock/lock doors, real time location systems (WIFI), and a solar-powered key. With the conceptual design, we now have a concrete idea of what our product will have; therefore, we can use each of our chosen solution principles to find out the cost of manufacturing our product. This will be shown in Phase III in the "Economic/Financial Modeling" section.

Check Work

We double checked our work and made sure our reasons were supported with evidence whether its from the web or from the course readings/note.

Learn and Generalize

Upon completion, we were able to fully understand the difference between FAST technique and Function Structure. Each method has their own distinction on how it can be used, and each one has different characteristics. These two steps are important when creating a new product because it will give the company an insight on how they can improve their product. It's important that they follow the steps to creating a perfect FAST diagram and Functional Structure. We were able to generate several alternative concept designs to see which I can select for further development.

4. Product Architecture / Product Strategy

Purpose: The Product Architecture will help us determine the market segments that we should mainly focus on. The product Strategy will allow us to create a diagram that will help us with the release our product.

Define:
1. Establish the technology platform and product platform
2. Define the appropriate product lines to serve the target market segments

Plan:
1. Have the core technologies defined
2. Determine market segments that better serve our product

Execute

1. Product Architecture

Step 1: *Create the the core (or defining) technology elements that are unique to the product*
Core (defining) technology elements:
1. Biometric lock
2. Sensor
3. Phone app

Step 2: *Determine the supporting technology elements necessary to obtain a functional working product*
Supporting Technology Elements:
1. X10 communication protocol
2. Lithium battery power source
3. Bluetooth technology

Step 3: *For each target market segments, use the product platform to create a product line to serve that segment*

Low-end: Households	Mid-range: Institutions	High-end: Enterprises

- Cheap
- Low performance
  - adequate battery life
  - adequate sensor distance range
  - phone app has few options
- Decent durability
- Minimal functionalities on phone app
	- Moderately priced
	- Better performance
	  - better battery life than low-end
	  - decent sensor distance range
	  - phone app has more options than low-end
	- Better durability
	- More functionalities on phone app
		- Expensive
		- Excellent performance
		  - excellent battery life
		  - excellent sensor distance range
		  - phone app has abundance of options
		- Excellent durability
		- Even more functionalities on phone app

Figure 11.1.1, Target Market Segments

2. Integrated Product (Management) Strategy

Step 1: *Establish (define) the underlying elements of the product platform: Core & Supporting Technology Elements*
Core (defining) technology elements:
1. Biometric lock
2. Sensor
3. Phone app

Supporting Technology Elements:
1. X10 communication protocol
2. Lithium battery power source
3. Bluetooth technology

Step 2: *Determine target market segments based on competitive strategy; and then prioritize the target market segments for the product*

Market Dimensions	Enterprises	$10 B	$7 B	$3 B	$7 B
	Institutions	$6 B	$6 B	$4 B	$5 B
	Households	$3 B	$4 B	$2 B	$4 B
		Security	Integration	Lock	Battery

Figure 11.2.1, Target Market Segments

Step 3: *Establish product lines to address (i.e., meet the needs of) the different target segments*
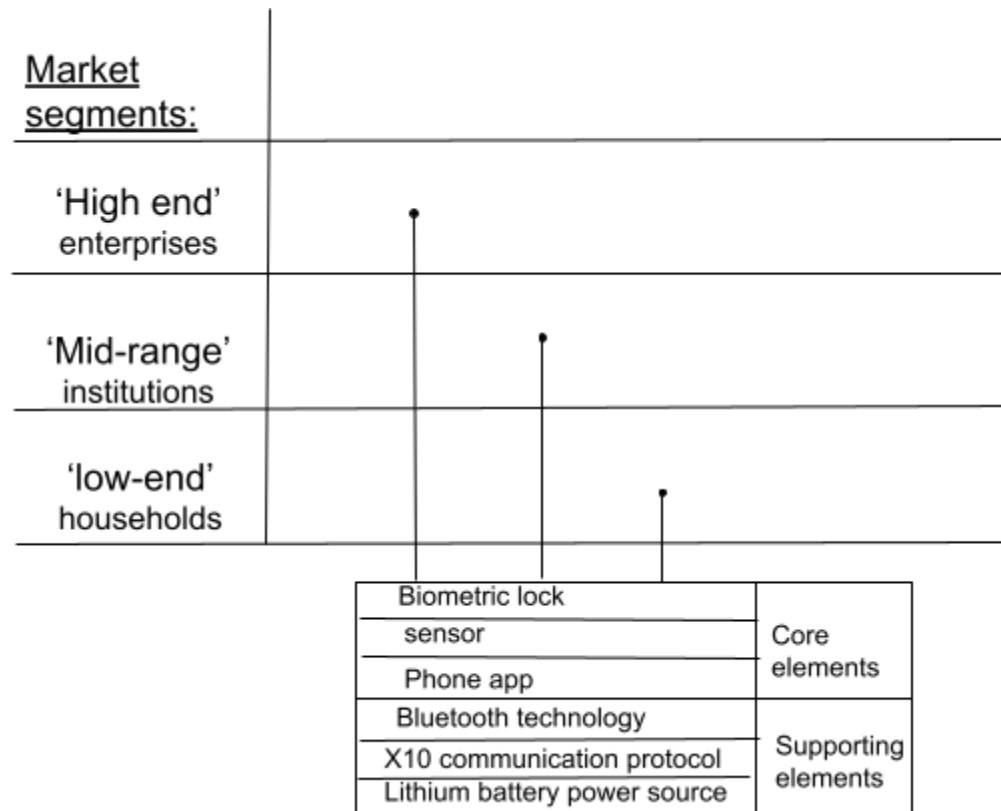

Figure 11.2.2, Product lines

Step 4: *For each product line, create the necessary project plan to introduce each product line to its target market segments*
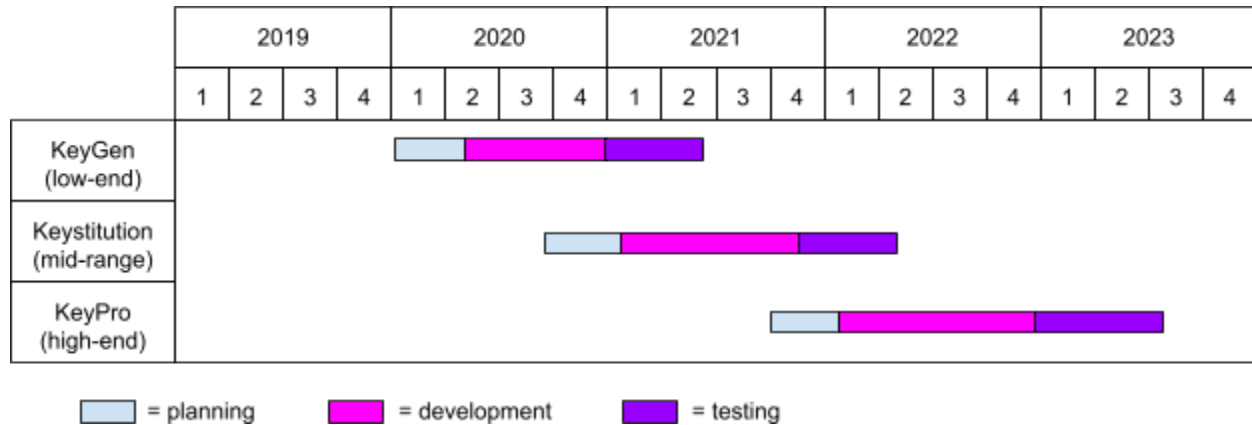

Figure 11.2.3, Product lines

Step 5: *Introduce product lines (to the market segments in a time-phased manner to "cover" (reach) all the desired market segments)*

Figure 11.2.4, Product lines

Conclusion
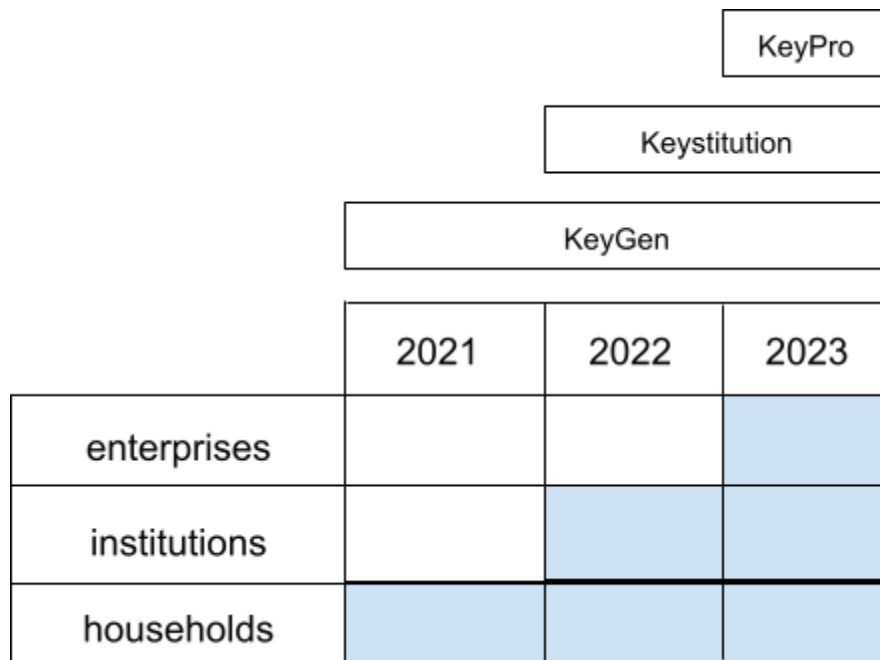
For smaller, home environments of low-end consumers, safety concerns have prompted the additional product line addressing the market segment in which the key is more durable, more home appropriate and low hazardous material. The principal's lower durability aspect carries low significance when this market segment does not value durability as highly as the mid-range and high-end consumers.

Check Work

We double checked our work and made sure our reasons were supported with evidence whether its from the web or from the course readings/note.

Learn and Generalize

Using what we know for the process of making the product platform/product line, we have learned more on what it takes to define a product. Identifying the common aspects of the products you want to offer is crucial to defining the platform. A product platform can hope to accomplish much more if it branches out into multiple market segments over time, and it is important to decide how to differentiate each product for each segment.

5. Failure Modes and Effects Analysis (FMEA)

Purpose: The FMEA will help us detect any possible failure within our products. It will help us improve the quality of the product by anticipating ways in which the product can fail, understand the effects of the failure, and then determine ways of preventing the effects of those failure modes before releasing the product to the market.

Define:
1. Perform a failure modes and effects analysis (FMEA) of the detailed design

Plan:
1. Create a FAST Diagram for the product
2. Identity potential failure modes that our product might have

Execute

Step 1: *Create a FAST Diagram for the product (from our preferred concept (Concept Design))*
1. Identify the key subsystems of the product
   a. Battery
   b. Phone App
   c. Mechanical Mechanisms
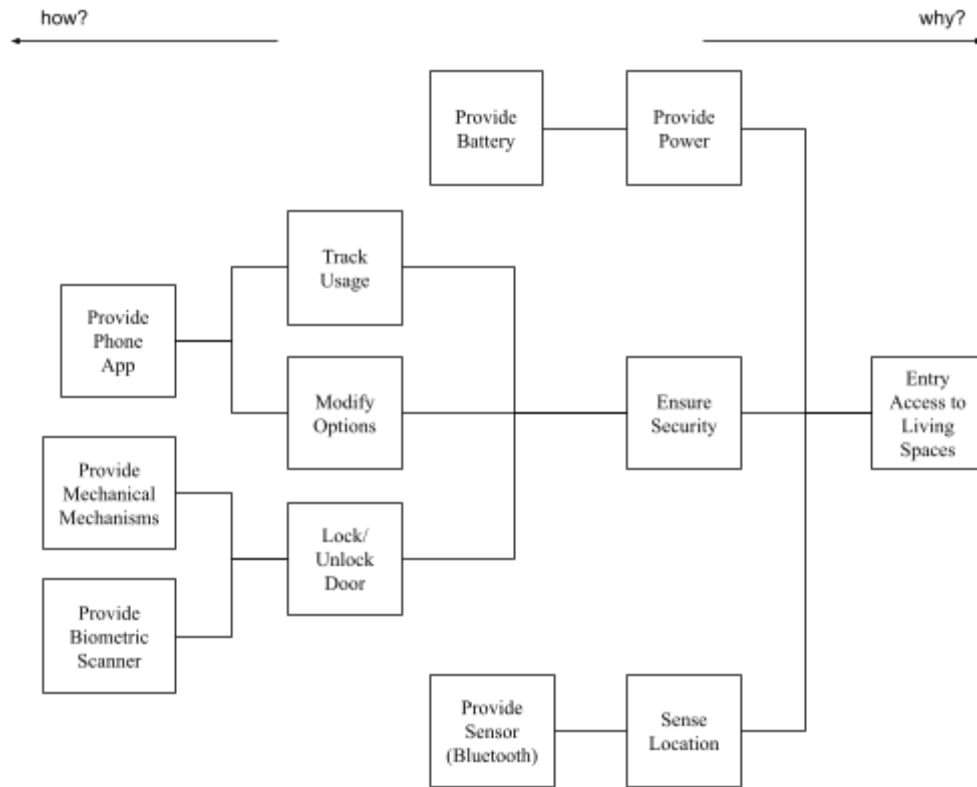   d. Sensor
   e. Biometric Scanner

2. FAST Diagram

Figure 12.1, FAST Diagram

Step 2: *For each subsystem, identify potential failure modes*

Failure #	Sub-System (Part)	Function	Potential Failure Mode	Potential Effects of Failure
1	Battery	Supply the necessary current	lock/key runs out of electricity	System not charged
2	Phone App	Unlock/lock door	app is down (due to bugs, errors, etc…)	No connection
3	Mechanical Mechanisms	Opening of door	lock not working in sync with key	Cannot open door
4	Mechanical Mechanisms	Opening of door	mechanism damaged	Cannot open door
5	Sensor	Identify user	not sensing distance between key and lock	Can't open door at distance
6	Biometric Scanner	Give access to user	not scanning fingerprint	Can't open door
7	Biometric Scanner	Give access to user	not sending data to the lock	Frozen of lock

Figure 12.2, Potential Failure Modes

Step 3: *For each failure mode, calculate a Risk Priority Number (RPN): RPN = (S)(O)(D) where:*

- **S** = *Severity of the failure mode (how severe is the effect of the failure?)*
- **O** = *Frequently of occurence of the failure mode (how frequently do we expect the failure to occur?)*
- **D** = *How hard is the failure to detect?*

Sub-System (Part)	Severity	Potential causes of failure	Occurrence	How will it be detected?	Detection	RPN
Battery	2*	Malfunction of battery	2	Check battery level	5	**20**
Phone App	1	No signals	3	Not showing up	1	3
Mechanical Mechanisms	2*	Disruption of data	2	Check app	5	**20**
Mechanical Mechanisms	2*	Broken hardware	1	Checking hardware	5	10
Sensor	2*	Not in range	2	Looking at sensor	4	**16**
Biometric Scanner	2*	Broken scanner	2	Not recognizing	5	**20**
Biometric Scanner	2*	Corrupted data	2	Checking data	5	**20**

Figure 12.3, Potential Failure Modes

* depends on the scenario: if the customer was running away from a murderer, it would be very life threatening if the battery died or the mechanisms weren't working; therefore, we very lightly factored that option into the severity of the failure

Step 4: *Prescribe suitable actions for each failure modes for which the RPN > 10*

Sub-System (Part)	Severity	Occurrence	Detection	RPN	Actions
Battery	2*	2	5	**20**	- Bigger battery - Include light
Phone App	1	3	1	**3**	
Mechanical Mechanisms	2*	2	5	**20**	- Send signals to user
Mechanical Mechanisms	2*	1	5	**10**	
Sensor	2*	2	4	**16**	- Have a light to notify user
Biometric Scanner	2*	2	5	**20**	- Send signals to user
Biometric Scanner	2*	2	5	**20**	- Send signals to user

Figure 12.4, Potential Failure Modes

Conclusion

We noticed that there were various failure modes. Most of them also had a high RPN. We needed to make sure that we have actions to combat those failure modes so that it won't happen again in the future. It's a good idea to have a FMEA analysis because it allows us to identify failure modes and how we can avoid them.

Check Work

We double checked our work and made sure our reasons were supported with evidence whether its from the web or from the course readings/note.

Learn and Generalize

We were able to learn more about the FMEA analysis. We learned how crucial these sections are because it gives a company what markets to target and any potential failure (problems) their product might have. We have also learned how important it is to have at least a couple of different alternatives just in case the original one decided to fail. That way, we can choose the better alternative for further development.

Commercialization (C)

1. Financial Model

Purpose: The Financial Model will help us determine the profit for x amount of years of the life cycle of our product. It starts with the development of the product using an NPV analysis to help us determine our expected profits.

Define:

1. Develop a base-case (nominal) Net Present Value (NPV) financial model in order to determine the expected profits (payoffs) from the product development projects
2. Perform sensitivity analyses on the base-case financial model in order to understand and quantify trade-offs between time, cost, and quality

Plan:

1. Create a base case for our product
2. Use the sensitivity analysis

Execute

1. **Create a base-case (nominal) financial model:**

SCENARIO INPUT PARAMETERS

Sales & Production Volume (units/year)	35,000
Development Cost (total $)	2,500,000
Unit price ($/unit)	199
Unit Productions Cost ($/unit)	48
Ramp-up cost (total $)	1,500,000
Marketing & support cost ($/year)	1,000,000
Annual Discount Factor (%)	10

($ values in thousands)	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Development Cost	-625	-625	-625	-625												
Ramp-up cost				-750	-750											
Marketing & support cost					-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250
Production cost					-415.625	-415.625	-415.625	-415.625	-415.625	-415.625	-415.625	-415.625	-415.625	-415.625	-415.625	-415.625
Production volume					8750	8750	8750	8750	8750	8750	8750	8750	8750	8750	8750	8750
Unit production cost					-0.0475	-0.0475	-0.0475	-0.0475	-0.0475	-0.0475	-0.0475	-0.0475	-0.0475	-0.0475	-0.0475	-0.0475
Sales Revenue					1741.25	1741.25	1741.25	1741.25	1741.25	1741.25	1741.25	1741.25	1741.25	1741.25	1741.25	1741.25
Sales volume					8750	8750	8750	8750	8750	8750	8750	8750	8750	8750	8750	8750
Unit price					0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199
Period Cash flow	-625	-625	-625	-1,375	-1,000	1,076	1,076	1,076	1,076	1,076	1,076	1,076	1,076	1,076	1,076	1,076
PV Year 1, r=10%	-625	-610	-595	-1,277	-906	951	928	905	883	861	840	820	800	780	761	743
Project NPV, $	5,259															

Profit/net cash flow for each quarter:

($ values in thousands)	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Period Cash flow	-625	-625	-625	-1,375	-1,000	1,076	1,076	1,076	1,076	1,076	1,076	1,076	1,076	1,076	1,076	1,076

Present value of the profit/net cash flow for each quarter:

($ values in thousands)	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
PV of the Cash flow:	-625	-610	-595	-1,277	-906	951	928	905	883	861	840	820	800	780	761	743

NPV (Profit): 5,259 ($5,259,000)

Project NPV, $	5,259

2. Sensitivity Analysis

10% increase in development cost:

SCENARIO INPUT PARAMETERS	
Sales & Production Volume (units/year)	35,000
Development Cost (total $)	2,750,000
Unit price ($/unit)	199
Unit Productions Cost ($/unit)	48
Ramp-up cost (total $)	1,500,000
Marketing & support cost ($/year)	1,000,000
Annual Discount Factor (%)	10
NPV	5,018

10% increase in production cost ($52.25/unit):

SCENARIO INPUT PARAMETERS	
Sales & Production Volume (units/year)	35,000
Development Cost (total $)	2,500,000
Unit price ($/unit)	199
Unit Productions Cost ($/unit)	52
Ramp-up cost (total $)	1,500,000
Marketing & support cost ($/year)	1,000,000
Annual Discount Factor (%)	10
NPV	4,901

10% increase in unit price ($218.90/unit)

SCENARIO INPUT PARAMETERS

Sales & Production Volume (units/year)	35,000
Development Cost (total $)	2,500,000
Unit price ($/unit)	219
Unit Productions Cost ($/unit)	48
Ramp-up cost (total $)	1,500,000
Marketing & support cost ($/year)	1,000,000
Annual Discount Factor (%)	10
NPV	6,760

3. Trade offs

Trade off between development cost and NPV:
For every 10% rise in development cost, NPV drops by 241 ($241,000)

Trade off between manufacturing cost and NPV:
For every 10% rise in manufacturing cost, NPV drops by 358 ($358,000)

Trade off between unit price and NPV:
For every 10% rise in unit price, NPV increases by 1,501 ($1,501,000)

Conclusion

Our product is more of a niche product, and is testing a moderately new market, so the profit over four years is modest given that. If we were to increase our price, doing so would have a large positive impact on our profit since our margins are huge. An increase to the unit production cost, on the other hand, would have a lot less impact on our overall earnings.

Check Work

We double checked our work and made sure our reasons were supported with evidence whether its from the web or from the course readings/note.

Learn and Generalize

This problem gave us a lot of insight as to how to do Financial Analysis. It seems tedious but if were patient enough well be able to learn a couple of things from the Analysis and from Excel. We also followed the tutorial to make this question a bit easier and just apply the numbers given here.

Conclusion and Guidelines

1. Conclusion:

By creating this new product, the smartkey, we went through all the steps of planning and developing a new product, thus gaining new knowledge and insight into how a company begins the creation of an original product. The first step to every action is to begin with a question: what problems are we trying to solve? Only after establishing the problems do we move on to planning the process of solving the problem; executing the problem should never, under any circumstances, be done without first identifying the problems needed to be solved and then planning them.

In addition to learning about the different tasks and activities necessary to create a new product, by trial and error, we also learned that we were more efficient by scheduling a time and meeting in person rather than working on the project by ourselves. When we had to work on it by ourselves, the motivation of finishing the task and completing it to a certain degree of accuracy was lacking (for the most part). It was only when we met up that our efficiency went up. The fact that there were others who could immediately answer our questions and help us improved our performance on the task or activities we were doing.

Not only did we learn about the different steps we have to perform in order to plan, develop, and analyze the product, but we also learned more about ourselves as a problem solver. When we first started, some of us dived head first into the execution of the problem: we didn't plan and researched topics in the order that the problem came to us. This resulted in us frequently backtracking on our progress since there were many other unforeseen issues that we didn't realize since we didn't plan out everything. Because of this, we've learned to plan out our problems and subproblems first before tackling the problem at hand. By doing so, we've become more efficient and our performance (accuracy, analysis of the problems, research) also increased.

2. Guidelines:

i) always identify the problems needed to be solved first

ii) after identifying the problems, make a plan for each of the problems

    a) identify what information is given, what information is needed, …

    b) makes it so that there isn't too much backtracking

iii) meetup frequently with group members in person

    a) meeting up in person increases efficiency and performance

Group contributions:

Meeting date: 12/8/18					
Name	Proposal	Phase I	Phase II	Phase III	Phase IV
Amol Arora	Contributed to the discussion of what the company should produce.	Mainly focused on Vision and Mission Statement of the company. After finishing, he assisted everyone with their work, checking to see if everything was correct or if someone needed help.	Mainly focused on the creation of the graphs and organizing the HOQ. Worked with team members to create a project plan for the entire project.	Mainly focused on the Economic/Financial Modeling Helped teammates finish any unfinished sections	Focused on creating the financial analysis for our product with the help of the team mates to make sure everything was done correctly in a timely manner
Andy Quach	Contributed to the discussion of what the company should produce.	Mainly focused on APP and risk analysis. He assisted everyone with their work, checking to see if everything was correct or if someone needed help.	Mainly focused on the completion of the APP. Worked with team memebrs to create a project plan for the entire project.	Created the outline for the product platform and line strategy, helped team mates finish any unfinished sections	Created the conclusion for the presentation included details for future development and what our strategies will be for TimTech
Jialing Tian	Contributed to the discussion of what the company should produce.	Mainly focused on creating the graphs for project planning. Also helped Amol and Andy with their parts of the phase. Double-checked everyone's work.	Mainly focused on helping with the completion of the APP and the HOQ. Worked with team memebrs to create a project plan for the entire project.	Helped with the completion of the product platform and product line strategy Helped team mates finish any unfinished sections in a timely manner	Worked on the vision and mission statement section with the help of the team mates Made sure that it made sense and presented to the class
Luis Valdivia	Contributed to the discussion of what the company should produce. Was the note taker for the discussion.	Mainly focused on outlining Phase I as well as adding the captions to the graphs created. Double-checked everyone's work.	Worked with team memebrs to create a project plan for the entire project. Focused on creating an outline, helped create the HOQ, and contributed to the conceptual design	Created an outline for the team to work on Helped create the FMEA analysis and its contents Made sure to help team mates to finish the section on time	Created the outline for the presentation Made sure everything in our project was correct and complete before presenting
Huanlei Wu	Contributed to the discussion of what the company should produce.	Mainly focused on market sizing map and customer analysis. Organized Phase I so that it flowed. Double-checked everyone's work.	Mainly focused on the completion of the FAST diagram. Did the HOQ with her groupmates together in person. Double-checked everyone's work and helped a little in every section.	Mainly focused on the Product Line and Product Platfrom Strategy section as well as the Failure Modes and Effects Analysis. Double-checked everyone's work.	Worked on the functionality slide and presented the functionality slide to the class.