TIM 105 Final Project Report

Group 2: RecTech Virtual Reality

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Executive Summary

Who Are We?

- Our company is RecTech is a medium sized company based off of Microsoft

What We Offer and Problem our Business Solves:

- Our company develops licenses and supports a range of software products, services and devices
- The company's segments include Productivity and Business Processes and More Personal Computing
- RecTech products include:
    - operating systems
    - cross-device productivity applications
    - server applications
    - business solution applications
    - desktop and server management tools
    - software development tools
    - video games
    - training and certification of computer system integrators and developers

Our Target Market:

- Our target market is the Virtual Reality industry since we are developing RecTech's very own Virtual Reality headset

Business Plan/Purpose:

- Company Vision:
    - To help an individual live in their wildest dreams.
- Company Mission Statement:
    - Create the opportunity for every organization, company, and individual to achieve their maximum potential with technology.
- Company Business Goals:
    - Redefine what it means to be productive and the business process within which technology companies operate.
    - Create more affordable, accessible, and personal virtual reality systems.

      Annual Sales Revenue: 580(M)
      Growth: 1.37%
      Net Income: 75.57(M)
      Profit Margin: 13%

Team Member Contributions

Tasks	Primary Member	Secondary Member
Project Lead	Robert Fazio	Subhas Desa
Industry Market Landscape	Everyone	
Company Summary	Everyone	
Business Goals	Everyone	
Development Goals	Everyone	
Functional Maps	Aaron Cheung, Christian Angel	Robert Fazio
Engineering	Robert Fazio	Benjamin Kent
House of Quality	Joshua Victorio	Benjamin Kent
Aggregate Project Plan	Benjamin Kent	Christian Angel
Project Planning	Rebecca Yi, Ashna Deo	Robert Fazio
Reverse Engineering	Joshua Victorio, Rebecca Yi	Aaron Cheung
Conceptual Design	Benjamin Kent	Rebecca Yi, Joshua Victorio
Product Architecture/ Product Strategy	Joshua Victorio, Christian Angel	Christian Angel
Detailed Design	Robert Fazio, Benjamin Kent	Christian Angel
FMEA	Asha Deo, Rebecca Yi	Robert Fazio
Financial Model	Benjamin Kent	Robert Fazio

Cross-Referenced Descriptions

I. **Define the problem**

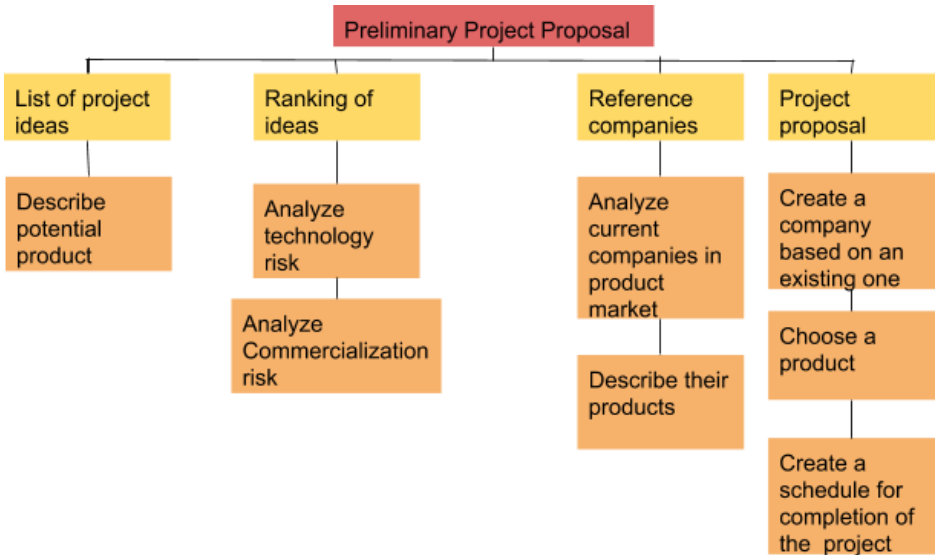
Create a 3-5 page cross-referenced description which include
(P1) a block diagram similar to a "function- structure", showing how all the parts of the report are connected to each other
(P2) and a short write-up which uses this function structure to explain "how the report should be used"

II. **Plan**

- Organize the report in order to connect each step to one another
- Create a diagram that shows specifically which section relate to one another and what they are focusing on
- Write a description on how the function structure should be used to understand our take on the problem that is presented to us

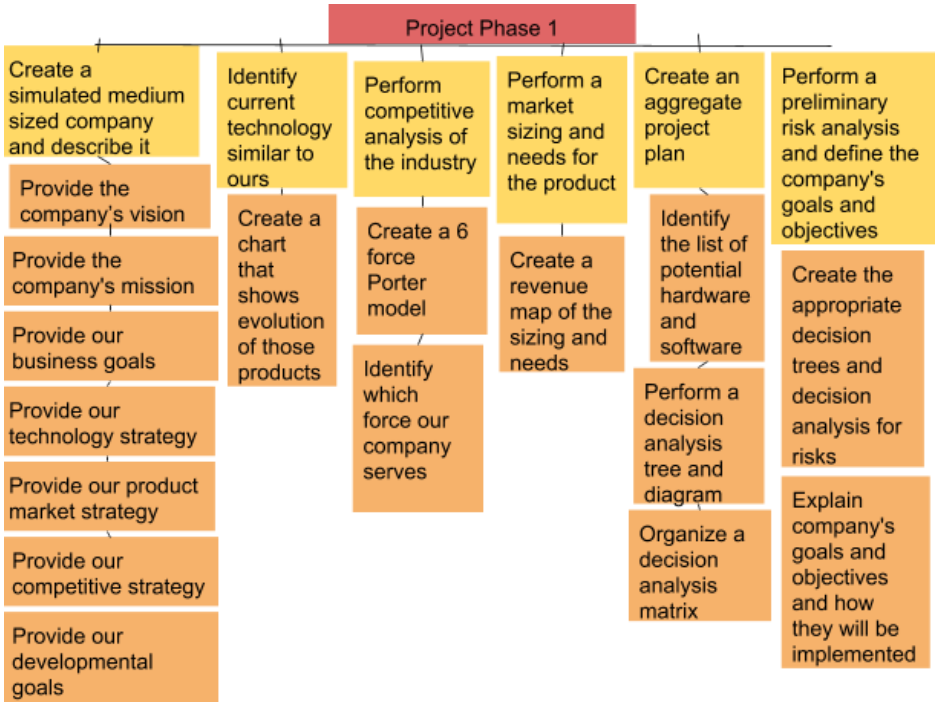
III. **Execute**

Preliminary project proposal:



In our preliminary project proposal we had to think of different potential tech products our medium sized company to work on developing. We broke down our top 3 potential products in list describing each of their functions and what current products can do and what can be improved to make them better. Our next step involved ranking each product based on their potential technology and commercialization risks involved with developing our elected products. In order to get a better understanding on how to develop a product we took at look at existing companies product lines to see how they impact they have made in the tech industry. All this researched allowed us to create a medium sized company named Rec. Tech that would focus on computer based tech that has a focus on VR systems. We ended off this initial step by creating a 9 step development plan that would lead to a finish product.

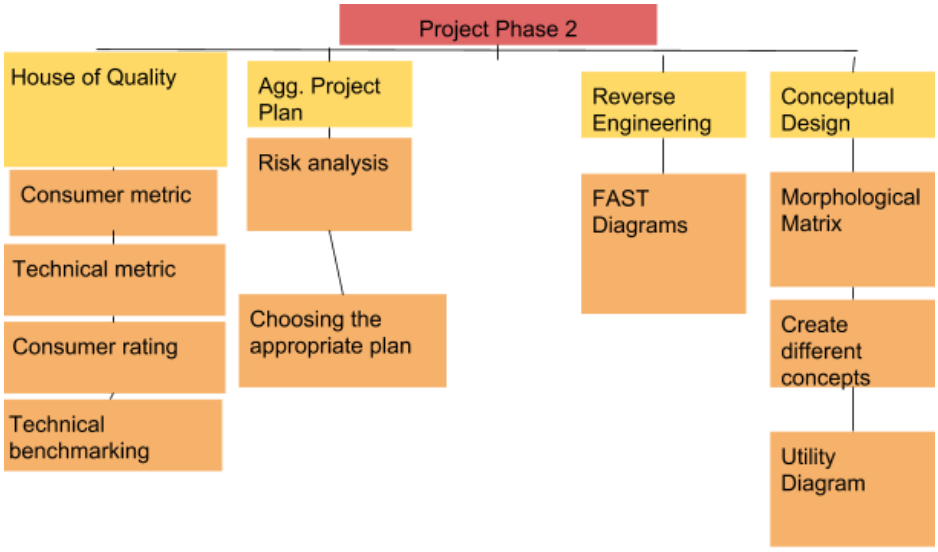
Phase 1:
(P1)



In our project phase 1, our main focus was to establish our company officially by giving a detailed description of our companies aspirations that would allow us to develop our VR headset technology. We started this process by providing our company's mission and goals that would influence our products development so it is more impactful. Furthermore, we developed our company’s technology, market, and competitive strategies that would allow us to create a product

that people actually need and want. In order to begin our product development there was research to be done that involved looking at other VR systems and their evolution through time that made them what they are known for today. Additionally, we analyzed the VR system industry by creating a chart that showed Porter's 6 forces and established where our company fit in the categories. Our next step defined our market sizing that would allow us to look at the customer needs that our product would have to satisfy to be successful. The real planning for our product started with the aggregate project plan where we build a decision tree to see what aspect of the products we were going to make in house and which were going to be supplied to us. We ended off this section by analyzing the risks involved with developing our in house technology so we could make the optimal most optimal choice that would cost us less in the long run.

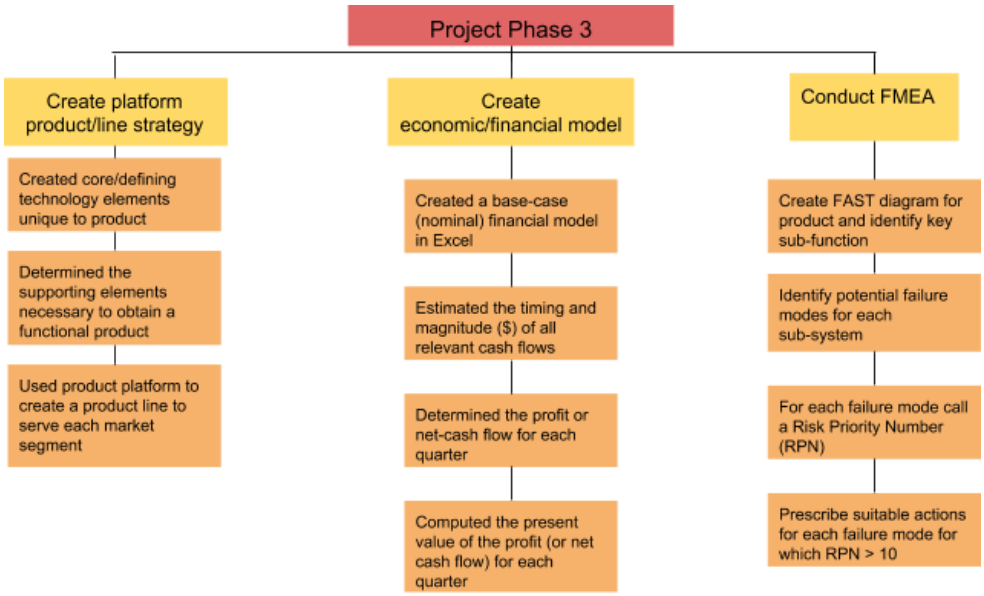
Phase 2:



In phase two the goals was to get the product idea up and running. First we found similar product that were one the market and reversed engineered them to understand how they worked. Once we gained an understanding of the product, we found what consumers wanted in their product. These two key aspects lead to the house of quality. In the house of quality, after find all of the metrics for both technical and consumer, the product was compared to the on market brands for consumer appreciation and technical benchmarking for the product. Now that we had an idea of

what the project looked like we created an aggregate project plan. What this did was take all of the researchable ideas and calculate the final payoff based off of how much it would cost. This allowed the team to choose the most economical combination of projects to research for this idea. Now that the projects where decided we were able to create a conceptual design. Using the technical benchmarks and the consumer metrics from the house of quality we generated the conceptual design. As a team we decided which functionalities were more important, along with the monetary limitations from the aggregate project plan we create the official conceptual design

Phase 3:



In our Project Phase 3 our major activities were to create our product platform/line strategy, an economic/financial model, and the failure modes and effects analysis (FMEA). First we started with creating the product platform/line strategy in which we identified the defining elements of our product as well as the supporting elements and then used the platform to create product lines. After this, we began creating our economic/financial model rather than doing the FMEA because we have not yet learned how to do a FMEA at that time. Starting with the economic/financial model, we began by creating the NPV excel sheet given to us in class and created a base case model as our starting point and from that we conducted a sensitivity analysis to see the change in

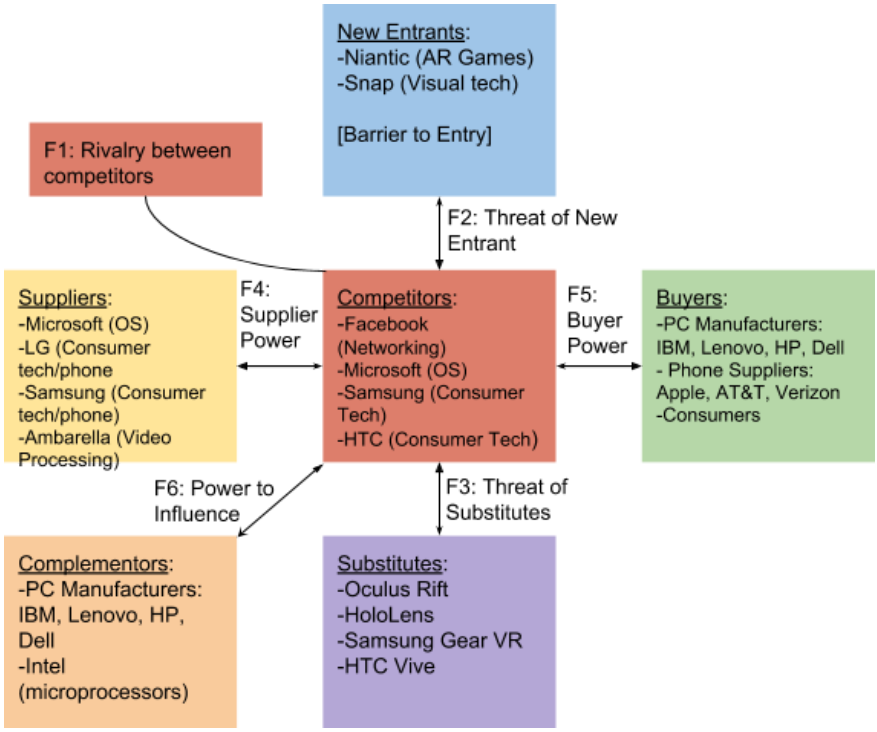
the NPV by conducting perturbations on the sales volume. Lastly, we created our FMEA which is based from the key sub-functions of our product given from our Function Structure and any additional sub-functions we have thought of. From that, as a team we judged the RPN for each sub-function and created suitable actions in order to satisfy each failure mode.

Management

Section 1: Industry-Market Landscape

Section 1.1: Port Model

Identify the competitors, suppliers, buyers, new entrants, complementors, and substitutes



Companies and Their Effect on Market:

- Microsoft: Microsoft will provide the operating system needed for the app that will work alongside our VR headset

- Competitors: Our competition in the VR industry includes the well established large tech companies such as Microsoft and Samsung that currently offer VR products but they lack accessibility for the average consumer.
- New Entrants: Since VR devices are still not at their peak of popularity most of the investment is going towards existing tech companies that have well known products.

Even so, companies like Niantic are becoming independent companies that are posing as new competition with their innovative products and software in VR.

- Threat of Substitutes: There are a good handful of VR products out in the market and because they are made by well known companies it is easy for consumers to purchase their products since they are trademarked with quality and reliability.
- Supplier: Suppliers for current VR technologies include companies like Ambarella who provide the software needed to create and capture a virtual environment.
- Buyers: VR in the current market is aimed towards phone producers as a compliment device or as a video game tool for PC manufactures.
- Complementors: Since VR devices don't seem to offer much when they are just on their own there are many complementary devices the main ones being PC computer and phones that help enhance the experience of all sorts of media

RecTech overall will be a supplier of VR technology that offers a more affordable, accessible, and personal product compared to those of our competitors. Our company will do this while considering other features of the industry landscape.
-We will supply our product to phone providers since our product will focus on enhancing people's mobile experience.
- Since our product will work with other devices we are also a complementor to phones and computers if people wish to make those activities more immersive.
-With our product being more accessible for the average consumer we will also serve as a substitute for those higher end VR products which offer similar features but for a higher price.

Section 1.2: Company summary

RecTech is our technology company (based on Microsoft). The company develops licenses, and supports a range of software products, services and devices. The Company's segments include Productivity and Business Processes and More Personal Computing.
RecTech products include:

- operating systems
- cross-device productivity applications
- server applications
- business solution applications
- desktop and server management tools
- software development tools
- video games
- training and certification of computer system integrators and developers.

It also designs, manufactures, and sells devices, including tablets, gaming and entertainment consoles, phones, other intelligent devices, and related accessories, that integrate with its cloud-based offerings.

Company Vision:
To help an individual live in their wildest dreams.

Company Mission Statement:
Create the opportunity for every organization, company, and individual to achieve their maximum potential with technology.

Company Business Goals:

- Redefine what it means to be productive and the business process within which technology companies operate.
- Create more affordable, accessible, and personal virtual reality systems.

Annual Sales Revenue: 580(M)
Growth: 1.37%
Net Income: 75.57(M)
Profit Margin: 13%
*taken from the 2017 Microsoft Annual sales report by looking at the 2015 number set

Company Technology Strategies:
Advance, state of the art virtual reality devices

Company Product/Market Strategy:
Build the best-in-class platform and product service for virtual reality.

Company Competitive Strategy:
We believe our products compete effectively based on our strategy of providing powerful, flexible, secure, and easy-to-use solutions that work well with technologies our customers already have and are available on a device

Section 1.3: Product market strategies

Market Strategy	Where Applied
Demographic segmentation- This strategy takes into account different variables such as age, life cycle stage, income, religion, race, and nationality to divide the population.	Microsoft uses this strategy in the development of their operating systems and office products.
Behavioral segmentation- This strategy divides the population based on behavior which focuses on how the population responds and uses a specific product.	The company uses this strategy in the development of operating system servers and their mobile devices.
Differentiated targeting- This strategy involves the analysis of the competition and the division of the market based on the features offered by similar products	This is used after the behavioral segmentation process in the development of phones and developer tools
Undifferentiated targeting- This strategy refers to the analysis of homogeneous products all around the world that revolve around in this case computers	Microsoft uses this strategy after demographic segmentation which helps in the development of their operation systems and office

Conclusion 1

As an ambitious Virtual Reality company, we analyzed started by dissecting our future market place and identifying the forces of the market. Competitor, substitutes, complementors, buyers, and sellers all play a part in our strategy. After summarizing our company and goals, we developed technology, market, and competitive strategies based on our target market.

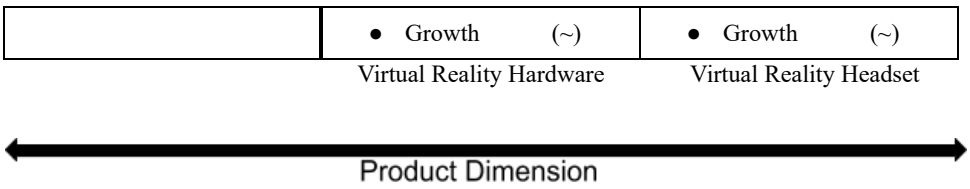
Section 2: Business Goals

Section 2.1 Market Size for VR Headsets:

Total market size for VR Headsets 2017: **$4.9** billion

Growth: **56.1%** compound annual growth rate

Commercial	● Sales Revenue(~) ● Growth (~)	● Sales Revenue(~) ● Growth (~)
Consumer	● Sales Revenue(~) ● Growth (~)	● Sales Revenue(~) ● Growth (~)
Enterprises	● Sales Revenue (~)	● Sales Revenue(~)



- As of right now, the market size for VR headsets is growing at an exponential rate and the predicted market for it is set to be around $28.3 billion by the year 2020
- The total revenue for Virtual Reality hardware as of 2017 is estimated to be around $2.6 billion and consumer software/services to be around $1.0 billion
    - Virtual reality hardware saw an 80% growth rate from 2016 to 2017
    - Virtual reality consumer software/services grew about 233% from 2016 to 2017

  Source: https://www.superdataresearch.com/market-data/virtual-reality-industry-report/

Section 2.2: Worldwide VR Headset Shipments…

Worldwide VR Headset Shipments, Segment Share, and CAGR, 2016 - 2021

Product Category	Segment Group	2016 Units	2016 Share	2021 Units	2021 Share	CAGR (2016-2021)
Virtual Reality	Commercial	1,838,109	19.9%	18,141,736	27.0%	58.1%
Virtual Reality	Consumer	7,399,326	80.1%	48,963,827	73.0%	45.9%
Total VR Headsets		9,237,434	100.0%	67,105,563	100.0%	48.7%

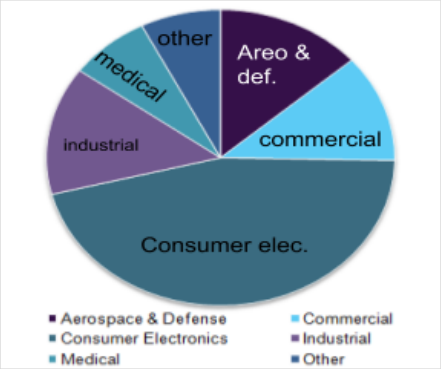
Source: IDC Worldwide AR/VR Headset Tracker, June 19, 2017

This chart shows how the VR headset will perform in the future and in turn will greatly assist companies in knowing the potential market for this product and its success. Since VR headsets

seem to be exponentially increasing in units and shares, companies can utilize this knowledge to capitalize on this product and further innovate it. We need this to perform our project because it gives us insight into the potential market of our product and how to move forward with any innovations or product development/planning.

Section 2.3: Market needs analysis

Virtual Reality market by application (%)



Source: http://www.grandviewresearch.com/industry-analysis/virtual-reality-vr-market

- For the VR market needs analysis, a majority of the market shares are due to consumer electronics
    - We can see that virtual reality headsets have started to be implemented into other applications other than consumer electronics and could potentially play a bigger role in the market share within the future
    - From future predictions based on the growth of the technological advancements with VR headsets, it seems that virtual reality software will outgrow its hardware allowing for more application implementations

Conclusion 2

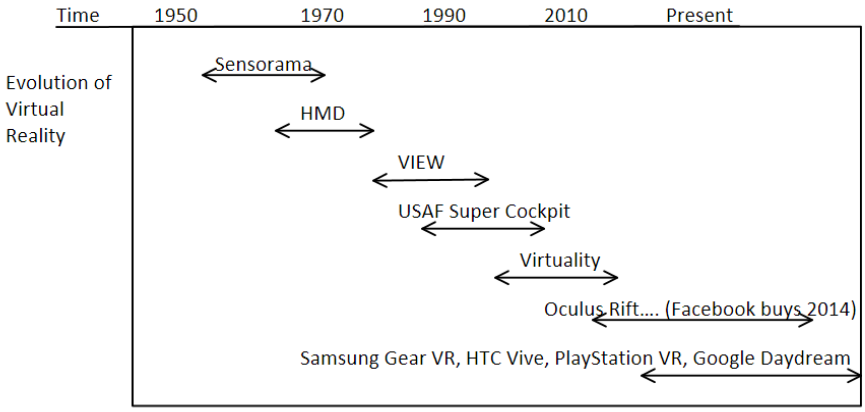
After we knew what our company was doing we need goals. We based our financial and market wide goals on similar competitors already in the market to more accurately gauge our future. We dissected our target market further with a market needs analysis to divide our target market into different segments based off the application of the VR device. This will be helpful for the product line strategy.

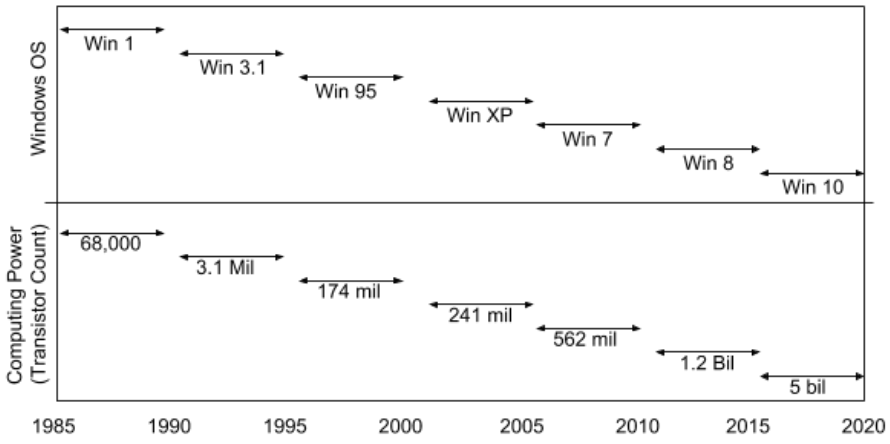
Section 3: Developmental Strategy:

Continue to make significant investments in a broad range of research and development to help revolutionize virtual reality.

Section 4: Functional Maps

Section 4.1: Engineering timeline





The first graph shows the evolution of virtual reality from the early 1950s to present time. The usage of the technology hasn't changed much because they are still trying to make an alternate reality that people can use. In some cases, USAF's Super Cockpit for example, they use it for more practical purposes to evaluate a pilot's safety. As more major competitors arrive, from 2014 to present, virtual reality devices have become more prominent in entertainment.
https://i1.wp.com/www.freeflyvr.com/wp-content/uploads/2017/04/History_of_VR_by_WorldViz.jpg?w=1200&ssl=1
https://en.wikipedia.org/wiki/Virtual_reality

Conclusion 4

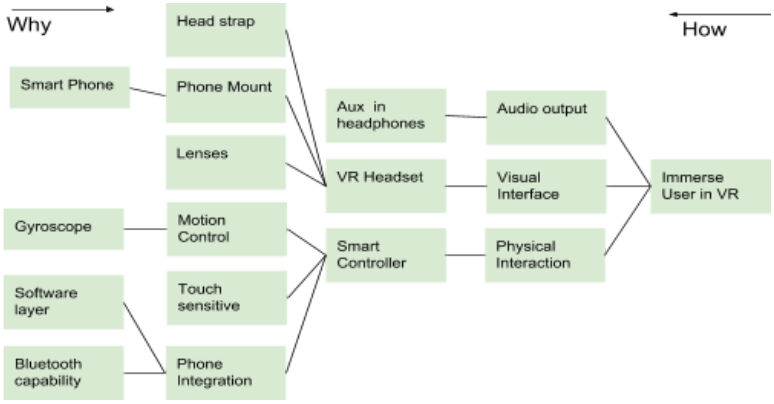
To grasp the target market and the engineering that follows the VR industry we utilized evolutionary functional maps. We used a functional map to analyze the evolution of the VR headset, and to see where our product should be aiming in the future. Another Functional map used was related to any software/hardware systems we might us in our headset and what technology we should be using in the future.

Section 5: House of Quality

Section 5.1: FAST Diagram

Be sure that you have created a detailed HOQ for your product.

SP1: Create a FAST Diagram for product



Section 5.2: List of Consumer Needs

SP2: List of consumer needs and assess importance from scale of 1-10

Customer Needs	Importance
Easy to connect to phone	10
Easy to set up	9
Sound isolation	7
Surround Sound	6
Lense width	8
Compact	7
Can withstand falling/Durability	7
Shock-proof	5
Easily Affordable	9
Payment Plan	8

Section 5.3: Technical Metrics

SP3: List of technical metrics and assess the importance: scale(1-10)

Technical Metrics	Dimensions (inches)	Years supported (years)	Weight (ounces)
Importance (1-10)	6	8	7

Section 5.4: Correlation of Customer Needs & Technical Metrics

SP4: Correlate the customer needs & technical metrics

i. S = strong positive correlation
ii. M = medium positive correlation
iii. = no correlation

	Easy to connect to phone	Easy to set up	Sound Isolation	Surround Sound	Lense Width	Light	Compact	Durable	Shock proof	Affordable	Payment Plan

Dimensions (inches)	S			M	S	M	S				
Years supported (years)		M								M	M
Weight (grams)						S		M			

Section 5.5: Correlation of technical metrics

SP5: Create a matrix that correlates the technical metrics to each other using a convenient scale.

i. "SP" = Strong Positive Correlation
ii. "MP" = Medium Positive Correlation
iii. "SN" = Strong Negative Correlation
iv. "N/A" = No Correlation

	Dimensions	Years Supported	Weight (ounces)
Dimensions	X	MP	SP
Years supported	MP	X	MP
Weight (grams)	SP	MP	X

Section 5.6: Customer Benchmarking

SP6: Customer Benchmarking

i. Customer Viewpoint
    1. Oculus Rift
    2. Google cardboard
    3. Samsung Gear VR
    4. Our product

Consumer ranking: scale (1-5) [Higher numbers are good, low numbers are bad]					
	Price	Immersion	Durability	Portability	Ease of use
Oculus Rift	1/5	4/5	4/5	2/5	4/5
Google Cardboard	5/5	2/5	1/5	4/5	4/5
Samsung	4/5	4/5	4/5	3/5	4/5

Gear VR					
Our Product	3/5	5/5	3/5	3/5	5/5

Sources:
https://www.pcmag.com/review/343413/oculus-rift
http://www.techradar.com/reviews/wearables/google-cardboard-1287573/review
http://www.techradar.com/reviews/samsung-gear-vr-2017

Section 5.7: Technical Benchmarking

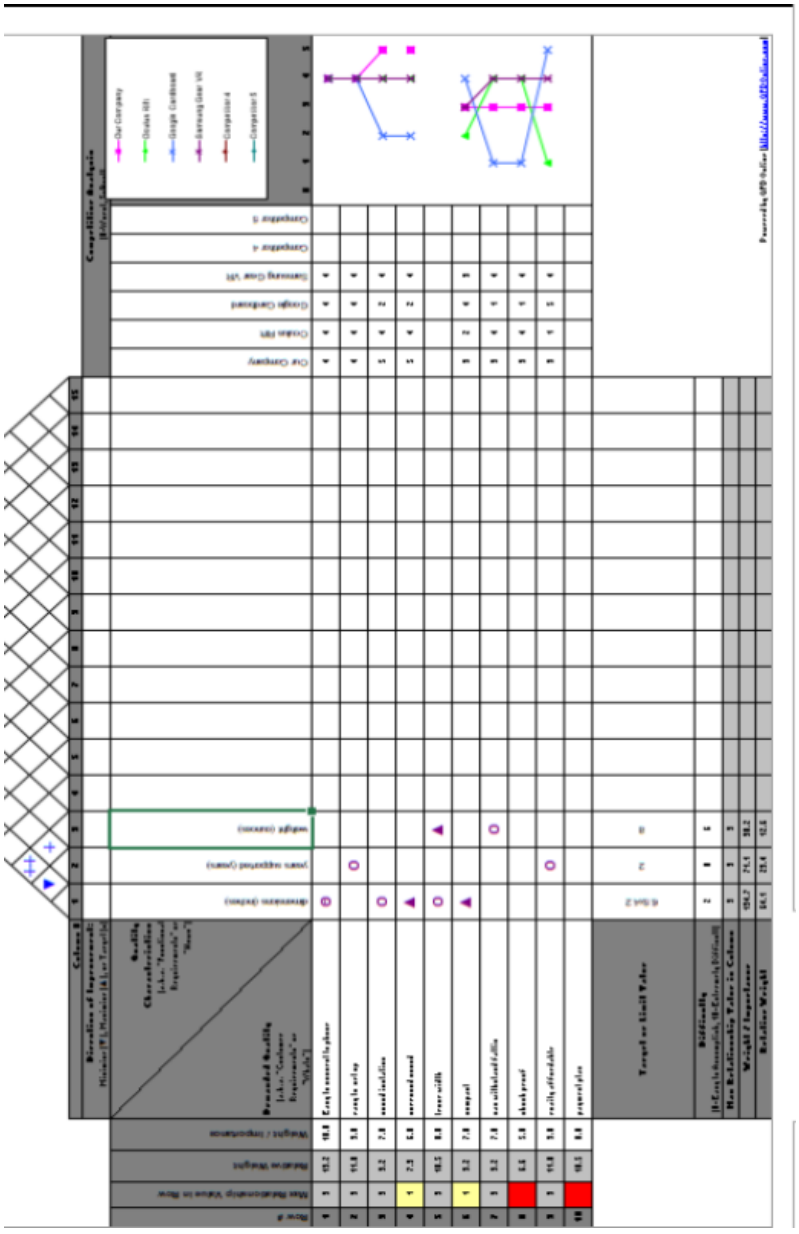
SP7: Technical Benchmarking

i. Technical Metrics
   1. Oculus Rift
   2. Google cardboard
   3. Samsung Gear VR
   4. Our product

	Dimensions	Years supported	Weight
Metrics	**Inches (Width/Depth)**	**# of years**	**Ounces (oz)**
Oculus Rift	6.73x4.02	1.5	16.64
Google Cardboard	0.75x0.12	3	3.3
Samsung Gear VR	8.2x4.8	2	12.17
Our Product	6.5x4.2	2	8

https://en.wikipedia.org/wiki/Google_Cardboard
https://en.wikipedia.org/wiki/Oculus_Rift

Section 5.8: HOQ Diagram



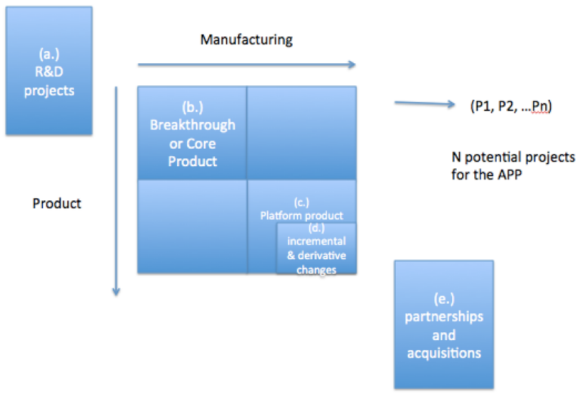
Conclusion 5

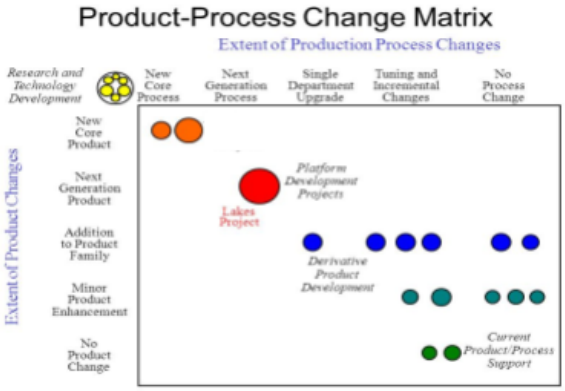
Before utilizing a house of quality process we dissected a competitor's previously existing VR device in a FAST diagram to find important sub functions. We used these subfunctions to create a list of customer needs and technical metrics that we rated and compared with one another to find relative importance. This relative importance for the device will come in handy for developing the conceptual design.

Section 6: Aggregate Project Plan

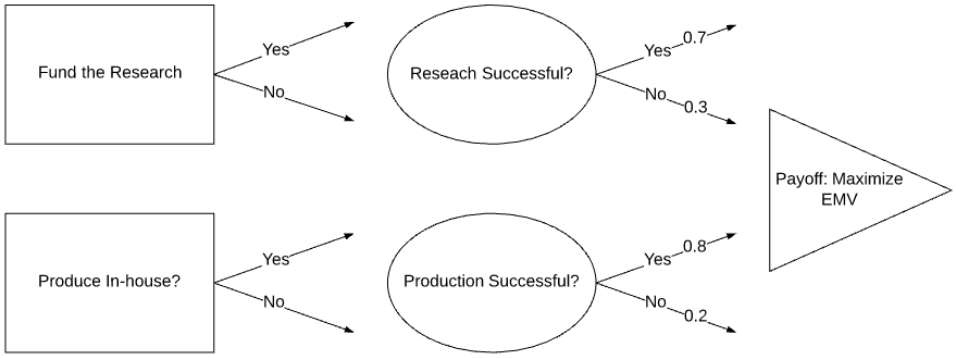
Selecting the right mix of product development projects for further development using the appropriate Decision Analysis and Optimization framework.

Section 6.1: Optimization Framework





Section 6.2: DA for Research/Production



Step 1) Identify the list of n Projects potentials

1) Develop virtuality headset
    a) Hardware
    b) Software

Step 2) For each project estimate the cost

1) Hardware:
    a) Inhouse $700-3400 per unit
    b) Purchase: $12.99 - 5000 per unit

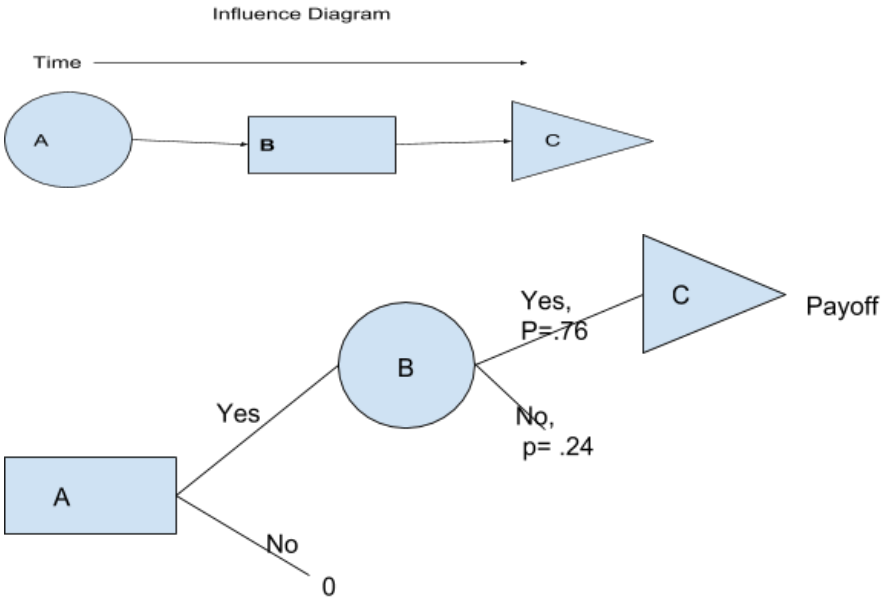
*How Much Does VR Development Cost?-ThinkMobile

2) Software:
    a) Non-gaming: $40k-70K per project
    b) Gaming: $50k-100K per project

*VR App Development Cost Explained-AppReal

For this project to work we must start with the hardware, due to the fact that this determines what software we use. After we determine the which software the development team will follow then we can choose how we wish to distribute our service/product

Section 6.3: Influence Diagram and Decision Trees



This is the D.A. tree for the first situation on the hardware to determine if the company should produce in house hardware.

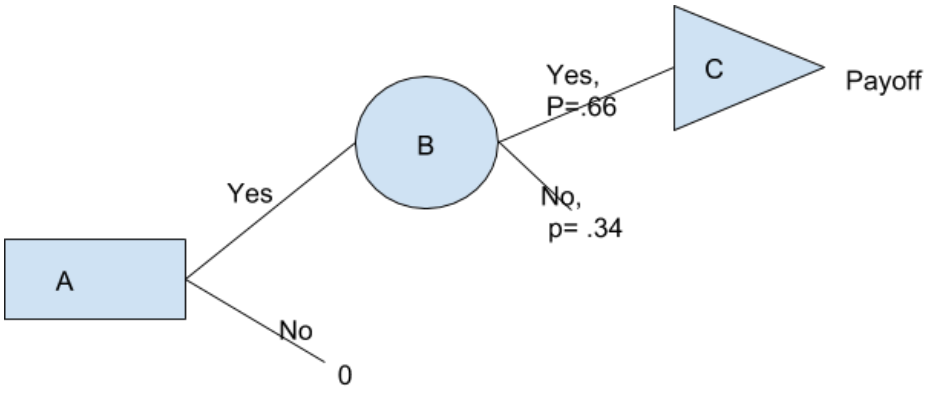
Key:

A: Produce In-House

B: Success of production

Cost of Production $1000

C: Payoff of production: $3400



This D.A. Represents if the company should outsource the production of the hardware.

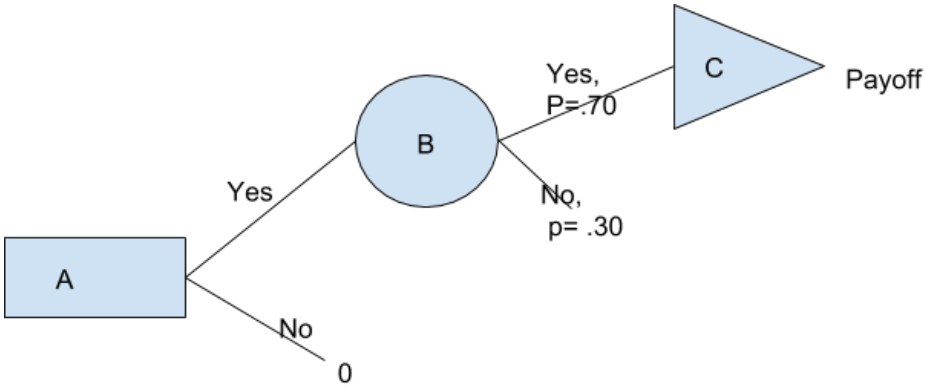
Key:

A: Purchase Hardware

B: Success of hardware integration

- Cost of integration 1500

C: Payoff of production: $5000



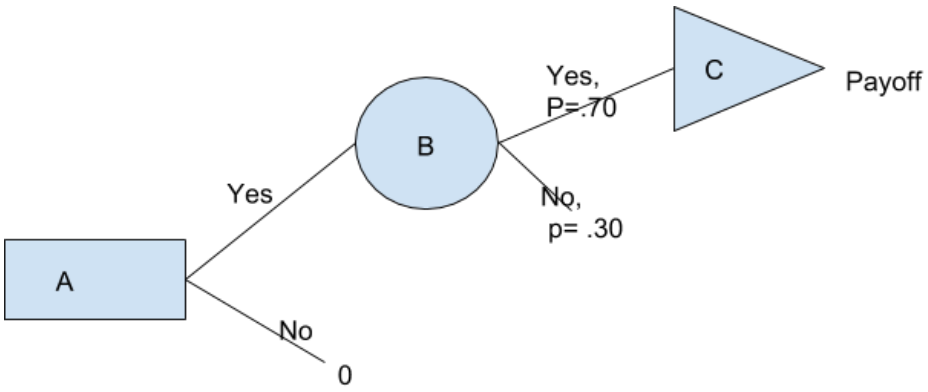
This D.A. represents the decision of building non-gaming software to be produced with the product.

Key:

A: Produce Non-Gaming Software

B: Success of Production
- Cost of production $15,000

C: Payoff of production: $50,000.



This D.A. tree represents the decision of building gaming software for the VR headset.
Key:

A: Produce Gaming Software
B: Success of Production
- Cost of Production $30,000

C: Payoff of production: $80,000.

Section 6.4 Cost and EMV

Project	Cost	Payoff
Hardware 1	$1000	$2344
Hardware 2	$1500	$2790
Software 1	$15000	$30500
Software 2	$30000	$47000

This shows the Cost and the EMV for the different hardware and software projects.

Section 6.5: Decision Analysis Matrix

Project Combination				Project cost				Project EMV				Total Cost	Total EMV
0	1	1	1	0	1500	15000	30000	0	2790	30500	47000	46500	80290
0	1	1	0	0	1500	15000	0	0	2790	30500	0	16500	33290
0	1	0	1	0	1500	0	30000	0	2790	0	47000	31500	49790
0	1	0	0	0	1500	0	0	0	2790	0	0	1500	2790
0	0	1	1	0	0	15000	30000	0	0	30500	47000	45000	77500
0	0	1	0	0	0	15000	0	0	0	30500	0	15000	30500
0	0	0	1	0	0	0	30000	0	0	0	47000	30000	47000
0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1000	1500	15000	30000	2344	2790	30500	47000	47500	82634
1	1	1	0	1000	1500	15000	0	2344	2790	30500	0	17500	35634
1	1	0	1	1000	1500	0	30000	2344	2790	0	47000	32500	52134
1	1	0	0	1000	1500	0	0	2344	2790	0	0	2500	5134
1	0	1	1	1000	0	15000	30000	2344	0	30500	47000	46000	79844
1	0	1	0	1000	0	15000	0	2344	0	30500	0	16000	32844
1	0	0	1	1000	0	0	30000	2344	0	0	47000	31000	49344

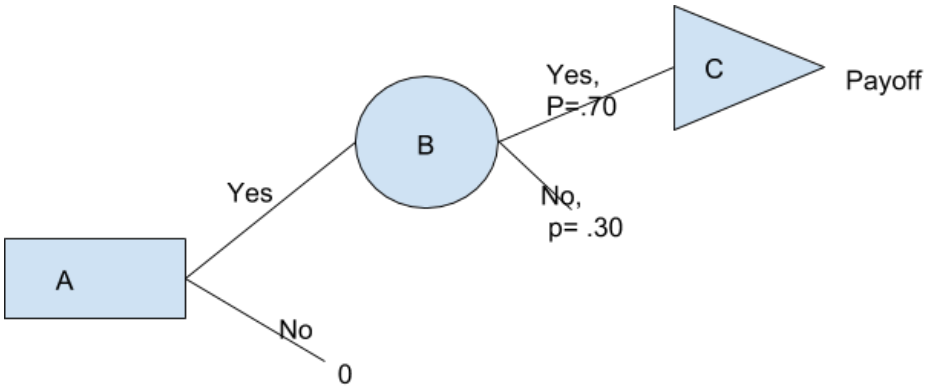
1	0	0	0	1000	0	0	0	2344	0	0	0	1000	2344

Decision Analysis Matrix for projects on Hardware and Software

Assuming that the company only has a budget of $40000, we limit the number of options that Rec. Tech. has to choose from when it comes to building possible combination. This option with the best payoff is number 11 with a combination of both inhouse and outsourcing hardware production with gaming software. The total payoff for that combination is $52134, with a cost of 32500. That means we have an excess of $7500 from the budget, which should be put back into research for the company.

Section 6.6: Preliminary Risk Analysis of Project Mix

SP1) Risk analysis of in house hardware production



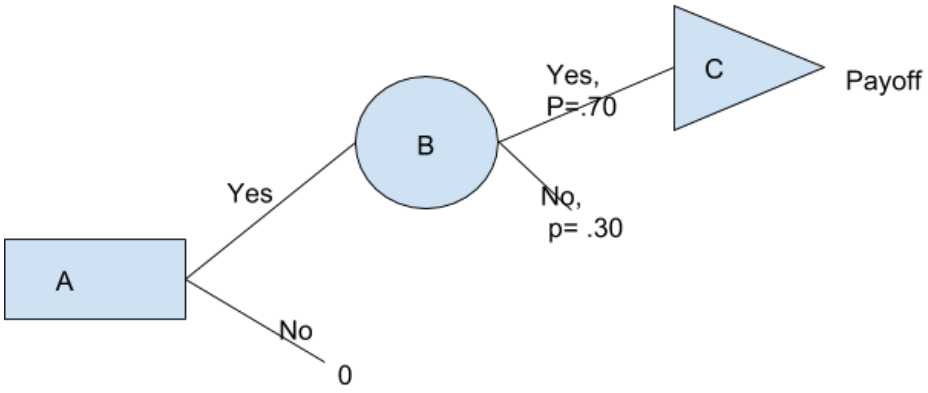
Decision analysis tree for in house hardware

Nominal probability = Pnom = .66
+/- 15%

.66 + (.15)(.66) = .759
.66 - (.15)(.66) = .561

In the first case with the increase 15% of success the decision to produce in house stays the same. In the second case of a decreased chance of success leaves us with a profit of 1468.4. This is still enough to follow with the plan.

Section 6.7: Decision tree for outsourcing hardware



Nominal probability= Pnom = .7
+/- 15%

.7 + (.15)(.7) = .805
.7 - (.15)(.7) = .595

In the first case with the increase 15% of success the decision to produce in house stays the same. In the second case of a decreased chance of success leaves us with a profit of 2367.5. This is still enough to follow with the plan.

Section 6.8: Risk Analysis of Gaming Software

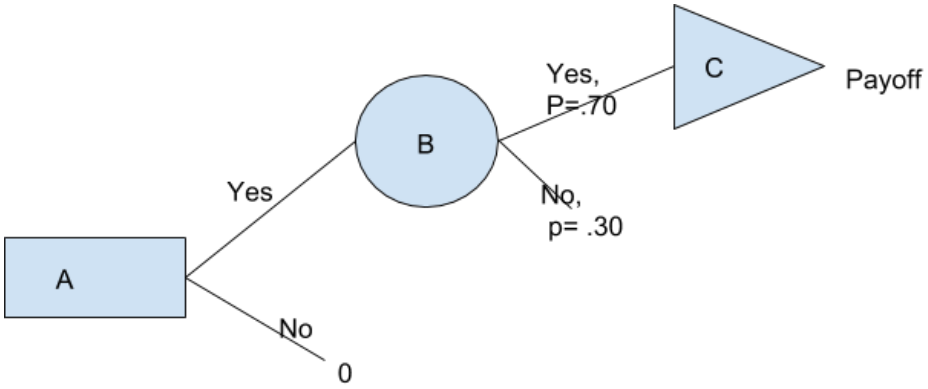


Figure 6.3: decision analysis tree for producing gaming software

Nominal probability= Pnom = .7
+/- 15%

.7 + (.2)(.7) = .84
.7 - (.2)(.7) = .56

In the first case with the increase 15% of success the decision to produce in house stays the same. In the second case of a decreased chance of success leaves us with a profit of 31600. This is still enough to follow with the plan.

Conclusion 6

We made an aggregate project plan to decide on manufacturing logistics. We realized the best payoff is with a combination of both inhouse and outsourcing hardware production with gaming software. The total payoff for that combination is $52134, with a cost of 32500. That means we have an excess of $7500 from the budget, which should be put back into research for the company.

Section 7: Project Planning

a. **Intent**:
   i. The intent of our VR headset is to provide the user with an immersed VR experience while also being able to share their experience with others around them

b. **Sub-tasks & Activities**
   i. Project Phase II
      1. Project Planning
      2. House of Quality
      3. Aggregate Project Plan
      4. Reverse Engineering
      5. Conceptual Design
   ii. Project Phase III
      1. Product platform/Line Strategy
      2. Economic/Financial Analysis
      3. Failure Modes/Effect Analysis

Section 7.1: Activity Matrix Project Phase III

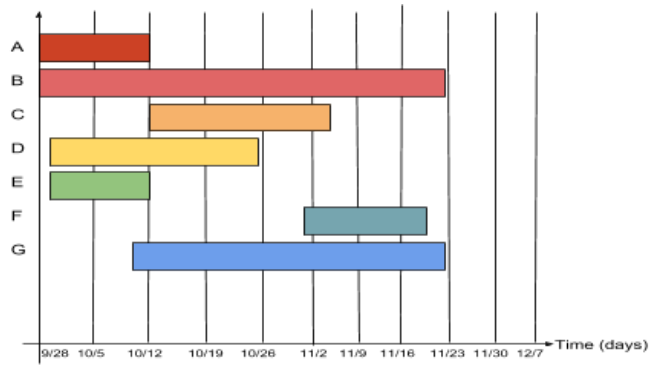
X ⇒ Depends on

Subtasks	Project Planning	Product Platform	Market Segments	Product Lines	Economic/Financial Analysis	Failure Modules	Effect Analysis
Project Planning **(A)**	Project Planning						
Product		Product					

Platform **(B)**		Platform					
Market Segments **(C)**		x	Market Segments				
Product Lines **(D)**		x	x	Product Lines			
Economic/Financial Analysis **(E)**					Economic/Financial Analysis		
Modules **(F)**						Failure Modes	
Analysis **(G)**							Effect Analysis

- Project Planning is independent
- Product platform, market segments, and creation of product lines are sequential tasks
- Economic/financial analysis is currently unknown
- Failure modes is currently unknown
- Effect analysis is currently unknown
-

Section 7.2: GANTT Chart



- A “Project Planning” depends on everything and everything depends on the project planning. It is updated as the phase is completed
- F “Conceptual Design” depends on C “HOQ”
- F “Conceptual Design” depends on E “FAST Diagram”
- C “HOQ” depends on E “FAST Diagram”
- G “Phase II report” depends on basically everything

The GANTT chart shows:

- The start and finish dates of the sub tasks and how they overlap with each of the other task.
- The duration of each individual subclass.
- Progress made on each task at any given point in time.

Section 7.3: PERT Chart

The PERT chart shows the evolution of the sub tasks and how they will flow into the next task of the project.

CPM:
A→B→D→C→F→G

This critical path method shows how A (Project Planning) is determined on B (Product Platform) and D (Product Lines) is determined on E (Economic/Financial Analysis) and C (Market Segments) due to the extended time frame needed to complete task D and all subsequent tasks will flow chronologically.

2. **Check your work:**
   a. We ran through the problem as a group
   b. Everyone was assigned an individual task to focus on the details
   c. Everyone went through each problem together after finishing.

Conclusion 7

We have learned that project planning is a very important aspect in any successful project. It provides a way to check over any progress made and aids in any further development towards the project.

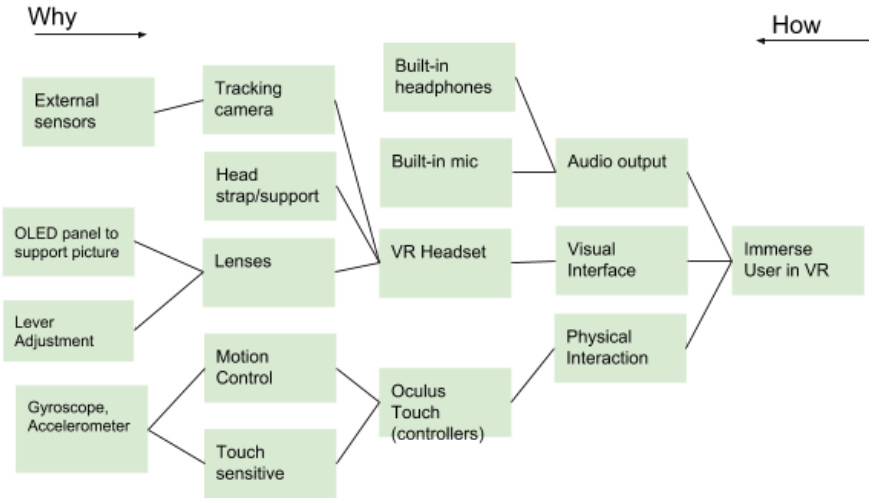
Management Conclusion

In this section we first mapped the industry market landscape for our product and established a competitive, technology, and market strategy for our company. With the making of our company we've established business goals and objectives such as the ROI, % market share, and revenue, along with the vision and mission of our company. We have also established developmental goals that would help us align with our strategies with the goals made. The functional maps created help pick what technologies and products to develop. These included time based evolution maps of our potential product. We then identified customer needs and from those made technical requirements as a basis for our House of Quality. We then made an Aggregate project plan using decision analysis. With this we were able to see the mix of products to be developed. Finally, we were able to make a GANTT and PERT chart to develop a project plan for completing each task.

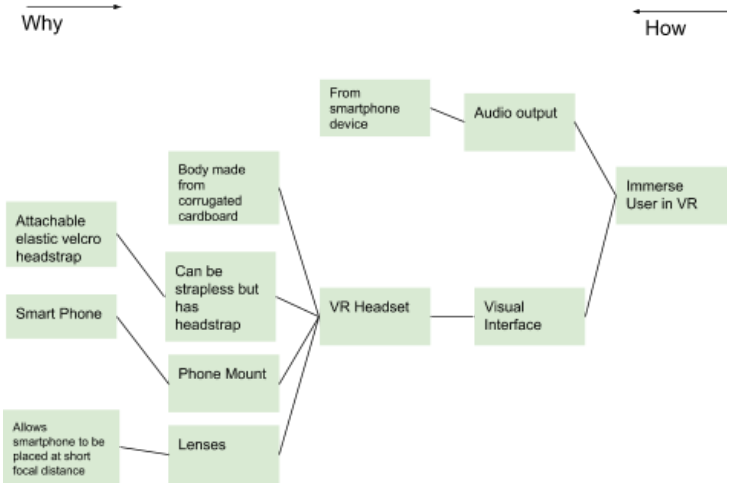
Section 8: Reverse Engineering

Identify existing products that are similar to your product idea and reverse engineer them using FAST.

Section 8.1: FAST diagram for Oculus Rift



Section 8.2 FAST Diagram for Google Cardboard



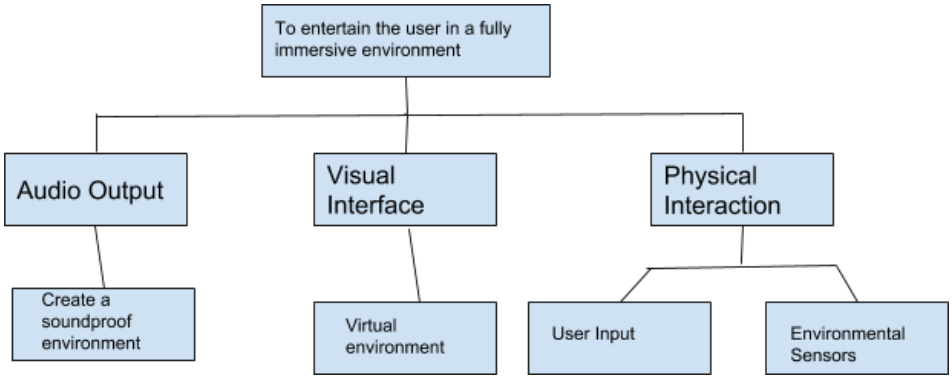
Conclusion 8

Before developing our VR products conceptual design we dissected two competitor's VR headset products, the Oculus and Google Cardboard. We ended up using most of the subfunctions from the Oculus for our function structure.

Section 9: Conceptual Design

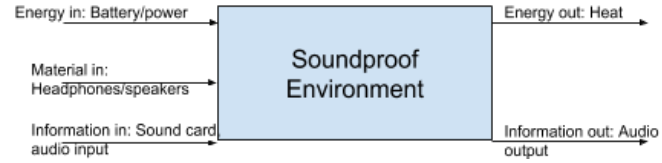
Apply the conceptual design process to create several alternative concepts for your product idea.

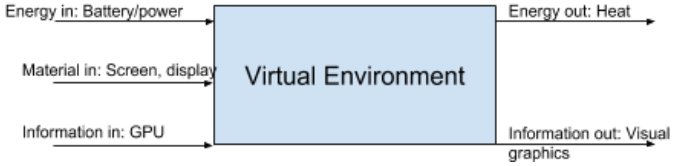
Section 9.1: Functional Structure of Product

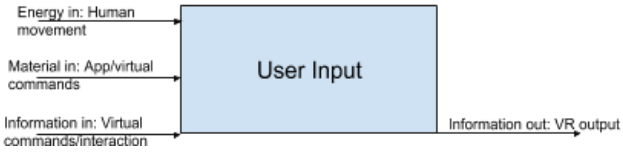


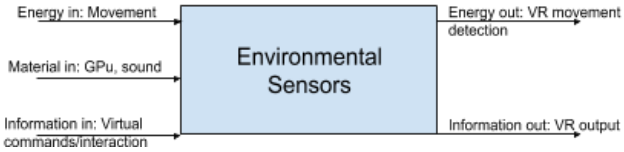
This is a flowchart of the key sub-functions that a VR must satisfy to be successful. The function structure shows the requirements for all of the VR headsets currently being used. The sub-functions will be used to find different pieces of technology that satisfy the different applications involved.

Section 9.2 Function Structure Flows









Section 9.3: Morphological Matrix

For each sub-function generate alternative solution principles in a morphological matrix

Solution principles \ Sub-functions	Solution principle 1	Solution principle 2	Solution principle 3	Solution principle 4
Soundproof environment	Sound proof headphones	Noise cancellation	Really loud speakers	soundproof walling
Virtual Environment	Micro Projections screens	LCD	Applications with formatted atmosphere	Higher Resolution application
User input	Nothing	Remote	Controllers	Sync gloves
Environmental Sensors	Infrared sensors	3D imaging sensors	Webcams	Built-in accelerometer

Figure F.2: This is the Morphological Matrix that allow us to create our designs. We will combine different options from the listed technology to create possible VR headset. These different designs will be compared using a standard model to determine which is the best design.

Section 9.4: Different Conceptual Designs

List of possible solutions:

Solution 1: Soundproof headphones, LCD, Remote, Webcams

Solution principles \ Sub-functions	Solution principle 1	Solution principle 2	Solution principle 3	Solution principle 4
Soundproof environment	Sound proof headphones	Noise cancellation	Really loud speakers	soundproof walling
Virtual Environment	Micro Projections screens	LCD	Applications with formatted atmosphere	Higher Resolution application
User input	Nothing	Remote	Controllers	Sync gloves
Environmental Sensors	Infrared sensors	3D imaging sensors	Webcams	Built-in accelerometer

Solution 2: Soundproof Headphones, Micro Projections, Controllers, 3D imaging sensors

Solution principles \ Sub-functions	Solution principle 1	Solution principle 2	Solution principle 3	Solution principle 4
Soundproof environment	Sound proof headphones	Noise cancellation	Really loud speakers	soundproof walling
Virtual Environment	Micro Projections screens	LCD	Applications with formatted atmosphere	Higher Resolution application
User input	Nothing	Remote	Controllers	Sync gloves
Environmental Sensors	Infrared sensors	3D imaging sensors	Webcams	Built-in accelerometer

Solution 3: Really loud Speakers, Higher resolution application, remote, infrared sensors

Solution principles \ Sub-functions	Solution principle 1	Solution principle 2	Solution principle 3	Solution principle 4
Soundproof environment	Sound proof headphones	Noise cancellation	Really loud speakers	soundproof walling
Virtual Environment	Micro Projections screens	LCD	Applications with formatted atmosphere	Higher Resolution application
User input	Nothing	Remote	Controllers	Sync gloves
Environmental Sensors	Infrared sensors	3D imaging sensors	Webcams	Built-in accelerometer

Solution 4: Noise cancellation, LCD, Sync gloves, 3D imaging sensors

Solution principles \ Sub-functions	Solution principle 1	Solution principle 2	Solution principle 3	Solution principle 4
Soundproof environment	Sound proof headphones	Noise cancellation	Really loud speakers	soundproof walling
Virtual Environment	Micro Projections screens	LCD	Applications with formatted atmosphere	Higher Resolution application
User input	Nothing	Remote	Controllers	Sync gloves
Environmental Sensors	Infrared sensors	3D imaging sensors	Webcams	Built-in accelerometer

Solution 5: Soundproof Walling, application with formatted atmosphere, nothing, built-in accelerometer

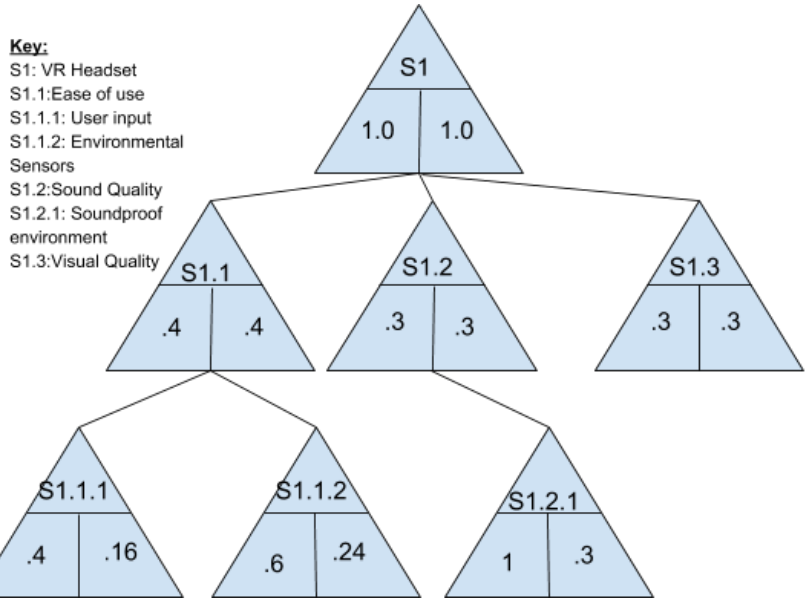
Solution principles \ Sub-functions	Solution principle 1	Solution principle 2	Solution principle 3	Solution principle 4
Soundproof environment	Sound proof headphones	Noise cancellation	Really loud speakers	soundproof walling
Virtual Environment	Micro Projections screens	LCD	Applications with formatted atmosphere	Higher Resolution application
User input	Nothing	Remote	Controllers	Sync gloves
Environmental Sensors	Infrared sensors	3D imaging sensors	Webcams	Built-in accelerometer

Solution 6: Noise cancellation, Higher resolution application, Remote, Webcams

Solution principles \ Sub-functions	Solution principle 1	Solution principle 2	Solution principle 3	Solution principle 4
Soundproof environment	Sound proof headphones	Noise cancellation	Really loud speakers	soundproof walling
Virtual Environment	Micro Projections screens	LCD	Applications with formatted atmosphere	Higher Resolution application
User input	Nothing	Remote	Controllers	Sync gloves
Environmental Sensors	Infrared sensors	3D imaging sensors	Webcams	Built-in accelerometer

The six different designs will be compared based off of a standard, built by the team on determining which sub-function are more important and which pieces of technology are more valuable to the concept design.

Section 9.5: Utility Function Diagram



This is a diagram showing the hierarchy of the criteria that is involved in building our VR headset. This diagram will be used to rank the different concept designs that the team created on a universal scale.

Section 9.6: Utility Function Chart

Selection Criteria	Absolute Weights	Concept 1		Concept 2		Concept 3		Concept 4		Concept 5		Concept 6	
		Concept Rating	Utility	CR	Utility	CR	Utility	CR	Utility	CR	Utility	CR	Utility
S1.1.1	.16	3	0.48	4	0.64	3	0.48	5	.8	0	0	3	0.48
S1.1.2	.24	3	0.72	5	1.2	4	0.96	5	1.2	2	.48	4	0.96
S1.2.1	.3	5	1.5	5	1.5	2	0.6	4	1.2	2	.6	4	1.2
S1.3	.3	4	1.2	4	1.2	4	1.2	5	1.5	3	.9	3	.9
Sum		Utility = 3.9		U= 4.54		U= 3.24		U=4.7		U=2.88		U=3.54	

Figure F.4: This figure shows the rating of the designs and their final utility. This diagram is used to determine which conceptual design has the highest utility and would be the most successful in the market. We chose a scale of 5 (highest) to 0(lowest) to rate the different technologies involved with each of the different sub-functions.

Take the design concepts generated in SP5 and rank them

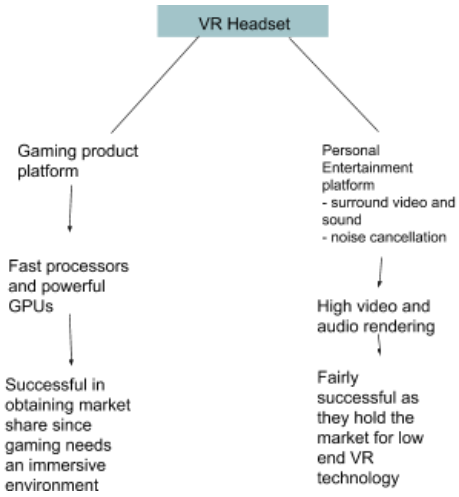
1. Concept 2
2. **Concept 4**
3. Concept 1
4. Concept 6
5. Concept 3
6. Concept 5

Conclusion 9

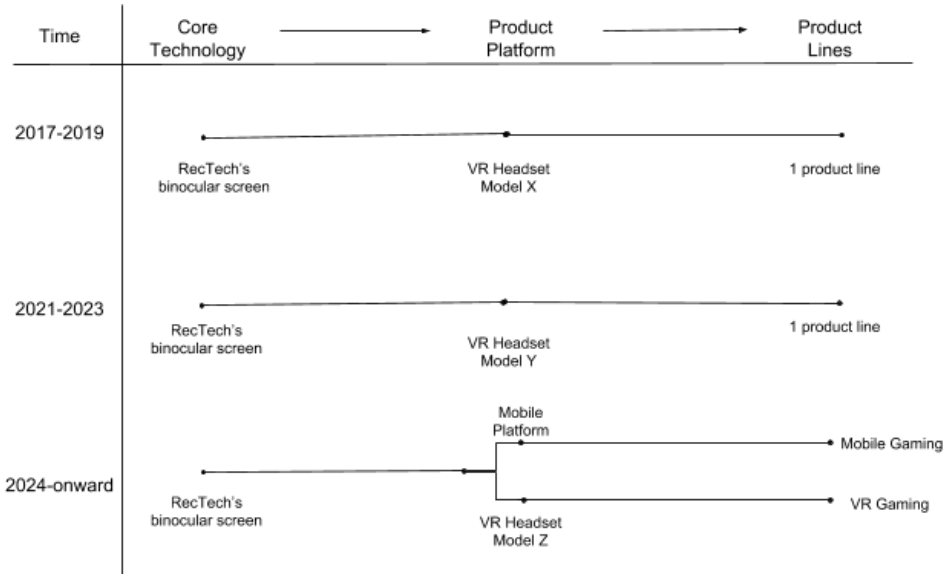
After Dissecting the Oculus for sub functions then using those subfunctions to create six conceptual designs, we found the most valuable design with a utility function diagram and table. We found that our Concept 4: Noise cancellation, LCD, Sync gloves, 3D imaging sensors, was the most valuable product in function.

Section 10: Product Line Strategy

Section 10.1: Product Lines



Section 10.2: RecTech's Product line strategy



Conclusion 10

This chart shows our product line strategy in which we will try and finish the implementation of our VR headset sometime within 2019 and then in the future, attempt to revamp our current VR headset and release a newer and better model in 2021. In 2024 we would like to expand our product platform to a third model of the headset as well as introducing a mobile platform for the headset for users who prefer a much more affordable option and going on from that, we will introduce a new product line dedicated to Mobile gaming.

Section 11: Failure Modes/Effect Analysis

Create a failure modes & effect analysis for our VR headset. Use this information to improve the quality of the product by anticipating failures.

- Read over FMEA handout
- Create a table subsystem/component by (S x O x D = RPN) with explanations
- Fill out corresponding functions
- Rate S, O, D with team discussion
- Calculate RPN
- Create actions to fix parts that have an RPN over the threshold (10).

S = Severity of failure mode ranging from 1 to 8*
O = How frequently does the failure occur ranging from 1 to 8*
D = How easy the failure is to detect ranging from 1 to 8*
RPN = S x O x D; higher RPN is more critical
* - (1 = harmless/infrequent/easy, 8 = dangerous/frequent/difficult)

Section 11.1: FMEA Chart

Part	Function	Potential Failure Mode	Potential Effects of Failure	Severity	Potential Cause of Failure	Occurence	How to Detect	Detection	RPN	Actions
Enhancing Lenses	Allows for user to see into virtual environment	They stop working	User can't see into vr environment	8	Manufacturing error/human impact damage	4	Run the device	2	64	Make sure it consists of high quality software components to minimize damage
Head strap/supp	Enables user to use	Non adjustable/	User unable to	2	Manufacturing error	1	Try the headstrap/s	1	2	

ort	device hands free	gets broken	hold up handless device				upport on			
Tracking Sensor/Camera	Allows for user to detect objects in the real world while being submersed in VR	Faulty sensor unable to detect things	VR environment gets distorted from reality	5	Software Bug	3	Run the device	2	30	Make sure it consists of high quality software components to minimize possible damage
Internal Battery	Provides power to sensors	Stops working	Device is unable to work all together	8	Human impact damage, Water damage	2	Run the device for a few hours	4	64	Possibly build sturdier battery able to withstand damages
Audio Input	Enhances vr experience by allowing user to hear sounds	Stops working	None/minimal sounds in vr environment	3	Manufacturing error	1	Attempt to play sounds/noises in vr environment to check if it works	1	3	
Control	Main source of interaction with vr environment	Breaks	User is unable to navigate the device	6	Human impact damage	3	Try using it when device is being run	4	72	Ensure that the control is sturdy enough so that human impact damage doesn't have that profound of an effect
GPU	Graphic Processing Unit shows rate at which frames are processed in virtual environment	Bug/Crash	Device is unable to process vr images	8	Faulty manufacturing error, software bug	4	Analyze graphics while device is in use and see if everything progresses smoothly	5	160	Make sure GPU works and isn't faulty above all other components since it's of highest priority

Conclusion 12

The failure modes and effects analysis tells us what elements need to be addressed during manufacturing of the components. Through this process we learned what components are of higher priority than others and which require actions to solve the problems regarding components with the bigger potential problems.

Development Conclusion

In this section, we found out that in order to understand our product, we first had to dissect existing similar products by using Function Analysis System Technique (FAST). Through this, we understood the primary function of the product, the subfunctions & subsystems that fulfill our product's functions. From this understanding, we moved on to designing our product and organized our functions in a function structure to create alternate design concepts. We then used our utility function to compare and rate each solution to find the total utility with the best payoff. After this, we established our technology and product platforms to finish off and create a detailed design. We concluded with a failure modes and effects analysis (FMEA) to find underlying elements within two platforms to make different product lines for each market segment.

Commercialization

Section 12: Economic/Financial Analysis

Section 12.1: Base Case NPV

Senario Input Parmeters	
Sales & Production Volume(units/year)	500000
Development Cost (total$)	2000000
unite Price ($/unit)	600
Unite production cost ($/unit)	160
ramp-up cost (total $)	100000
Marketing & support cost ($/year)	500000
annual discount facotr(%)	15
Base-Case NPV	418467

Figure: Scenario Parameters

These are the base case that we generated by looking at the data for Samsung VR of 2016 for the sales and production volume. The rest of the data was either taken from the Aggregate project plan or generated as a group.

Base Case																
	Year 1				Year 2				Year 3				Year 4			
Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
($ Value in thousands)	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Development Cost	-500	-500	-500	-500												
Ramp-up cost				-50	-50											
Marketing & Support					-125	-125	-125	-125	-125	-125	-125	-125	-125	-125	-125	-125
Production Cost						-20,000	-20,000	-20,000	-20,000	-20,000	-20,000	-20,000	-20,000	-20,000	-20,000	-20,000
Production volume						3000	5000	7000	10000	13000	16000	23000	25000	26000	25000	30000
Unit production cost						-6.67	-4.00	-2.86	-2.00	-1.54	-1.25	-0.87	-0.80	-0.77	-0.80	-0.67
Sales Reveue						75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000
Sales Volume						125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000
Unit Price						0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Period Cash Flow	-500	-500	-500	-550	-175	54875	54875	54875	54875	54875	54875	54875	54875	54875	54875	54875
PV year 1, r=2%	-500	-482	-465	-492	-151	45649	43999	42409	40876	39399	37975	36602	35279	34004	32775	31590
projected NPV,$	418467															

Figure: Base Case

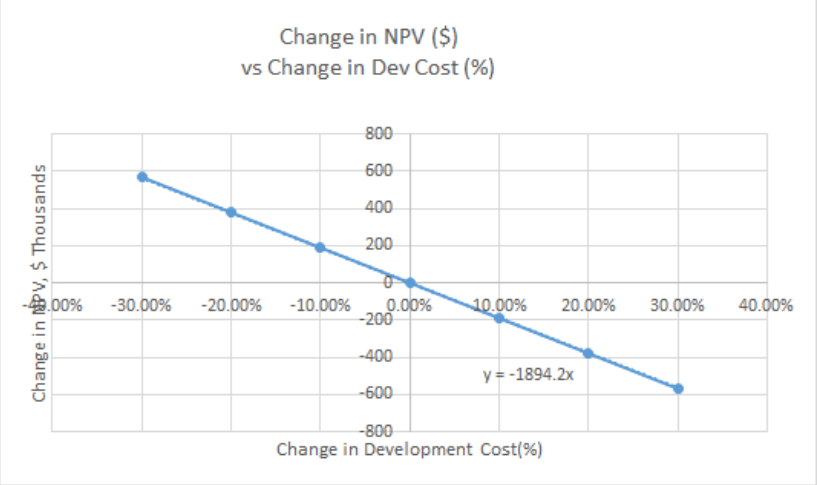
This figure shows how much the product will be worth after 11 quarters. We are assuming that product will take about 3 quarters to develop and that the ramp up cost are reasonable. The rest of the information was taken from samsung or generated as a team.

Section 12.2: Sensitivity Analysis

Base Dev Cost,$	change in Development	Development Cost, $thousands	Change in Develoment cost, $thousands	NPV, $ Thousands	Change in NPV,%	Change in NPV, $ Thousand
2,000	30.00%	2,600	600	417,899	-0.14%	-568
2,000	20.00%	2,400	400	418,088	-0.09%	-379
2,000	10.00%	2,200	200	418,278	-0.05%	-189
2,000	0.00%	2,000	0	418,467	0.00%	0
2,000	-10.00%	1,800	-200	418,657	0.05%	189
2,000	-20.00%	1,600	-400	418,846	0.09%	379
2,000	-30.00%	1,400	-600	419,035	0.14%	568

This figure shows the change in the net present value of the project if we change the sales volume.

Section 12.3: Development Cost Graph



This is a visual representation of the effects of the sales volume on the net present value.

Section 12.4: Sales Volume Chart

Base Dev Cost,$	change in Development	Development Cost, $thousands	Change in Develoment cost, $thousands	NPV, $ Thousands	Change in NPV,%	Change in NPV, $ Thousand
2,000	30.00%	2,600	600	4,258,233	-0.01%	-578
2,000	20.00%	2,400	400	4,258,426	-0.01%	-386
2,000	10.00%	2,200	200	4,258,619	0.00%	-193
2,000	0.00%	2,000	0	4,258,812	0.00%	0
2,000	-10.00%	1,800	-200	4,259,004	0.00%	193
2,000	-20.00%	1,600	-400	4,259,197	0.01%	386
2,000	-30.00%	1,400	-600	4,259,390	0.01%	578

This figure shows the change in the net present value based off of the change in development cost.

Commercialization Conclusion:

We created a Net Present Value (NPV) model in order to determine the expected profits from the product development projects. The NPV analysis models the appropriate cash flows. We also performed a base case financial model to understand and quantify trade offs between time, quantity and costs.

Project Conclusion

Our group set out as an ambitious new entrant to the VR market place, RecTech, a company based on Microsoft was developing the first of its VR devices. We started by analyzing the market and creating a strategy. After we established a strategy we created realistic goals and set out with the planning and development of our product. We compared customer needs with technical metrics to find the relative importance each subfunction had in VR products. We decided a combination of inhouse software with outsourcing hardware was the route for manufacturing. Then we developed a few conceptual designs based on the most important sub functions and selected the most valuable concept to develop as our product. After we developed a few different products based on our concept and made a strategy for planning, developing, and releasing those products. After we analyzed possible failures in our product to handle in development rather than after release. As our teamwork improved throughout the process of

developing this product resulted in a more scrutinized, yet successful product. The organized process we executed over the last few months has proven to be priceless; using it in the projects in the future will help improve the quality of our work. Thanks to the TIM 105 TA's and especially Professor Subhas Desa for the support and guidance throughout the project. See you all in 125!