

ENGINEERING 510
ENGINEERING DESIGN
MIDTERM

Directions:

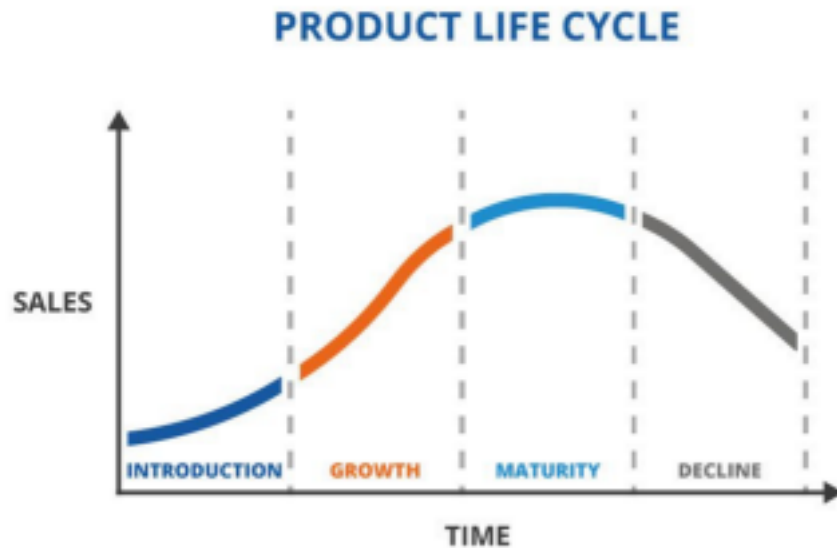
Use another sheet of paper with a reference to the problem number to answer the questions. You can use Word or Powerpoint with JPG pictures pasted from anything you write or draw for your responses. Convert your final answer pages into a PDF.

Problems:

1. Describe a phased product development process. What is the benefit of using a process to create and commercialize a product idea?

The PDP has five phases describing the process of a product from ideation to commercialization. The phases are ideation, feasibility & planning, design & development, verification & validation, and commercialization. In the ideation phase, you are using empathy maps, looking at the blue ocean, etc to locate an area that has unrealized needs in order to find a problem statement. This then moves on to the feasibility & planning phase which examines how feasible the plan is in relation to the market and target audience. This phase will also involve the planning behind the solution to the problem. The next phase is the design & development phase where we delve further into the specifics of the solution. We are looking at all of the design considerations and systems/subsystems that the solution will encapsulate. During the verification & validation phase, we are looking for ways to evaluate the solutions robustness and quality. We can look to see if it falls within six sigma. For the final phase, we are looking at commercialization. In this phase, we determine how to launch the actual product whether it be manufacturing, keeping up with monitoring product quality, looking at the marketing. We want to think of all of the ways we are feeding our product into the public market.

2. Explain the product life cycle and why it needs to be considered in product development.



The product life cycle looks at the life cycle of a product where the introduction phase is looking at new product development. This is where the product is launched into the market and first sales are being measured. Generally, there is not a lot of sales in this phase, but money is spent on marketing to the public to increase popularity of the product. Growth phase is where the product sales start to rapidly increase as the product further penetrates into the market. The product is becoming more known and starting to get the attention of other competitors. Growth and maturity is where the product is in continuous improvement to compete with other competitors. The maturity phase is where the sales are at its highest, but is not growing or decreasing. At this point, the market has been saturated with similar products acting as competition. Then in the decline phase, the product reaches obsolescence and sales decrease reaching the end of the products life cycle.

3. How do you use a multigeneration map to explain a design strategy to an executive who wants all features the first time? How does it help you tell a story on your knowledge growth path to achieve an ultimate product? How can a CORE Map supplement this discussion with a pushy CEO?

A multigeneration map is a great tool to devise a course of action on a product coming to life. To a CEO who wants all the features the first time, the multigen map will show them that all the features will eventually be produced, but the more important features will be focused on in the early generations so that we can be smart about where we are investing our time and resources. With these early generations we'll have time to gather feedback on our product and fix any major issues before we reach our final desired product. This also allows the product to have a progressional journey of improvements rather than taking the risk that a product with all the features the first time will generate revenue over a long period of time. It helps tell a story on your knowledge growth path to achieve an ultimate product, by showing in the early generations what the current capabilities of the team can accomplish. A core map can supplement this discussion by visualizing to the CEO what today's technology and current knowledge can accomplish and where we might possibly want to invest some more time and energy in the future as we may be lacking on the knowledge and the technology to accomplish certain features of the ultimate product.

4. Translate the vague customer statement into a need statement ("I need a XXXX to do XXXXX") that can be used to build a prototype.

- a. "See how the leather on the bottom of the bag is all scratched; it's

ugly."

I need a non-scratch durable bottom-of-bag design to protect the value

and condition of my leather bag when placing it down throughout its

use.

b. "This bag is my life; if I lose it I'm in big trouble."

I need a small tracking chip that can be placed in a bag, tracks location, and can make noise when prompted through a mobile device, to easily find my important bag when it is lost.

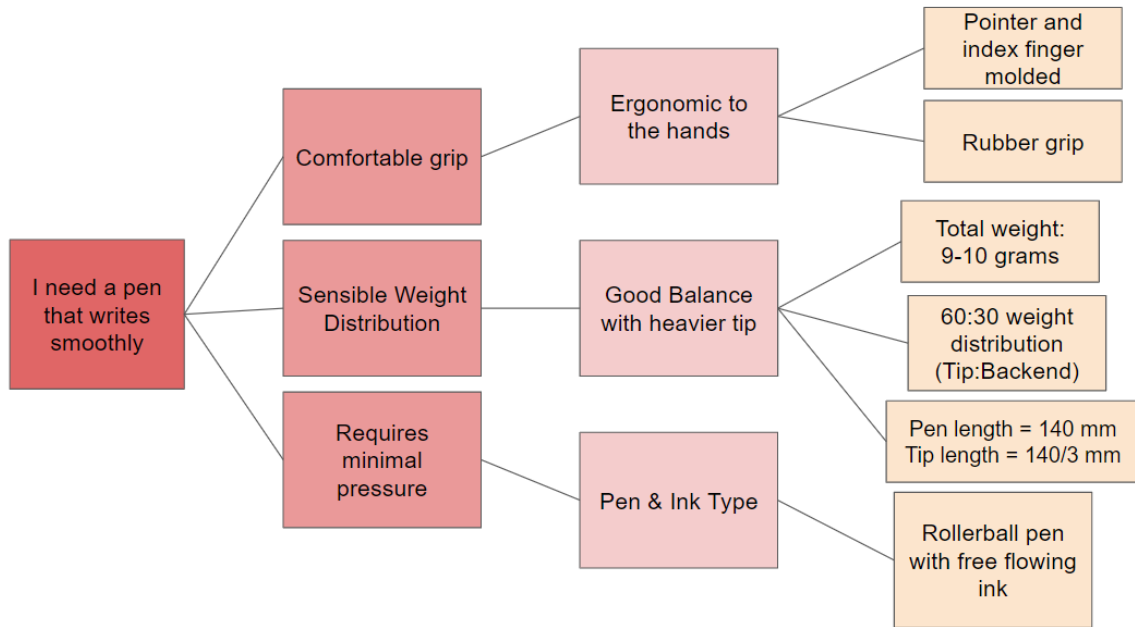
c. "I never use both straps on my knapsack; I just sling it over one shoulder."

I need a knapsack with one comfortable shoulder strap to be able to sling over one shoulder.

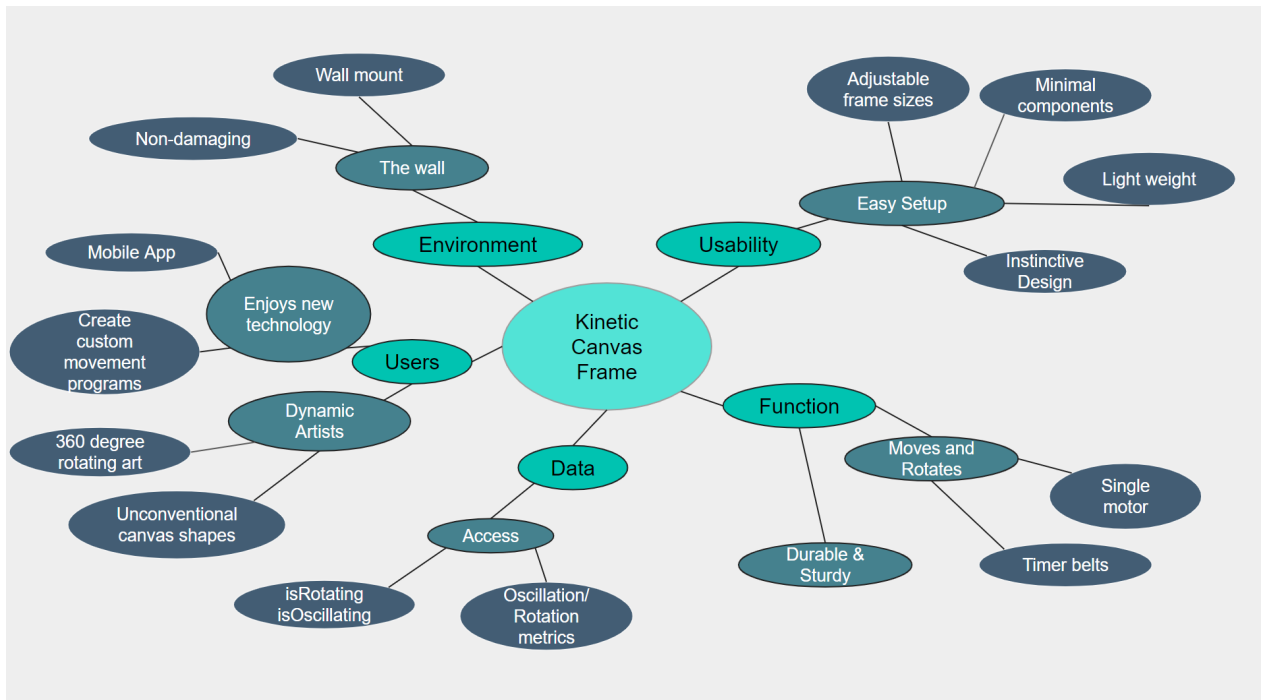
Or

I need a knapsack with removable adjustable shoulder straps to be able to choose to sling just one strap over the shoulder.

5. Derive a CTQ tree for a pen to write smoothly



6. Use a mind map to generate 10 areas of innovation opportunity for an area of your personal passion using the core requirement sub-topics levels



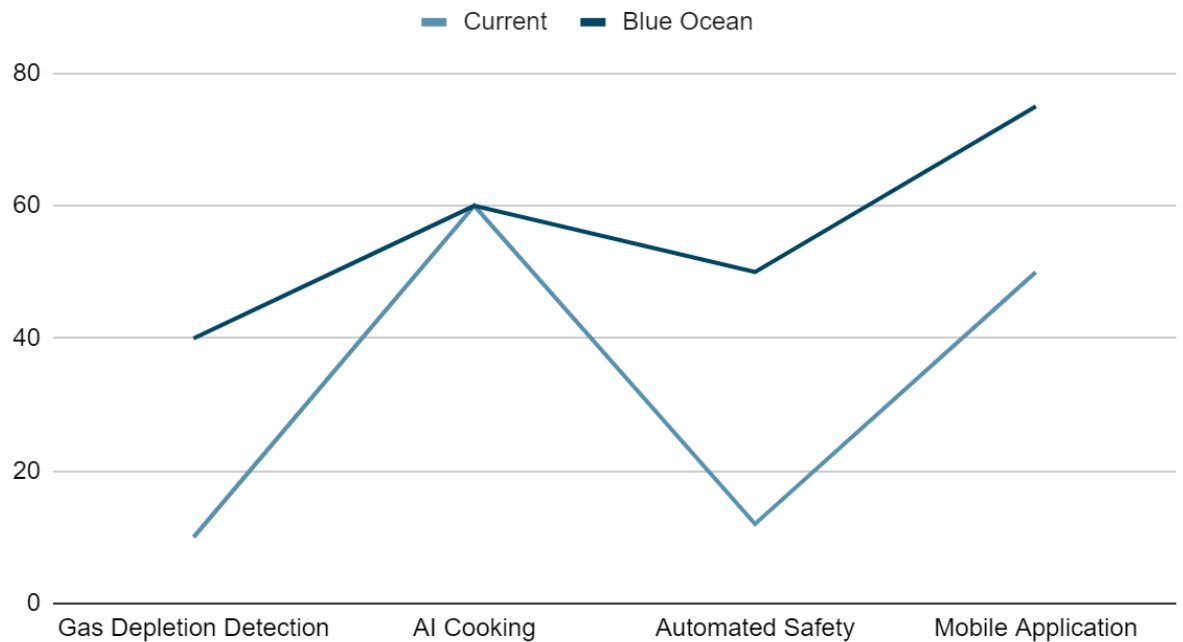
7. How might you establish precise and measurable specifications for intangible needs such as “the mobile phone must look high tech”?

I would create a CTQ tree starting with the customer's need “the mobile phone must look high tech”. That can then split off into more specific drivers to the requirements for example, the drivers could be “Sleek design”, “futuristic colors”, etc. Those drivers can yet be split off again, for example, sleek design can become further drivers “thin”, “minimal buttons“, “rounded edges” which can then finally establish the measurable specifications of the thinness being X millimeters, X number of buttons, X degrees of rounding of the edges. Futuristic color can be specified color X and Y.

8. Decompose the problem of designing a new barbeque grill using “Chunks” into a functional decomposition based on user interactions with the product. Now consider Weber Inc. (the largest BBQ grill company in the world) hires you to design a new grill system. Use a Blue Ocean Strategy Canvas to find opportunistic product/service/process attributes to help them become more competitive. Hint: use your knowledge of AI, IoT, APPS to facilitate a thought process.

BBQ grill chunks: control knobs, igniter, cooking grate, temp gauge, burners, grill hood, gas source.

A user uses the control knobs to control the fire, igniters ignite the flame, the cooking grate is where the meat is placed and cooked, the temperature gauge shows the user the temperature of the grill. The burners are responsible for heating up the cooking grate, the gas source is being used to heat up the burners, the grill hood is there to ensure the safety of the griller and the quality of the cooked meat.



Areas that can improve with the chunks in this process can be a detection system that notifies the user that there is a depletion in gas. Some grills already have smart features such as wifi grilling which allows the user to adjust the temperature and set timers for the grill. When examining the blue ocean strategy our best options would be to improve upon the mobile application and to have better automated safety. A good automated safety feature that would help with not wasting gas would be an automatic shut off. The cooking grate can have a scale on it that measures if there is anything left on the grill and if the burner persists to be kept on there can be an automatic shut off so that no fuel is wasted. These features would make having a grill safer as there is no gas leakage, and with the mobile application you can monitor your grill by potentially having other features such as a camera that you can access through your mobile application in which you can examine the state of your cooking meat and then adjust the control knobs accordingly through the app.

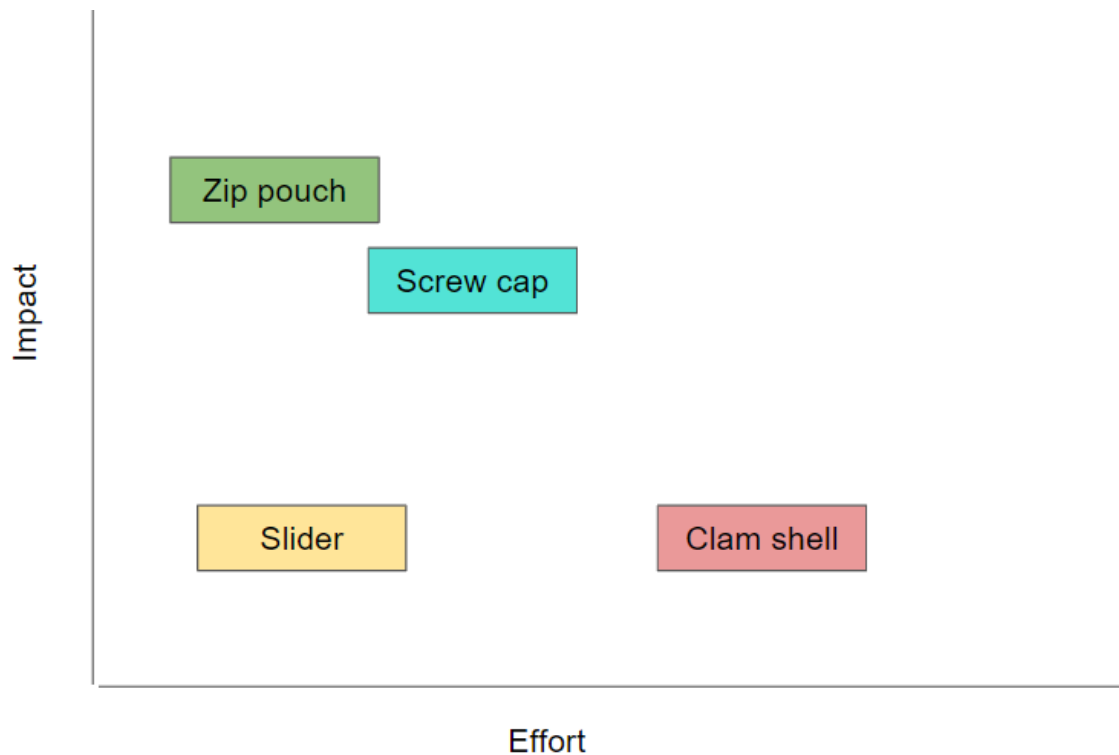


9.Score the concepts for a pencil holder. How would you attack this problem using a combination of tools like the PUGH chart and prioritization matrix to communicate to engineering management about a product development plan to undertake.

| Criteria | Weights | Zip Pouch | Clam Shell | Screw Cap | Slider |
|----------------|---------|-----------|------------|-----------|--------|
| Ease of Use | 4 | + | + | -- | + |
| Durability | 3 | ++ | S | + | - |
| Secure Closing | 3 | ++ | - | ++ | - |
| Size | 2 | + | - | S | + |
| Total + | X | 18 | 4 | 9 | 6 |
| Total - | X | 0 | 5 | 8 | 6 |
| Score | X | 18 | -1 | 1 | 0 |

Looking at the Pugh chart we can see that there is a clear winner being the zip pouch because of its excellent durability, size, closure mechanism, and ease of use. When compared to the other options the zip pouch is much more practical and useful to manufacture as the clam shell design may open up inside of a bag, and when opened it can only hold half the amount of pencils. The screw cap is not as easy to use because it has a cap that you will have to screw and unscrew and if it tips over all your pencils will fall out. The slider pencil case is typically the cheapest out of the all as they are typically made of two flimsy boxes of plastic which have very low durability. It has a large capacity for pencils however it can easily slide

open without a snap button securing it closed.



If you look at the graph above we can see that a zip pouch has the lowest effort in manufacturing with its simple zipper and bag design. Based on the pugh chart we see it has the highest impact than the other designs. This places the zip pouch at the highest priority. The worst option would be the clam shell as it will be harder to manufacture with its two pieces being joined together and possibly needing magnets or a clipping system, and it has a low impact as it scored the lowest in the pugh chart. The screw cap is a top contender to the zip pouch but still does not yield as much of an impact as the zip pouch and has slightly more effort when considering the manufacturing of a cap that threads perfectly into the other piece.

10. The executive board at Rockstar Video Game Entertainment is debating if they should make a version of Mafia V available for a MacOS platform which can be sold at a higher price as these users have more expendable cash for luxury items. The NPV for the PC platform was \$274M after 4 years of commercial launch. The marketing department provided the following data in the spreadsheet below. You are the lead software engineer and you are worried about

overloading your programming resources and are staying up too late at night ejecting concentration. Is it worth engineering a new MacOS platform? To answer the questions, derive an NPV incorporating a valuation spreadsheet using the risk profile for software development found in the chart shown in class.

| | YEAR | | | | | |
|---------------------------|--------------|-------------|-------------|-------------|-------------|-------------|
| Market Data | 0 | 1 | 2 | 3 | 4 | 5 |
| Number of MacOS Users | 97,230,242 | 99,631,009 | 101,082,223 | 105,008,212 | 103,091,001 | 101,089,334 |
| Number of MacOS Gamers | 1,740,421 | 1,783,395 | 1,809,372 | 1,879,647 | 1,845,329 | 1,809,499 |
| Number of GTA enthusiasts | 1,688,209 | 1,729,893 | 1,755,091 | 1,823,258 | 1,789,969 | 1,755,214 |
| | | | | | | |
| Game Sales | | | | | | |
| Units Sold | 0 | 1,712,594 | 1,737,540 | 1,805,025 | 1,772,069 | 1,737,662 |
| Unit Price | \$0.00 | \$109 | \$109 | \$89 | \$69 | \$39 |
| | | | | | | |
| Development Cost | | | | | | |
| Programming | \$10,000,000 | \$2,100,000 | 0 | 0 | 0 | 0 |
| Testing | \$2,500,000 | \$500,000 | 0 | 0 | 0 | 0 |
| Pilots | \$6,000,000 | \$1,400,000 | 0 | 0 | 0 | 0 |
| | | | | | | |
| Marketing Costs | | | | | | |
| Boxes | | \$3,400,000 | \$3,658,000 | \$3,012,899 | \$2,800,111 | \$1,998,339 |
| Online Distribution | | \$2,900,000 | \$2,900,000 | \$2,900,000 | \$2,900,000 | \$2,900,000 |
| Server Provider | | \$699,000 | \$699,000 | \$699,000 | \$699,000 | \$699,000 |

$$N_0 = -10,000,000 - 2,500,000 - 6,000,000 = -18,500,000$$

$$N_1 = 1,712,594 * 109 = 186,672,746 - 2,100,000 - 500,000 - 1,400,000 - 3,400,000 - 2,900,000 - 699,000 = 175,673,746$$

$$N_2 = 1,737,540 * 109 = 189,391,860 - 3,658,000 - 2,900,000 - 699,000 = 182,134,860$$

$$N_3 = 1,805,025 * 89 = 160,647,225 - 3,012,899 - 2,900,000 - 699,000 = 154,035,326$$

$$N_4 = 1,772,069 * 69 = 122,272,761 - 2,800,111 - 2,900,000 - 699,000 = 115,873,650$$

$$N_5 = 1,737,662 * 39 = 67,768,818 - 1,998,339 - 2,900,000 - 699,000 = 62,171,479$$

Current US discount rate = 5.50 %

$$NPV = -18,500,000 + 175,673,746/(1+0.055)^1 + 182,134,860/(1+0.055)^2 + 154,035,326/(1+0.055)^3 + 115,873,650/(1+0.055)^4 + 62,171,479/(1+0.055)^5 =$$

\$583,938,177.19

After four years after the initial investment the NPV for the MacOS platform is around 583M dollars. The PC Platform had a 274M dollar NPV and looking at NPV alone I would say it is worth investing the time to develop the software. The risks we are looking at would be a low demand of the product with having issues and delays in the development phase. In the first year of commercial launch we are estimated to make back the initial investment, and the return on investment is at around 3000 percent, so I would determine it to be a low risk to develop the software even with any setbacks.