Compact Cable Case

Phase 2 Progress Report

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Designed Specialized Operations

ME 263 - Section 127

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Executive Summary

The purpose of this report is to prepare information regarding the problem Designed Specialized Operations took steps on how to solve, in accordance with research gathered for the problem. DSO. saw a prevalent issue that many people face in their everyday lives and routines that could be improved quite easily. The problem that DSO. chose to improve on is the transportation of cords, whether for computers, phones, calculators, etc. and the complications that come with tangling and portability when you need to take them somewhere. The second phase of this project includes new avenues of analysis that will be discussed in this executive summary and subsequent areas of the report.

The first step in phase two dealt with generating concepts. Utilizing function decomposition, a diagram of the main functions (the subsets of the ‘primary function’) along with sub functions was created and from there a morphological chart was made. This is the initial brainstorming that DSO used to base more physical designs on. Ultimately, a total of fifteen different designs were created from the morphological chart. With each design containing unique characteristics incorporated from primary and sub functions the overall design that Designed Specialized Operations has in sight can be visualized more clearly in this step.

The second task for phase two includes the Bill of Materials, primarily based on the final design found from the analysis of the functional decomposition and the chosen design from the morphological chart. Using the final design and part models, a Bill of Materials was created along with detailing the manufacturing process of the product and its subcomponents. The main focus of the BOM is to outline the cost per part that DSO expects to have when fabricating and constructing the final design in order to give a metric to base success on. One important aspect of this was where the required purchased parts were coming from. Vendors such as McMaster Carr were used to gauge prices for many parts of the design. As for the assembly done by DSO, this entails 3D printing and the physical construction. The BOM outlines the cost of the assembly to be simply the assembled parts which include the exterior casing. The cost per cubic inch of PLA filament that the printers use along with the exact cubic volume from CAD modeling that our design is can both be used to determine the assembly costs.

The final aspect of phase two involved the examination of finances that DSO will see from the business perspective of product design. This includes direct labor, manufacturing, research and development, and retail costs. A fifteen quarter economic projection was done applying conclusions about break even points, returns of investment, and other important financial points. Each main section; Costs Associated with Direct Labor, Assumptions for Project Economic Analysis and the Project Economic Evaluation Spreadsheet and Graphs, all contain essential data for DSO to market and evaluate future phases of production. The Project Economic Evaluation (Appendix B) included a spreadsheet that detailed numerous amounts of production inputs such as annual production, tooling and fixture costs, the assembly costs previously mentioned, and many more that all factor into the fifteen quarter projections. Also contained in this phase are the break even point, return on investment, rate of return, and other key financial points that are indispensable when performing evaluations.

The exploration done by Designed Specialized Operations found that the market for a solution exists and is interested in designing, testing, and presenting a device meeting customer needs. The physical size and shape this product will take will resemble a tape measure and the main advantages it will have over other products already in the market are the portability of the device, the ease of use by the consumer, and the versatility of the different types of cables that can be used for the application of the design. These aspects, along with others, set DSO's product apart from market competitors.

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Introduction

The purpose of this report is to outline the main method of concept generation used in phase two of DSO's design process. The sections of this report are split up to create a holistic review of the progression to the problem of the Compact Cable Case.

These sections will include the initial concept generation tactics; brainstorming, functional decomposition, and utilizing a morphological analysis to create designs from ideation. Following the generation of concepts, the top four will be overviewed in further detail along with the primary concept and what it entails. A comparison of this will be done from that off phase two with what was previously constructed in phase one and applying concepts of benchmarks.

The Bill of Materials is one of the most important parts of the second phase and this section will include the purchased parts, custom manufactured parts, and assembly parts needed for the design as well as, the quantity of each item required for the design.

The economic analysis will take another section of this report to outline the net worth diagrams for the upper and lower estimated quantities in terms of production costs. Other main aspects that the economic analysis will discuss are the break even point, rate of return, and the return on investment.

The penultimate section of the report is the project scheduling for the future of product design is outlined and shown in the form of a Gantt chart (Appendix F). This is to help the team stay on track and organized while finalizing deliverables, holding any necessary team meetings (case to case basis), or other scheduling concerns for DSO.

Lastly, the final conclusion and remarks for the report and overall second phase of this project will be made.

Problem Definition

While Designed Specialized Operations has gone through phase 2 of the design process, there have been no changes made to the problem definition. It remains unchanged from phase 1, as the idea and scope of the project is the same. That being said, the problem definition is as follows.

Designed Specialized Operations is to design a product for cable organization for individuals who own technology devices which will feature compact, non-tangling cable storage and portability. The target consumer audience is anyone owning a technology device such as a phone, tablet, computer, or anything else requiring cable charging.

People who own technology devices often run into problems with their charging cables getting disorganized, tangled, or even ruined. From a survey distributed by Designed Specialized Operations, it was found that 91.9% of people with tech devices deal with these problems on a regular basis (figure 2). From talking directly to a few survey takers, they described their frustration with chargers being cluttered on the floor and getting tangles in their chargers when commuting with them. The takeaway that DSO. took from these conversations and the survey results was that a product needs to be designed to conveniently organize any cable of choice while being both portable and hard to lose.

Currently, consumers solve the problem of cable disorganization with many different solutions, one of the most prevalent being small cable hook guidelines. Another common solution when taking into account the portability of cables is retractable chargers. However, these solutions have their gaps. Cable hooks are a more temporary solution for when consumers hope there will be a better product on the market, which is what DSO. intends to make. The retractable charger products currently on the market are the inspiration for the product being designed by DSO. However, these retractable chargers are cheaply made, ineffective at charging, and non-durable. DSO. looks to use the concept of this product to design a much better quality, more durable, and more universal product.

The product being designed by DSO. is supposed to be universal to whatever cable is being used. The Compact Cable Case is to function similar to a tape measure, such that the cable will remain organized inside its casing until required use. Then, the consumer can pull out the desired length of cable for use. When finished with use, the consumer can let the cable retract back into the casing. There will be a carabiner attached to the casing of the product so it is easy for consumers to take with them on the go. Depending on what cable is being used, the consumer can open the casing and change out the cable to their choice.

Through different types of research, DSO. has come up with the most important customer requirements. These include being low cost, durable, portable, adjustable, aesthetic, ergonomic, and accessible. The engineering requirements associated with the customer requirements can be found in the House of Quality in Appendix A. From these engineering requirements, DSO. aims to make the solution under 100in^3 in volume, hard to break, able to fit up to 0.5in diameter cables, less than 24 ounces, and priced at or under $20.

In their survey administered, DSO. found that consumers would be most willing to pay for a product priced between $10 and $20. Through further research, DSO. discovered that in 2018, 69.6% of the US population has a smartphone [1]. This is equivalent to approximately 227 million people just in regards to one sector of usability for the product being designed [2]. From this number, a reasonable estimate for yearly sales would be 227 thousand units sold. DSO. thinks they can reach 0.1% of the population in the US due to the newness of the product and the fact that human nature likes to stick with what they know works.

Concept Generation

The entire idea of phase 2 of the design process is to start the product design and development. The first step in all of this is brainstorming. This is where concept generation starts. The process through the design was that each member of DSO was to create as many different designs as possible. This gave way to creative development and a multitude of choices for the final design. While this was the brainstorming process, let’s delve into what was being brainstormed.

Designed Specialized Organization was tasked with creating a functional decomposition diagram, as seen in Appendix C. The purpose of this diagram is to give a rough overview of the functions of the compact cable case. It’s designed like a tree; at the top is the trunk, the actual product itself. The product then branches into 3 main functions: portability, cabling, and replaceability. Portability regards how well the product travels, while cabling details the mechanisms (retraction, winding, and locking) of the cable and replaceability covers the ability to change out cables in the product.

While these are the main functions of the product, they don’t give too much design insight because there are sub-components to each function. Because of this, sub-functions were derived from each main function and can be seen on the diagram. Going left to right, let’s start with the portability function. This is broken into the sub-functions of its shape, adherence to surfaces, and clipping. The shape can affect how this product is able to fit in pockets and bags, which is a large portion of portability. Along with this, the adherence of the product will make it travel well if it can stick to any desired surface. Lastly, the clipping function describes something such as a carabiner or a key ring, which allows the product to clip to pants, bags, or other materials that are being traveled with. Having a clip would greatly increase the portability of the product.

Next is the cabling function. This function was broken down into the retraction/winding mechanism, the locking mechanism, and the tangle free mechanism. The retraction/winding mechanism is exactly what it seems: some sort of material or device that winds the cable back into the casing exactly like a tape measure. The locking mechanism covers the locking of the extended cable, which is also identical to a tape measure. Lastly, the tangle free mechanism is the component inside the product that keeps the cable from getting tangled on itself. These three sub-functions are all based on how the cable is meant to work, hence why they were derived from the cabling function.

Lastly, there is the replaceability function which consists of the opening/closing and loading/unloading sub-functions. The opening/closing sub-function is in regards to how the casing of the product is opened and closed. This is obviously how the user is able to get to the cable to replace it. The loading/unloading sub-function covers how exactly the cable will be taken out and put back in.

With the functional decomposition diagram made, this allowed DSO to be able to create a morphological diagram. Each sub-function from the functional decomposition diagram was turned into a component of the product. With these functions identified, each member of DSO brainstormed at least one design for each function. This opened the door to many unique designs for the product's functionality. The morphological chart created can be seen in Appendix D.

Looking specifically at each sub-function, first comes the shape. Four individual shapes were designed for the product: there is a square, circle, triangle, and hexagon. The next sub-function is the surface adherence. The three methods to achieve this were brainstormed as magnets, suction, and tape. Moving on to the clipping sub-function, this only consisted of two designs, being a press-fit and carabiner. Next sub-function was the retraction/winding mechanism, which was brainstormed as being a wind up arm or a button. After this sub-function is the locking mechanism. This consists of magnets, a rubber stopper, a locking pad, and an internal lock. The next sub-function is the opening/closing of the casing. The four ways brainstormed to do this include screwing the caps, clipping the caps, having hinges, and a pin and slide lock. Moving on to the tangle-free mechanism, the three designs for this include grooves, a wheel, and tubing. The last sub-function detailed in the morphological chart is the loading/unloading of the cable. This is detailed by three designs, including a bearing fit for the cable, a pin to loop the cable around, and a yin-yang to wrap the cable around.

Concept Selection

The team generated a multitude of concepts to meet predetermined design constraints and customer requirements. The top four designs were selected based on various criteria including simplicity and functionality.

The first of these four designs, as seen below in Figure 1, entailed a square casing with a press fit belt clip and a magnetic case. This allows the product to be very portable and hard to lose. Users can take advantage of magnetic surfaces to stick the product to and use the belt clip to keep it conveniently close to them at all times. This meets our requirement for portability and accessibility. Furthermore, a bearing fit design is employed to allow the cable to unwind smoothly about the central axis. This mechanism also keeps the cable locked so that it doesn't slip around when the retraction occurs. A handle is connected to this subcomponent to allow the user to wind up the cable. A magnetic clamp lock is used to “save” the position of the extended cable and lock it in place. It is released during the retraction and extension process to avoid friction. The loading and unloading of the cable, also known as the replacement process, is made possible by the case being openable. This exposes the inner components and the loading chamber for the cable - a grooved cylinder to direct the cable. A clip lock is used to secure the top and bottom case together.

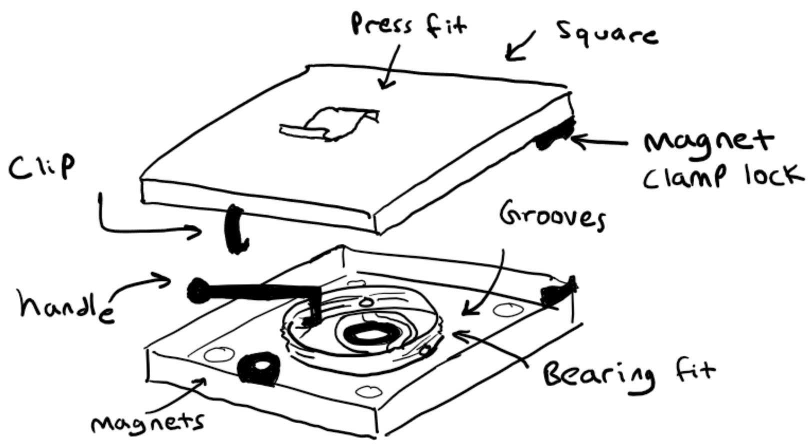

Figure 1: First chosen concept design; Concept 1

The second design that DSO chose, as seen below in Figure 2, consists of a circular casing with a carabiner and a rubber suction cup to solve the portability and accessibility issues. Like the previous design, a handle is used to wind up the cable. The cable length is controlled by a rubber stopper that pinches the cable and employs friction to “lock” a length in place. Releasing this will allow the user to smoothly wind/unwind the cable. It is wrapped around a yin-yang design and rests on a wheel to keep the cable controlled and intact with the casing. The casing detaches from its lower half to allow the user to load and remove the cable when they would like to swap it out. This is made possible with a slide lock; this allows the user to easily twist and remove the casing to separate the two halves.

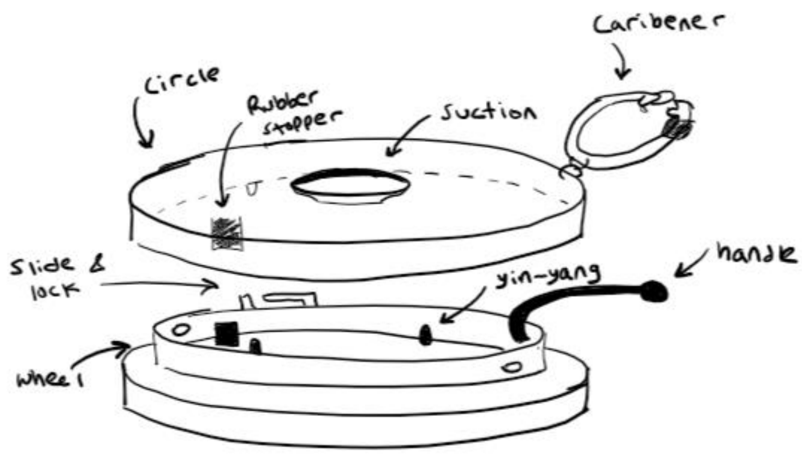

Figure 2: Second chosen concept design; Concept 2

The next design that DSO chose is another circular casing that disassembles from a simple twisting motion and is reconnected by screwing onto grooves that surround the inner components. The inner components consist of many of the same features as those in Concept 2 such as a rubber stopper, a yin-yang and wheel cable housing, and a carabiner. The primary difference in this design is leveraging a push-stop button that entails a spring-loaded recoil feature as opposed to a manual wind-up handle. Furthermore, the outer surface is made magnetic to improve surface adherence in contrast to a suction mount.

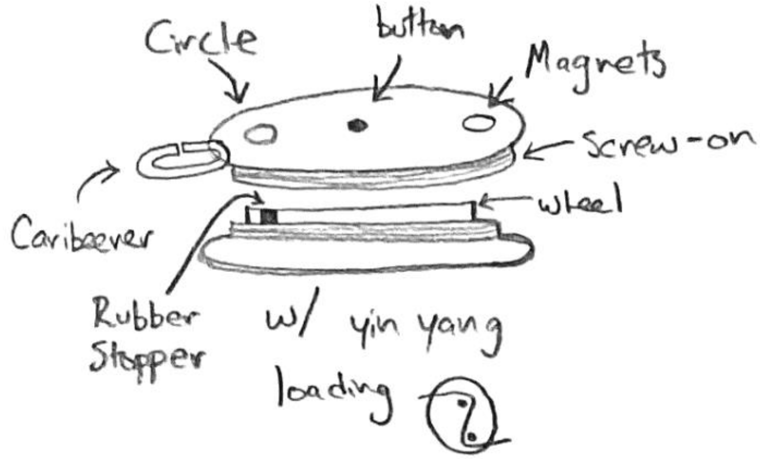

Figure 3: Third chosen concept design; Concept 3

The final design chosen by the team employed many of the aforementioned features including a circular casing, a carabiner and suction mount for portability and accessibility purposes, and a spring-loaded mechanism controlled by a push-stop button. The key difference in this design is using a wheel/bearing design as opposed to a yin-yang cable housing. Furthermore, a pin-slide lock was used instead of a threaded casing. Lastly, a locking pad was employed to simulate a press-fit friction lock to control the length of the extended cable.

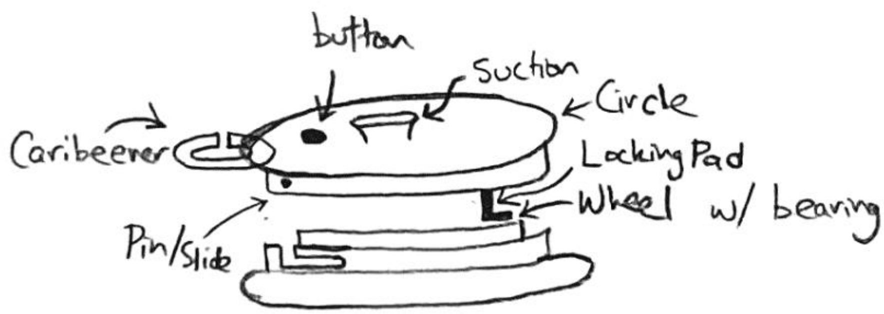

Figure 4: Final concept design; Concept 4

Primary Concept Description

Following careful review of the top four designs, the team evaluated the ease of manufacturability, approximate costs, efficiency, functionality, and customer requirement satisfaction associated with each design. A slightly altered version of Concept 3, as seen in Figure 3, was chosen as the primary concept design that met all engineering specifications and customer requirements.

As seen below in Figure 5, the concept of a push-stop button was removed for simplicity purposes. Instead, the team decided that a spring loaded wheel, that houses the cable, will create a natural retraction function and thus a button need not exist in the design. To control the retraction, a rubber stopper will be used. A tape measure's retraction abilities are analogous to this design. Furthermore, the team decided that a carabiner offers more flexibility than a belt clip and thus should be included. Similarly, a suction cup will allow adherence to all surfaces, even magnetic ones, and thus is more favorable than a magnetic casing. Moreover, it can also be seen that the perimeter surface is threaded to allow the casings to screw onto each other.

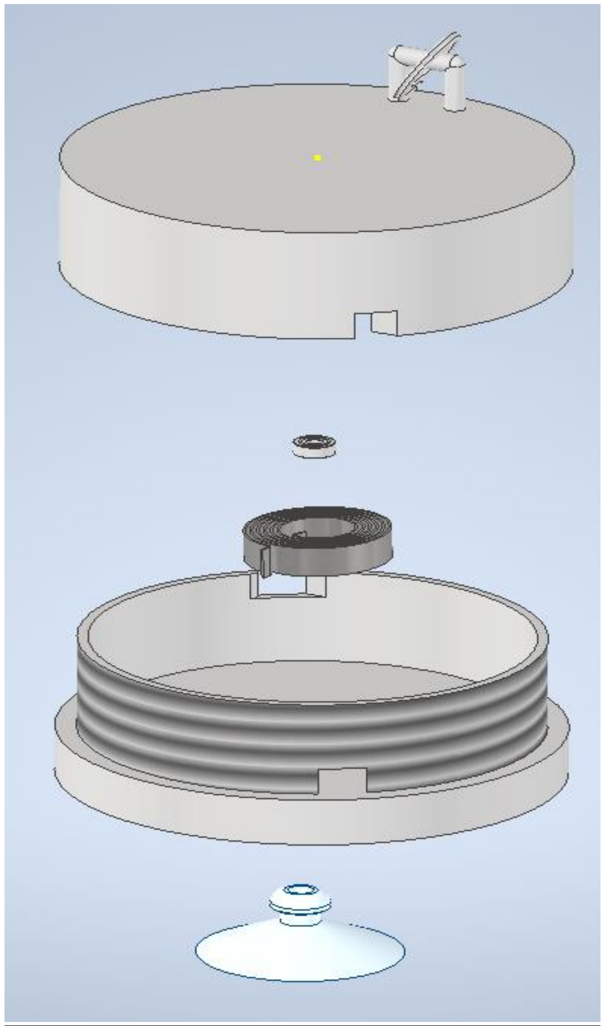

Figure 5: Primary Concept Design

As seen in the drawing below in Figure 6, the internal components consist of a circular spring, a bearing, and a yin-yang design. The bearing was included to prevent friction between the wheel housing and the cable. Press fitting a cable housing onto the bearing will allow the part to spin freely about the bearing. Since this feature is mounted to a bearing, and since the bearing will be connected to the spring, the cable housing will have tensioned rotational motion. This will essentially create a spring loaded retraction system for the cable. The cable is threaded through the circular cable housing under the yin-yang mechanism to allow it to be secured and constrained to the motion of the cable housing.

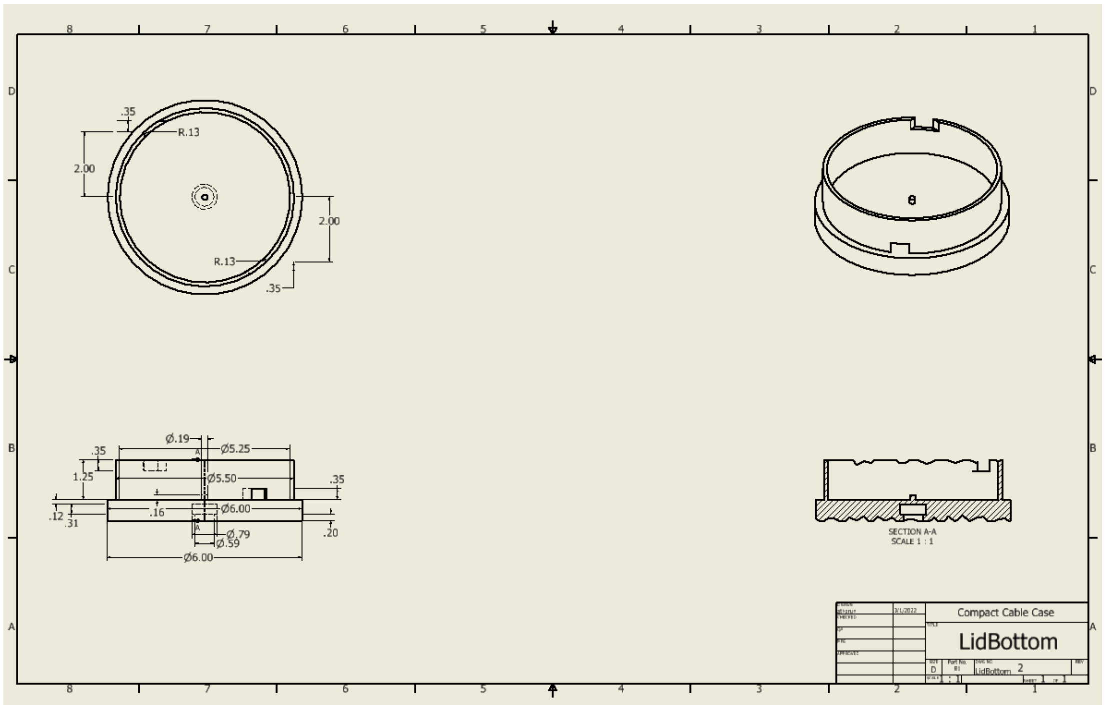

Figure 6: Primary Concept Design Bottom Casing Drawing

Bill of Materials

With a primary design in place, Designed Specialized Operations can then use the design to come up with a bill of materials. This details the parts to be made and bought, covering their costs from suppliers. These suppliers included technical wholesalers such as AliExpress, McMaster Carr, and Service Net. The bill of materials will then be used later for financial purposes.

This first group of parts to be covered will be the purchased parts. These make up everything but the exterior casing of the product: this includes the suction cup, key ring, slide lock, rubber pad, spring loaded wheel, and bearing. As seen by the design provided in Appendix E, DSO will be using 1 suction cup and 1 bearing in their design of the Compact Cable Case. These are both sourced from AliExpress, and will cost $0.02 per suction cup and $0.23 per bearing. Similar to the suction cup and bearing, there is 1 key ring included in the design. The key ring will be sourced from McMaster Carr and costs $0.08 per unit. Along with these previous parts, there is 1 slide lock included in the design for DSO. This slide lock is sourced from Service Net and will cost $1.04 per unit. While these previous parts all have a single quantity, the next two parts are used in the design based on dimension. The first of the two is the rubber pad. There will be 0.5 squared inches of area used of rubber per product, costing $0.04 per unit. The other part used based on dimension is the spring loaded wheel. A length of 60 inches is used in the design of the Compact Cable Case, and therefore will cost $3.48 per product. Both of these previously mentioned products are sourced from AliExpress.

With the purchased parts detailed, this leaves the custom manufactured parts to be covered. The two parts of the Compact Cable Case to be custom made by DSO include the top case and the bottom case of the product. These will each be 3D printed. The volume of the top case is 12.728 cubic inches, which equates to a cost of $2.39. The bottom casing has a volume of 20.185 cubic inches with a cost of $3.78. These parts will be made of PLA filament.

The only type of assembly part being used would be glue. The entire product would be put together by tight fits and glue, so these costs are not thrown into the bill of materials, but rather the financial analysis. The overall cost of manufacturing the Compact Cable Case is $11.06, with an expected retail of $19.99 leaving a profit margin of $8.93 per product.

Economic Analysis

The economic analysis performed by DSO can be examined by looking at four different areas of interest; net worth diagrams, the break even point, rate of return, and the return on investment.

Net worth correlates to the total value of assets a corporation, in this case; DSO, owns without considering liabilities. The net worth diagrams in Appendix B show the projected net worth for DSO over a fifteen quarter period. One includes interest and shows the raw values whereas another accounts for interest and gives a more realistic conjecture.

The break even point refers to the time required for the profits from sales to equal the investment costs. There are many elements that affect when this happens, some include the annual production, production costs, and retail prices. DSO saw their break even point around the fourth quarter (Appendix B).

Rate of return (ROR) is the interest rate that makes the net present value of cash flows zero. It is desired for the ROR to be greater than the expected interest rate and allow the project to make money but this requires an estimate of the cash flow over the predicted life of the venture. Utilized the “Goal-seek” function in excel the estimated ROR that Designed Specialized Operations came to was a value of 504.16% (Appendix B) which is greater than the annual interest rate.

Lastly, return on investment (ROI) is the percent return on an investment per year which essentially helps you understand how much profit or loss your investment has earned. The investment for DSO is represented by the capital investment costs that are paid in order to bring the product to market. The goal is to maximize the return on that investment and the value DSO came to can also be seen in Appendix B.

Project Scheduling

To ensure the product was developed in a timely manner, Design Specialized Operations (DSO) divided the project into three phases - each with a distinct goal in mind. The first phase focused on brainstorming, while the second and third phases focused on modeling and prototyping respectively.

The main goal of Phase 1 was to develop and design a problem statement that needed to be answered. After weeks of brainstorming, the team decided to design the Compact Cable Case. Next the team chose to survey the potential customers by asking them about features that they would like to see on the product as well as the targeted price they would be willing to pay for this product. The team summarized the general trends seen in the survey responses in the House Of Quality which can be seen in Appendix A. A summary of the Phase 1 scheduling can be seen in Appendix F.

As the team moved into Phase 2, the main goal was translating the customer's survey responses into ideas. DSO first completed a functional decomposition chart which can be seen in Appendix C. The team then used the ideas generated in this chart to design the elements seen in the Morphological Chart, which can be seen in Appendix D. DSO then used the ideas designed in the morphological chart to design 16 potential concepts. After further evaluation of how well each concept met the customer's requirements, the team finalized a single concept. A culmination of the team's efforts through this second phase can be seen in the exploded assembly design of the final concept (Appendix E). A summary of the Phase 2 Scheduling can be seen in Appendix F.

DSO's plan for Phase 3 is to begin designing and prototyping our Compact Cable Case. Throughout the rest of the project, the team will work relentlessly to modify and design the best

Compact Cable Case that is durable, accessible and portable, as reported in our House of Quality (HOQ). Throughout the first week, the team will design a low fidelity prototype. The team will use simple materials and align closely to the final concept design. The purpose of this model is to understand the strengths our design has while noticing the potential improvements that could be made. After designing the low fidelity model, DSO will spend another week thoroughly testing the model. First, the team will test each individual component to ensure they work as intended. If a component is seen to not work, the team will refer to alternatives found on the morphological chart. Once each component is thoroughly tested, the team will test the efficiency and the accuracy of the overall product. The team will analyze the durability, accessibility and portability of the product as those were the most valued aspects reported in the HOQ. As the team conducts these tests, they will note down any potential changes that could be made to better the design.

These improvements and results garnered from testing the low fidelity model will fuel the team's high fidelity model. The team will spend another week designing the high fidelity prototype. As the team designs this model, they will use the materials intended for the final product. The purpose of this model is to create a more finalized prototype that mirrors the product that will enter the market. Once again, the team will thoroughly test the high fidelity prototype. The team will spend the remaining 2 weeks conducting these tests. First, the team will inspect the durability of all the materials and the efficiency of the cable retraction mechanics. Next, the team will focus on testing the suction mechanisms on the product. Finally, the team will conclude testing by testing the overall efficiency of the product. Overall, the team has an organized and detailed plan for the third phase which will help them stay on track and successfully design the project. The Gantt chart for Phase 3 can be seen in Appendix F.

Conclusions and Recommendations

Overall, the problem definition remained the same as the first phase - Designed Specialized Operations is to design a product for cable organization for individuals who own technology devices which will feature compact, non-tangling cable storage and portability. Throughout the first two phases, the team has primarily focused on developing a problem statement, conducting market studies and designing a concept that adheres to the trends discovered throughout the market research.

As the team began the second phase, the team's goal revolved around creating a successful design. The team first utilized a function decomposition to understand the base functions that the product must have. Then, every member created numerous designs for each internal element within the product, which allowed the team to have a multitude of options as they moved forward to finalize a concept. Next, utilizing the designs of individual internal elements previously created, each member designed a variety of full concepts. Then, the team came together and analyzed each concept to determine whether it could be successful. Eventually, using the standards received through our market surveys, the team finalized a singular concept. To help visualize this concept, DSO designed a 3-D exploded view using computer software.

DSO utilized a Bill of Materials to help track the expenses incurred throughout the project. The suppliers for DSO include technical wholesalers such as McMaster Carr, Service Net and AliExpress. The first group of parts include the parts that must be purchased for this product. These parts include the suction cup, key ring, slide lock, rubber pad, spring loaded wheel, and bearing, which total to $4.89. The second group of parts include the parts that must be custom made by the team. These parts include the top and bottom cases and total to $6.17.

The overall cost of manufacturing the Compact Cable Case is $11.06, with an expected retail of $19.99 leaving a profit margin of $8.93 per product.

The economic analysis performed by DSO examines many significant areas of interest; net worth diagrams, the break even point, rate of return, and the return on investment. The net worth diagram takes into account DSO as the single owner over a fifteen quarter period. As noted in the economic analysis, the break even point refers to when the profit from sales equals the investment cost. As shown in our analysis, the projected break even point is the fourth quarter. The rate of return (ROR) is the interest rate that makes the net present value of cash flows zero. Utilizing “Goal-seek” the team calculated DSO’s ROR to be 504.16%. Lastly, the return on investment (ROI) is the percent return per year on an investment. The calculated return on investment for Design Specialized Operations was 1148.15%, which shows a strong profit in the investment.

As the team wraps up Phase 2 and moves onto Phase 3, they will closely follow with their schedule to stay on track. The main goals for the third phase include creating two prototypes and thoroughly testing each one of them. As shown by the consumer surveys and economic analysis, an effective compact cable case is a well desired product. Design Specialized Operations has proven through economic analysis that the product is a strong return on investment, making it prime to succeed on the market. The team plans to work diligently to design a product that gives consumers what they want.

References

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Appendices

Appendix A: House of Quality

HOUSE OF QUALITY	Who (Customers)			Calculations		How (Engineering Specifications)						Calcs.	Now (Benchmarks)		
What (Customer Reqs.)	Travelers	Children	Students	Total Consumer Sum	Requirement Weight	Selling Price	Total Weight	Max cable Diameter	Ease of Use	Maximum Volume	Production Material	Totals	BeatBuddy Cable Organizer	Global Industrial Cable Retractor	PCNation Retractable Cable
						$	ounces	in	N/A	in^3	N/A				
						D	D	U	N/A	D	N/A				
Low Cost	2	1	3	6	9%	9	3	0	1	3	9	25	2	5	5
Durable	5	4	4	13	19%	1	3	1	1	3	9	18	1	1	3
Portable	5	3	5	13	19%	0	3	3	1	3	3	13	5	5	4
Adjustable	3	2	3	8	12%	1	1	9	3	9	0	23	4	3	2
Aesthetic	2	2	2	6	9%	1	0	1	3	3	3	11	1	2	2
Ergonomic (simple use)	3	5	2	10	14%	1	1	3	9	1	3	18	3	4	3
Accessiblity	4	5	4	13	19%	0	1	1	1	3	1	7	2	2	1
Totals	24	22	23	69	100%	13	12	18	19	25	28	115			
How vs What Calculations	Weighted Importance					0.167	0.167	0.167	0.167	0.167	0.167	1.000			
	% Importance					11.30%	10.43%	15.65%	16.52%	21.74%	24.35%	100.00%			
	Importance Ranking					1	6	3	2	4	5				
	BeatBuddy Cable Organizer					19.90	10	--	--	64.65	--				
	Global Industrial Cable Retractor					17.93	24	--	--	15.34	--				
	PCNation Retractable Cable					16.33	16	--	--	1.17	--				
	Performance Targets	Target (Delighted)				16	15	0.125-0.5	--	22	--				
		Threshold (Disgusted)				20	20	0.5	--	60	--				

Ratings Legends

Now vs What
1 = Reqt. not met
2 = Reqt. someetimes met
3 = Reqt. usually met
4 = Reqt. frequently met
5 = Reqt. fully met

Who vs What
User Scale: 0: low - 5: high

How vs What Correlation Strength
Values: (0, 1, 3, 9)

The House of Quality represents the culmination of market and customer research done by DSO. formulated in a graphical representation.

Appendix B: Project Economic Evaluation Spreadsheet

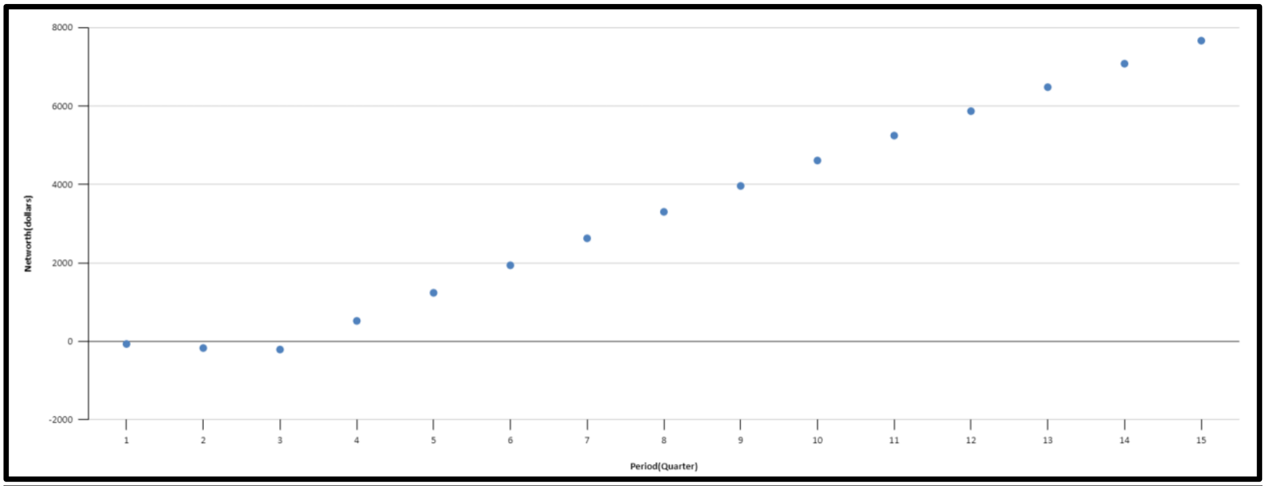
INPUT		
Interest Rate/ year=	8	%
Analysis Periods/ year=	4	#
Tooling and Fixtures=	80.85	(000)
Annual Production=	750	(000)
Estimated Cost of Purchased Parts=	4.89	$
Estimated Cost of Fabricated Parts=	6.17	$
Estimated Assembly Cost=	10	$
R&D Cost=	134.264(	(000)
Cost, % of Retail=	25	%
Return to Project, % of Retail=	30	%

CALCULATED			
Interest Rate per Period=	0.02	rate/period	
Estimated Mfg. Cost=	21.06		$
Retail Price=	84.24		$
Build per Period=	187.5	(000)	#
Total Program Build=	2250.00	(000)	#
Total Retail Sales=	189.54	(10^6)	$
Return to Project=	56.862	(10^6)	$
Net Present Value=	7662.9	(000)	$
No Interest Present Value=	9261.89	(000)	$

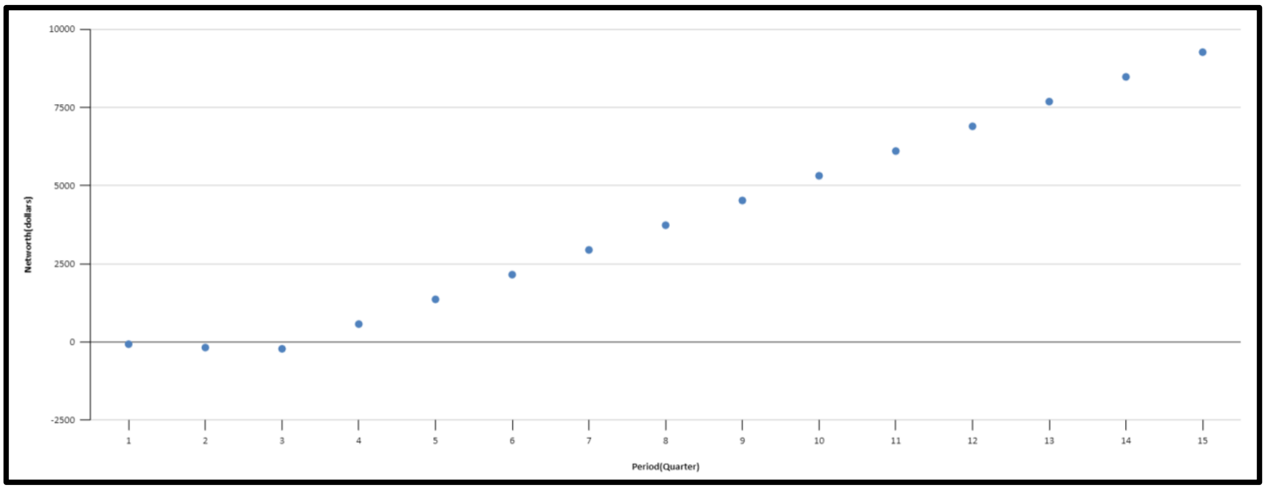
	Quarters																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Sum	
R&D Costs (000)	67.13	67.13	0	0	0	0	0	0	0	0	0	0	0	0	0	134.26	(000)
Tooling & Fixtures (000)	0	40.425	40.425	0	0	0	0	0	0	0	0	0	0	0	0	80.85	(000)
Production (000)	0	0	0	187.5	187.5	187.5	187.5	187.5	187.5	187.5	187.5	187.5	187.5	187.5	187.5	2250	(000)
Cost of Production (000)	0	0	0	3948.75	3948.75	3948.75	3948.75	3948.75	3948.75	3948.75	3948.75	3948.75	3948.75	3948.75	3948.75	47385	(000)
Plant "Sales" (000)	0	0	0	4738.5	4738.5	4738.5	4738.5	4738.5	4738.5	4738.5	4738.5	4738.5	4738.5	4738.5	4738.5	56862	(000)
Sales Minus Cost (000)	0	0	0	789.75	789.75	789.75	789.75	789.75	789.75	789.75	789.75	789.75	789.75	789.75	789.75	9477	(000)
Net For Quarter (000)	-67.13	-107.56	-40.425	789.75	789.75	789.75	789.75	789.75	789.75	789.75	789.75	789.75	789.75	789.75	789.75	9261.89	(000)
Net Worth (000)	-67.13	-174.69	-215.11	574.64	1364.39	2154.14	2943.89	3733.64	4523.39	5313.14	6102.89	6892.64	7682.39	8472.14	9261.89		(000)
Present Value	-65.8	-103.4	-38.1	729.6	715.3	701.3	687.5	674.0	660.8	647.9	635.2	622.7	610.5	598.5	586.8	7662.9	(000)
Net Worth Present Value (000)	-65.8	-169.2	-207.3	522.3	1237.6	1938.9	2626.4	3300.5	3961.3	4609.2	5244.3	5867.0	6477.5	7076.1	7662.9		

Break-Even Point	4th	quarter
NPV	7662.87	$ (000)
(ROI)	1148.15	%
(ROR)	504.16	%
Min Production Without Interest	17.02	(000)
Min Production With Interest	19.75	(000)

These figures show the estimated evaluation based on projected inputs for the 15 quarter term outlined in the given documents.

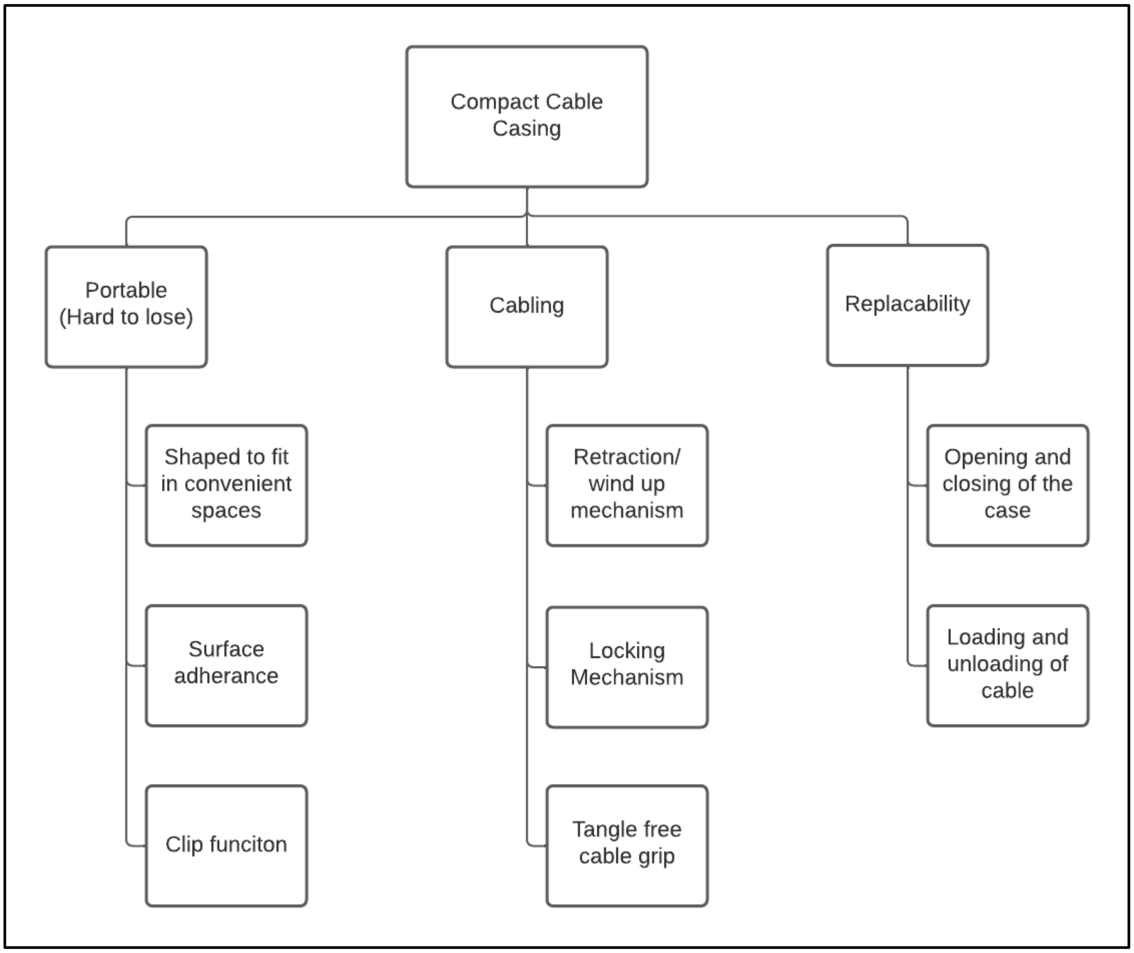


Net worth diagram with interest.



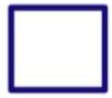
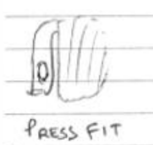
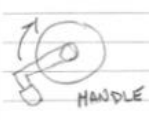
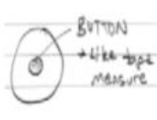
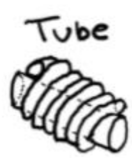
Net worth diagram without interest.

Appendix C: Functional Decomposition Diagram



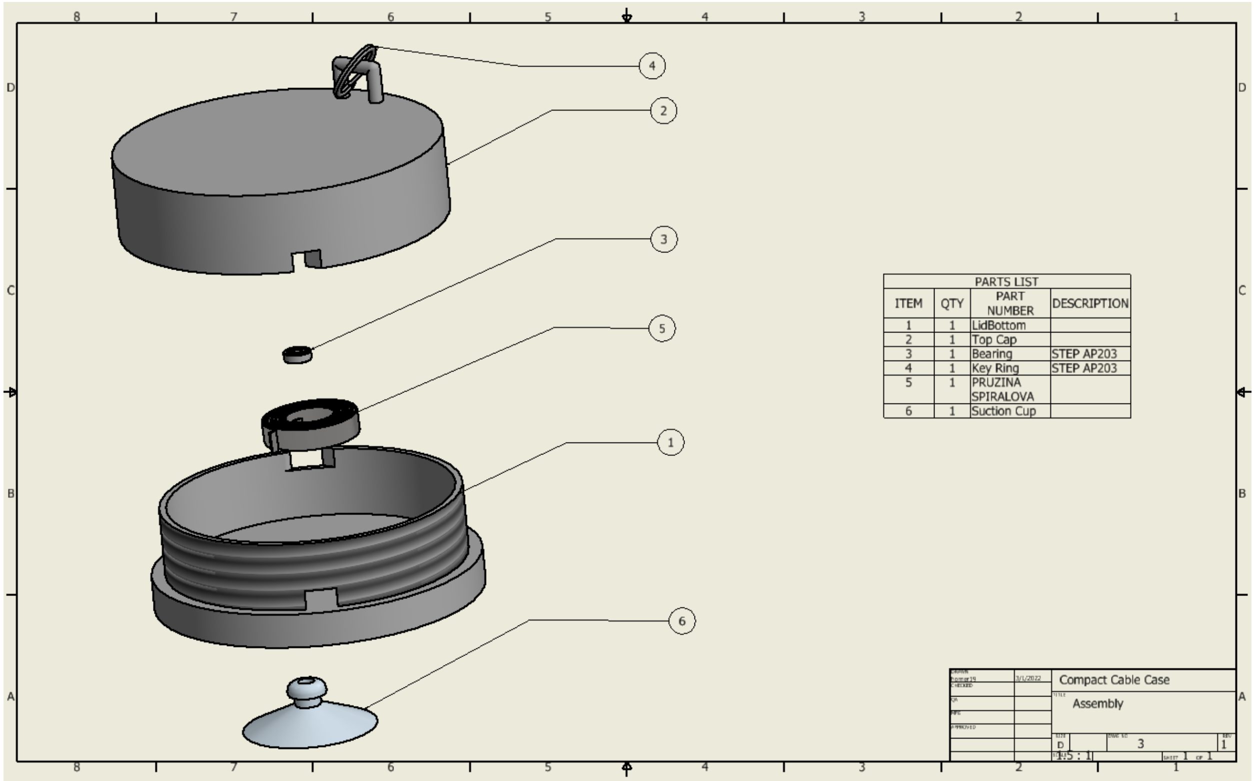
This is the functional decomposition diagram. It serves as a tree of functions and sub-functions. The three main functions include portability, cabling, and replaceability. There are multiple sub-functions for each primary function that branch off.

Appendix D: Morphological Chart

Product Sub-function	**1**	**2**	**3**	**4**
Shape (to Fit in Convenient Spaces)				
Surface Adherence				
Clip Function				
Retraction/ Wind Up mechanism				
Locking Mechanism				
Opening/Closing of the Case				
Tangle Free Cable Grip				
Loading and Unloading of the Cable				

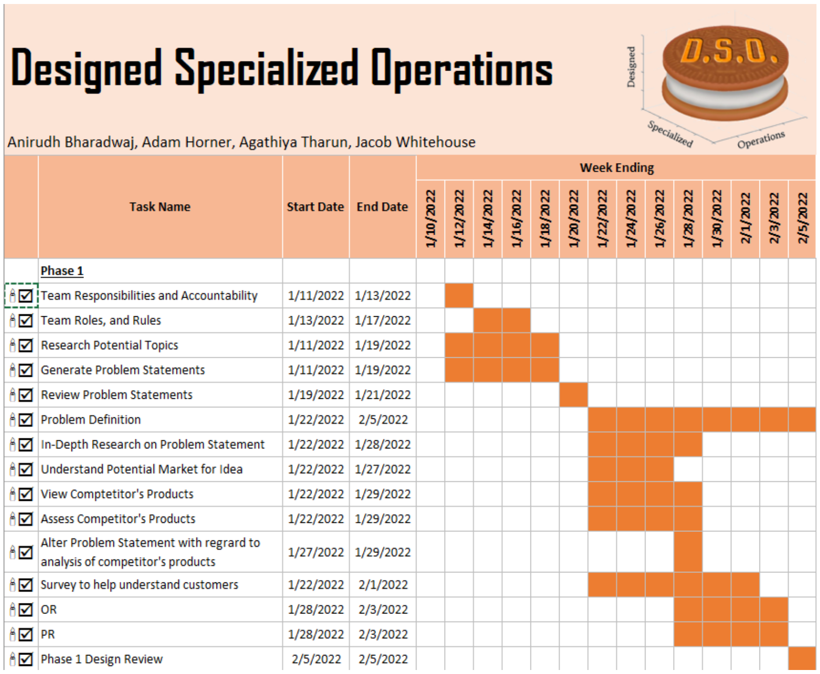
This is the morphological chart which details each sub-function and the design to accomplish each sub-function. One design from each row will be chosen to be implemented into the final design.

Appendix E: Exploded Assembly Design



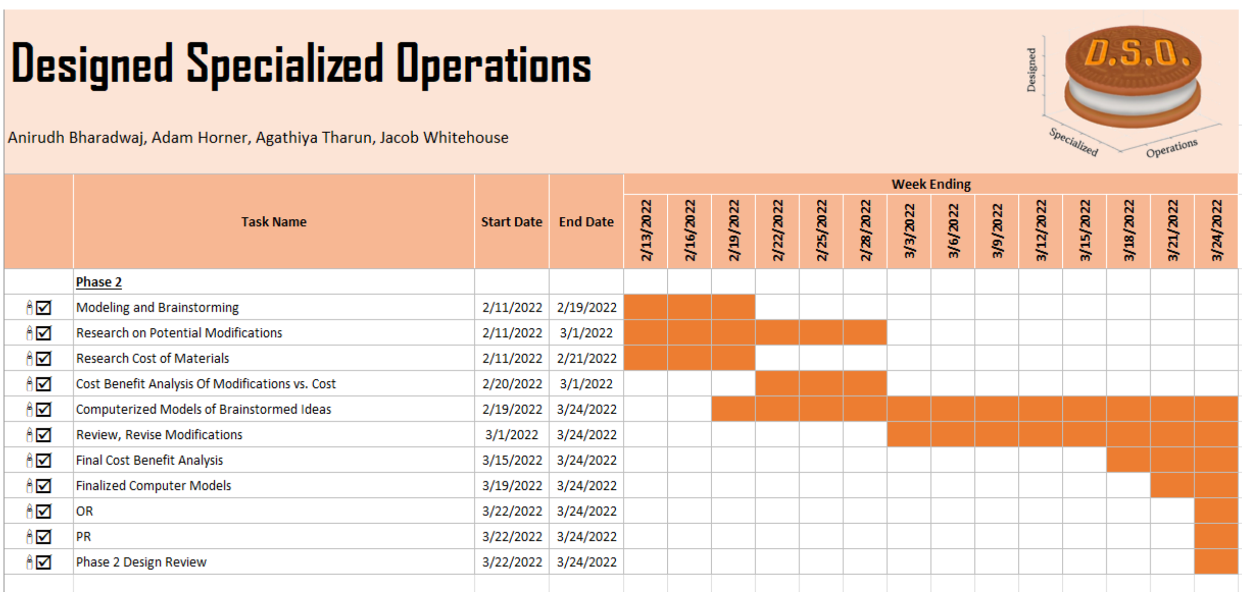
This figure details the final design of the Compact Cable Case and its components. These include exterior casing, a keyring, a bearing, a power spring, and a suction cup.

Appendix F: Gantt Charts



Task Name	Start Date	End Date
Phase 1		
Team Responsibilities and Accountability	1/11/2022	1/13/2022
Team Roles, and Rules	1/13/2022	1/17/2022
Research Potential Topics	1/11/2022	1/19/2022
Generate Problem Statements	1/11/2022	1/19/2022
Review Problem Statements	1/19/2022	1/21/2022
Problem Definition	1/22/2022	2/5/2022
In-Depth Research on Problem Statement	1/22/2022	1/28/2022
Understand Potential Market for Idea	1/22/2022	1/27/2022
View Comptetitor's Products	1/22/2022	1/29/2022
Assess Competitor's Products	1/22/2022	1/29/2022
Alter Problem Statement with regrard to analysis of competitor's products	1/27/2022	1/29/2022
Survey to help understand customers	1/22/2022	2/1/2022
OR	1/28/2022	2/3/2022
PR	1/28/2022	2/3/2022
Phase 1 Design Review	2/5/2022	2/5/2022

The Gantt chart is used for project planning and scheduling. This is the team's Gantt chart for the completed Phase 1.



Task Name	Start Date	End Date
Phase 2		
Modeling and Brainstorming	2/11/2022	2/19/2022
Research on Potential Modifications	2/11/2022	3/1/2022
Research Cost of Materials	2/11/2022	2/21/2022
Cost Benefit Analysis Of Modifications vs. Cost	2/20/2022	3/1/2022
Computerized Models of Brainstormed Ideas	2/19/2022	3/24/2022
Review, Revise Modifications	3/1/2022	3/24/2022
Final Cost Benefit Analysis	3/15/2022	3/24/2022
Finalized Computer Models	3/19/2022	3/24/2022
OR	3/22/2022	3/24/2022
PR	3/22/2022	3/24/2022
Phase 2 Design Review	3/22/2022	3/24/2022

This is our Gantt Chart for Phase 2. This is used to benchmark the team's progress.

Designed Specialized Operations

Anirudh Bharadwaj, Adam Horner, Agathiya Tharun, Jacob Whitehouse

	Task Name	Start Date	End Date	Week Ending													
				3/24/2022	3/27/2022	3/30/2022	4/2/2022	4/5/2022	4/8/2022	4/11/2022	4/14/2022	4/17/2022	4/20/2022	4/23/2022	4/26/2022	4/29/2022	5/2/2022
	Phase 3																
☐	Finalize Computer Model	3/24/2022	3/27/2022														
☐	Finalize Materials After Cost Benefit Analysis	3/24/2022	3/27/2022														
☐	Design Low Fidelity Prototype	3/24/2022	3/31/2022														
☐	Test Low Fidelity Prototype	4/1/2022	4/9/2022														
☐	Analyze Results from Tests	4/7/2022	4/10/2022														
☐	Design High Fidelity Prototype	4/8/2022	4/17/2022														
☐	Test High Fidelity Prototype	4/11/2022	4/28/2022														
☐	Use ME263 resoure to help enter then product on the market	3/27/2022	4/29/2022														
☐	OR	4/24/2022	4/28/2022														
☐	PR	4/24/2022	4/28/2022														
☐	Phase 3 Design Review	4/24/2022	4/28/2022														

This is our Gantt Chart for Phase 3. This is used to set the team's schedule and goals during this phase.