40-Quart Cooler Design Team

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Concept
Generation & Selection

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Contents

Introduction

This report addresses the design team's progress over the past few weeks in regards to generating potential design concepts and evaluating the potential performance of each one. During this process it was important to keep in mind the objectives of the project outlined in our problem statement and to refine our direction.

The needs of the client, Jason Costello, are wide and sweeping in nature. There were many possible directions that this capstone project could have focused its attention in. One of our jobs was to listen to his business needs and choose a direction in which we felt we could make the biggest and best impact on the business. Addressing the most pressing issues that are outlined in the needs identification report, the identification of the need was formed. The client desires a 40 quart sized ice chest that yields low uncertainties in the manufacturing process and provides the features and price that appeal to a wide range of customers.

Through thorough consideration of this need the goal of the project was identified and is stated as such. Produce a 40-quart cooler that shares quality and features with the best models in the market but at a reduced price. The challenge that the engineering team faces is to innovate the design of the cooler in such a way that it has minimal impact on the current MSRP of the 40-quart size.

From the beginning of this project the team has been discovering new ways in which we can maximize the efficiency of our designs to best fit Mr. Costello's business needs. Initially he was interested in the implementation of a quick access port for the cooler that would allow the user to access the contents of the chest without opening the entire lid and facilitating heat transfer. After some consideration, the team decided that this feature did not belong on the smaller 40-quart sized cooler. However this feature maintains a position in the design plans, as it will be implemented on 120-quart sizes and up in the future. Another discovery in the design process centers on the latch design. The team realized it would be more advantageous to design a latch the final designs are generated in CAD software. That was backwards compatible onto a wide range of coolers that all use the same latching system. This latch, dubbed the PM latch, will be overhauled to eliminate its unreliability and provide superior performance on all cooler types that use its configuration. The team will attempt to weed out all of the possible changes to the project definition before designs reach the final stage.

Concept Generation

2.1 Cooler A

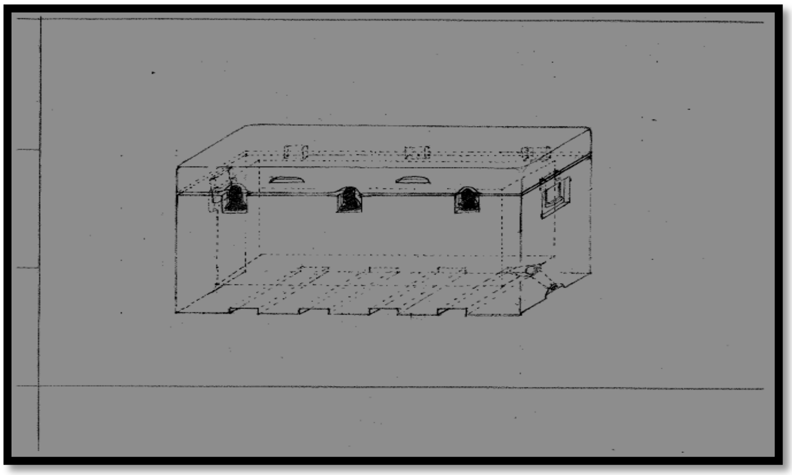


Figure 1 - Isometric view of design A

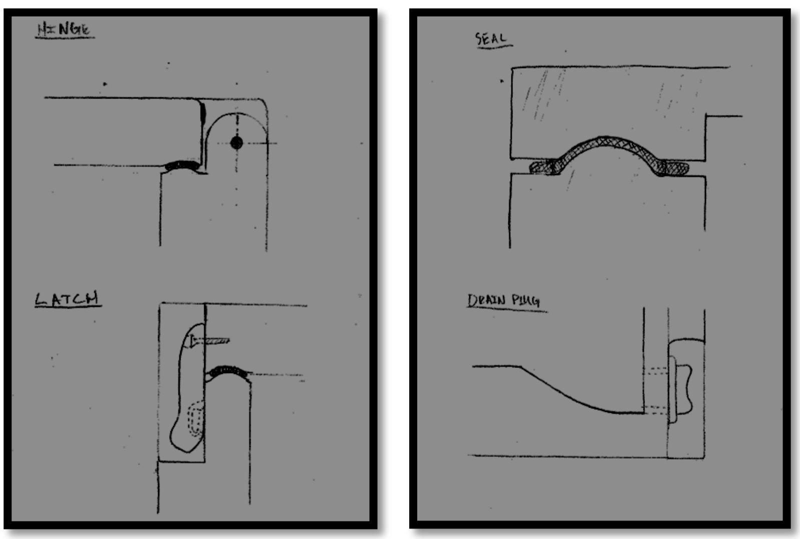


Figure 2 - Latch design (left), seal and drain plug design (right)

The design for this cooler consists of very simple elements and standard geometry (Figure 1). The purpose of this is to build a more refined design around. Should this be the chosen design, the dimensions can be easily changed as the design changes. The main hull of the cooler is designed to be near rectangular. This is to ensure maximum volume of the inside of the cooler and to promote easy heat transfer calculations through simple geometry.

Inside the hull is the drain plug, which is a standardized part. The drain plug will screw into a sleeve bolted to the outside of the hull and has a rubber seal around the perimeter (Figure 2). There will be a small scooped-in section on the floor of the inside of the hull to guide drain water out of the cooler with ease.

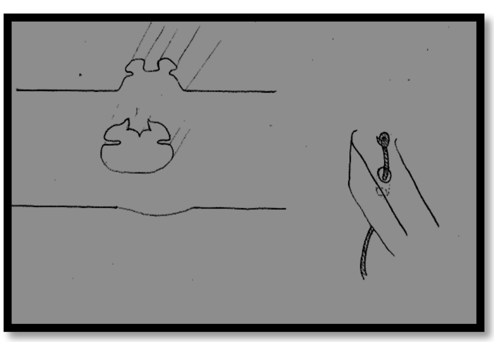
As for the seal between the hull and the lid, the design consists of a protruded, curved radius on the base that fits flush with a recessed radius on the lid. A piece of waterproof foam insulation covers the length of the ridge and runs around the perimeter of the space between the hull and the lid (Figure 2). This design ensures a near airtight seal, added cross sectional area to reduce heat transfer and possess no harsh edges.

The handles of the cooler are consistent for all three designs and consist of a rope-handle design. A nylon rope with a plastic handle threaded onto it ties or channels into the top of the hull. The handle also falls flat and flush against the hull. There will be clips on the hull to ensure restriction of movement when handles are not in use. The benefit of this handle design is that it is cheap, lightweight, strong, easily installed and easily replaceable.

The latch system consists of a rubber pull-down hook that affixes to the lid and pulls down onto a male joiner of the hull (Figure 2). This creates a force on the lid and causes the foam to squash down and create a strong seal. The latches fit flush into the cooler and are cheap and reliable.

2.2 Cooler B

Figure 3 - Isometric view for design B



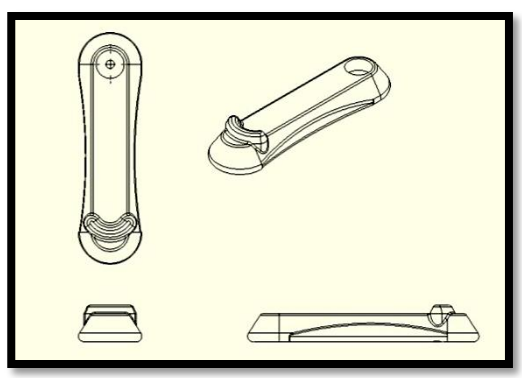


Figure 4 - Rubber design and lock-slot and hinges (left), latch design (right)

This cooler follows a different shape than the other two designs. It has tapered sides down towards the bottom. There is a lip around the top of the cooler. This is where the latches, handles, lock-slot and hinges fit flush into (Figure 4).

The seal for this cooler is similar to the last except that it is comprised of rubber and not foam. The molded rubber seal fits into a slot molded into the lid and pressed down into a grove around the perimeter of the space between the cooler and the lid.

The latch and handle system for this cooler is the same as Cooler A. One small difference is that the handles do not fall flush next to the hull; instead they hang down to the side of the hull (Figure 4). There can be plastic clips affixed to the hull to prevent hang-ups as well.This design also consists of a lock slot on the front. This is a small slot for a normal u-lock to slide into to lock the cooler. The design also has guides on the top for tie downs.

<u>Cooler C</u>

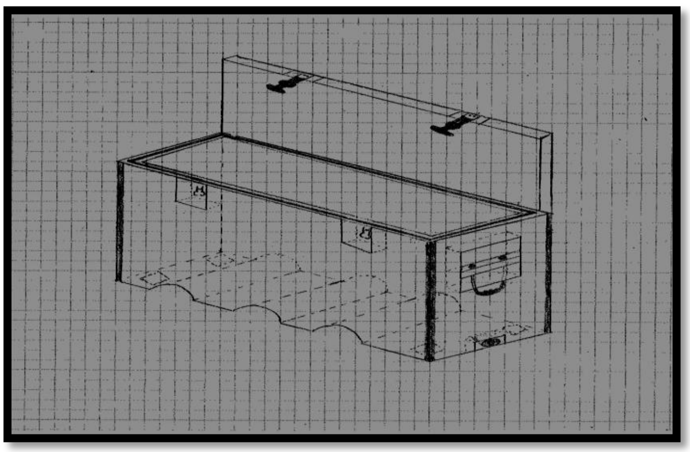


Figure 5 - Isometric view of design C

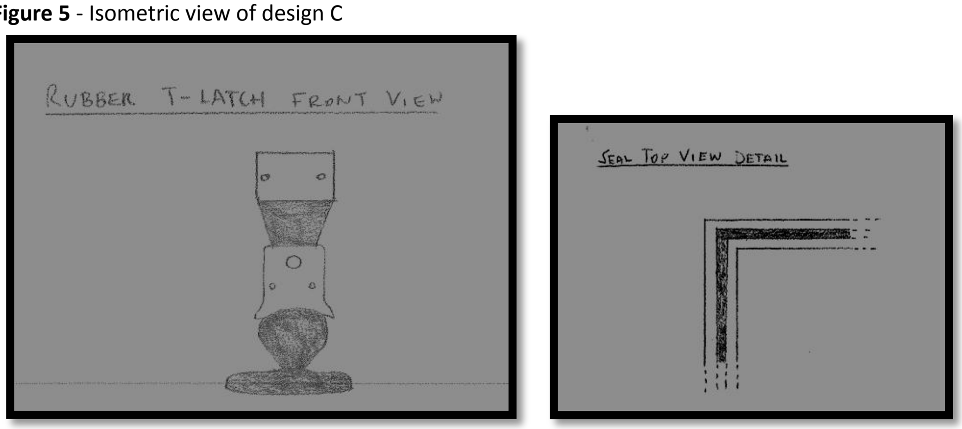


Figure 6 - Latch design (left), seal design (right)

The third cooler designed by the team offers several features that are supposed to make the product long lasting, simple to manufacture, and fitted with standardized components such as latches and drain plug.

Thanks to the thick walls this cooler will be provided with, it will offer superior ice retention so that the clients will be able to keep their food and beverages cool for several days (Figure 6). This cooler is designed so that no element in it is protruding out. This design characteristic is supposed to make the product extremely long lasting since it is not exposed to numerous additional stresses and fatigue due to components sticking out. Since every element is flush designed, this cooler design will dramatically reduce the shipping costs for Canyon Coolers. This is because it allows for nesting within different cooler families.

This element is extremely important to our client, considering shipping a cargo container costs about $ 8000 and the number of coolers per container could be increased from roughly 400 to about 700/800. The team sees the fact that this cooler is fitted with some standardized elements as a major advantage since it allows us to buy excellent latches and drain plugs rather than designing them ourselves, saving the client money and offering a more reliable final product to the customer at the end of the day.

Concept Selection

To determine which features are more important than others a pairwise comparison must be performed, Table 1. In the pairwise comparison each feature is matched against all of the other features. The ones that are more important receive a '1' in the corresponding row. For example if the cost row is examined we can see that the cost is more important (receiving a '1') then everything other than the ice retention and durability (receiving a '0'). After each feature is compared pairwise we sum the rows left to right. In the light blue column the raw score can be seen. In the yellow column we normalized the raw score by dividing by the sum of the total scores. Now we have a weighted score of each feature that will be used later in our decision matrix to make justifiable decisions on feature choices and overall cooler design.

	Cost	Ergonomics	Ice retention	Durability	Latches	Lock slot	Tie downs	Drain Plug	Asthetics	Dynamic Handle	Total	Normalized total
Cost	NA	1	0	0	1	1	1	1	1	1	7	0.155
Ergonomics	0	NA	0	0	1	1	1	1	1	1	6	0.133
Ice retention	1	1	NA	1	1	1	1	1	1	1	9	0.2
Durability	0	1	0	NA	1	1	1	1	1	1	7	0.155
Latches	0	0	0	0	NA	1	1	0	1	1	4	0.0888
Lock slot	0	0	0	0	0	NA	0	0	1	0	1	0.0222
Tie downs	0	0	0	0	0	1	NA	0	0	0	1	0.0222
Drain Plug	0	1	0	0	0	1	1	NA	1	1	5	0.111
Asthetics	0	0	0	0	0	1	1	0	NA	0	2	0.0444
Dynamic Handle	0	0	0	0	0	1	1	0	1	NA	3	0.0666

Table 1 - Pairwise comparison of design criteria

Table 1 above shows the criteria that will dictate the performance rank of our chosen designs. These criteria are ice retention, durability, cost, and ergonomics. One of the most fundamental things of the engineering design process is concept selection. Here we weigh the ideas and features of the potential cooler and perform an analysis to determine the best course of action. At this point we have generated some features and options to analyze. Unfortunately the features that we want to include are not measured with the same units; in fact a lot of our features cannot be measured with units at all. To standardize how we compare different features we need to put everything on the same scale. The multiple criteria scale presented in Table 2 does just that. Under each feature listed you can see the units and how each feature is rated. Some features are well defined like cost and the corresponding price points. Other features take a more subjective form rating from poor to excellent. On the far left we correspond the ratings of each feature to a number from zero to five. Zero being the worst rating and five being the best. With this chart we can convert the individual rating of each feature to a corresponding zero to five rating, making them easy to compare.

Value	Cost ($)	Ergonomics	Ice retention (Hours)	Durability (Cycles)	Latches	Lock slot	Tie downs	Drain Plug	Asthetics	Dynamic Handle
5	179.99	Excellent	240	100000	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
4	184.99	Good	192	50000	Good	Good	Good	Good	Good	Good
3	189.99	Satisfactory	144	10000	Satisfac-tory	Satisfac-tory	Satisfac-tory	Satisfac-tory	Satisfac-tory	Satisfac-tory
2	194.99	Adiquate	96	1000	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate
1	199.99	Tolerable	48	500	Tolerable	Tolerable	Tolerable	Tolerable	Tolerable	Tolerable
0	200+	Poor	24	100	Poor	Poor	Poor	Poor	Poor	Poor

Table 2 - Multi-criteria scale for elements of design

The team performed two different types of analysis to provide the client with different choices: a weighted analysis and a non-weighted analysis. Both of the decision matrices are based on the previously discussed multi-criteria scale but the weighted matrix is supposed to better compare the three designs we are offering to Canyon Coolers. Table 3 shows the score each cooler received (0-5) based upon the breakdown displayed by the multiple criteria scale of Table 2. Table 4 applies the weights determined from the pairwise comparison, Table 1, by multiplying each value by the weight associated with the criteria. For all three designs the most important elements are the ice retention followed by durability and cost. Design of cooler B is the best one numerically, but since all the coolers are extremely close on the judgment scale no design will be favored when discussing with the client.

Design Option	Cooler A	Cooler B	Cooler C
Cost	2.8	3	3
Ergonomics	3	4	2.5
Ice retention	4	3.5	4.5
Durability	5	4	5
Latches	5	4	4
Lock slot	0	4	3
Tie downs	2	4	2
Drain Plug	3	3	3
Aesthetics	3.5	4.5	3
Dynamic Handle	4	4.5	2

Table 3 - Design matrix for non-weighted analysis

Design Option	Weight	Cooler A	Cooler B	Cooler C
Cost	0.156	0.436	0.467	0.467
Ergonomics	0.133	0.400	0.533	0.333
Ice retention	0.200	0.800	0.700	0.900
Durability	0.156	0.778	0.622	0.778
Latches	0.089	0.444	0.356	0.356
Lock slot	0.022	0.000	0.089	0.067
Tie downs	0.022	0.044	0.089	0.044
Drain Plug	0.111	0.333	0.333	0.333
Asthetics	0.044	0.156	0.200	0.133
Dynamic Handle	0.067	0.267	0.300	0.133
Totals	**1.000**	**3.658**	**3.689**	**3.544**

Table 4 - Design matrix for weighted analysis

Progress Report

The Gantt chart, shown in figure 7 below, shows the team's progress plan throughout the fall semester. The grey bar in the middle shows the completion progress.

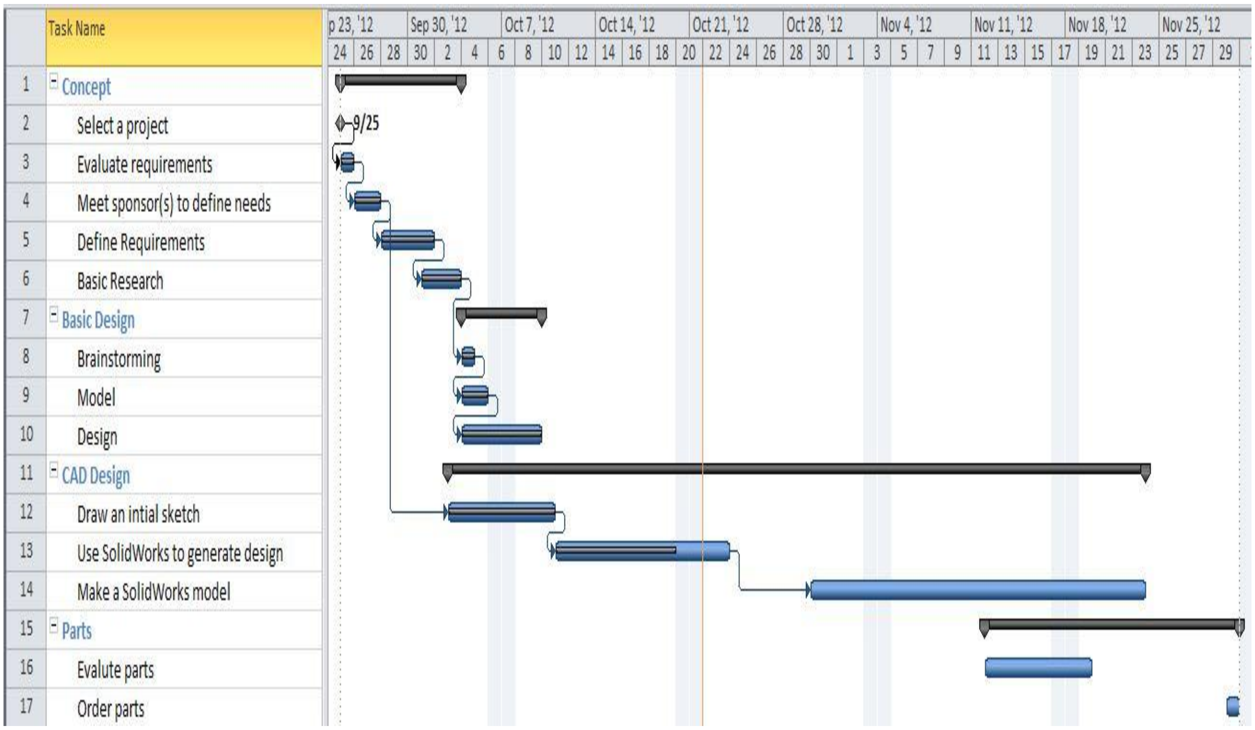


Figure 7 - Gannet chart

Conclusion

From the analysis done in this report an overall final design can not be determined. Since each ice chest received such a close score from the weighted decision matrix, designs that were favorable from each individual concept will be compiled together. The team will move forward refining these designs in CAD software. These more complete and accurately dimensioned drawings will be presented to the client for feedback. Mr. Costello reserves the ultimate decision on presented designs. After that meeting, which is set for next week, the team will make the necessary adjustments to our concepts and return them to the client. This process will be iterative until a final design is agreed upon.

References

1. www.canyoncoolers.com

    This is the client's website
2. http://www.thmarine.com

    This website used to get some information about parts
3. http://www.grainger.com/Grainger/BATTALION-T-Handle-Latch-1XPA8

    This website is used to get information about the latch part