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CLUB CAR COMPETITIVE COST ANALYSIS

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ABSTRACT

There are major differences between the commercial and consumer markets. Commercial markets cater to industry while consumer markets focus on everyday customers who are interested in satisfying their own needs. Contrast to the John Deere Gator CX, the Club Car Carryall 1 focuses on the industrial market and is designed for a robust environment. Club Car's key goal is to enter the consumer market, and this article aims at defining how teardown analysis, cost analysis, and value engineering were used to implement an innovative and cost effective design that will yield a tangible product that Club Car can incorporate in its future production line. A culmination of 650 man-hours, and an estimated budget of $12,800, have resulted in a redesigned vehicle that satisfies the scope. The Club Car Carryall 1 now caters directly to the consumer market, while maintaining a competitive edge with the current market leader John Deere.

1 INTRODUCTION

1.1 Background

Ingersoll Rand Club Car is recognized as an industry leader in the market pertaining to golf, utility, and transportation vehicles. Club Car is known for its efficiency and long-lasting value. Today, over 40 base models with applications in golf course, grounds maintenance, industrial, academic, and commercial markets are available. The manufacturing of quality products is paramount to the employees of Club Car and has been the driving force behind the company for over 35 years. The company's relationship with its customers is equally important, and its worldwide distribution network includes over 600 distributor, dealer, and factory branch locations. Based in Augusta, Georgia, Club Car is dedicated to focusing on state-of-the-art engineering with products including: rustproof aluminum frame, rack-and-pinion steering, Tranquility® gasoline powertrain; resilient ArmorFlex® body; PowerDrive® System 48™, and the new IQ™ System electric vehicle power and operating systems.

1.2 Objectives

The objective of Club Car Inc.'s Competitive Manufacturing Analysis Project was to perform a complete vehicle teardown of a John Deere Gator CX and a Club Car Carryall 1 in order to establish a competitive cost analysis between the two vehicles. A detailed bill of materials, associated part costs, labor hours, and a list of best/worst manufacturing practices were fully outlined in a detailed report. In addition to the cost comparison, suggestions were made on how to recreate the Carryall 1 so that it can be priced competitively against the John Deere Gator CX, which currently leads the consumer market. Deliverables for this project were to be completed within 650 man-hours spanning from August 2004 through April 2005, and the proposed expenditures, excluding labor costs, were to remain within budget of an estimated $1,300.

1.3 Proposed Approach/Solution

1.3.1 Relevant courses taken

The following courses have contributed to the expertise necessary in completing this project: Industrial Cost Control, Engineering Economy, Manufacturing Processes with lab, Work Measurements & Methods Engineering, and Project Management & System Design. These courses have provided relative information correlating to the project, and cover topics such as cost analysis, cost modeling, design, manufacturing, teamwork, and organization.

1.3.2 Data to be collected and analyzed

The data needed to produce the design deliverables for this project was provided by both the consulting team, and

company personnel. Company personnel was expected to provided: Club Car Carryall 1, John Deere Gator CX, sample competitive teardown report, material costs, sequence of events for the Carryall 1, detailed plant tour describing several processes, complete bill of materials for the Carryall 1, labor rates, and tact time per job function. The consulting team was expected to provide detailed photos, market research on the Gator CX, and general research on John Deere.

1.3.3 Methods to be used

Technical methods that will be employed in the project include the creation of a process map that outlines the process design, and the creation of a function diagram, which describes product design. In addition, the following methodologies will be implemented during the execution of the project: value engineering, design for assembly, competitive cost comparison, and function evaluation. A design for assembly calculator is a useful tool that will enable us to make accurate decisions when suggesting a new ideology for the Club Car Carryall 1.

1.3.4 Rationale for the proposed approach

The complexity of this project required a steadfast plan that clearly outlined the process that was used to accomplish the set out goals. Value engineering, design for assembly, competitive cost comparison, function evaluation, process maps, and function diagrams were the technical methods that would ensure an effective approach in fulfilling the objective, because they outlaid a process for performing the milestones set in this project.

1.4 Benefits: Qualitative\Quantitative Performance Criteria

Upon completion of this project, Club Car Inc. was able to examine the data outlined on the Competitive Cost Analysis to determine whether or not it would be feasible and profitable for them to enter the consumer market, in which the John Deere Gator CX currently leads. The implementation of this project limits the risk associated with entering a new market, and theoretically can save Club Car Inc. millions of dollars if the decision is made not to enter the market; or generate millions of dollars if Club Car Inc. decides to enter the market. Overall, cost relevant to risk was significantly lowered, and Club Car Inc. will be able to make a better informed decision.

2 SYSTEM DESIGN

2.1 Description of Work Tasks

The major work tasks have been categorized generally as define, measure, analyze, improve, and control. We planned to define the problem, measure current practices, analyze results, improve methods, and control the outcome of our deliverables.

2.2 Deliverables

Tangible products of the completed project include:

1. A Function Diagram created to organize all parts from each vehicle
2. A Bill of Materials for each vehicle
3. Cost Matrices of Parts and Labor
4. A report detailing the analysis
5. Details on areas where the vehicle design aided the manufacturing process (best practices)
6. Details on areas where the vehicle design hindered the manufacturing process (worst practices)
7. Presentation summarizing the findings

2.3 Project Organization

The team is comprised of eight students, four of which have in depth knowledge of Industrial & Systems Engineering, and four that have an in depth understanding of Mechanical Engineering. The combination of both disciplines ensured a key focus on three of the main core areas involved in this project: manufacturing, cost, and labor.

2.4 Related Experience

This group has had a variety of work experience that was beneficial to the completion of this project. From a manufacturing standpoint, all members had familiarity and experience in a manufacturing environment. This comprised of redesigning several production lines to streamline a production process, converting a shop from a push to a pull system, performing time studies, designing a mistake-proof strategy to improve a problematic assembly station, analyzing production system designs, and applying Lean and 5S concepts. In addition to solid manufacturing backgrounds, several group members also have had experience with project management including coordinating meetings, tracking project process, defining milestones, and general management; these types of skills are vital to coordinating and

executing a project of this scope. From a software standpoint, the group has also had experience with Microsoft Excel, which will serve as a tool to view, create, and rearrange the BOM's. All members have knowledge and hands-on experience with AutoCAD which will be used to redesign parts in the Club Car.

2.5 Equipment, Software, and Facilities

In order to complete the project objectives, use of specific equipment, software and facilities was needed. The most cost-consuming equipment items will be one Club Car Carryall 1 and one John Deere Gator CX. These were the actual vehicles used to perform the vehicle disassembly, with the aid of a standard tool kit and a snap-ring tool. In addition, a digital camera was used to properly record and document the tear down process. The equipment was stored at a VDOT facility in Blacksburg, VA. All parts of the process that involved physically using/altering the carts was to be done in this facility. In order to perform the comparative cost analysis, document the process, and create the project deliverables, Microsoft Office Suite and Microsoft Project were used.

2.6 Alternatives

2.6.1 Components

Throughout the course of the project numerous alternatives were generated when considering what components to modify or omit. The team decided to focus on three main categories: fasteners, inches of weld, and material. These three categories were then further broken down into subparts. For fasteners the team considered nuts, bolts, pins, and washers. Materials consisted of injection molded plastic, steel, and aluminum. We were able to decipher the amounts of each fastener, material, and inches of weld, in order to decide on what areas of the Club Car to focus on redesigning.

2.6.2 Verification

The cost function matrix and the labor calculations are what the team used to compare each vehicle by its function category. Among functions we calculated which vehicle was more economical in each category. The bill of materials provided a summary that included the number of nuts, bolts, and smaller parts correlating to each function; while the function cost matrix provides an estimate of the part costs distributed between functions.

3 COST SECTION

This project involved several expenditures, all of which were necessary to yield an effective result. Cost associated with this project include: John Deere Gator CX, Club Car Carryall 1, tools, paperwork, and two onsite trips. Appendix A has a graph comparing our actual costs to our anticipated costs.

4 RESULTS

The outcome of our team analysis concluded that cost saving could be increased by focusing on re-design of the following functions: Support Car, Support Objects, Accelerate Vehicle and Market Vehicle. These functions cost Club Car a total of $570.28 more then John Deere.

4.1 Support Car

The physical parts that contribute to the Support Car function are tires, front suspension and rear suspension. Through reverse engineering it was apparent that the John Deere Gator CS does not have a traditional rear suspension assembly like the Club Car Carryall 1. Due to this fact it was apparent to this team that Club Car can save approximately $244.09 by removing their current rear suspension assembly and replacing it with tires similar to the Gator which provide for a softer passenger ride and less turbulence for transported material. These tires are essentially softer and allow for some dampening during the ride and cost approximately $148.47 less then the tires currently used by Club Car. By making these changes, the functionality of the Carryall 1 was not hindered as it can still perform all tasks as well as reducing Club Cars costs.

4.2 Support Objects

The function identified as Support Objects consists of all components that restrain or hold objects that will be transported using the vehicle. These components were identified to be the bed assembly, the seat assembly and the floorboard. The seat assembly was addressed by removing the current bench-seat assembly that is currently implemented in the Carryall 1. This assembly was replaced by a re-designed bucket seat option that resembles the Gator CS. By reducing material used in the seat, the re-design will save Club Car a total of $37.72 per cart without sacrificing functionality.

Also, the bed assembly was completely re-designed. As a result of reverse-engineering the team identified that the Carryall 1 bed costs approximately $307.12. In order to reduce this cost the re-design mimicked the bed gate latch system of the Gator which eliminated all latching mechanisms and utilized gravity to hold the bed gate into place. Also, the team reduced cost by eliminating intricate

body panels and replacing them with a structural bed cage with an aluminum sheet metal bed floor and side. These changes radically simplify the Carryall 1 design and provide for a more efficient assembly process. The new bed re-design provides $166.33 of saving per cart and improves easy of operation with the new gate latch system.

The teams re-designs of the bed assembly and seat assembly will save Club Car approximately $204.05 per cart.

4.3 Accelerate Vehicle

The Accelerate Vehicle function encompasses the pedal assembly and tires. Our analysis showed that a re-design of the Carryall 1 pedal assembly would not be economical. Therefore the team focused on alternate tires. It was learned from reverse-engineering process of the Gator CS that Club Car could switch their current tire to that used in the Gator. This tire helps compensate for the removal of the Carryall 1 rear suspension, as well as performs all tasks associated with accelerating the vehicle. By swapping tires Club Car will save approximately $148.47 per cart while performing all functions needed by a cart in this market.

4.4 Market Vehicle

Physical parts that contribute to the Market Vehicle function were identified to be tires, body panels and the bed assembly. Tires contribute to marketing the vehicle because they can distinguish between a golf cart, which is not what our target audience wants to buy, and a rugged outdoor vehicle with large-durable tires as used by the Gator CS. As discussed in the previous results section, the alternate tires provide significant cost savings while improving the appeal of Club Car's product.

Also, the bed is a distinguishable component of the Carryall because of its all-aluminum construction and no-rust capabilities. However, the current bed utilized in the Carryall 1 is too intricate. As discussed in section 4.2, the bed assembly was simplified to save Club Car $166.33 per cart. It also maintains the company identity by keeping their aluminum assembly, thus not sacrificing their ability to market the vehicle.

Body panels were identified to be an inefficient way to provide rigidity to the Carryall 1 due to their complexity. The quantity and complexity of body panels were greatly reduced thus providing a cost savings of $112.78 Consequently, rigidity of the cart was sacrificed and the team added components to the frame to maintain rigidity. The cost of the new frame was increased by $94.21 but it outweighed by eliminating other more expensive physical components that served the same function.

4.5 Total Cost Savings

Through the creation of a function diagram and cost analysis the team was able to identify what function can be improved to reduce cost of the Carryall. By reverse-engineering the Club Car Carryall 1 and John Deere Gator CS the team learned what physical components contributed to each function and the differences between how Club Car and Gator's made these components. The team then brainstormed many re-design options and decided on the most efficient and capable designs. Ultimately the team's re-designs provide Club Car with a total cost savings of $689.28 per cart.

5 RECOMMENDATIONS

Recommendations include:

1. Air intake: remove the air intake tubing and invert the air filter box, then reposition the air intake to fit under the driver's seat.
2. Bed: simplify bed assembly by removing the steel support structure for the bed, and replace it with a newly designed aluminum support structure. This reduces the number of parts, fasteners, amount of aluminum, and omits steel entirely in the bed. Eliminate the moving parts in the tailgate latching system and make the component slide instead.
3. Rear suspension: remove the existing rear suspension system and modify the frame's I-beams to connect directly to the rear axle, hence compensating for support. Also, add rubber bushings between axle and frame.
4. Tires: replace tires with larger yet softer all-terrain treads. This compensates for lack of a rear suspension and makes the vehicle more aesthetically appealing.
5. Seat assembly: split the bench seats into two separate units allowing for a center console in which we can add cup holders and a gear shifter. Simplify the armrests by utilizing one piece of aluminum for each side versus welding several pieces of steel together. The modification to the seat assembly also adds to the aesthetic appeal of the vehicle.
6. Gear shifter: relocate gear shifter to the center console in order to enhance aesthetic appeal. This also reduces reaching distances, hence making it more ergonomic to the user.
7. Fuel system: reshape the fuel tank to a rectangular design, so it can fit in the new side panel assembly
8. Body panels: simplify the design by reducing the overall material used to fasten and make the body panels. Substitute the frame in its place to give it a more rugged look.

9. Frame: instead of utilizing an integrated body and frame the team recommends incorporating an aluminum tube frame and surrounding it with aluminum sheet metal. By adding more aluminum to the frame we reduce the more costly materials associated with the body panels.
10. Integrate Club Car's durability with Bobcat's image and reputation to make a consumer appealing vehicle.

These recommendations insure a cost savings, and increase aesthetic appeal, which are vital factors to making the Club Car appeal to the consumer market. The idea of culminating Bobcat and Club Car will revolutionize the way Ingersoll Rand does business. However, it will indubitably satisfy the goal Club Car has in mind for the new Carry All 1.

6 CONCLUSIONS

The primary goal of this project was to design a vehicle for Club Car using an existing model as a baseline, which would be competitive in the consumer market. The first step to making this vehicle competitive in the new market was to reduce the material and labor costs so that it could be affordable to the everyday consumer. This was accomplished by performing a vehicle teardown of the Club Car Carryall 1 and the market leader, John Deere Gator. From this teardown a bill of materials was created for both vehicles and organized by function. The material costs were based on the quantities of fasteners, injection molding, aluminum, bends, and welds. The labor costs were based on the time associated with each fastener, spring, and assembly used for the construction of both vehicles. Using the organized bill of materials and the associated costs, the areas with the greatest opportunity for improvement were identified to be the rear suspension, seats, frame, bed assembly, and the air intake. These areas were then analyzed more in depth and redesigned to reduce costs. After the redesign efforts were completed, material costs were reduced by $359.56 per cart and labor was reduced by 24%. The reduction in cost was driven by a 54% reduction in the total number of parts for the redesigned assemblies. The recommendations given will effectively reduce the material and labor cost needed to build a Club Car Carryall 1. Because it is impossible for an outside consulting group to precisely determine how much it costs John Deere to build a Gator, the team cannot state that the new designs will lead to a vehicle with a lower retail price. But by implementing the given recommendations, Club Car can be ensured that the retail price gap between the two vehicles will be greatly reduced, and will give them a strong start towards producing the most cost efficient vehicle possible.

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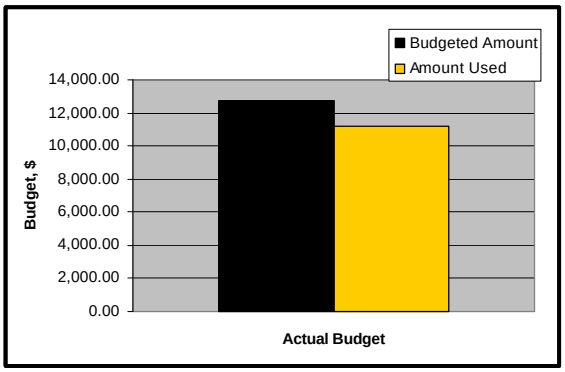
APPENDIX A: BUDGET

Table 1: Budget Comparison



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