**FAMU & FSU COLLEGE OF ENGINEERING**
**Department of Mechanical Engineering**


**EML 4551C – Senior Design – Fall 2012**

# Product Specifications and Project Plan

## Mobility Lift for European Insider Applications

Group # 19

**Lauren Hulett**
**Phong Tran**
**Richard Valle**

Project Sponsor: Harmar Mobility Inc.


Project Advisor: Dr. Carl A. Moore, Ph.D.

**TABLE OF CONTENTS**

## INTRODUCTION

The client is Harmar Mobility. Harmar Mobility is a company which designs and manufacturers' mobility lifts, which can be utilized in home, office and automobile applications.

"Harmar is an innovation and design leader that is dedicated to helping individuals enhance their mobility, independence, and quality of life. Their wide ranges of accessibility and mobility solutions are all built to offer the highest quality, reliability, and value." (Harmar.com)

Harmar Mobility currently provides mobility lift solutions for a wide range of vehicles in the United States. However, the majority of vehicles driven in Europe are much smaller and more compact than those in the United States. This prevents the lifts currently offered by Harmar to fit into European vehicles. Our goal is to provide a solution for the individuals who transport themselves in smaller vehicles and require a mobility lift. The task is to design a lightweight interior lift to compete in the European automobile Market.

## PRODUCT SPECIFICATION

### CUSTOMER NEEDS AND EXPECTATIONS REVISITED

The needs and expectations, presented below, will be discussed further in detail in the sections that follow.

The task is to design a lightweight, interior mobility lift to compete in the European automobile market. The specific needs given to us by the client are:

1. It should be light weight, and easy to handle.
2. It should have a standard fold down option, something like the David from B&S or Carolift 40.
3. Capacity of 60kg (130ish lbs), so you are between the 40kg (88 lbs) and the 90kg (198 lbs).
4. Motor needs to be as low as possible.
5. Adjustable boom height and length
6. Small remote control
7. Installable on passenger or driver side (Very important b/c of the UK)
8. Lightweight materials. AL055 is very heavy compared to European competitors.

After Speaking with the Harmar Mobility Representative, this is what will be expected of our team:

1. Become Familiar with Harmar products
    a. Visit the Sarasota facility.
2. Perform Market Analysis on European competitors.
    a. Evaluate product function/features
    b. Evaluate product appearance
    c. Identify product shortcomings
    d. Estimate product cost (in US$)
3. Develop Harmar Concept (to be equal to or better than competition)
    a. Determine product criteria
        i. Function/Features
        ii. Appearance
        iii. Estimate cost

4. Review with Harmar Team
    a. Create 3D model
    b. Perform FEA/Structural Analysis
5. Review with Harmar Team
6. Create 2D drawings
    a. Conduct Drawing review with Harmar Engineering
i. Conference Call or in person
7. Obtain quotes for all components
    a. Create Bill of Material
    b. Create cost summary
8. Build Prototype unit
9. Perform tests
    a. Static Load test
i. Verify unit is able to lift 3 times the rated capacity (390 lbs)
    b. Cycle Test
i. Unit must perform 10,000 cycles with rated capacity
10. Sell thousands of units in Europe each year!

**CONSTRAINTS**

The list of constraints for our project are that the lift be user-friendly to seniors, low weight, strong, aesthetically pleasing, and compact allowing it to fit inside small European vehicles. Based on the initial market research, we opted to utilize the Volkswagen Golf, the best-selling car in Europe in 2011, as the testing platform to aid development of our product.

Since this will be a product marketed towards consumers, the mobility lift must be safe and the reliability must be tested. Our mobility lift has to pass the safety factor of 3 set by Harmar. The mobility lift must also pass the static load test of 390 pounds, and cycle test of 10,000 times with load rate of 130 pounds.

## COMPONENTS

### *Lift Apparatus and Folding Mechanisms*

The lift apparatus is the mechanism that will be attached to the mobility device in order to raise it off the ground and into the vehicle. The current lift apparatuses that Harmar Mobility employs include cables with hooks that attach to the base of the mobility device or a platform that the mobility device can drive onto. For the purposes of this project, given the weight of the mobility devices to be lifted plus a factor of safety of 3, the lift apparatus must be able to bear a load of 180 kg. Since no design concepts have been generated thus far, it is impractical to perform calculations of the forces acting upon the lift apparatus at this point.

Since the European vehicles are already somewhat limited in the cargo area, a folding mechanism will be utilized to enhance the space in the cargo area where the lift is installed. Depending upon the design implemented, the folding mechanisms will vary. As a team, we have not yet decided if the folding feature will be manual or operated by the motor. The best scenario would be to have it operated by the motor, since the target market is already limited in their mobility, but because of various constraints, this might not be feasible.

### *Motor and Electrical*

The team is presented with two options, a manual or a mechanical means of lifting the user's mobility device. Since the product itself is to be designed for the physically impaired, it would be unwise to use a manual style lift system. Therefore, it then becomes necessary to account for and research the eventual motor to be used.

While, at the time of this report, the final design has yet to be decided upon, a few parameters for a motor may still be determined. For example, the project calls for a lifting ability of roughly 60 kg. Knowing the height from ground to the bed of the hatchback on our Volkswagen Golf to be about 0.495 m, an energy requirement of 294.1 J is needed. Therefore, estimating a maximum lift time of about 1 minute, a motor with a power output of 4.85 W is needed.

While this rudimentary analysis is nowhere near complete, the purpose is clear. The power output of the motor will be a significant feature of our project. Other

constraints including but not limited to weight, factors of safety, and location will also be dealt with accordingly.

It must also be noted that the client is a fully functional and operating business with similar products at their facilities. Upon initial discussion with the client, it was determined that an available motor may, in fact, be supplied to the team outright. Therefore, the teams analysis for the motor may become a design constrain as well.

Further electronic controls will be dealt with at the time of the final design selection. The use of a remote control is still under discussion among the team and the client.

*Base and Upright Components*

Since we are limited by the small cargo space of the Volkswagen Golf, the dimensions of our mobility lift are somewhat constrained. Table 1 illustrates the dimensions

| Item | Dimensions (approximate) |
|---|---|
| Height | 28-30 inches |
| Width | 16-20 inches |
| Thickness | 2 inches |
| Extension Arm/Apparatus | 36 inches |

**Table 1: Approximate overall dimensions for the mobility lift**

The extension arm will have a built in contracting and extending mechanism for convenience. We also plan to design the mobility lift with quick release folding mechanism that allowed the unit to fold down at its base for space saving.

Due to the fact that this is a consumer-based product, we need a safe and reliable structure and material that can endure the European weather. A concern when designing the lift is that it be visually appealing to the consumer, however, it is necessary to balance the aesthetics with functionality and strength of the product. The base will be mounted directly onto the vehicle, and will also used as the mounting surface for the motor housing. The upright is an important part of the unit, it must be able to handle a 390 pound load static test and also survive the repetition of numerous folding and unfolding cycles. The extension arm is also an integral component, as it is where the majority of the load will distributed. The contracting and extending mechanism must survive the heavy load and cycle test as well.

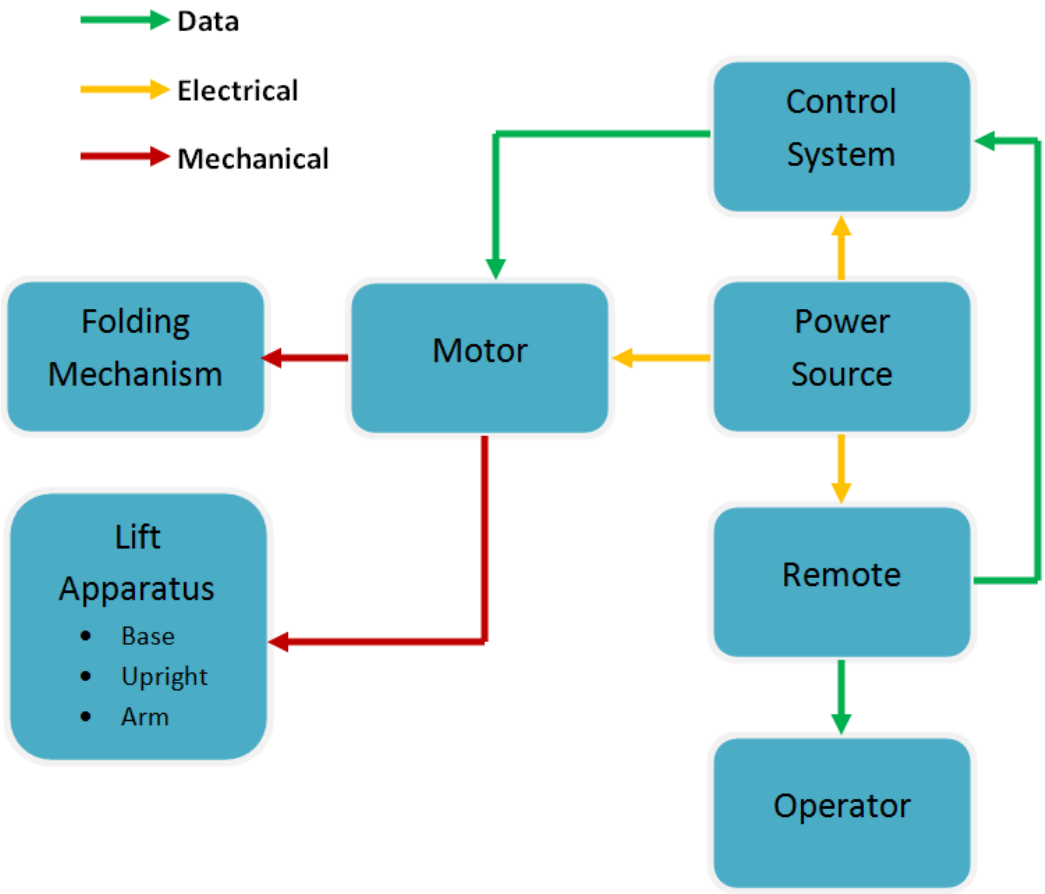
## MATERIAL SELECTION

Accounting for all the constraints above, especially the weight issue and reliability factor, we are planning to use high grade aircraft aluminum for the main structure of the mobility lift. Utilizing this high grade aircraft aluminum provides an excellent choice due to its tension and compression strength and high fatigue limit which can endure the long cycle test of 10,000 repetitions. In addition the mobility lift must be able to withstand the cold weather in Europe, which this aluminum can achieve.

Another reason that we choosing aluminum is for its easy machining ability compared to steel or titanium since we have limited resources of machining equipment at the college of engineering machine shop.

We have not made any specific selection whether to use aluminum extrusion or tubing because we have not finished designing the mobility lift. Material cost must also be considered prior to the final decision. We are planning to thoroughly analyze the mobility structure and simulate the real world condition using the Pro-engineer program. Before we make a final material selection, we will consult with our sponsor, advisor, and machine shop personnel.

**FUNCTIONAL DIAGRAM**



## LEARNING NEEDS

At the time of writing this document, mechanical systems and their applications seem to be the primary area of focus required to complete the project at hand. However, that is not to say that this subject area is the only one that will be used. Additionally, a proper knowledge of material science and selection may be employed for determining the final product's strength, durability, and physical attributes such as weight. Also, a fair amount of knowledge in analyzing static and dynamic systems is to be expected.

Of more importance, since the given project is to be used and made into production, a strict set of codes, guidelines, and safety specifications are to be met. Further complicating things, the intended demographic is to be European consumers. Therefore, knowledge of the codes and regulations set in place Europe is to be sought. Since the product is also intended for use in a vehicle, ASE and/or ASME standards will be researched to determine if any criteria are set in place.

## BUDGET

Our budget allocation for designing and building the mobility lift for European interior applications is $500. This budget is low compared to other groups; however, Harmar mobility Inc. will provide some of the hardware needed including the motor, control system, and other electrical components necessary. It is too early in the design process for us to determine the actual cost of the project. At this stage we can only estimate the material costs for the entire structure. Table 2 outlines the estimated material costs

| Item | Approximate Cost |
|---|---|
| Fasteners | $25.00 |
| Pulley and Cable System | $95.00 |
| Painting/Cosmetics | $40.00 |
| **Total** | **$145.00** |

**Table 2: Approximate material costs**

These costs estimations above are based on McMaster-Carr as the supplier. The actual cost of the project might be more or less depending on the design.

In addition, the manufacturing cost of this project is still unknown at this point because we are still in the early stages of the design process. However, we will strive to keep costs as low as possible by designing the project with budget minded manufacturing resources, and we will continue consulting with machine shop personnel. In calculating the labor cost we will keep entry level salary for mechanical engineers and mechanical assembler, and intermediate salary for machining costs.

Allocations will be set aside for testing and analysis. It is likely that we will need to rent a wheelchair to serve as testing platform. We also plan to use our budget for travel expenses to visit the Harmar mobility dealer locally and Harmar's headquarter and manufacturing plant in Sarasota, estimated at $150. A request to increase our budget may be necessary, but that depends on our final design. All of these costs will be added to the total cost of research and development. We will report back to our sponsor a total cost, and after performing a market analysis a selling price in the European market can be determined.

The Gantt Chart below provides a visual timeline for the project goals and milestone to be achieved during the Fall 2012 semester. (Please refer to page 13)

**FALL 2012 SEMESTER OVERVIEW**

- **Start**
- Initial Set up/Contact
  - Week 3 – 6
  - Introduce ourselves to all parties involved. Form a good line of communication.
  - Sponsor: Mike Savinsky
  - Phone: (941) 308 - 7331
  - Email: Michael.Savinsky@Harmar.com
- Build/Maintain Website
  - Week 4 – 16
  - Create initial mock website. Will be updated and maintained throughout semester.
  - URL: http://eng.fsu.edu/me/senior_design/2013/team19
- Needs Assessment
  - Week 3 - 5
  - Milestone: Prepare/complete Needs Assessment Report
  - Due: Thursday, September 27, 2012
- Product Research
  - Week 4 - 7
  - With Needs Assessment completed, can now focus on product research. (Client and completion)
- Concept Generation
  - Week 6 - 8
  - With product research in progress, more knowledge for concept generation will be given. (1 unique concept per group member)
- Choose Design (Decision Matrix)
  - Week 7 - 8
  - Each member's concept will be compared for a final design to be determined.
- Project Plan/Project Specs
  - Week 5 - 8

    - Milestone: Prepare/complete Project Plan and Specifications Report
    - Due: Thursday, October 11, 2012
- CAD Drawing
    - Week 7 - 9
    - With final design determined, extensive CAD drawing will be made.
- Midterm I Presentation
    - Week 7 - 10
    - Milestone: Prepare/complete Midterm I Presentation
    - Due: Thursday, October 25, 2012
- Market Analysis
    - Week 8 - 10
    - Sufficient knowledge of design should be known; therefore, market analysis may be determined.
- Order Parts (Market/Harmar)
    - Week 10 - 16
    - Finalized design to be given approval to begin ordering parts for assembly in Spring 2013.
- Harmar Visit
    - One Day: Week 10 - 12
    - Group members will convene to decide on one day to visit Harmar Mobility in Sarasota, FL.
    - Address: 2017 47$^{th}$ St, Sarasota, FL 34234
- Midterm II Presentation
    - Week 10 - 13
    - Milestone: Prepare/complete Midterm II Presentation
    - Due: Thursday, November 15, 2012
- Simulation/Analysis
    - Week 12 - 16
    - Computer analysis will be conducted to ensure design is robust enough for physical implementation.
- Final Design Report
    - Week 13 - 16
    - Milestone: Prepare/complete Final Design Report
    - Due: Thursday, December 6, 2012
- **Finish**

**FALL 2012 WEEKLY SCHEDULE OVERVIEW**

On a weekly basis, team members will convene to discuss any new or current goals relating to the project. Information will be exchanged via online team repository created on a Google© account. Also, the team website will be updated when new information becomes available.

The sponsor will be contacted via a phone call every other Friday. The agenda for the phone call will vary slightly from week to week, but will primarily consist of an update on progress, questions we may have regarding anything design related and any additional topics needing to be discussed or clarified. In addition, any reports that are turned in for the purpose of grading in this class, we intend to provide a copy to our client as well.

Furthermore, on a biweekly basis, team members will meet with the project advisor, Dr. Carl A. Moore. At these meetings, advisor input will be taken into consideration for new and upcoming goals. Additionally, members will meet with the course instructor, Dr. Kamal Amin for their schedule biweekly meeting. At this point, biweekly reports on the team/project progress will be submitted.

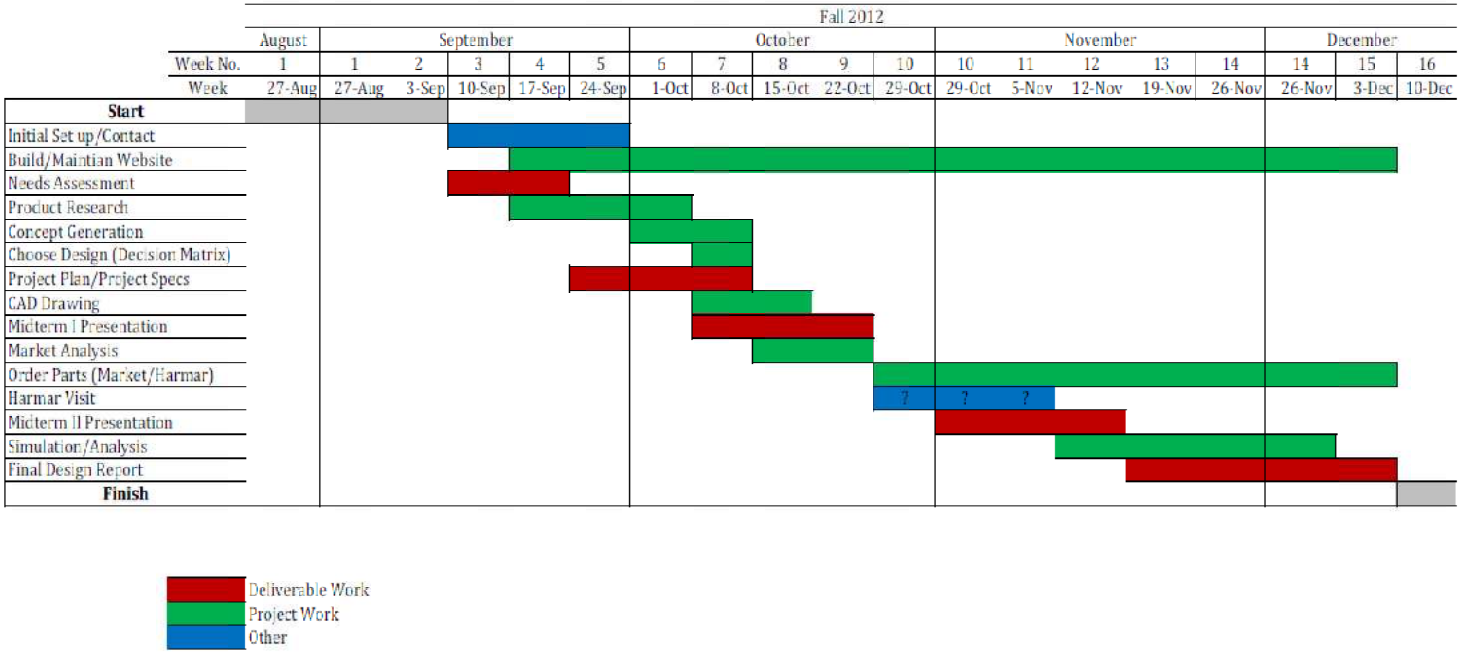
Lastly, the team has discussed and agreed upon visiting the Harmar Mobility facility once each semester.

EML4551
Senior Design I

Team 19

Harmar: Design Mobility Lift for European Insider Applications

Lauren Hulett
Phong Tran
Richard Valle



## WORK CITED

http://www.harmarmobility.com/products/itemDetail.cfm?proID=22&tabName=Specifications

http://www.autoadapt.com/produkter/PDF/carolift/Bring-your-wheelchair-along_EN.pdf

http://www.onbeperktinbeweging.nl/documents/Engels-Kofferbakliften.pdf

http://www.mcmaster.com/

http://www.asminternational.org/content/ASM/StoreFiles/05224G_Chapter14.pdf

http://bestsellingcarsblog.com/2012/03/03/europe-full-year-2011-top-318-all-models-ranking-now-available/