Hobie Cat Kayak

Senior Design Proposal
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Executive Summary

The objective of the Hobie Cat Kayak project is to design an adaptive system to transfer energy to propel the Mirage Drive System of the Kayak. The Mirage Drive System exists to propel a kayak by using two flippers instead of a traditional kayak paddle. The Mirage Drive System transfers energy from the user's legs to flippers. Our mechanism will adapt the Mirage Drive System to transfer energy from the user's arms to the paddles. This will allow any user with one or two arms to efficiently propel the Hobie Cat Kayak with a simple push and/or pull motion of one or two arms. Our client, Steve Grudzien of Patriot Products, Inc. plans to market this system to kayaking clubs for the disabled and directly to end users. Our product will reduce the minimum requirements for independent kayaking to just one functional arm.

Introduction

Kayaking and fishing independently is a healthful, enjoyable recreational activity that millions of people around the world enjoy. Unfortunately, hundreds of thousands of people with limited use of their legs and arms are unable to enjoy independent kayaking and fishing. The Mirage Drive System is a third generation propulsion system that allows people with limited use of their arms to propel a Hobie Cat Kayak.

The Mirage Drive System essentially transforms the back and forth motion of a user's legs to a forward thrust via two flippers mounted to the bottom of the kayak. These flippers have been modeled based on a penguin flipper and refined with CFD analysis. The Mirage Drive generates three times more thrust per stroke than a traditional kayak paddle with surprising ease. The Mirage Drive has been proven as a revolutionary device, but it still leaves behind anybody without use of their legs. Our mechanism allows anybody with at least one functional arm to enjoy the same type of kayaking that we all take for granted. Our group firmly belives that the value that our project can provide to disabled users far exceeds its small costs in design, fabrication, and materials.

Project Description

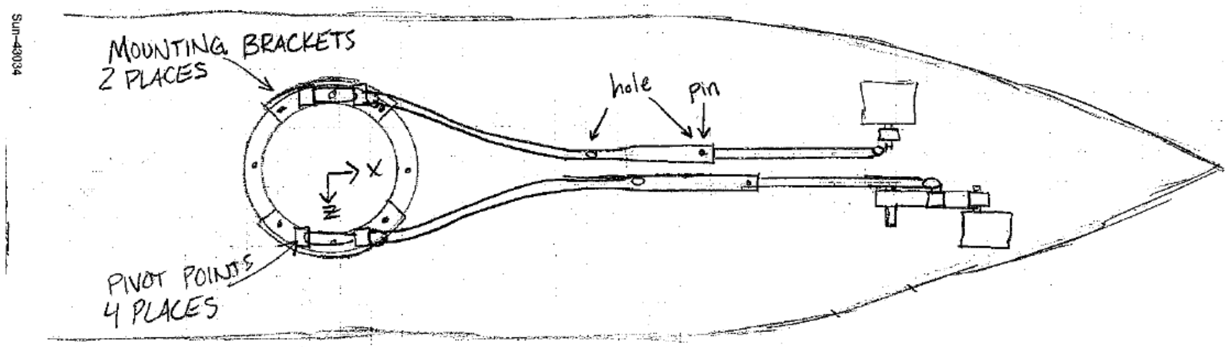
Our mechanism transfers power from the user's arms to the Mirage Drive System of a Hobie Cat Kayak. All of our proposed mechanisms are simple, reliable, and cost effective. Our project will not eliminate any functionality of the existing kayak and Mirage Drive System. This means that the user should be able to sit comfortably in the kayak with or without the mechanism installed. The mechanism will be simple and lightweight to minimize cost, maintenance, and transportation effort. Our mechanism will be easy for the user to install and remove by himself without special tools. Finally, all of our materials will be corrosion resistant as our environment may be saltwater.

Proposed Methodology

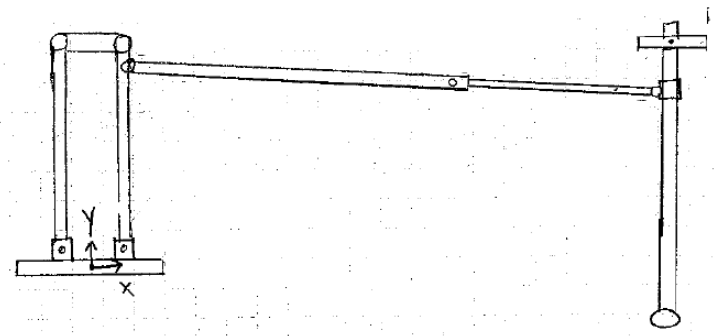
Taking all of the above mentioned requirements into account, all of our group members quickly discussed three very similar concepts for transferring energy from the user's arms to the Mirage Drive System. It was tempting to pick a very specific design and begin prototyping the same day, but we stuck to the formal design process and came up with three general designs.

Design #1 – Two push pull rocker arms

Our first, most popular design consists of two rocker arms hinged at an access hatch just in front of the user's seat. These arms rock back and forth in opposite directions and are driven by a pushing and pulling motion from the user's arms. The rockers are connected to the arms of the Mirage Drive by two independent bars. A general arrangement for the rocker arm system is shown below:



Plan View

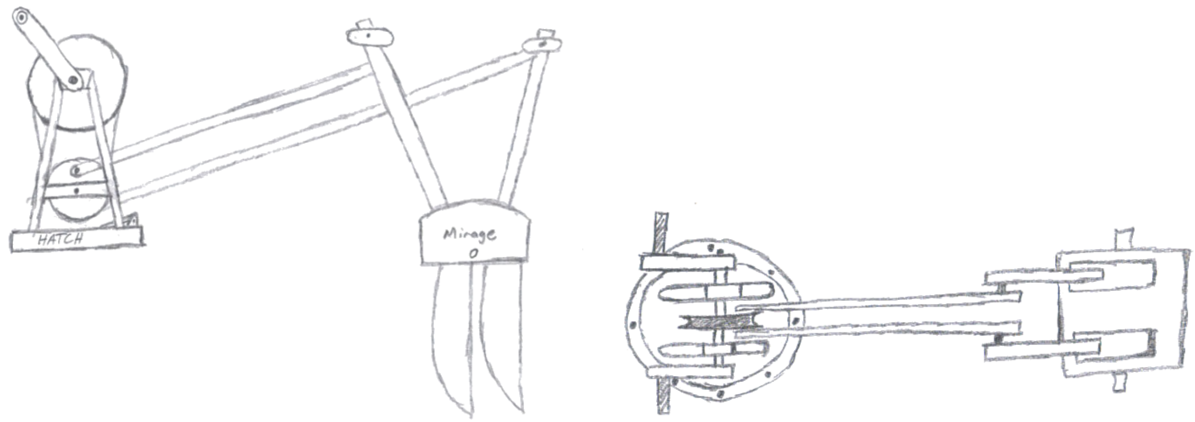


Elevation View

This system's greatest advantage is the transmission of maximum force with the best path of motion. We believe that this design will cause the user the least amount of fatigue and will generate thrust at maximum efficiency (and highest kayak velocity). Our client was also favored this class of design at our first meeting.

<u>Design #2 – Hand crank</u>

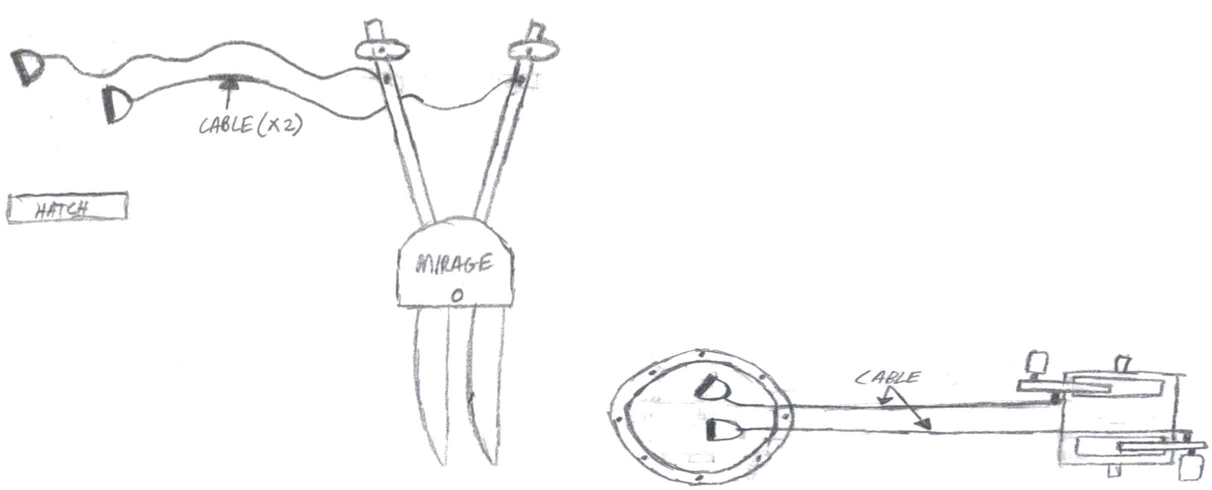
Our second design also employs a four bar linkage principle, but replaces the two rocker arms with a crank –connecting rod linkage to the Mirage Drive arms. The crank would make a complete revolution for each 60 degree stroke of the Mirage Drive arms. The crank would be similar to the hand cranks already in use on bicycles for the disabled. A general arrangement of the hand crank system is shown below:



This design would allow us to use commodity parts that are easily changeable by the user. A rotary motion might be easier for certain disablilities as well. This system would be the heaviest and most complex, with most of the weight above the center of gravity of the kayak, possibly increasing the tendency to roll the kayak. This design also introduces the requirement for at least one sealed bearing which adds cost, weight, and complexity.

<u>Design #3 – Direct cable</u>

Our third design is the most simple. It consists of two cables, one tied to each of the Mirage Drive's arms. The other end of each cable attaches to a handle. The user pulls one cable at a time, with the pulling motion of one cable returning the opposite arm in preparation for the next pull. The cables can have changeable handles and variable lengths. A general arrangement of the direct cable system is shown below:



An obvious disadvantage of this design is the exclusive use of a pulling motion for propulsion. This cuts the amount of power supplied per stroke roughly in half. However, a very significant advantage is the extreme simplicity of a cable, handle, and clamp on the Mirage Drive. The use of cables also requires the user to provide an optimum motion for each pull without a fixed path like the previous two designs. This lack of a fixed path coupled with the pulling motion would cause much more fatigue as compared to the previous two designs. The simplicity of this system also makes it the easiest for the user to install and remove. This design would exclude one-armed users from being able to propel the kayak, as there would be no means to return the opposite arm of the Mirage Drive. This is obviously a significant disadvantage.

House of Quality

Our team compiled an initial house of quality to better explain the advantages and disadvantages of each of our three designs.

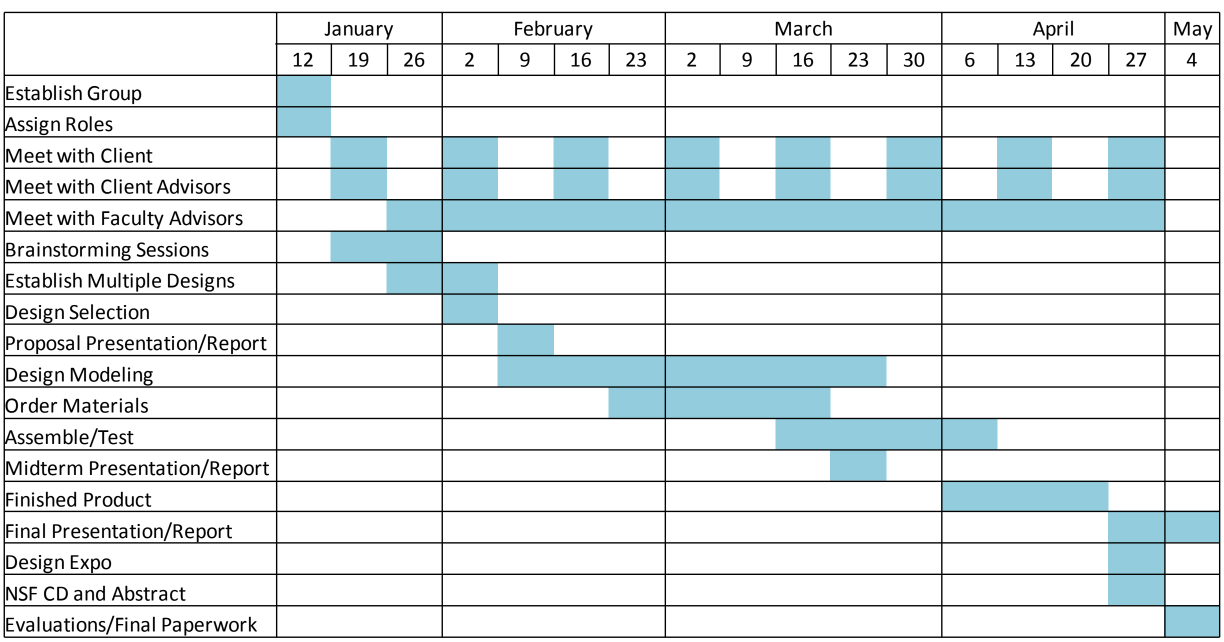
House of Quality

	Importance	Rocker	Crank	Cable
Safety	4	4	4	5
Light Weight	4	4	3	5
Cost	3	4	3	5
Original Function	2	5	3	5
Ease of Use	4	5	3	3
Adaptable	5	5	4	1
Durable	5	4	3	4
score		119	90	102

There were no major surprises when we saw the totals from our house of quality. Rather, the house of quality confirmed our suspicions and provided quantitative data to represent our feelings about each design. Our team is confident that the rocker mechanism will be the best overall mechanism to transfer energy to the Mirage Drive system. We plan to compile separate houses of quality as needed throughout detailed design of our project. The most likely candidate for a house of quality is our material selection process, as our environment is very corrosive (saltwater in summer).

Work Plan and Project Deliverables

Our goal for this project is to provide the best overall mechanism to meet our client's requirements. We have 16 weeks to meet with our client and advisors to guide our decisions and warn us of potential problems before they delay the final delivery of the product. Each member of our group understands the importance of communication, both within the group and with our clients and advisors. We have already met with all concerned parties, and have established frequent communication with regular meetings. Between meetings, we have discussed potential issues and incrementally improved our design ideas. Our specific timeline is shown in detail below:



We plan to evaluate our progress and any deviations from the plan shown above at each and every group meeting. This will allow us to adjust our resources proactively so that we meet our final deadline without any surprises throughout the semester.

All group members are expected to make equal contributions to the completion of the project, and all group members understand the time and effort requirements needed to meet these goals. Each group member has also chosen a specific role based on his individual talents. Matt Ricciardi is our team leader and is responsible for coordinating communication and meetings between all parties. He will also continually evaluate our progress and establish intermediate goals to meet deadlines. Brian Back is our technical liaison. Brian has a strong fabrication background and access to machining resources. Ryan Wackerly is our purchasing agent. Ryan works in heavy industry maintenance and has experience purchasing from major suppliers. Zach Walker is our webpage specialist. Zach has extensive experience with designing, hosting, and maintaining small to medium scale web applications for small businesses and individual clients.

Proposed Budget

We believe that we our mechanism will make the most efficient use of material to build the most cost-effective mechanism possible, without sacrificing functionality or reliability. We will use common materials and commodity fasteners to build our mechanism. Some of the fabrication processes may be moderately complex, but our tolerances can be loose without sacrificing safety due to simple motions and low forces required. We are designing our project with reasonable cost and easy fabrication in mind. Our current budget has been compiled from a very preliminary bill of material and with order-of-magnitude pricing from major vendors:

Preliminary Budget

Bulk Material:	$150
• Stainless Steel Plate • Stainless Steel Rods	
Rod Connectors:	$150
• Rod End • Quick Connectors	
Misc. Materials:	$200
• Fasteners • Bearings • Handles • Prototyping	
Machining Costs:	$65/Hour
Testing Facilities:	$50/Hour
Total:	$500 + Machining and Test Time

References

The Hobie Cat website has an excellent description of the Mirage Drive System with pictures and videos to explain the mechanism's operation:

http://www.hobiecat.com/kayaking/miragedrive.html