CHAPTER 13
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CABIN LIFT SYSTEM FOR RACING SAILBOAT

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INTRODUCTION

A lift system is needed for the Challenged America racing sailboat to allow cabin access for sailors with disabilities. Once completed, the cabin lift system carries a user from the cockpit down to the floor of the cabin. The design must fulfill an extensive list of requirements where the main goals are user safety and minimal weight added to the existing structure. A system was designed where guide tracks are mounted to the existing ladder, with a seat assembly raised or lowered by an electric winch. At the top position, the seat back can be lowered to allow a sailor to slide from the cockpit to the seat or vice-versa. This is the optimal design due to its ability to transfer the user safely between locations, the addition of a minimal amount of weight, and ease of interfacing with the existing structure.

The Challenged America sailing program is modifying a Nelson-Marek 43 racing sailboat to accommodate crew members with a wide range of physical and sensory disabilities. This program is located in San Diego and is dedicated to introducing sailing as a therapeutic and rehabilitative activity to individuals with disabilities, their loved ones, and professionals in healthcare and rehabilitation. The cabin lift system will be used by several of the regular crew members during recreational and competitive sailing.

SUMMARY OF IMPACT

The purpose of this project is to design a lift system to allow non-ambulatory crew members independent mobility from the cockpit of the Challenged America racing sailboat to the cabin below and back up again.

TECHNICAL DESCRIPTION

The design is comprised of a seat assembly which rides on marine-grade tracks attached to the hand-rails of the existing companionway ladder, actuated by a sealed ATV winch. It requires minimal modification to existing boat structures, and will allow normal use of the companionway ladder when the lift is not in operation.

Fig. 13.1. Cabin lift system attached to mock-up of ladder.

The two guide rails are anodized aluminum extrusions which support recirculating ball-bearing cars; these are manufactured by Harken and typically used for travelers and other sail-management applications. The rails or tracks clamp to the vertical rails of the existing ladder and to brackets added to the top of the cabin. Two cars ride on each track and support the seat against lateral loads due to the pitching and rolling of the sailboat.

A fully sealed ATV winch (Warn XT15) provides the power to lift the seat through a range of about five feet. This model is selected for its environmental resistance, reasonable power requirements and generous load capacity. The winch is placed under the top step of the ladder to minimize any interference with the normal function of the ladder. Two separate low-stretch synthetic lines run from the winch drum up to pulleys mounted at the top of the guide track, then back down to the seat assembly.

The seat has rigid bottom and back panels, with side gusset plates to support the applied loads in the vertical and fore/aft directions. The back panel is hinged to allow it to be dropped down to the level of the cockpit opening. This enables a user to make a sliding transfer from the cockpit to the seat, and then flip the seatback up for support during the ride down. The seat bottom panel is also hinged; the front portion flips downward to support the seat panel so that it can be used as a step when the lift is in the lowered position.

The operation of the system is controlled by the user with sealed momentary-contact pushbutton switches – one for up and one for down. An automotive relay switches the 12VDC power from the boat's marine batteries, with limit switches to stop the vertical travel at top and bottom positions.

A wooden mock-up of the cabin and ladder was built for testing the system. The performance testing was successful, and integration onto the boat by Challenged America is planned for Summer 2009.

The cost of the lift system components is approximately $1900, with an additional $150 spent on the cabin mock-up.

Fig. 13.2. Use of the Cabin lift system demonstrated by a volunteer.

WINCHTOP GRINDER FOR SAILBOAT

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INTRODUCTION

A winch is a mechanism having a drum on which rope is coiled, and can be tightened with a crank or handle that allows easier adjusting or hoisting of sails. Traditional winches, ubiquitous on sailboats, rotate about a vertical axis and require significant arm, trunk and lower body strength to be used effectively. An ergonomically improved device would employ handles rotating about a horizontal axis using an opposing motion like a bicycle crank. Such systems, often referred to as pedestal grinders, are commonly used on large racing sailboats, allowing dedicated crew members to generate the higher forces needed to control large sails. If such a system could be adapted to smaller winches, it could allow crew members with limited lower body strength to work more effectively in the cockpit of a medium-sized sailboat.

The goal of this project is to design a mechanical adapter to an existing (traditional) winch, allowing a seated user to drive the winch with a bicycle-crank-like grinding motion. This winchtop grinder is designed for strength, light weight, ease of attachment/detachment, and corrosion resistance. The grinder is also needed to operate in both forward and reverse directions, in order to utilize the two- or three-speed gearing of the winches.

The project was sponsored by the Challenged America sailing program located in San Diego. This non-profit organization is dedicated to introducing sailing as a therapeutic and rehabilitative activity to individuals with disabilities, their loved ones, and professionals in healthcare and rehabilitation. Challenged America is modifying a high-performance Nelson-Marek 43 racing sailboat to accommodate crew members with a wide range of physical and sensory disabilities. Supportive seats with four-point harnesses allow crew members with disabilities including paraplegia to work effectively in the cockpit. The winchtop grinder adaptation will be used by several of the regular crew members during recreational and competitive sailing.

Fig. 13.2. Winchtop grinder components.

SUMMARY OF IMPACT

The winchtop grinder provides a portable device for crew members with limited lower body strength to comfortably and efficiently raise and adjust the sails of a boat.

TECHNICAL DESCRIPTION

The winch is a rotating drum with a star-shaped drive socket on top into which normally fits an L-shaped handle. This handle rotates in the horizontal plane and can easily be moved to different winches to adjust various sail control lines. The winchtop grinder replaces the conventional handle and converts an opposing vertical motion into a horizontal rotation that turns the winch.

The most critical element of this design is the right-angle drive between the crank handles and the output spline. Conventional right-angle gearboxes are typically designed for higher speed operation; in this case, the system must handle the full drive torque of at least 80 foot-pounds at very low speed. A standard bevel-gear unit with sufficient load ratings would have been prohibitively large and heavy. Consequently, the winchtop grinder is designed around a pair of commercial socket-drive universal joints. These were found to have sufficient torque capacity while being compact, inexpensive, durable, and easily replaced in the field if needed.

The rest of the winchtop grinder system consists of a tubular stainless steel crank shaft with a pair of rotating hand grips. A standard ½" drive socket connection attaches this shaft to the universal joints. Another output shaft (a modified socket extension) applies torque to the machined square drive spline that fits into the top of the winch. Each of the two shafts rotates on a pair of sealed ball bearings, which are mounted in a two-piece aluminum housing.

The resulting system provides a novel and useful winch accessory, enabling an individual to apply powerful and ergonomically efficient torque to a winch from a seated position. It requires no modification to the winches, and is easily removed to load or unload lines (ropes) from the winch. Additional improvements to the design are, further reductions in weight and streamlining the design to avoid sharp edges. The winchtop grinder assists sailors with disabilities to compete with their able-bodied counterparts at any level.

The total cost for parts and materials is approximately $500.

Fig.13.3. Winchtop grinder in use on racing sailboat.