CHAPTER 10
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KNOT-TYING DEVICE

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INTRODUCTION

Knot tying, an essential task in sailing, requires a high level of dexterity. The goal of this project was to design a device that would enable someone with limited dexterity (pincer grasp) of at least one hand to tie a bowline knot for a range of rope sizes. The requirements for the device were that it be: 1) portable; 2) capable of operating for an extended time in a marine environment; 3) secured easily during use; and 4) safe from cut or pinch hazard.

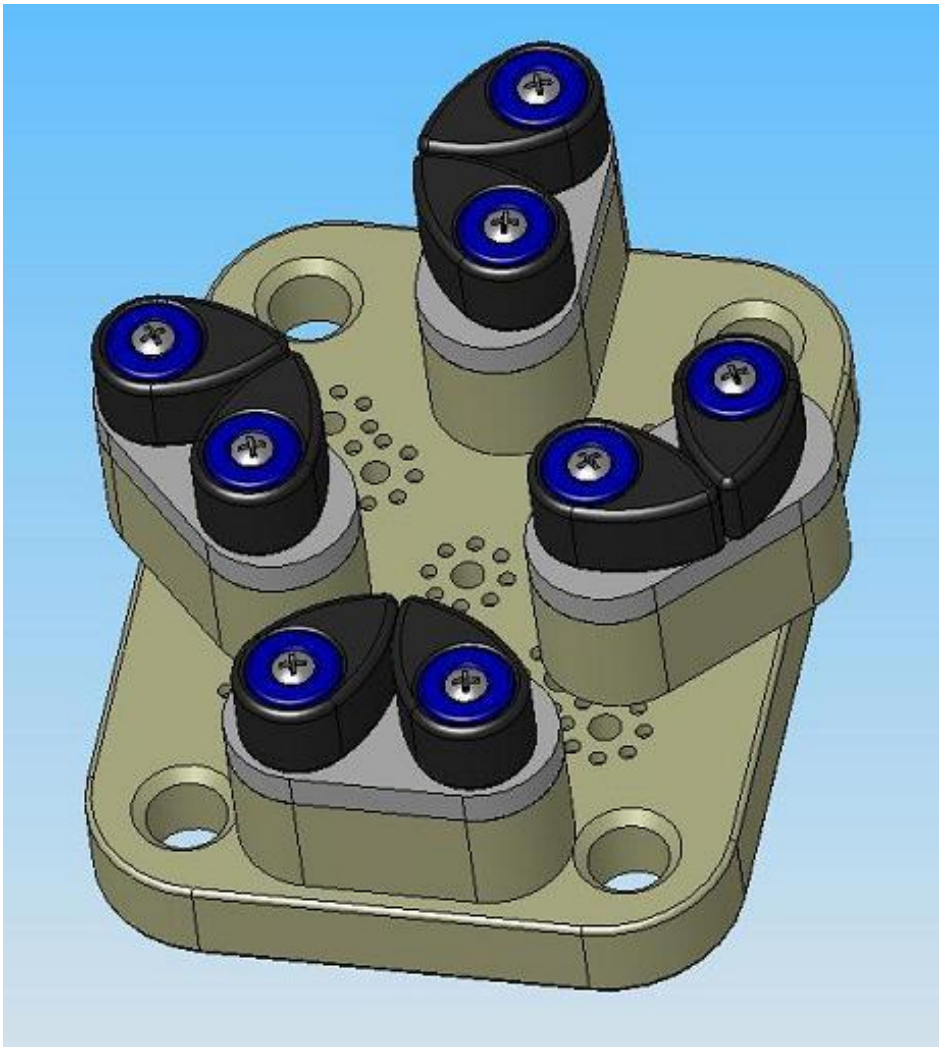

Fig. 10.1. CAD Model of Knot-Tying Device.

Important considerations in the design included: 1) user comfort; 2) safety; 3) protection from saltwater corrosion, temperature extremes, and dynamic loading forces due to motions of the boat; 4) accounting for electric power and weight limitations inherent in a racing boat.

SUMMARY OF IMPACT

The bowline knot is used to secure lines to sails, lash other objects to the boat, and is one of the most common knots needed on a sailboat. This device enables an individual with limited hand mobility to tie a bowline knot unassisted. No other device is known to be available as an assistive technology for tying knots.

TECHNICAL DESCRIPTION

A hand-held board with cleats attached to one side is used to hold a rope in position while tying a knot. The cleats can be positioned on the board in different arrangements to best facilitate a particular type of knot. The device consists of a plate machined of ABS, which can accommodate risers attached by a single threaded screw and oriented with pins. The risers have cleats attached that can be positioned to allow rope slippage in one direction but fixing it along the other. Four cleats (see Fig. 10.2) are needed to tie the bowline knot. The device can also be used to tie a half-hitch knot. Other knot styles are being tested.

The total cost of the project was $130.

Fig. 10.2. Final Prototype of Knot-Tying Device.

CENTER PEDESTAL GRINDER WITH PIVOTING BASE FOR RACING SAILBOAT

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INTRODUCTION

Winches are a common mechanical device used on sailboats for hauling in and tensioning a variety of sail handling and control lines. Traditional winches use a crank handle mounted directly to the vertical axis of the drum, which is wound in a circular direction. This arrangement requires the user to have substantial trunk and lower body strength to power the lateral motions required of the handle. This motion can pose an ergonomic challenge for able-bodied sailors and can be nearly impossible for individuals with physical disabilities or lower body strength limitations. The center pedestal grinder

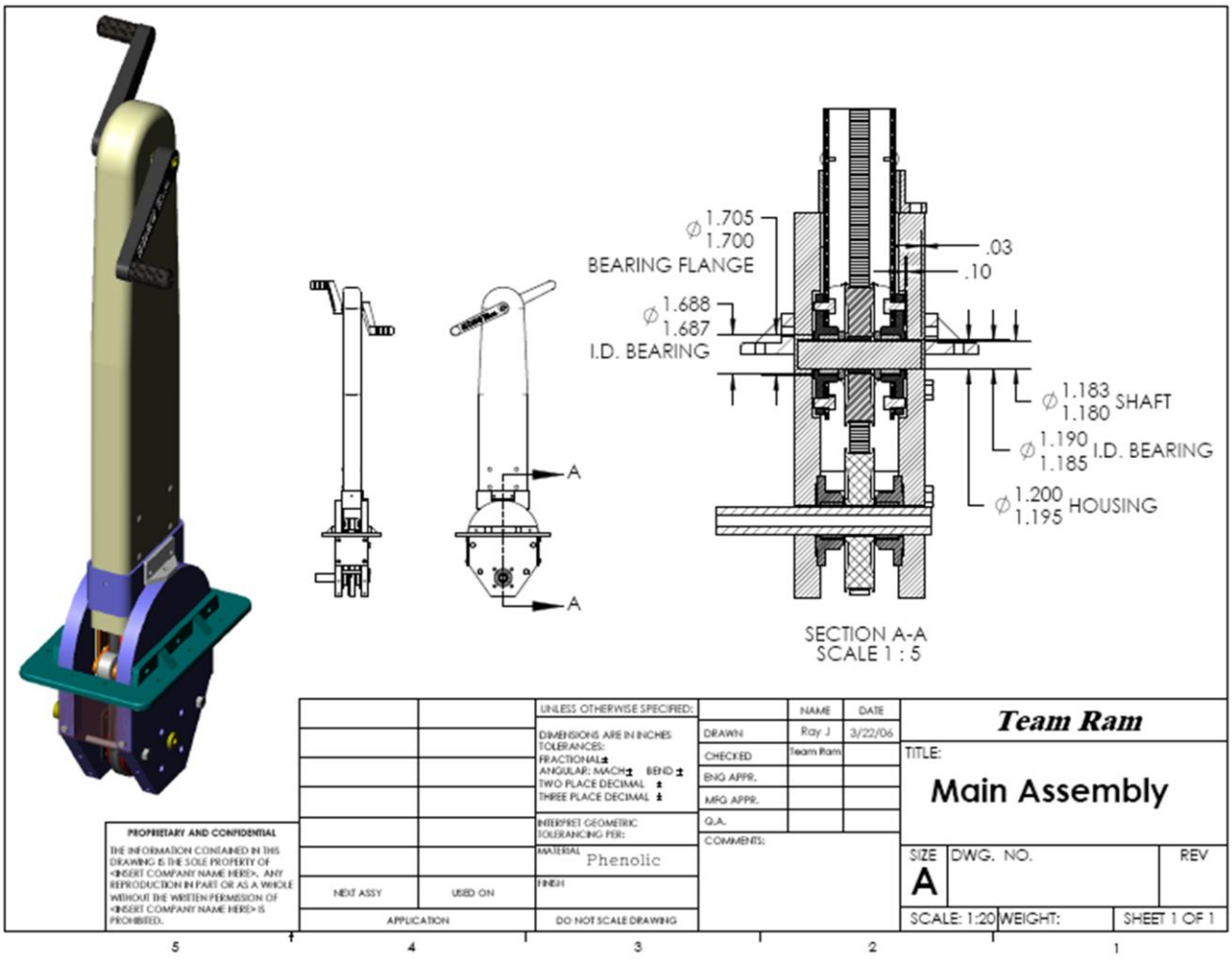

Fig. 10.3. CAD Model and Assembly Drawing of Pedestal Winch Grinder.

allows a single user to control the motion to several winches by interfacing with a gearbox mounted under the deck. The gearboxes provide multiple speeds and allow the user to direct power to different winch drums.

The goal of this project was to design a mechanical interface with a commercially available pedestal winch that could be rotated for use by a crewmember sitting on either the port or starboard side of the cockpit of a 40' racing boat. The pedestal would mate with commercially available gearbox and drive shaft components mounted below the deck.

SUMMARY OF IMPACT

The center pedestal grinder enables crew members with limited lower or upper body strength and mobility to control sailing line tension to raise and adjust the sails of a boat. The center pedestal allows crew members seated on deck-mounted chairs to work a variety of winches from a single position.

TECHNICAL DESCRIPTION

The pedestal grinder (see Fig. 10.4) is a common device in larger racing sailboats today, and is typically operated with both hands while in a standing or crouching position. The center pedestal winch grinder employs a "coffee grinding" mechanism that is mounted in the center of the boat's cockpit and is connected to winches on either side of the boat. The design enables crewmembers in a seated position, such as those with paraplegia or lower limb amputation, to effectively grind with a powerful, bicycle-like hand motion at chest level.

A belt drive pedestal from Harken served as the starting point, with Harken representatives providing help in securing the proper drive elements. Stock parts were chosen for the upper portion of the pedestal, including the hand crank assembly, bearings, pulleys, and toothed drive belt.

Once the standard moving parts were identified, the design tasks shifted to designing a pivoting base assembly to support the modified pedestal at the desired position and interface with the standard below-deck drive components. This assembly transfers the drive power from the pivot to the output shaft. This base includes a quick-release position lock accessible to the user and also holds a flange to mount the device to the deck. Prototype

Fig. 10.4. Prototype Pedestal Grinder.

assembly as well as patent disclosure filings are in progress.

The total cost of the project was $3500.

WHEELCHAIR LUGGAGE ASSIST DEVICE

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INTRODUCTION

A woman who uses a wheelchair and is an avid traveler requested a device that would aid her in travelling through airports with carry-on bags. There are devices currently marketed for attaching luggage to wheelchairs, but they are all rear-mounted, bulky, and meant to be used with an assistant.

The objective of this project was to design a luggage assist device that would allow people who use wheelchairs to view and access their carry-on luggage, enabling them to travel more independently. The design of the device was to minimize any negative impact on wheelchair mobility and maneuverability. Specific criteria included that the device: 1) not hinder the maneuverability of the chair; 2) enable the user to

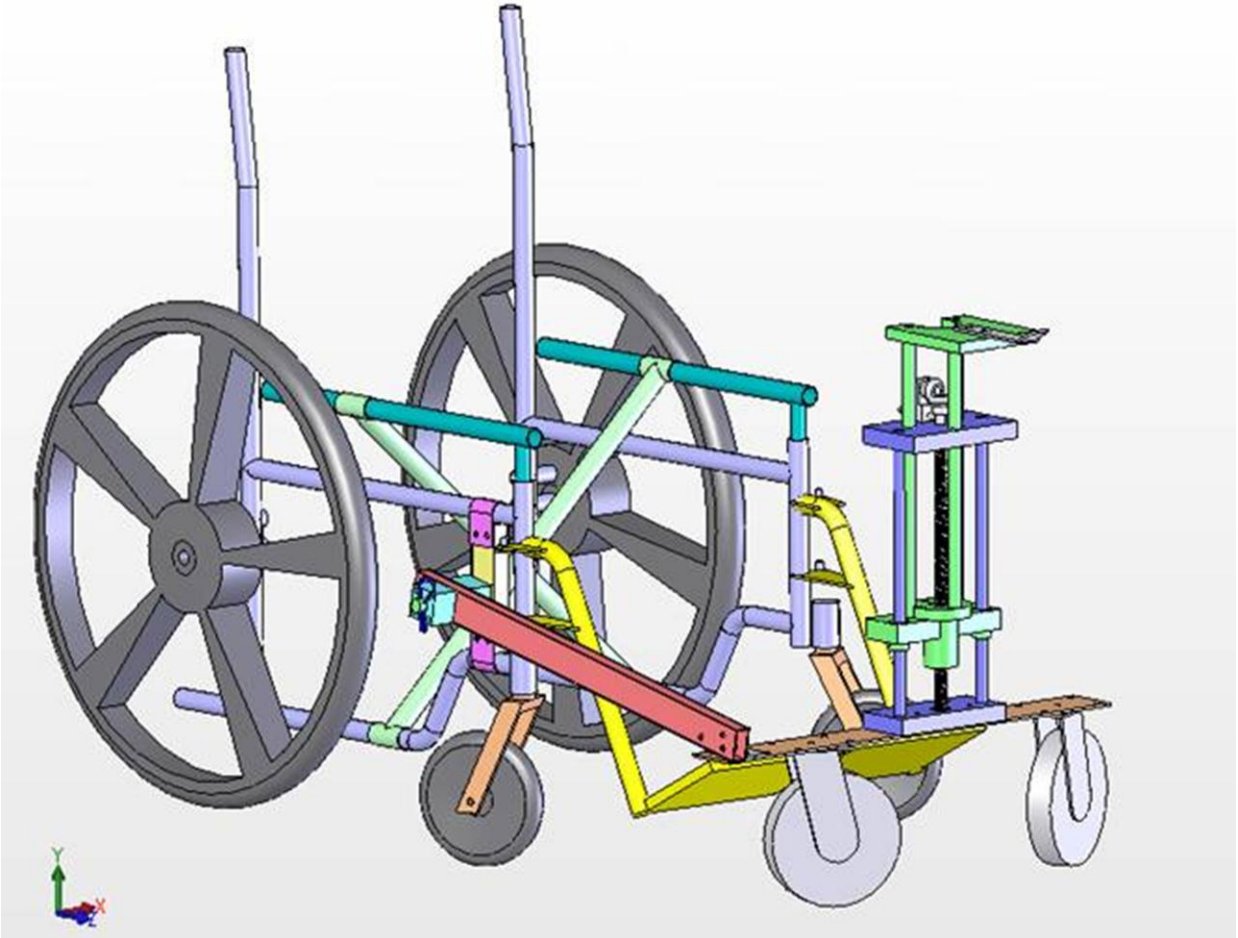

Fig. 10.5. CAD Model of Wheelchair Luggage Assist Device.

load and unload the packed bag without assistance; 3) allow for a standard carry-on size bag; and 4) allow the chair to collapse for storage; 5) be able to be mounted to a majority of standard chairs; 6) not touch the user unintentionally; and 7) allow the user to transfer in and out of chair.

The wheelchair luggage assist device (see Fig. 10.5) is used to assist people in wheelchairs in transporting their luggage without using their hands. It consists of a rack mounted in front of the wheelchair that can be tilted for loading and unloading and easily removed for storage (see Fig. 10.5).

SUMMARY OF IMPACT

The device carries the luggage in front of the user, keeping the bag in plain view at all times. The user can reach forward and add or remove things from the bag. Rear-mounted systems require the user to twist around to view or reach into the bag and typically require an assistant. The front-mounted design provides greater independence by keeping the bag in view and within easy reach of the wheelchair user. This design aids in security and compliance with airport safety regulations.

TECHNICAL DESCRIPTION

The wheelchair luggage assist device is mounted to the right front side of the wheelchair. It consists of an attachment plate and a pivoting arm that extends forward to a trolley. The design employs casters on a pivoting arm to keep all wheels and casters in contact with the ground when encountering uneven or transitional surfaces. The trolley has a base plate supported by two casters. On the base plate is a lead screw, connecting one stationary plate and one sliding plate, serving as the lifting mechanism. A hand crank operates the lead screw and moves the sliding plate upward, lifting the luggage. A prototype is shown in Fig. 10.6.

The device was made to fit to a common thread design available in most manual wheelchairs on the market. The most critical feature is the arrangement of the lower frame and down tubes connecting the drive wheels and casters along the bottom of the chair's frame. The design of the attachment plate is an "S" shaped rise that allows the caster to clear the otherwise low-slung tube. Future improvements of the design would be to improve the lifting mechanism for ease of use and to reduce the weight of the device.

The total cost of the project was $350.

Fig. 10.6. Prototype of Luggage Assist Device.