CHAPTER 15
UNIVERSITY OF SOUTH ALABAMA

School of Engineering
Mechanical Engineering Department
Mobile, Alabama 36688

Principal Investigator:

Cecil H. Ramage (205) 460-6168

Paper Product Loading Aid for a Goodwill Employee

Designers: Philip J. Davis, Chris DeArmon, David Epperson
Client Coordinator: O'Neal Collier, Goodwill Industries of Mobile
Robert Perry, Rehabilitation Engineer
Supervising Professor: Dr. A. J. Wilhelm
Department of Mechanical Engineering
University of South Alabama
Mobile, Alabama 36688

INTRODUCTION

Goodwill Industries of Mobile Area employs mentally and physically disabled individuals to repackage paper products into larger bags for warehouse-type retailers. Several employees have disabilities that prevent them from performing this task at a rate equal to other non-disabled employees.

In order for the re-packaging process to be efficient without an assisting device, the employee must use two hands: one to open the plastic bag, and one to load the paper products into the bag. A Goodwill employee named Ernestine had polio at the age of nine months, which disabled her left arm. Because of this, Ernestine has to lean against the edge of the table, securing one edge of the bag, in order to open the bag with her other arm. Ernestine then has to grab a paper product and stuff it into the plastic bag. This is difficult, since this motion must be completed before the bag closes.

A loading fixture was designed and constructed to allow disabled individuals to package paper products at a faster rate. Ideas investigated for the design are as follows:

- Compressed Air Source with Synchronized Clip
- Ramp Made of Sheet Steel
- Blower with Synchronized Clip

Compressed Air Source with a Synchronized Clip:
In this proposed design, compressed air is used to inflate the bag. The idea was discarded because the volume flow of air produced is not enough to fully open the bags. Also, the high velocity of the air tended to destroy the plastic bags by catching an edge of the bag and ripping it. For these reasons, it was decided that a compressed air source is not an acceptable solution and it was not pursued any further.

Sheet Steel Ramp:
This design is based on the concept of a sheet steel wedge that keeps the end of the bag open during the loading sequence.

Blower with a Synchronized Clip:
The design consists of a dual squirrel cage fan with a solenoid actuated holding clamp. The blower design is based on the idea of inflating the bag with moving air, which would keep the bag fully open, until the moving air source is removed at the end of the loading sequence. The bag is then held in place by a clamp actuated during the loading sequence.

Design Selection
The ramp design was not chosen because it failed to meet crucial design criteria of at least a 10% increase in packaging rate of production. The blower device, however, exceeded this crucial design criteria by allowing Ernestine to package toilet tissue at a rate 30% faster, and package paper towels at a rate 23% faster than without the device. The device is shown in Figure 15.1. These rate increases are determined from a time study of a video taping of the two loading operations. The blower device was chosen as the final design because it met all of the constraints and exceeded all of the design criteria. The diagram in Figure 15.2 is a graphic representation of the design.

Summary of Impact

Ernestine is now able to package paper products at a greatly increased rate, and is also enjoying having such a technical device at her workstation. The loading aid is a pleasure to use, is non-obstructive, and is expected to withstand assembly line conditions.

The line supervisor indicated that Ernestine would like to remove the "buzzer" from the loading aid. I believe that this buzzing is from the clip actuating solenoid.

The staff of Goodwill Industries of Mobile is very pleased with the students' sincerity and desire to make certain the device fit well with Emestine.

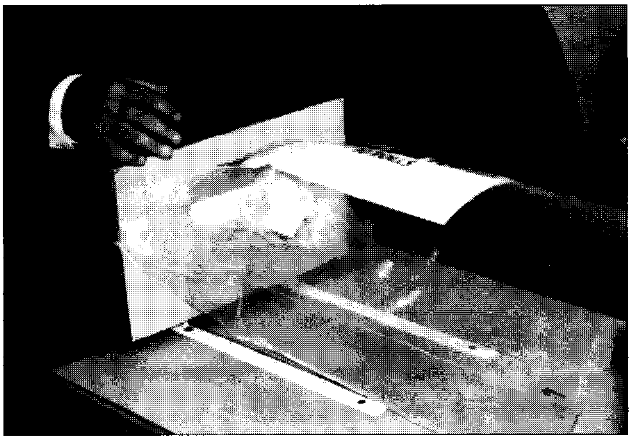

Figure 15.1. Photograph of Paper Product Loading Aid.

TECHNICAL DESCRIPTION

Operation:

An electronic system controls the loading aid components to simultaneously energize the blower motor and de-energize the clamp actuating solenoid. The switch mounted on the electronics box activates a double-pole, double-throw relay which either energizes the actuating solenoid or the blower motor.

The device is operated by the following sequence of steps:

1. The button on control box is pressed. This raises the bag clamp by energizing the solenoid. Power to blower is disengaged.

2. The lip on the open end of the bag is placed under raised clamp.

3. The button is pressed again. The spring-loaded clamp is released by de-energizing the solenoid. The blower is energized and the bag inflates.

4. The paper products are loaded into bag.

5. The button is pressed to stop the blower and raise the clamp. This releases the bag.

The device opens plastic bags quickly and easily, and keeps the bags open in order to allow quick and easy loading of the paper products. Additionally, Emestine claims that the device allows her to derive greater pleasure from her job in that the frustration she previously experienced due to the awkward nature of packaging paper products with the use of only one arm is significantly lessened. The approximate total cost of the blower device is $300, not including labor.

The ramp device, while even more cost efficient than the blower device and simple to construct, did not meet design criteria of at least a 10% increase in rates of production for both paper towels and toilet tissue. The principal problem with the ramp device is that while it reduced the amount of time Ernestine used to actually place the products into the bags, all the time saved in this step is used up by the time used to fit the bag over the device in preparation for loading.

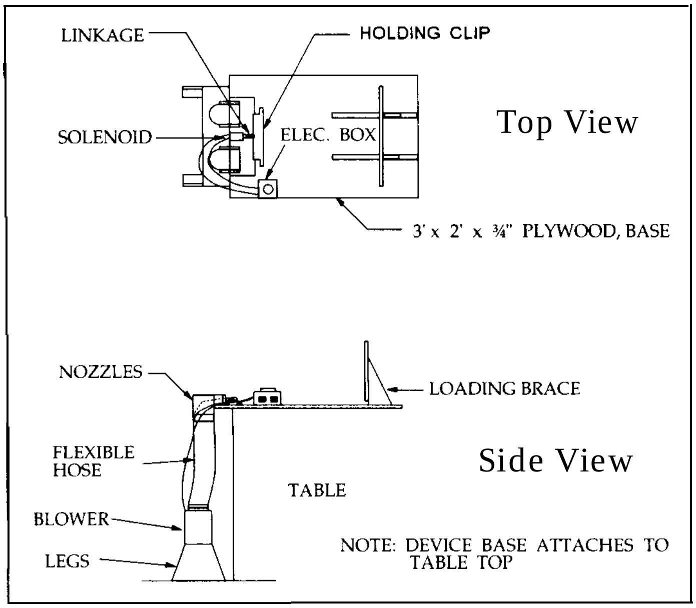

Figure 15.2. Drawing of Paper Product Loading Aid.

TIG Welding Adaptation

Designers: Guy Chetrit, James Dungan, John Glover
Client's Coordinators: Robert Perry, Rehabilitation Engineer
Supervising Professor: Dr. Cecil Ramage
Department of Mechanical Engineering
University of South Alabama
Mobile, AL 36688

INTRODUCTION

Matthew, a Tungsten-Inert Gas (TIG) welder by trade, had his right arm amputated below his elbow. He has learned to weld with his left hand. He has a prosthesis designed to accept various adapters that allow him to perform various tasks. He has attempted to devise adapters to feed a welding rod into the molten area as he welds. His attempts, for one reason or another, have not met his satisfaction. In addition, the inability to efficiently weld using the TIG process has hampered his ability to remain employed. The TIG welding process consists of shrouding the weld arc with an inert gas (usually Argon) in order to produce high-quality welds. With the TIG welding process, tungsten is used as an electrode to produce the arc. The welding rod is needed to provide make-up metal for the weld.

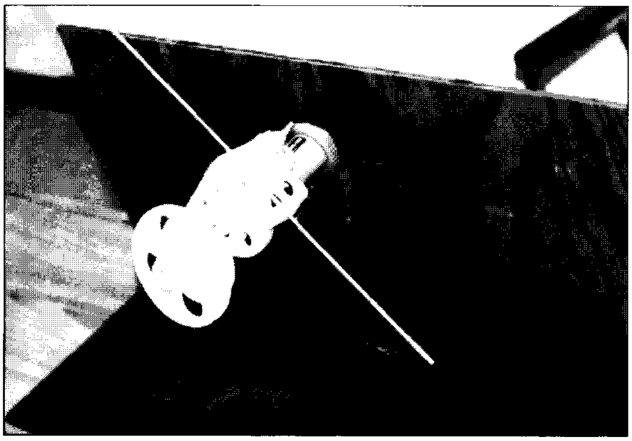

Figure 15.3. TIG Welding Adaptation.

The design group's objective is to design and manufacture an adaptation for Matthew's prosthesis that will efficiently advance the rod for continuous welding with little or no effort exerted by the welder. In doing this, Matthew will hopefully gain confidence in the device and will be competitive with other TIG welders.

One possible design employs a sharp point slider (a pivoting device that is L-shaped with a sharp tip to grip the rod). Cable tension acting on the top of the pivot point creates forward motion of the edge, therefore advancing the rod. The cable tension is created by extending the prosthesis arm or possibly by the other hand.

A second design configuration uses a ratcheting device with friction feed rollers to guide and advance the rod. A spring loaded roller presses the rod against the toothed surface of the ratchet. Cable tension creates the ratcheting motion to advance the rod.

A third design possibility uses an actuating rod that provides a stroke motion that is attached to the upper arm, and run the length of the prosthesis. The advancement of the rod occurs with the pumping motion of the arm.

The current prosthesis has a clamp at the end and is actuated by extending the arm to create cable tension. This clamp could possibly be modified to hold and advance the rods. A ball joint would be used at the end of the prosthesis with all design solutions to increase flexibility. The joint would act as a wrist and give the motion required to feed the rod to the weld puddle.

SUMMARY OF IMPACT

When this device is coupled and fit to Matthew's prosthesis, he should be able to operate it in a manner very similar to everyday welding, particularly because of the ball joint.

If this device is acceptable to the user, or inconspicuous enough, he would not have to stop welding until a new rod is needed, thus increasing his rate of welding and making him more competitive.

TECHNICAL DESCRIPTION

The prosthesis consists of an aluminum feeder mechanism and a composite swivel ball joint. Advancing the rod is powered by the friction between the work and the drive wheel. A feed ratio of 2.25:1 was used in the final design; that is, for every 1 inch the drive wheel travels, 2.25 inches of wire will be fed. An aluminum frame and components were chosen because aluminum is very lightweight, strong and also resists corrosion very well. A photograph of the prosthesis is shown in Figure 15.3.

The flexibility of the wire feeding device is very important because of the many different positions the welder is expect to weld. Matthew basically has no right hand or wrist; therefore, the swivel ball joint is determined to be the best replacement for wrist movement and flexibility. The ball joint is easily operated by the use of a single twist key. The ball joint allows 360” of rotation about the X-axis and 180” of rotation about the Y-axis and Z-axis. The overall length of the ball joint is 2.875” and is $1\frac{1}{2}$" in diameter.

The drive wheel is made of .375 inch thick aluminum and is knurled on the edges to grip the welded material. A course knurl is used to give the best gripping surface possible for the drive wheel. The diameter of the drive wheel is 4", which is about the width across the knuckles of a human hand. The drive wheel was located $1\frac{1}{2}$" away from the weld seam or wire feed to reduce the effects of heat on the device and interference with the welding process.

The drive gears are 20°, full depth, spur gears with a 32 pitch and a gear ratio of 3:1. The gears are made of Delrin, a very strong and lightweight plastic. The pinch wheel is made of $\frac{1}{4}$" thick aluminum and knurled to grip the welding rod which is to be fed. The size of the pinch wheel was determined by the feed ratio of 2.25:1. The required size of the pinch wheel is 3”. The idler wheel is made of $\frac{1}{4}$" thick aluminum, and has a groove machined in the centerline circumference that is to used to maintain the contact between the different size wires and the pinch wheel. The idler wheel is mounted in a manner to maintain compression between the pinch wheel and idler wheel.

The ratchet device is used to allow only forward wire feed. This is to prevent the wire from reversing the wire feed during the welding process. The spring ratchet is mounted to the frame to stop backwards rotation of the gears. The shafts for the device are made of 5/16" diameter aluminum rods, and are mounted using retaining clips. The gears and drive wheels are pressed on the shafts and keyed to ensure a secure fit. The frame and wire guide are made of 1" by .1875" aluminum bar. The wire guide is necessary to add strength to the device, while holding the rod steady during the welding process.

The weight of the prosthesis adaptation is approximately $1\frac{1}{2}$ lb. The cost of manufacturing the adaptation is $450.

Design and Fabrication of a Child Suspension Walker

Designers: Shelley Combs, Phu Nguyen, Frank DeCord
Client Coordinators: Robert Perry, Rehabilitation Engineer
Supervising Professor: Dr. Cecil Ramage
Department of Mechanical Engineering
University of South Alabama
Mobile, Alabama 36608

INTRODUCTION

A suspension walking device was designed and built for an eleven-year-old child with athetoid quadriplegic cerebral palsy. The child had surgery in the past year to correct the orientation and range of motion of his legs. However, he still lacks the control and coordination of his muscoskeletal system to walk unassisted, and is growing too heavy to continue to be supported by his parents. The suspension walker, which is comprised of a four-wheeled frame and a detachable harness, gives the child the stability and freedom to walk on his own once he is positioned in the device. The detachable harness reduces the total amount of time and effort required to place him in the walker. This suspension walker allows him to exercise his legs more frequently and for longer periods of time. A photograph of the walker is presented in Figure 15.4.

SUMMARY OF IMPACT

The suspension walker is having a great impact on Daryl's life. We have found that it is easier to control on grass and carpet than on bare floors, and it still takes more than one person to put Daryl in and take him out. Daryl is still learning to steer.

The walker provides partial weight support and Daryl walks at his own pace without his mother or father straining their backs. The walker is durable and good looking, and should provide many years of exercise and recreation.

TECHNICAL DESCRIPTION

The suspension walker was specifically designed for this particular child. An existing walker could not be easily modified for his use due to his physical abilities, and the space constraints of his living quarters.

The walker frame is made of aluminum to minimize weight. Front casters provided the maneuverability for his excursions around the house and 16-inch-diameter bicycle wheels mounted at the rear provided stability. The width of the assembled walker is limited by the width of the smallest door he has to traverse, 28 inches. The front of the bottom bar is lowered to act a guard to resist damage to the walker and to prevent the walker from tipping.

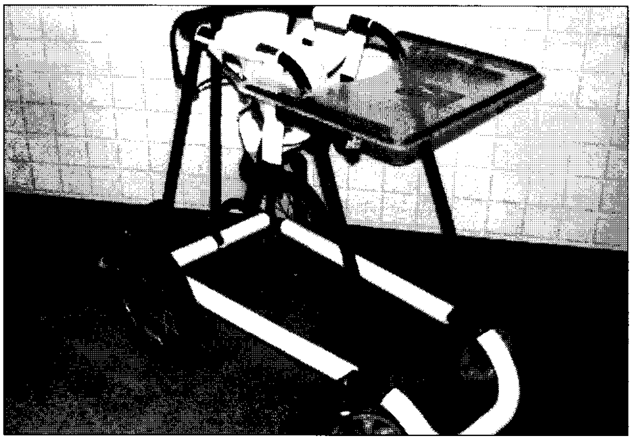

Figure 15.4. Photograph of a Child Suspension Walker.

Major features of the design include a provision to attach the child's wheel chair tray to the frame, a provision to adjust the height of the frame by 2 inches, and a detachable harness. Hinged extensions were attached to the frame to provide for the attachment of the child's wheel chair tray when placed in the down position and to provide for ease in positioning the child in the walker when in the up position. The attached tray provides the child a new device that incorporates the familiarity of an old item to which he had become accustomed. In addition, the tray provided additional stability to his upper extremities.

The frame height is made adjustable by the addition of a back wheel plate assembly. The assembly consistes of a plate welded to the frame with three holes spaced one inch apart. This enabled the back wheels to be removed and reassembled in one of the lower holes of the plate. This allowed for an increase of two inches in frame height.

The support harness is designed to be detachable from the frame. The harness is made detachable in order to be placed on the child when he is laying down. Once in place, the child and harness can be lifted and hooked onto the frame. This method reduces the amount of lifting necessary to position the child in the frame, and requires only one person to perform. The harness was constructed, shaped to Daryl's body, and then modified for the attachment of nylon strap supports. Four nylon straps pass through slits cut in the harness to form a hook type fixture to support his legs. Another piece of nylon went around each of his thighs, and fastened with Velcro to support his torso.

Total project cost of the project was $375.

Design of a Weaving Loom for L'Arche Mobile Inc.

Designers: Charles Fulcher, Ronald Johns, Dimitrios Mathews, Frank Bush, Jr.
Client Coordinator: A. C. Reeves
Supervising Professor: Dr. George Douglas
Department of Mechanical Engineering
University of South Alabama
Mobile, Alabama 36688

INTRODUCTION

L'Arche of Mobile is a Christian community composed of physically and mentally challenged individuals living together as a family in several homes with an instructional staff. The L'Arche community requested a weaving loom to be designed and built for making place mats. It is desired that the loom be usable by most members of the community with minimal supervisory input. This necessitated that the loom have a simple, intuitive input motion to alternate the warp threads and provide a mechanism that allows for more than one weaving per set of threads.

The problem addressed is the design and construction of a rigid heddle loom using a crank-slider mechanism to transmit an arm handle motion into a vertical motion of the heddle, which alternates the warp threads. Multiple weavings per set of threads were accomplished by furnishing the loom with a supply roller, which held the unused threads, and a take-up roller, which collected the finished work and advanced a new set of threads. A photograph of the loom is shown in Figure 15.5.

Other design solutions considered for alternating the weaving threads are an electronically driven linear actuator, a gear and pulley system, and a screw drive. These are not chosen primarily because they compromised several of the design objectives, two of which are design durability and a simple user input motion.

SUMMARY OF IMPACT

The loom was delivered and preliminary testing has been done. No major problems have been encountered. The loom has one very positive attribute, the rollers on each end greatly reduce the time expended when a product is completed. This releases the supervisor to perform other tasks.

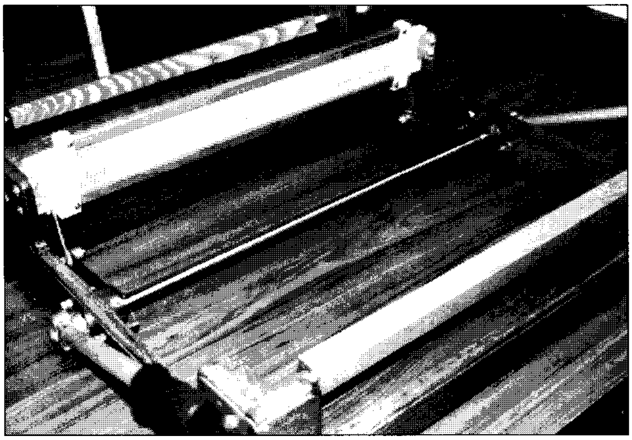

Figure 15.5. Photograph of a Weaving Loom

TECHNICAL DESCRIPTION

Definition of Terms:

1. Warp-the thread(s) that lie lengthwise on the loom frame
2. Weft-the thread(s) that is interwoven with the warp threads
3. Shed-the opening made by raising or lowering the warp threads through which the weft yarn passes
4. Shuttle-a device which carries the weft through the shed
5. Heddle-a device which is used to lift the warp threads in order to create the shed

The loom operates by moving the warp threads vertically to create a shed. The shuttle is then passed through the shed to the other side of the loom. Then the warp threads are moved in the opposite direction creating another shed. The shuttle is then passed to the previous side. This procedure is repeated until the desired weaving is completed.

The loom design uses a rigid heddle to alternate the warp threads. Heddle mounts are attached to either side of the heddle. The heddle mounts serve two purposes: they attach the heddle to the coupler links and they also serve as inserts for the guide rails. The guide rails ensure that the heddle moves in a vertical direction.

The coupler links are part of the crank-slider linkages which transmit the user input motion to heddle. The input crank links, which are connected to the coupler link by pin joints, are rigidly connected to the main shaft, which connects two straight arm handles. The arm handles are pulled down 15” from their equilibrium position to lift the warp threads up and pushed forward 15” to move the warp threads down.

The warp threads are advanced by turning a pair of rectangular wooden rollers which are attached to both ends of the loom frame. The rear roller, which initially holds the desired amount of thread to be used, feeds the warp threads to the take-up roller, or the front roller, as the user continues to weave. The rollers allow for approximately 20 feet of warp thread to be installed thereby allowing more than one weaving per warp thread set.

The cost of the loom project is approximately $205.