
CHAPTER 11

STATE UNIVERSITY OF NEW YORK AT BUFFALO

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Torso Support Walker Allowed Seven Year-Old Girl to Walk for First Time

Student Designers: Michael P. Girard, Frederick A. Roy, Gary L. Voight
Handicapped Coordinator: Jim and Judy Oubre,
Supervising Professor: Dr. Joseph C. Mollendorf
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FINAL EDITION

THE BUFFALO NEWS

258 Pages

SUNDAY, DECEMBER 10, 1989

\$1.25



Sarah Oubre skates with her new walker, flanked by mother Judy Oubre, left, and father Jim Oubre on a Buffalo Leisure Rink.

INTRODUCTION

Sarah Oubre, age 7, suffers from cerebral palsy. As a result, her limited motor ability requires her to use a walker for independent mobility. Parents **Jim and Judy Oubre** have enrolled Sarah in the SABAH (Skating Association for the Blind and Handicapped) program as a recreational activity. The program is well known for its therapeutic benefits to participants. The Oubres will participate in formal lessons from October 1989 to February 1990 at the Orchard Park Leisure Rink.

Sarah's original walker was a box-like round-tubed frame on casters, with a bicycle seat suspended from three points. The design allowed Sarah to sit on the seat, rather than to bear her own weight by standing. This prompted Sarah to move backward by pushing off the ground with her feet, as if she was moving away from a desk in an office chair. This backward motion, encouraged by the original walker, was of negative therapeutic value, as viewed in terms of developing an upright forward walking posture.

Walker helps patient from wheelchair to ice

UB invention brings happiness to girl, 7, who, until two weeks ago, didn't walk

By MARY SHERIDAN
Staff Reporter

Sarah Oubre giggled and clapped her hands as she slowly inched across the skating rink.

"I was let around here about 10 feet, the 7-year-old girl has only been walking for two weeks."

"Who says so?" said the mother, Judy Oubre.

Room with several people. An old-fashioned ice rink in a schoolhouse, unable to even get around for her conventional walker.

But during the past three months, a University at Buffalo professor and some of his engineering students designed a walker that not only lets her walk, it lets her walk with a little more grace.

The child, an only child and second in the family, had been in a wheelchair for two years, a time when her mother, Judy, was at the height of her life.

"I was thinking a good time," Sarah said, looking up innocently when it was her turn to walk.

Sarah's journey to the rink was not without its challenges. Her mother, Judy, had to be convinced by her father, Jim, that she should try walking.

Her father, Jim, was the one who suggested Sarah might enjoy passing a walking stick to her for the first time. The teacher, Harris

Wright, is a volunteer with the Buffalo group, the SABAH, an acronym for the Blind and Handicapped.

When Harris asked the girl, last summer, she was given a conventional walker used by many of the handicapped skaters. However, because of her awkward condition, she was unable to use it.

She suggested the purchase of the new walker. Elizabeth H. Henshaw, is married to a mechanical engineering professor at the University at Buffalo.

The professor, Dr. Joseph C. Mollendorf, designed a wheelchair and invented engineering the new walker.

Making a walker for Sarah was not an easy task. The design of the chair was a challenge. The new walker, the one that Sarah is using now, was designed by Harris, Wright, and Mollendorf.

The new walker, the one that Sarah is using now, was designed by Harris, Wright, and Mollendorf.

"They'll let it walk on its own, with wheels and what it needs to allow to get it, it always nervous to make it perfect for me," Mrs. Oubre said.

Two weeks ago, Sarah came to the UB laboratory where the walker was being tested.

She got into her walker, and

she skated.

Skater: Girl looked forward to skating

Continued from Page 1

the first time in her life, she was able to walk.

"She got it so she just took off," Mrs. Oubre said. "I'm not the best, she was so excited."

"She said, 'Mommy, Mommy, I'm going to be a skater.' Then the 'mommy' around, and said, 'I'm excited.'"

As her father looked on, Sarah's mother was so proud of her. She was so proud of her.

The walker is designed to accommodate Sarah's weight, so that she can push her weight forward to enter with or skate.

The project is one of the 100 students are designing this year with a five-year grant. Mollendorf received from the National Sci-

ence Foundation.

The other projects are also aimed at helping handicapped persons. They include a hand-powered truck for a child paralyzed from the waist down and a car-

rying device for a child who cannot walk.

Under the grant, the researchers can use graduate students to help them design.

Mollendorf said, however, that to improve parents are making the walking the computer comparison with a five-year grant. Mollendorf

received from the National Sci-

For Sarah to participate in the SABAH program this past summer, the design of the original walker required that a parent lift and hold Sarah from the rear belt loop so that she maintained an upright position. The prohibitive exertion for either parent allowed for only short periods of exercise. Sarah was able, with difficulty, to emulate the skating/walking motion.

SUMMARY OF IMPACT

Overall this project has been very successful and satisfies all the specified requirements. The Torso Support System (TSS) is designed such that Sarah now has the means to practice walking skills that, until now, were very limited. The features of the TSS and how they accommodate Sarah's needs will now be addressed.

- The unpadded seat encourages Sarah to bear her own weight. This causes a slight discomfort to prevent her from being lazy, but provides sufficient support if she tires.
- The actual Torso Support mandates the forward stance necessary for Sarah to propel herself forward. This is also padded sufficiently to ensure Sarah's comfort over an extended use.
- The Plexiglass skirts prevent any problem Sarah may have experienced with her feet becoming entangled in the walker frame. They also channel her feet in a longitudinal direction to encourage her to walk in a straight forward motion.
- The castors have been "pinned" with removable bolts so that Sarah can master the straight, forward motion. When Sarah gains sufficient strength and skill the pins can be removed to provide both greater mobility and therapy that would result from being able to walk in other than straight line directions.
- The Torso Support System has a great deal of adjustability incorporated in the design. The system can be moved longitudinally and vertically. The degree of inclination of the Torso Support can be changed as well as the distance between the Torso Support and the seat. This will allow use of the walker both on and off the ice, adjust to a more erect stance as Sarah improves, and adjust for Sarah's growth.
- The "on-board tool kit" and standardized fasteners allow quick and easy adjustability.
- The use of the existing walker with minimal structural change gives it greater versatility (with or without TSS). It was also more economically feasible to implement the existing walker than to create a wholly new walker design.

We have been encouraged by Sarah's physical therapists that Sarah's skills will improve rapidly when Sarah can use this device on a daily basis. Sarah's parents are great motivators and will play a very important role in her therapy. Sarah is currently much stronger on her left side. She is prone to push off with both feet instead of using her feet alternating, thus she needs coaching. Sarah will benefit greatly from parental assistance and coaching as she becomes stronger.

TECHNICAL DESCRIPTION

Analysis of Sarah using the original walker, and input from her parents, suggested the new design should position Sarah in an upright and pitched forward stance. The design group agreed this would be best accomplished by modifying the original walker design.

The most obvious alternative - to reposition the seat - was explored. By shortening the rear straps, the front of the seat was angled down. Sarah experienced significant discomfort in this position, since she attempted to support her weight on the center strap running between her legs to the front of the seat.

Various supporting criteria in addition to the desired stance, were determined to be requirements of the new walker:

- Require user to bear her own weight
- Preclude inclination for Sarah to move backward
- Foster development of walking skills
- Provide general user comfort
- Provide minimal passive support of full body weight for safety and when client tires
- Maintain overall size of original walker
- Preserve integrity of construction of original walker, i.e., no holes should be drilled in frame members
- Allow for use both on and off the ice
- Allow for adaptations as user gains mastery of walking skills
- Provide adjustments to allow for some physical user growth
- Prototype of design should be completed by 1 November 1989

Solution

The bicycle seat and support hoop were removed from the original walker. An aluminum tube, sized for a friction fit, was bent to a U-shape and inserted in the existing frame. A square carbon steel tube, the "trunk", was attached using U-bolts to the

aluminum tube below in the rear, and to the existing frame member below in front. The trunk had milled vertical and horizontal slots running longitudinally for adjustment of supports to be attached. Together these two elements extend the possible range of user motion and provided a base to mount other elements, yet maintain the integrity of the existing frame.

Both a forward support member and a seat support were mounted to the trunk. Each was connected to the torso support/seat linkage. The linkage features a wooden seat, connected by a seat post to the seat support, and connected by hinge to the torso support. The torso support, backed by sheet metal, was molded of AquaplastTM by Ms. France. The forward support member completed the connection of the torso support to the trunk.

The hinge link was constructed from steel. Unless noted, all other components and minor brackets, plates, etc., were fabricated of aluminum. US sized fasteners and hardware were used throughout.

The emphasis of this approach was to provide a maximum degree of adjustability. The seat is adjustable in height and longitudinal position. The torso support-to-seat distance is adjustable along the hinge link. The forward upright and seat supports are adjustable together (for relative user position within the frame) or individually. Overall, any reasonable angle of inclination is available in at least two configurations.

Results

The test results are summarized chronologically, in terms of Sarah's progress and design changes implemented.

First Trial Session - Oubre Residence - November 1989

The carpeted floors and confines of the Oubre residence prohibited extensive testing. The walker accommodated Sarah well in terms of size and support. She experienced difficulty moving in a straight line, probably due to unequal strength in her legs. Sarah's feet tangled in the extended seat post. The hinge link, fabricated of heavy sheet metal, deformed to an unacceptable degree. It was replaced by one of steel strip before the next session. In general, the Oubres and the design group expressed confidence. Permission was granted to make any necessary frame alterations.

Second Trial - Jarvis Hall - 28 November 1989

Physical Therapist Amy France and Dr. Mollendorf were both present. The wide hallway provided an excellent proving ground. Sarah moved satisfactorily in the walker. Side and center Plexiglass skirts were proposed to prohibit the entanglement of her feet. A decision was made to "pin" the casters to allow only straight line motion. Ms. France suggested two straps around torso support would be best for stability.

Third Trial Session - Leisure Rink - 1 December 1989

This was the first trial of the torso support system on ice. An initial ground test showed positive results with the skirts in place and the wheels "pinned". Further results on ice were very positive. Wheel hole covers for the skirts were deemed necessary to prohibit interference with Sarah's skate blades. Graduations along adjustable members were proposed.

Fourth Trial Session - Jarvis Hall - 5 December 1989

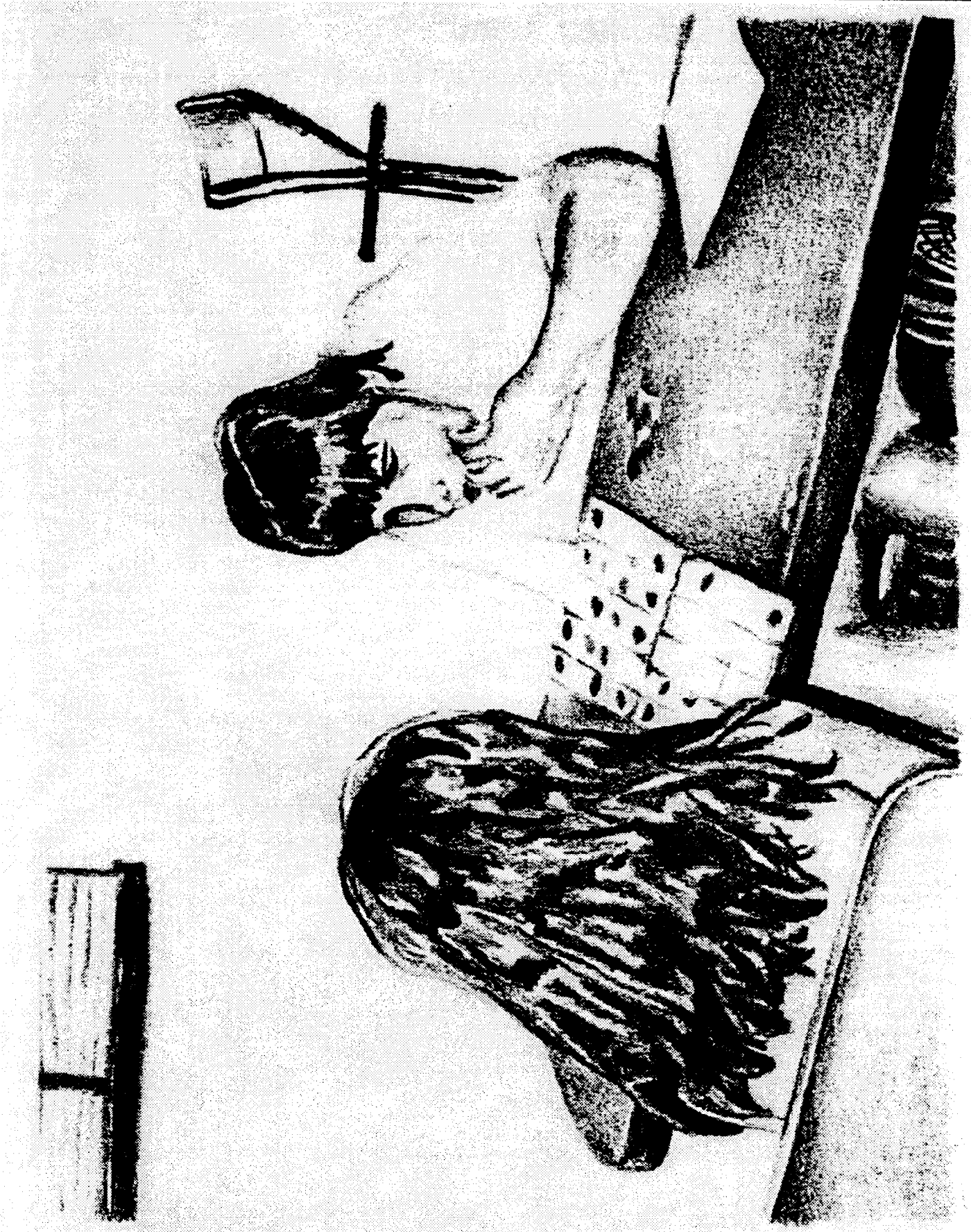
With the wheel hole covers in place, Sarah moved sixty feet under her own effort. Ground adjustment settings were determined. An on-board tool kit for standardized fasteners was required.

Fifth Trial Session - Leisure Rink - 8 December 1989

Channel 7 News and The Buffalo News reporters were present. Sarah demonstrated excellent familiarity and progress with the walker.

Project Turnover - Leisure Rink - 15 December 1989

The walker was to be presented to the Oubres. The total project cost was about \$150.



Special Switch Operated Remote Television Controller To Permit TV Control by Individuals with Limited-Function

Student Designer: Joseph G. Griffen

Handicapped Coordinator: Dr. Ronald Stein,

Supervising Professor: Dr. Joseph C. Mollendorf

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INTRODUCTION

The device described here is a television controller for a quadriplegic boy, Matthew. He only has use of his head and uses an electric wheelchair. He operates this chair by using head switches. Besides slight gestures, he communicates via a computer voice and Morse code. Matthew is reliant on his family, so any improvement would allow him more freedom. A television controller would help him and his family attain this. Before this project, he had a controller that permitted him to rotate through the channels. Consequently, a family member was needed to turn the TV on or off. The presently described controller allows him to change channels and to turn the set on and off. All the parts are store-bought and no machining is needed, so it is of minimal cost. The device is a conventional universal remote control that can be purchased at an electronics or appliance store. It has been modified so the on/off and channel changing functions can be controlled externally. The external controls are switches triggered by head motions so no other body motion is needed. Two other designs were considered but, due to complexity and cost, were not pursued. They were the mechanical arm/joystick and the infrared light/coding board. The construction was mostly soldering and ohming of wires and leads. A little bit of drilling to the case

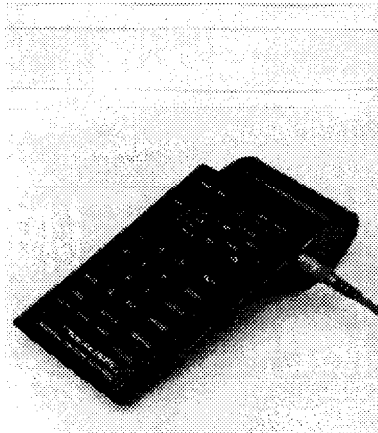
was done but other than that, the case was not breeched. The testing consisted of actual TV interaction and a simulated head switch. Adjustments were made accordingly.

SUMMARY OF IMPACT

This TV controller permits Matthew to turn his TV set on and off and change channels. This was not possible with a conventional remote control. It is easy to use. Touching the head switches with his head is all that is required. It is easy to connect. Anyone can plug it in for him. Conventional use of the remote is still preserved so any other member of his family may use it. It was inexpensive. The cost was about \$80. It can be adapted to suit most brands of TVs, VCRs and cable boxes. The controller is not limited strictly to TVs. Stereos, computers and other infrared controlled devices also could use this technology. Furthermore, any modem appliance could be adapted to this idea with some further research.

TECHNICAL DESCRIPTION

The specific goal was the design of a television



controller that would allow the user to turn the set on and off and switch the channels by himself using head switches. The physical capabilities of the user were the first issue to address. Could he move any other part of his body other than his head? Was he capable of discernable speech? As mentioned earlier he only has controlled movement of his head. The rest of his body is virtually paralyzed so his head is the only logical place for the controller. His speech is not discernable so his only verbal communication is through use of a computer. Two head switches used for dot and dash in Morse code are connected to an Apple computer that is mounted on his wheelchair. This converted the code into speech. A speech controller was not considered feasible because of the expense in additional computer hardware and software. Would this controller in any way limit his communication or maneuverability? This controller does limit his communication ability because the head switches used for Morse code are also the ones used for TV control. As for his maneuverability, his head switches for control of the chair are independent of the switches that control the TV functions. Another consideration was designing the controller without tampering with his existing device. This is done by working with a new remote control unit. The connectors to the switches are common. Connecting the new remote only requires the connection of two plugs. The cost of the new controller is very reasonable. A new remote, signal amplifier, RCA jacks, wiring, switches for testing, and solder were the only items to be purchased. These are common items in electronics and appliance stores. Some basic wiring and easy soldering are the only processes that need to be performed.

Solution

The remote was **ohmed** out (measuring resistances across electrical contacts) to find the voltage drops for the selected functions. Once the location of the on/off and channel changer resistors had been found, soldering could begin. It turned out that each function did not have a specific resistor or diode so direct soldering to these components could not be done. Each function had a characteristic voltage, but this could not be used to advantage. The other side of the remote circuit board had the contact positions for the carbon pads that were directly connected to the conventional switches. These positions were directly related to certain functions. In order not to damage the conventional switches the paint was scratched off the leads to these positions. With these exposed leads, wires could be soldered to the board without interfering with conventional use. The leads of these wires

were connected to female RCA jacks. Each of the two functions had its own jack. The use of two connectors permitted separate headswitches, one for on/off, one for channel selection. The existing remote has a signal amplifier on it to boost the signal. The new version also employed the same signal amplifier. The design has been changed drastically from the original plans. The initial design called for use of a joy stick and a mechanical arm. Next, an infrared light mounted on a cap aimed at a coding board was considered but this was too expensive and the resources to design or construct it were not readily available. Since the head switches were already being used, the new design was much more feasible and economical. Though the other designs performed more tasks, they were too complicated and cumbersome.

Results

The initial testing took place in my parents' home. The TV used was a Portland 19" remote control television. A VCR also made by Portland was used in this first test. A simulated head switch was hooked up to the remote to ensure total circuit testing. The results indicated that the remote was responding but to the wrong functions. The on/off function made the TV go to channel 6 and the channel changer made the TV go to channel 2. Since the remote is based on ramp voltages (each function has its own voltage level) the voltages were being disrupted somewhere in the circuitry. The conventional functions had the same problem that helped to verify this. David Sepulveda of the University at Buffalo Computing Services Staff gave me some insight to where the problem may lie. He mentioned that one of the leads may be shorted across another one causing incorrect voltages to go to certain functions. This may have occurred during the soldering. The flux from one solder connect may have been strong enough to eat through the paint covering another lead. This is how the short may have occurred. The solder connects were redone with smaller wire and care was taken not to short across any other leads. The second set of tests were done with a Zenith TV and a Goldstar VCR. This time the tests were successful. The simulated head switches controlled the on/off and channel switching functions respectively. The cost was about \$80 for the project.

Variable Height Wheelchair Transfer Device To Facilitate Transfer at Mismatched Elevations

Student Designer: Timothy M. Gould

Handicapped Coordinator: Jeanne and John Fadale

Supervising Professor: Dr. Joseph C. Mollendorf

*Mechanical and Aerospace Engineering Department
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INTRODUCTION

The objective of this design project was to create a device that would assist a person in placing a physically handicapped child into a wheelchair from the floor level. This device is for Jeanne and John **Fadale** and their five year old child Cameron. Cameron, who weighs approximately 60 pounds, has cerebral palsy and has little to no control over his body. His size and weight prevents his mother from lifting him directly into the wheelchair without the danger of injury to herself and Cameron. As exercise, Cameron spends a good deal of time on the floor at the request of his physical therapist. Mrs. **Fadale** often must get Cameron into his wheelchair by herself. This device enables her to do this easily.

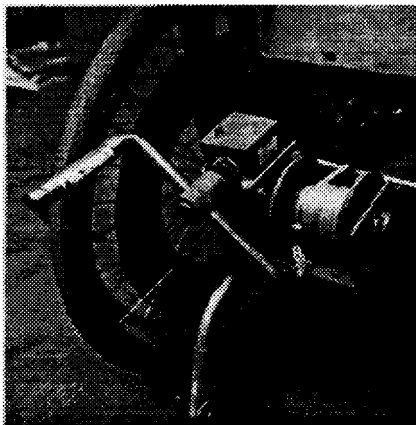
SUMMARY OF IMPACT

The Inclined Lift Seat has been completely built and tested. It was delivered to Cameron and his family on May 14, 1990. Mr. and Mrs. **Fadale** used the device and determined that it would help alleviate the problem of Mrs. **Fadale** having to lift Cameron into his wheelchair regularly. The device is easily assembled and operated. The winch fits nicely on the back of the wheelchair, the ramps snugly hang from the handles of the wheelchair and the seat rides well up and down the aluminum track. Also,

the back hinged bar on the seat allows for Cameron to be slid extremely easily onto the seat of the wheelchair. With the device having been user-tested and having successfully completed the design conditions, it can be said that the Inclined Lift Seat works. This is not to say that the lift does not have its imperfections; because it does, but the device is user-friendly enough to be used everyday.

TECHNICAL DESCRIPTION

The basic design goal was to devise a system to get Cameron into his wheelchair as easily as possible. To satisfy this goal of easy usage, the device must be convenient to operate, quick and efficient.



Minimum effort should have to be expended in setting up the device, operating it, disassembling and storing the device. Also, of course, the device has to be safe for a handicapped child to use, i.e., no sharp comers and good support for his weight. Little will be gained from a device that is kept in a closet and not used. By satisfying these design requirements, the device should be user-friendly enough to be a viable way of placing Cameron in his wheelchair.

Solution

At this point in the design process, the parameters and the criteria for completing the stated objective have been set. Now, the solution process in which the proper design, fulfilling all laid out requirements, will be discussed. Initially, there were two major questions that needed to be answered to complete the objective. First, what kind of lifting mechanism would be used? Second, how would the seat lower to the floor? The first question was relatively simple to answer. The choices were either a 12-volt motor with a gear reducer or a hand powered mechanism such as a jack or winch. Since the device was going to be operated by a second individual (not Cameron) there was not a need for an electric motor. The significant weight of the motor, gear reducer and battery and the availability of hand powered winches with the appropriate gearing ratio solved the first question. A hand powered winch with a worm gear was chosen. The winch chosen has several features. The worm gear in the winch allows for the hand crank to be on the front of the winch instead of the side. More importantly, it is inherently self locking. The weight of the child and seat cannot unwind the winch at any time, so there is no danger of the seat rapidly sliding down the lift. Only the hand crank can lower the child. The second question contained the crux of the design. The initial solution to the problem was to alter an existing wheelchair so the seat of the chair lowered to the floor level. Cameron could then be slid onto the seat and raised mechanically to original seat height. This idea proved to be difficult to fabricate. Cutting into the existing frame and altering the wheelchair permanently did not seem a reasonable solution. Another system was then devised. It was a slide type of arrangement with a separate seat moving from the floor to the height of the wheelchair seat along a track. The hand winch provides the lifting mechanism. This device would not alter the wheelchair and would consist of several parts. Channel or "U" shaped aluminum was chosen for the track. A finite element analysis using STAAD (a finite element computer program

on the VAX), along with preliminary hand calculations were performed to identify the necessary size of channel needed. A 1" x 1" and 1/8" thick channel was chosen. The aluminum extends from both wheelchair arms to the floor at an approximate angle of 35 degrees. There are two stabilizing cross pieces of aluminum bar between the two tracks. The seat, which rides on four bearings in the channel aluminum, has significant side supports to keep Cameron upright during operation. An aluminum bar was placed at the height adequate for support on three sides of the seat with the front being open allowing him to be slid on to the seat. The back piece is hinged to open the back so Cameron can be slid off onto his wheelchair. Also the seat is padded and all sharp comers have been sanded or milled down. The third and final part of the device is the hand powered winch. An easy way of attaching and removing the winch to the back of the chair had to be devised. Several different solutions were considered, including hinged collars that fit around the tubing of the wheelchair or pinning a metal piece between the back tubes with a quick release mechanism. Fortunately, the configuration of the wheelchair allowed for a piece of aluminum to be securely held in place without any attachment directly to the wheelchair itself. The winch would be bolted to this cross member and could be used to raise the seat by use of a cable. The layout of the seat, length of the channel aluminum and all other needed dimensions were calculated from measurements taken from the wheelchair.

Results

A majority of the fine designing, i.e., exact angle of the slide with the floor or the amount of aluminum cut off one side of the aluminum channel, was done during fabrication of the device. The hinged back bar on the seat was created during this period. Also, so were the addition of plastic strips inside the aluminum channel. This was done to allow the bearings to have clearance and to avoid significantly cutting down one side of the channel, which would have greatly decreased the strength of the channel. Mr. Roger Teagarden, of the Engineering Machine Shop, provided significant help in manufacturing the device.

The final design and configuration of the "Inclined Lift Seat" is shown in the pictures. It consists of three main parts, the slide, the seat, and the winch.

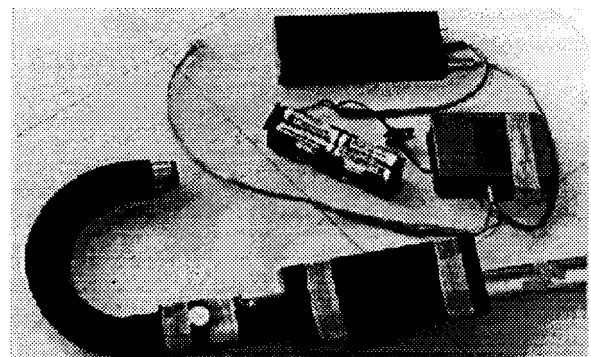
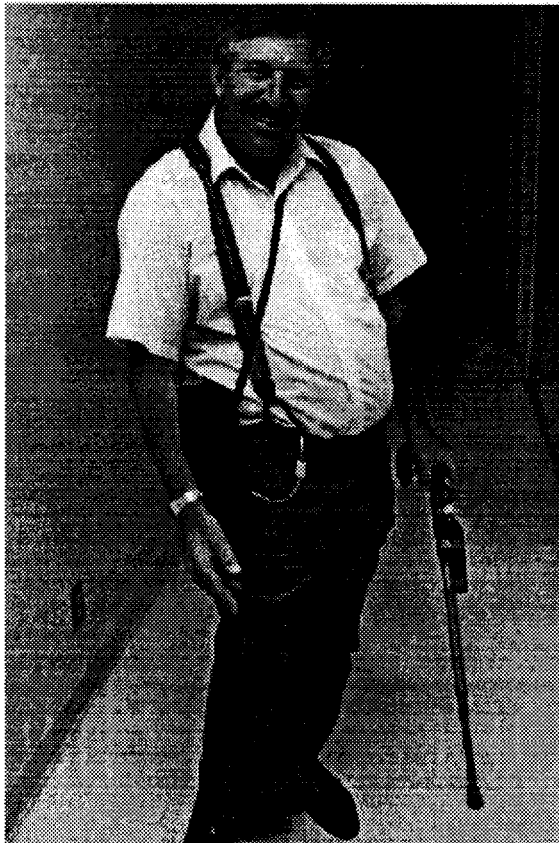
Radio-Controlled Electrical Muscle Simulator Eliminates Wires and Heal Switches in FNS

Student Designers: Rebecca T. Romanowski, Michael D. McPartland
Handicapped Coordinator: Dr. Jay Leavitt, Device-User
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo, Buffalo, New York 14260

INTRODUCTION

This project is designed to facilitate the use of an electric stimulation system for Dr. Jay Leavitt. It involves the modification of previous designs such that the system is more compact and lighter. Invariably, the system became rather simple to operate. The most obvious changes made involved the size of the box containing the system and the sources of energy used. The circuit box was reduced from (2.625 in. x 5.125 in. x 1.625 in.) to (3.25 in x 2.125 in x 1.125 in.), which is much easier to wield. To accommodate the reduction in size, the power supply became external rather than internal. No major problems occurred in this project. In addition, after testing the receiver with Dr. Leavitt's transmitter, we found that they were

compatible. Therefore, the only changes in the system that Dr. Leavitt noticed were the size change in the receiver and the freedom from repeatedly opening the receiver to change the batteries. The project is dependent on a previous solution to the original problem. Some years ago, Dr. Leavitt was in an accident in which his neck was broken. Amazingly enough, Dr. Leavitt regained many of his functions, although his right leg was not capable of being lifted to walk, thus dragging behind him. To aid in his walking, a system was previously developed to introduce electric stimulation to his leg, causing it to lift when he walked. This system was connected through a series of wires. In time, the wires proved to be a hindrance, as they would often break down. Early this semester, Michael McPartland developed a remote-control system, thereby eliminating the need for external wires. The only fault with this idea was its size. Therefore, the problem at hand was to scale-down this mechanism to suit the needs of the user.



SUMMARY OF IMPACT

After finding all the needed results, it is possible to say that the system worked as we expected it would. A smaller system that is easy to operate and maintain has been created. Thus far, no further modifications to improve the system are apparent.

Perhaps a recommendation for the future of this system is for it to be mass produced, as the cost is definitely within the boundaries of most people's budgets. It could be sold as an accessory to existing electric stimulation systems, or developed with newly created ones.

TECHNICAL DESCRIPTION

The ultimate goal for this project was to create a system that would be simple and convenient for Dr. Leavitt's use. In addition, in the case of malfunction at any time, the problem could be found without major difficulties. To create a system that is simple and convenient to use, the original receiver needed to be altered slightly. While meeting these design requirements, the simplicity of the device will aid in finding any malfunctions, should they occur.

Solution

The circuit designed by Mike McPartland worked well, as Dr. Leavitt has told us. Although this is true, there was still some need for optimization. To meet this need, Mike altered the circuit slightly. However, the major differences between the two final products were choice of the power source and the resulting dimensions used.

The power source for the receiver in the first design consisted of two "triple-A" and one "double-A" size batteries. With this type of circuitry, the system was forced to fit into a box that was too large for Dr. Leavitt's needs (2.625 in. x 5.125 in. x 1.625 in.). With an external power source (spliced from the power-pack for the electric stimulation itself), it became much easier to scale-down the original design. With this done, the size of the system is decreased to (3.25 in. x 2.125 in. x 1.125 in.).

The system works so that a transmitter activates a relay connected to the receiver, which in turn, sends power to the electric stimulation system, thus moving the leg. In this device, the transmitter (with a frequency of 27MHz) and receiver are taken from a remote-controlled toy car and used with a resistor, a series of diodes, voltage regulator, and LED, and a relay. Activation takes place when a button on the

transmitter is pressed by Dr. Leavitt and sends the signals to the receiver. For this purpose, the receiver has a switch that remains on for the entire time that the system is being used. The transmitter is on Dr. Leavitt's walking cane and the receiver is kept in a small shoulder bag with the power source.

Once the circuit was redesigned, the specifications made, and the parts obtained, the construction was the only aspect left to be done. The first step in constructing this device was to solder the circuit together on a circuit board. In doing this, the space used must be kept in mind. The size of the box containing this system is only (3.25 in. x 2.125 in. x 1.125 in.), while the switch and receiver take up most of the available volume. In addition, the connecting wires must be color-coded (in case of malfunction) for ease of repairs.

After the circuit was built, it was tested with the transmitter to ensure that there were no shorts in the wires and the system was correct. When it was certain that the circuit worked as expected, the entire system was put into the box. This process contained a great deal of trial - and - error in fitting the components in their respective spaces, since there were other aspects to keep in mind, along with the constraints from the connecting wires.

Results

After testing and constructing the receiver without major problems, the system proved to be successful. It was tested both at close and long ranges, and after a small wire was attached within the box (to act as an antenna), the receiver was able to pick up the transmitting signals from distances up to 10-15 feet. Although the system will most likely never be used at these distances, it is encouraging to realize that in the case of an accident, or other instance, the system had this capability.

The question of whether this receiver might pick up the frequencies of other transmitters, such as garage-door openers was considered, and we came to the conclusion that the antenna on the receiver should not be large enough to permit this dilemma. If, however, problems do arise in this area, the wire could easily be shortened without affecting the system. The total project cost was about \$25.

Removable Kitchen Handrail Supports To Enhance Mobility and Effectiveness

*Student Designer: Peter N. Cionitti,
Handicapped Coordinator: Mrs. Esther Barker,
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo, Buffalo, NY 14260*

INTRODUCTION

This report illustrates the process and design alternatives and solution of a product specifically requested by Mrs. Esther Barker. Her daughter, Susan, has a disability that requires a special system to physically support her during kitchen activities. Prior to the existence of the presently conceived device, when Susan Barker wanted to use the kitchen, she stood at the counter and held onto a vertical pole mounted from the countertop to the ceiling. Her lack of lower trunk support required the use of this pole to maintain an erect position. From here, she attempted to accomplish all those activities common to a kitchen environment. Her range of motion was limited to her "wingspan" while holding this pole. The pole is also an obstruction to the non-handicapped members of the family, and from an aesthetic standpoint it was obviously not an integral part of the kitchen. Mrs. Barker has expressed her need for a system that would support the activities of her daughter, and act as an integral part of the kitchen. She wanted a horizontal handrail mounted near the countertop that would allow her daughter greater movement around the kitchen. She also wanted this handrail to be removable for regular kitchen cleaning.



SUMMARY OF IMPACT

This handrail system worked effectively. All the cabinets and drawers remained functional, the handrail was removable, the cabinets were not marked in any way; and, most of all, the client was very happy with the results. She now has the freedom she needed in the kitchen, and her mother is not worried about her safety.

This system could be easily adapted to most kitchens because the space between cabinet doors (the mounting location) is rarely less than 3/4".

TECHNICAL DESCRIPTION

There were five key issues to consider in this problem:

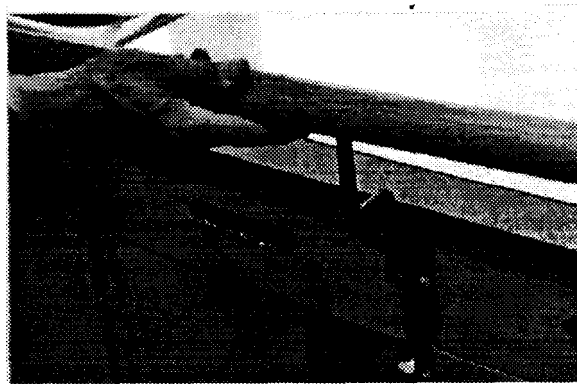
1. Distance from the floor to the handrail.
2. Location for mounting of brackets in relation to cabinet doors and countertop.
3. The removability of the handrail from its brackets or altogether.
4. Size of the handrail (diam.).
5. Materials (color, strength, preferences etc.).

Each of these issues required a consideration in the overall design.

Method for Solving the Problem

The following is the method that was used to solve each of the above key issues.

1. Distance from floor to handrail. This measurement is dependent on three factors: countertop height, client's height and distance between cabinet doors and underside of countertop. A comfortable handrail height would make



the product the most responsive to client needs. However, the other two variables dictated to a large degree just how high this handrail should be to allow clearance for drawers and cupboards.

2. Location of mounting brackets. This issue is dependent on two factors: distance between cabinet doors and underside of counter, and the amount of finger space needed. If the distance between the top of the cabinets and the underside of the countertop is too small to allow mounting of the brackets, they will need to be mounted directly to the nosing of the counter. Mounting under the counter would be the preferred method however, to reduce the amount of damage to the countertop.
3. Removability of handrail. To solve this problem, a locking joint must be used. This joint needs to release easily and securely hold the rail in place.
4. Handrail size. To properly size the handrail, information must be gathered concerning the client's strength and span. This information could only be obtained through testing.
5. Materials. Materials choice depends on a number of factors. First is the strength of the material required to support the client's weight. The strength of the material is also a function of the distance that the rail must travel between brackets. This could be altered by the location of the under-counter appliances.

Another consideration for the selection of materials is the existing materials used in the kitchen. It is important that this handrail does not appear obtrusive or out of place in the kitchen. Lastly it is important to note the preference of the user and her mother.

Possible Solutions

The design alternatives below reflect a strategy based on possible configurations of the countertop.

1. Room to mount under the cabinet. This strategy allows the bracket to be mounted under the counter directly to the cabinet. This design would cause no damage (screw holes) to the countertops. It would need to extend beyond the edge of the countertop to allow for finger space when the hand is wrapped around the rail. The mounting hardware must include a plate behind the cabinet to which mounting bolts attach to distribute the force of these bolts.
2. No room to mount under the cabinet. This strategy considers a bracket mounted directly to the nosing of the counter. This is a less desirable solution because of the damaging effects of the mounting holes in the countertop. Finger space behind the rail would be provided by the design of the thickness of the bracket. This bracket could be designed to wrap under the counter for added stability. Since this bracket relies on screws or **lags**,

it probably would need to be placed at shorter intervals along the length of the counter than the under counter strategy.

This increases the possibility that one of these mounting brackets would be in the way of a comfortable position along the handrail.

Fastening Strategies

1. This strategy involves a twist-to-lock pin that pops into a slot securing it in place. This was the first strategy and probably the least effective.
2. This strategy makes use of a cam bolt. It requires a screwdriver to twist the cam to lock a bolt mounted on the handrail. This set-up may be a hassle to use because of the screwdriver. The system may be modified, but in its basic form it could be too difficult to use.
3. This strategy uses a sleeve and pin joint to lock the handrail sleeve to a post mounted on the cabinet. A pin is then slid into place to lock the sleeve to the post. This requires a close fit between post and sleeve. Its pin joint would however be easy to operate.
4. This strategy has a lag mounted in the handrail with a machine thread on the opposite end. When the rail is placed onto the bracket, a threaded twist knob screws it securely in place. This can be easy to use as long as there is enough room to twist the knob without interference.

During the interview I spoke with Esther and Susan and determined that the handrail would be sufficient for allowing freedom of movement (in a standing position) throughout the kitchen. I presented Susan with 4 different diameter tubes, and asked her to chose the size that was most comfortable and easy to hold. She chose the 1-1/2" diameter size. With the information concerning the distance between drawers and countertops (1/4") it was clear nothing could be mounted in this area. So with the possible solutions prepared before this meeting, I opted to mount the bracket on the front edge of the counter. Oak was the material chosen for the handrail. It is very strong and attractive when finished.

The bracket was mounted by bolting straight through the cabinet using a nut and washer on the other side. This proved to be a strong reliable system that allowed all the cabinets and drawers to be opened without obstruction. The total cost was about \$50.

Hand-Power-Assist Tricycle To Permit Use with Limited Leg Capability

Student Designers: Thomas A. Reid, Michael K. Ziemathis

Handicapped Coordinator: Mrs. Susan Heilig,

Supervising Professor: Dr. Joseph C. Mollendorf

Mechanical and Aerospace Engineering Department

State University of New York at Buffalo, Buffalo, NY 14260

INTRODUCTION

The objective of this project was to design and build a hand-powered and controlled tricycle for a boy named Nicky Heilig. Nicky suffers from **Spina Bifida** and has very limited use of his lower legs and upper thighs. Nicky is a very vibrant and enthusiastic nine year old boy. He is as sharp if not sharper than most children his age. He exhibits excellent manual dexterity in his hands and upper body. Before beginning the project we met with Nicky and his mother, Sue Heilig. After meeting with them we discovered just how active and intelligent he was. We found that he would have the strength and coordination to power and steer a hand driven and controlled tricycle.

SUMMARY OF IMPACT

The hand powered tricycle could be used to help other people as well as Nicky. Anyone with limited use of their legs, but near-normal arm strength and dexterity could benefit from the use of this tricycle.



This tricycle is expected to be an excellent form of exercise because of its ability to increase upper body strength and to retard atrophy in the legs. It also will provide Nicky with a feeling of self sufficiency as he will be able to travel by himself and keep up with his friends.

Nicky recently came in so that we could make some final size adjustments and he saw the Tricycle. His face lit up with excitement and joy. The look on his face reminded us what this project was all about. Many people's lives could be made much easier if more people with the ability sat down for a few hours and thought about what they could do to help.

TECHNICAL DESCRIPTION

Scope and Goals

Our main goal was to design and build a hand powered tricycle. This goal was divided into many parts ranging from the appearance and performance of the tricycle to its effectiveness. The frame design was to be kept as simple as possible for a variety of reasons. The most important among these was to keep the overall weight of the tricycle to a minimum. This would allow Nicky's parents to take the tricycle with them when traveling or visiting friends. The frame was to exhibit a low profile to keep the center of gravity close to the ground. This would keep Nicky from tipping over when going around corners. A wide rear wheel base was also needed to help keep the tricycle stable and upright. The low profile also would make the tricycle easier to mount and dismount. The frame was also kept simple to avoid unnecessary welding and machining.

At the request of Nicky's mother, a major feature was added to the tricycle. This idea was to add a follower for Nicky's feet. This follower would force his legs to move in a circular pedalling motion like a normal bicycle. This motion would both strengthen his legs and prevent atrophy. According to Sue,

strengthening his leg muscles would help him to walk better on his own and rely less on his crutches.

Another desirable feature was a multi-gear drive system. This drive system would allow Nicky to begin in a low gear in which it would be easy to pedal, and then upshift as he began to pick up speed. This also allowed him to go faster without drastically increasing his hand speed. A five speed gear system was implemented. The reason for choosing a five speed is the availability of the gears from a ten speed bicycle. Another benefit of this system is the ability to coast when his hands or arms get tired. Coasting will allow him to shift gears and brake without having to pedal simultaneously. With a direct drive single gear wheel, none of these features would have been possible.

A feature that we originally wanted to add was an easy access seat. This would allow Nicky to mount and dismount the tricycle easily, and without any outside aid. He then could ride any time he desired. This was not easily attainable, however, and fortunately resulted in little or no penalty. Three “knobby” tires provided excellent traction in wet conditions. This is especially important, since Nicky’s weight will not be concentrated on the front drive wheel. The wheels are 22” in diameter that will allow for low torque hand input, and less force needed to brake. The wheel bearings are very efficient and allow him to glide for long periods without significant frictional losses. We hoped that all of these features would make the tricycle easy and fun for Nicky to use, and also make it beneficial to his health. We feared that if the tricycle wasn’t fun to use, Nicky, like any other boy his age would quickly get bored with it and stop using it.

Solution

For stability, the center of gravity of this tricycle should be kept as low as possible. Nicky presently has a “kiddy” tricycle that has tipped over on numerous occasions. When the “kiddy” tricycle was built, it suited four year old Nicky just fine however he has grown significantly and his original tricycle is no longer big enough for him. Our original frame design had to be modified when we learned that Nicky could only bend his knees 90 degrees. This forced us to raise the seat so that he could reach the follower pedals. Since this raised the center of gravity we compensated by slightly increasing the rear wheel base.

We next came to the problem of how to get a follower pedal for Nicky’s feet. We toyed with the

idea of coming off the front wheels with the follower but realized that the front wheel was too far **forward** for his feet to reach. We then thought of taking a chain off the front wheel to a sprocket mounted on the frame that he could reach it. This idea also failed because a sprocket mounted to the frame would not turn with the front wheel, and the chain would come off when he turned a corner. This resulted in our final design for the follower that has the pedals driven by the rotation of the rear wheels. Since the axles of the rear wheels do not turn, we needed to attach a gear to one of the rear wheels that turned a shaft attached to another gear between the two back wheels. This gear drives the pedals that move Nicky’s feet. At this time we also realized that we needed a way to keep Nicky’s feet on the follower pedals. He does not have enough strength in his legs to keep his feet on the pedals while they are rotating quickly. To avoid an injury, we decided something like Velcro straps could be used. These could be left permanently on the pedals. They also would allow Nicky to quickly remove his feet when he was ready to get off the tricycle. We found that the neck on which the hand drive pedals were to be mounted was not long enough. To fix this problem we replaced the neck from the original bicycle with a longer pipe that was bent to bring the pedals close enough for Nicky to reach them. The actual pedals were replaced with handle grips. These were placed on shafts that were mounted on bearings so that they were free to spin. This allows him to keep a good firm grip on the pedals at all times. One of the harder parts of the design was how to mount the two rear wheels. The original design called for two nine inch cantilevered wheels. This design proved unsuitable for a number of reasons. If this design were used we could not use “knobby” tires, and Nicky wanted **BMX** tires. Also there would have been no way to attach the brakes. A standard cable brake system was used for its simplicity and reliability. The cantilevered wheels would have required some machining to accept the wheel hub. With standard bicycle wheels no machining would be needed; only two pipes bent into forks to mount the wheels on, and a small amount of welding. The total cost was about \$350.

Quiet and Expanded Capability Braille Writer To Facilitate Taking Class Lecture Notes

Student Designer: Sean R. Kelly, Senior

Handicapped Coordinator: Shelly Bamrick, Device-User

Supervising Professors: Dr. Victor Demjanenko, Dr. Joseph C. Mollendorf

Mechanical and Aerospace Engineering Department

State University of New York at Buffalo, Buffalo, NY 14260

INTRODUCTION

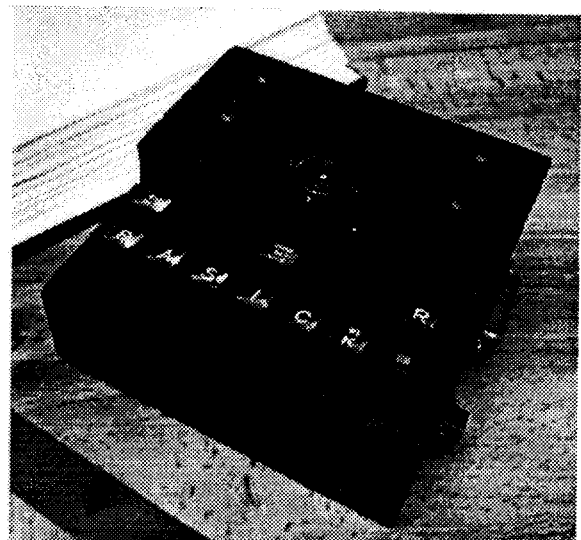
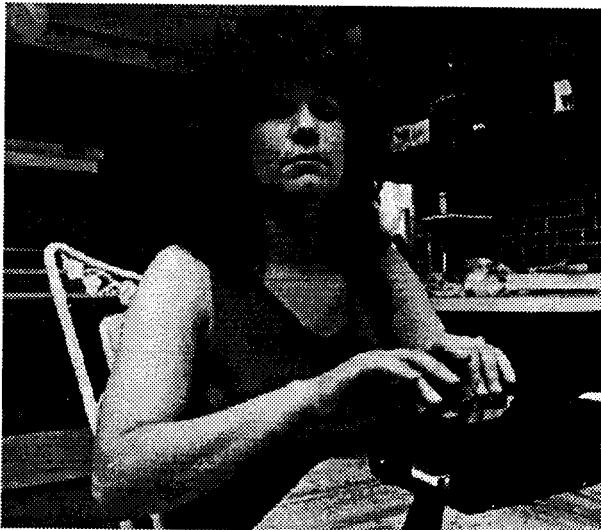
Shelly Bamrick is a blind woman on campus who has trouble taking notes in class. She is unable to use her Perkin's Braille Typewriter in class because it makes too much noise. Therefore, she currently takes notes by using a template and stylist. This technique is slow and tedious. On the average, she is seven to eight sentences behind what the professor is saying. She desired a quiet and efficient way to take notes in class.

SUMMARY OF IMPACT

This project has resulted in a device that provides a quick and efficient way for a blind person to take notes. This was accomplished by creating a small portable computer that is braille compatible. The computer can interface with an I.B.M. Personal Computer as well as a braille printer. This design meets Shelly's needs. It is quiet, fast, and versatile. Notes can be saved to files and the files can be edited before printing. The computer weighs less and is smaller than the Perkin's Braille Typewriter, thus making it portable.

TECHNICAL DESCRIPTION

There are several computer-aided devices for the blind currently on the market. Tele-Sensory Incorporated manufactures Versi-Braille, which is a computer, but instead of a screen it has a membrane that can produce the braille letters on it. Thus the client can read what is being typed. Versi-Braille cost approximately \$7000. Blazy Engineering manufactures Braille and Speech, which is a computer with a voice synthesizer. This makes it possible for a blind person to hear what is being typed. Braille and Speech cost approximately \$1000. A third computer that is commercially available is Note-A-Braille produced by Smith Kettlewell. Note-A-Braille is a note taking computer that can interface with an I.B.M. P.C. The approximate cost of Note-A-Braille is \$400. The computer that has been designed here resembles Note-A-Braille in that it can interface with an I.B.M. Personal Computer. The user will take the computer to class, use the computer to take notes, then later, go to an I.B.M. Personal Computer (or compatible) and through a serial port send the notes stored in memory to the I.B.M. P.C. The I.B.M. will translate the file into a



text file that can be used with user's word processor, A program was also created to translate braille abbreviations (known as Grade 2) into common language (Grade 1). Once this is done the file can be sent to a braille printer. The design involved both hardware and software.

Hardware: Quiet Braille

- 1.) Standard 6 Braille Keys
the 'B','A','M','T','C','K' keys, a space bar (the 'R' key), a character return (Char Rtn), a backspace ('S' key), and a Special Function Key (Esc key)
- 2.) Serial Port and cable
- 3.) Audible Signal Device
- 4.) Six AA Rechargeable Batteries
- 5.) Power cord
- 6.) 1 Megahertz Crystal
- 7.) Eprom Chip #27C128-15
- 8.) Latch Chip #74HC373
- 9.) RS-232 Chip #Max232CPE
- 10.) Inverter Chip #74HC04
- 11.) Processing Chip #80C31
- 12.) 64K Ram, 2 #62256LP-15
- 13.) IBM Personal Computer with a serial port
- 14.) Braille Printer

Software: Quiet Braille

An assembly language program to run the computer. This program will record which keys are pressed and in what order. This program has five special functions that are enabled by pressing the escape key down into its lower position: 1) A new file is created by pressing the character return key and 2) The amount of memory used can be checked by pressure the 'A' key. The bell will ring a prescribed number of times to indicate the amount of memory. 3) The number of files can be counted by pressing the 'M' key. The bell will ring once for every file present in memory. 4) The send key is the 'S' key. To send successfully the following steps must be followed:

- A. Plug **serial** port into both computers.
 - B. Using communication software on the IBM (Procomm) set parameters to 300 baud, No parity, 8 bit. (300,n,8,1).
 - C. Type **Alt P** on IBM.
 - D. Select correct parameters, return, esc on IBM.
 - E. Type **Alt F1** on IBM and name file: 'FILE1.'
 - F. Press the 'S' key on Quiet **Braille**. It will beep once.
 - G. Wait for second beep.
 - H. Type **Alt F1** on IBM and send is complete.
- 5) To clear the memory on the machine type 'T', then 'C', and then the 'K' key.

Braille is stored in memory based on binary numbers. A standard letter is represented by an eight bit code. The first two numbers in the code is '01'. The remaining six numbers depend on which keys are pressed down. The 'K' key represents the third number and the 'B' key represents the eighth number. If a key is depressed the number becomes a '1', if not pressed it remains a '0'. So the letter 'A' is '01000001'. For special keys the first two numbers are '00'. Character return is '000001101' and newfile is '00001010'. For the I.B.M. P.C.: A program receives the file (Procomm). A program translates Grade 2 into Grade 1 and creates a standard ASCII file that can be used by most word processors. Due to the complexity of grade 2 braille this program had to be simplified. The general rule this program follows in handling abbreviations is, if a character is not unique in braille, the program will translate it as a whole word contraction **only**.

Results

I have met with Miss Bamrick, and we have come up with a design that meets her needs. I have also designed a circuit that meets our objective. To conserve power, the braille writer will run at a speed of one megahertz. Static CMOS Ram will be used for memory. This Ram requires a small amount of power when the computer is off. Also, the processing chip was chosen for its low power consumption. The circuit has been constructed and a box has been built to house the circuit. The assembly language program has been written and compiled. (This was done by Dr. Demjanenko and Joe Bogdan.) The grade 2 translator program has been completed. Both the software and the hardware have been tested and proof of concept has been shown. There remains some minor software to be written but the machine is usable at the present time. The machine is also portable. It weighs two pounds and is contained inside a 5in x 5in x 3.5in box. A serial cable will be used to communicate between the IBM and the Quiet Braille. Also a power cord is used to recharge the internal batteries. A portable computer was loaned to me by a local computer distributor, Drew Systems. Ms. Bamrick is now using this machine to take notes in class. With this she is learning how to use the talking terminals at the Law Library and Lockwood Library. Both Libraries have a braille printer. With the project nearing completion, the main task left is to thoroughly instruct the user on how to use the machine. Once this is done, the machine can be delivered and the user can reap the benefits of this project. Total costs were about \$200.

Row Reader III

Facilitates Following a Line of Written Text by Isolating It

Student Designers: Michael P. Girard, Frederick A. Roy, Gay L. Voight

Handicapped Coordinator: Marge and Chuck Taylor,

Supervising Professor: Dr. Joseph C. Mollendorf

Mechanical and Aerospace Engineering Department

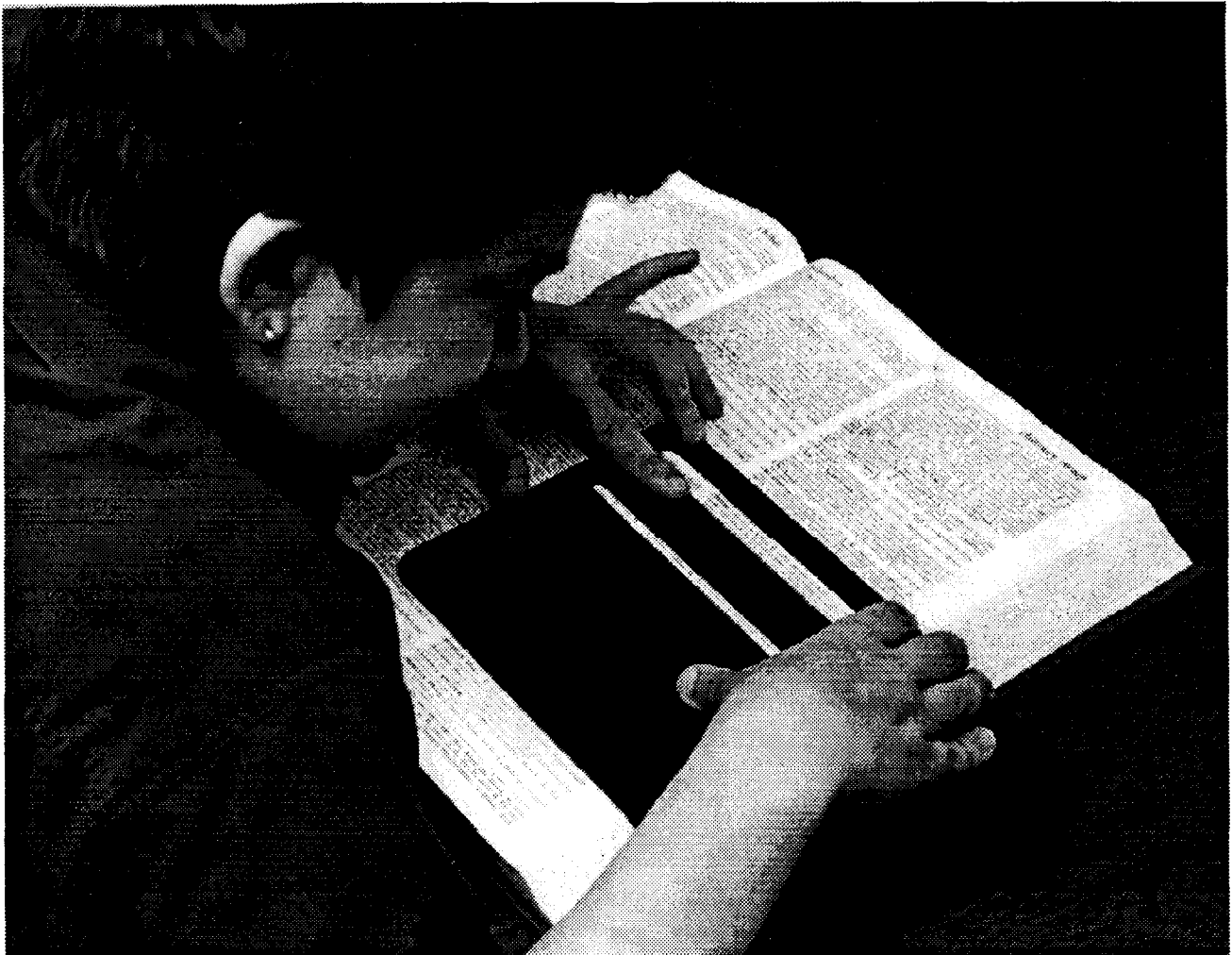
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INTRODUCTION

Beth Taylor currently suffers from both a mental and visual disability. One of her tasks at her place of employment is to take attendance. Her disability makes it difficult to distinguish one line from another, thus causing her to make incorrect entries. Beth also sometimes finds it difficult to follow a line of text while reading.

SUMMARY OF IMPACT

The problem solved by Row Reader IIITM was one of definition and simplification. Initially, before the problem was clearly defined, the proposed designs for the device were intricate and very complex. The resulting final design, however, is a very simple and effective device.



The Row Reader IIITM meets all the desired specifications and was very inexpensive to produce. Due to the obvious simplicity of the device, no recommendations can be made for improvement.

TECHNICAL DESCRIPTION

We determined that the design would have to meet the following specifications

- Aid in the Reading of Text
- Aid in the Marking of Column Data
- Convenient and Easy to Use
- Lightweight and Portable
- Stable in use (no slipping)

Solution and Results

The first prototype device for Beth was one piece of 5 x 10 x 1/8 inch clear plastic with slots of 1/4 and 9/20 of an inch cut along the longer axis. The prototype was mailed to Beth for use and evaluation on 26 September 1989.

The design group contacted Beth's mother, Marge, for an evaluation of the device. Marge indicated both the overall and slot dimensions were well-sized for Beth's needs. She reported that Beth felt the device was a serviceable aid. Marge agreed with the group's belief that an opaque plastic material would eliminate the annoying parallax associated with the prototype design.

The final prototype, the Row Reader IIITM, was one piece of 6 x 10 x 1/8 inch dark black translucent Acrylite acrylic with beveled slots of 1/2 and 1/4 of an inch. This design was mailed to Beth for use and evaluation on 15 November 1989.

Again the design group contacted Marge for an evaluation. She indicated that the bevel machining made the surface of the plastic opaque, thus making the device much more effective. The black translucent acrylic also allows Beth to see where she is oriented on the page without lifting the template. Marge remarked that Beth was very pleased with this model and no other modifications could be suggested.

Large Keypad for a Calculator Overcomes Problems Arising from Small-Target Keys

Student Designer: Bruce C. Bator

Handicapped Coordinator: Beth Taylor, Device-User

Supervising Professor: Dr. Joseph C. Mollendorf

Mechanical and Aerospace Engineering Department

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INTRODUCTION

The project described here involves the design of a calculator keypad with individual key dimensions of 1" x 1". The reason for the design is to allow people with a variety of handicaps to use a handheld scientific calculators. Such handicaps might include poor motor control of the hand/fingers, poor eyesight and obesity. The large keys afford advantages to each type of disability. People with poor dexterity who may or cannot depress the desired button(s) before may be able to do so with this design. The large keys allow for larger labels, thus allowing poor-sighted people the opportunity to use these devices. Obese people who may not be able to push just one key, especially with today's compact designs, now can use the scientific calculator.

SUMMARY OF IMPACT

This device enabled a large keypad to be used with a conventional handheld calculator. The project was completed by reconstructing the internal circuitry of the calculator on the new keyboard. It seems appropriate that such calculators be

constructed by companies to allow the convenience and power of these devices to be brought to the handicapped for several reasons. One such reason is the variety of handicaps that would benefit the design. Such handicaps include poor motor control, obesity and poor eyesight. These people currently have available to them very few calculators, and those calculators perform only the four basic functions. Such a person's productivity could be greatly enhanced if they were afforded the use of the high powered calculators now on the market. Another reason for further development is the ease of modification to existing production lines. The circuitry is the same as that used in smaller calculators and the only modification would be the spacing between keys. Such a modification would take minimal set-up time and perhaps no new machinery would be needed. The only other modifications needed are in the size of the casing keys. Overall, the project was a success. It demonstrated the ability to design and construct a large keypad calculator.

TECHNICAL DESCRIPTION

Solutions

Three basic solutions were proposed for the final design. They were mechanical, electro-mechanical and electrical. The mechanical design would directly depress the desired key through a geometric mechanism. The electro-mechanical design would close an electrical circuit and activate a mechanical device, a push-type solenoid, to depress the desired key. The electrical design would directly activate the computer chip through interfacing with the keypad. Factors considered in choosing the final design were modification of existing calculator, simplicity, cost, number of moving parts, number of connections needed, overall size/weight and portability.

Modification of existing calculator

Changes to the existing calculator were to be avoided. Both the mechanical and electro-mechanical designs would not alter the calculator. All



parts to be added would be either over or around the existing calculator. The electrical design required opening the case, cutting parts out of the case, and connection to the computer chip. Any of the alterations could damage the calculator in an irreparable manner.

Simplicity

The simpler the design, the easier the production of the design becomes. The electrical design is the simplest since the wiring for each key can be duplicated from the existing circuitry and a minimum of machining is necessary in the design. The mechanical design is simple, but complicated geometry is needed to activate the keys when factors such as ability to read the display are added. The electro-mechanical device also requires the geometric arrangement of the solenoids to be considered. Also in this design, two units are needed. One unit houses the solenoids and the other would house the switches that activate the solenoids as well as the power supply needed by the solenoids.

cost

The mechanical device would have costs to consider in the machining of parts, the housing of the mechanism, the key return system necessary and the wear reduction measures that must be taken. The electrical device's costs rise from the wiring, switches, and switch housing. The electro-mechanical design would have costs stemming from the purchase of solenoids, switches and power supply in addition to the wiring and housings. A constant cost to all designs was the purchase of a calculator.

Moving parts

Fewer moving parts in a design lessen the chance of failure. The only moving parts in the electrical design are the switches. They could be commercially purchased, translating into reliable, durable movement. The same type of switch would be used in the electro-mechanical design. The solenoids also would have reliable moving parts. The mechanical design would have numerous moving parts, any of which could fail due to stress and/or fatigue.

Connections

The electrical design has many soldered connections that could fail due to breakage since many at the chip would be fragile. The electro-mechanical design would have numerous electrical connections similar to the electrical design and also would have the mechanical connections between the solenoids and the switches. The mechanical design would have numerous mechanical connections within the geometry of the mechanisms. These mechanical

connections are subject to wear and fatigue and, therefore, subsequent failure.

Overall size/weight

The electrical design would be the lightest and smallest of the designs. The new keyboard would have the dimensions of a notebook and be constructed of lightweight plastics and metals. The mechanical device also would have similar overall dimensions and employ as many lightweight materials as possible. The electro-mechanical design would have a keyboard similar to that of the electrical design in addition to the solenoids and solenoid housing. The power supply for the design would add considerable weight to the device.

Portability

Both the electrical and mechanical designs could be carried in a **bookbag** since the dimensions of each are that of a notebook. In both cases, however, a high profile might prevent portability in this manner. The electro-mechanical design has two separate units that must be carried and the added weight of the power supply and the second unit greatly decrease its portability. After evaluating each design, the electrical design was chosen as most suitable for construction.

Construction

The first step in the construction process was to understand how the calculator operated. Each key activates a unique set of pins on the computer chip. The computer chip is attached to the LCD driver, which displays the calculations. Since only the keyboard was to be modified, the connections between the chip and the driver were to be left intact. The internal circuitry was traced to determine the pin combinations. The same circuitry is reconstructed within the new keyboard. The keys are made of 1/16th" Plexiglass. The Plexiglass is lightweight and has a satisfactory strength to weight ratio. The need for a good ratio is that there are no supports from the edges of the key back to the switch. The switches are stiff, preventing the inadvertent pressing of the wrong key. The user can place his/her finger on the correct key and hold it there with sufficient pressure to steady it while not activating the circuit. The wiring between the switches and the chip is accomplished with 22 gauge stranded wire. The total project cost was about \$82.

Soak Chair

Permits Easy Access to Swimming Pool

Student Designers: Richard R. Krall, Raymond P. Martucci, Jacob T. Roush

Handicapped Coordinator: Mrs. Binkowitz, Fredonia BOCES

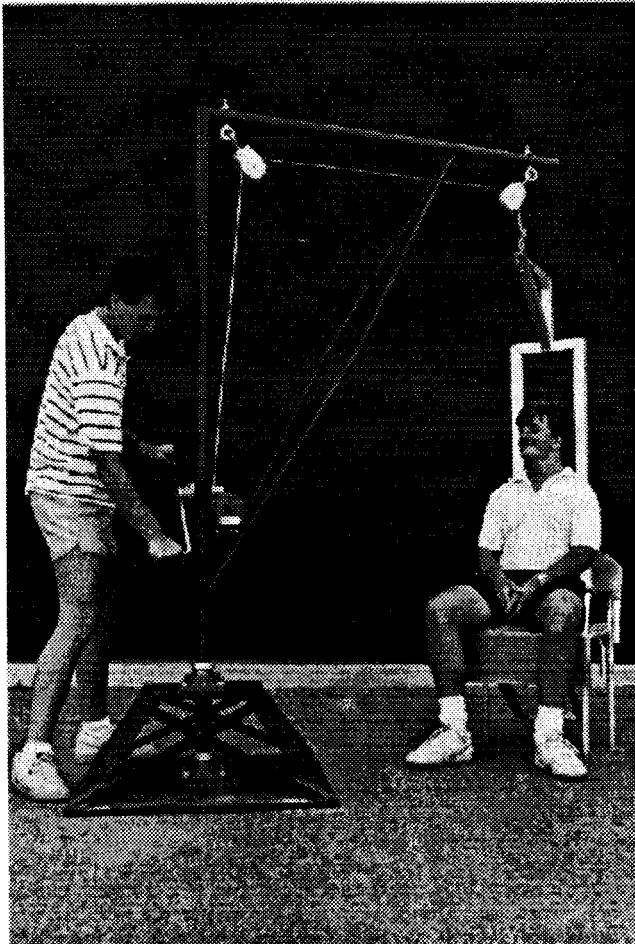
Supervising Professor: Dr. Joseph C. Mollendorf

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INTRODUCTION

We decided to build a device that would allow handicapped people to enter a swimming pool while sitting in a chair. This device would safely submerge a handicapped person into the water and then safely lift the person out of the water. As a result, disabled persons could enjoy one aspect of life that their handicap may otherwise prevent them from having. Psychologically, they would gain increased self-esteem, independence, and happiness by being able to enter a new and exciting environment.



SUMMARY OF IMPACT

This device will safely enable a handicapped individual to enjoy public or private swimming pool recreation. The present design would serve as an affordable prototype for a company, or a recreation apparatus for an individual. Material selections and structural analyses have been done. The finite element analysis revealed an acceptable safety factor.

TECHNICAL DESCRIPTION

Decisions had to be made regarding the basic shape, structure, and mechanical operation of this device. Environmental and load conditions on the device had to be analyzed. The choice of materials had to be made. Structural and force analyses had to be performed to determine the minimum required sizes of the various components of the device. Other factors to be considered are mobility (fixed or portable), cost, feasibility, and marketability. This lift or soak chair, as we shall call it, must be very strong. It had to incorporate a high safety factor (5-10). The design of this lift had to be kept simple so that problems could be anticipated and corrected before construction began. Simplicity also enabled the construction of the device at a reasonable cost, while still incorporating all the aforementioned design factors.

Solution

The first step was to develop the basic design for this soak chair. Our group had many brainstorming sessions discussing this and the various needs of the user. Similar existing devices were observed and discussed.

Our final design is intended for semi-permanent implementation at a public or private concrete-based **inground** swimming pool. The device may logically be broken into three basic units: base, structural crane, and chair. The "swing" mechanism will provide easy accessibility because the chair

may be rotated to the **poolside** allowing the individual easy transfer to his/her wheelchair. This also provides more mobility, since the person may pivot back and forth with his arms, while in the water. The diagonal element in the frame is to support the large moment force applied to the lift from the occupied chair. All construction and lubricated moving parts are to be above water. The lifting and lowering are to be done with a manually operated winch, pulley and cable system. A hand winch is less expensive than a motor and provides better load holding control. This design is also simple and modifications may easily be added. The chair seat requires special attention because it needed to be comfortable, safe; water compatible, and strong enough to be lifted while occupied. Seatbelts could be added to secure the person. Supporting the chair is a structural frame that will bear the stresses incurred during lifting. The crane will serve as the main support structure, while the base assembly (pod) will provide rotation ability. A finite element analysis of the stresses, bending moments, and deflections in the crane members was performed. These results were used to determine optimum material selection and sizes. The remaining task was to determine the exact method of attaching the winch, pulley, and cable system to the main frame as well as the proper sizes and load ratings of these components.

Results

Regarding the chair assembly, its design was shaped by the parts that were available. A weak, rudimentary **aluminum** chair frame was obtained from a surgical supply store. Clear cherry wood was bolted to this frame. The wood added to the stability and strength of the chair. It also will provide some buoyancy to the chair while it's in the water. Linseed oil was applied to the wood to protect it from the water. Seat belts and arm cushions could be added. Having finalized the design of the chair frame, it was calculated to weigh no more than 50 pounds. Considering a 250 pound individual in addition to a 100 pound safety factor results in a 400 pound force on the cable. This estimated information along with engineering data for aluminum alloy **6300-T5** was used in a complete finite element analysis of the chair frame. The frame was designed using 1.5" square aluminum tubing 0.125" thick. Using **RFRAME3.FOR**, the structure was analyzed. This structure required 23 elements and 10 nodes. The distribution of the 250 pound load was determined (neglecting the weight of the frame), and the maximum moment was 17,678 N-cm. The corresponding fiber stress was

calculated to be 3,704 N/cm/cm. This compares to the yield stress for aluminum of 21,400 N/cm/cm for a safety of 5.7. The greatest shear force was 1,309 N. This results in a stress of 295 N/cm/cm, a safety factor of 71. Considering torsional stress, the largest torque encountered was 15,234

N-cm. This results in a stress of 5,409 N/cm/cm for a safety factor of 4.0. Complete analysis of the structural frame and pod assembly was also done for 1.900" outside diameter standard-220 XXS black iron pipe with .400" wall thickness. This material provides adequate strength with affordable bearings. The deflections and rotations in all three coordinate directions were also calculated. In view of the overall deformed geometry, we see no problems in the implementation of the pulleys and winch. This final geometric structure with applied loads yields a maximum bending moment of -176,640 N-cm. Using the flexure formula for a symmetric member, the stress was calculated to be 18,030 N/cm/cm. The yield stress for structural steel is 24,090 N/cm/cm. The largest shear in the structure is 6,55 N producing a stress of 539 N/cm/cm, again below the yield stress. All axial forces in the compression members fall far below the buckling loads. The pod, or base assembly, utilizes radial bearings to enable rotation of the structural crane. They can withstand hard usage encountered in the toughest environments of abrasive dirt and moisture. Both bearings with accessories are affordable and readily obtainable. The pod was constructed with 0.250" steel plate and 2x2x.25" angle iron. Regarding the cranking system, the first consideration was the type and size of winch to use. A worm gear winch has two rotating gears with perpendicular axes. The inherent resistance to movement in the meshing of the two gears creates a natural braking system so that even if the handle is released, the load won't fall. This is the main reason the worm gear winch was chosen for the soak chair.

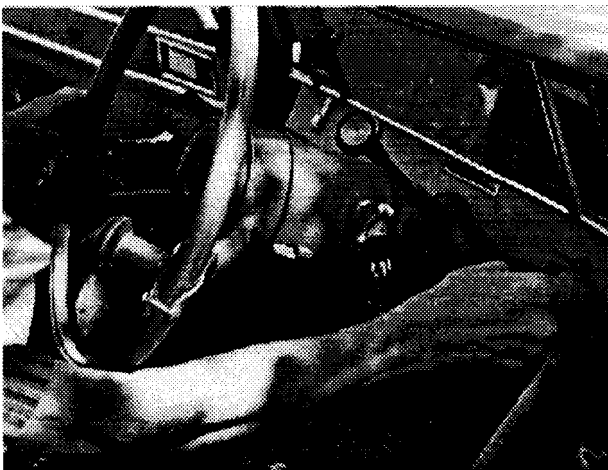
The Them 462 worm gear winch with a 1000 lb. load rating was chosen. The 1000 lb. load rating enables easy handle turning and keep the load capacity from falling too close to the operating load. The total project cost was about \$1,000.

Anti-Spastic Automobile Power Steering System A System with Variable Sensitivity

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INTRODUCTION

This device is for a handicapped man, Larry, who has difficulty driving an automobile because of spasticity resulting from Cerebral Palsy. He is in his thirties and lives in the downtown Buffalo area. His handicap prevents him from having full control over his physical capabilities thus making it difficult to turn the steering wheel. Larry wanted to have a car that he could steer more easily at low speeds but safely at high ones. Larry has a driving permit and a custom braking system already installed in his 1981 Dodge Aries K. The subject device is a power steering system that was designed to allow him maximum control at low speeds (parking) and maximum safety at high speeds (highway driving). It includes a lighted toggle switch located on the dashboard near the steering wheel that can be used to turn the power steering on and off. The final product fits between the power steering pump and the steering gear of the car. The original hoses were removed. Activating the power steering with the switch "on" develops 100% power to the steering gear. When the valve is de-activated, a lesser amount of fluid reaches the steering gear thus reducing the "power" assist effect. In this position, the rest of the fluid returns to the pump (at low pressure). Since this path includes two needle valves, the amount of power in the steering in the "off" position is adjustable.



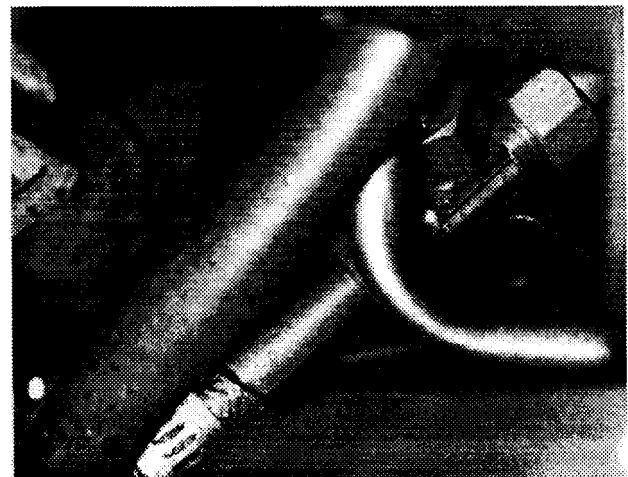
SUMMARY OF IMPACT

A car that a handicapped man normally could not drive has been customized so he can drive it. The steering has been altered so he can drive with comfort and control at all speeds and conditions. Although the basic technology already existed in the automobile field, the switchable "on-command" option is new. The system developed in this project can be used with most pump-driven power steering devices. The output of different pumps will determine the size of the three-way valve needed in the supply line. Because of the high pressure output of the pump, we had few choices of electrical valves to buy. As more valves become available, the cost of this design will hopefully decrease. This could help many more handicapped people drive a little easier.

Approximately twenty-five miles of road testing duplicated the desired results and the proper safety standards that we set out to develop.

TECHNICAL DESCRIPTION

There were two designs considered for this project. The first was a variable power steering system, the second an on/off, "on command", power steering system.



The variable system had the power steering going from 100% on, continuously down to completely off. The valve would open and close in proportion to the speed of the car as measured from the drive shaft. Many problems were encountered with this design. It was very difficult to find a valve that would open and close proportionately with an electrical signal. Most local hydraulic companies did not sell such valves and to obtain one would have been expensive. Another problem was the conversion of the shaft speed to an electrical impulse. Although a device was purchased from a car parts catalog that converted shaft speed to an electrical impulse, it was beyond our ability to calibrate the components to get the required results.

The second design considered was the "on command" on/off system that was eventually used. It did not sacrifice performance and was simpler and less expensive. Its main component is a **3-way, 2-position** valve. It was activated by a large toggle switch mounted on the dash board. When off (deenergized), the fluid by-passed the power steering gear box. In the on position (energized), about half the fluid is sent to the power steering gear box and the rest is sent back to the pump. The fluid leaving the pump is at about 1000 psi and the return pressure is very low. The valve was solenoid operated at 12 volts and was designed to withstand a pressure drop of 5000 psi. This was more than enough to safely perform the task.

The first thing that needed to be done was to have power steering installed on the car. Luckily the car had the option of having power steering, so no custom work had to be done. A new rack and pinion steering unit with pump was purchased.

The installation was as follows. First we had to disconnect the high pressure line and remove it. Next, the new system had to be sized up correctly to account for clearance and to make sure the connectors would fit flush. This was the most difficult part because of the trial and error involved. Once the high pressure line was installed, the low pressure line had to be cut. This enabled us to get the loop-back part of the system hooked up. Since the pressure was low, we used clamps to fasten there. Lastly, a plate was installed to shield the valve from the road and other debris.

The solenoid was wired to a 20 amp accessory fuse that was used only when the car was on. This prevented the battery from being drained if the switch was left on accidentally. The wiring was run

through a tube to protect it from the heat of the engine and the road elements.

Most of the testing consisted of driving the car to see how it responded in real world situations. It was driven between campuses several times. While driving the steering was switched several times from manual to power "on-the-fly" with no problems. The manual steering that is meant for highway driving was very stiff, as expected. This was the feel we were looking for. With the power steering on, the car drove very easy and could be operated using one hand. Again, this is what we were looking for. The only problem was a slight leak in one of the compression fittings that was tightened up with no further leakage. On the third day of field testing the unit started to make a squealing noise that was attributed to a lack of fluid. The fluid was replaced and the squealing stopped.

To facilitate our design, we purchased (from a junk yard) a pump and a power steering gear matching the year of the Dodge Aries being modified. Two test valves were used to duplicate the diverging path. These items cost approximately \$95.00.

The Portaquinas

Easily Stowable Wheelchair Writing Platform

Student Designer: Michael A. Gwin

Handicapped Coordinator: Todd Vaarwerk, Device-User

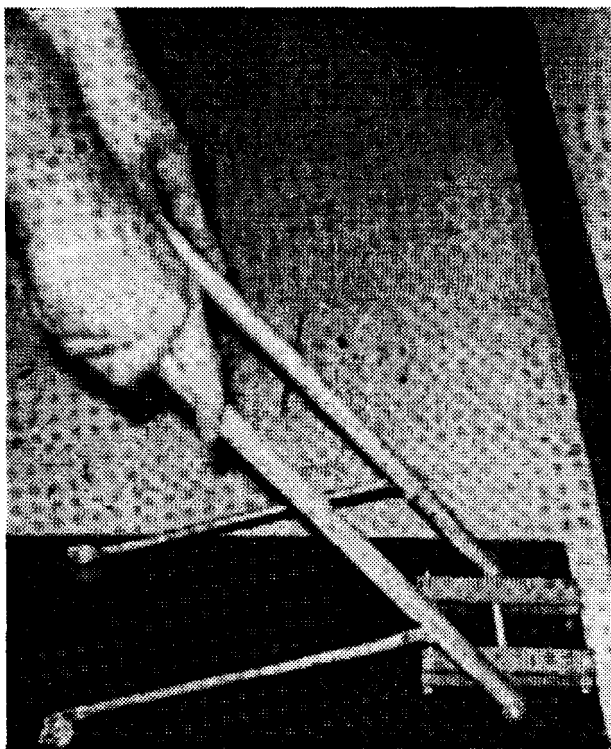
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INTRODUCTION

In today's academic world, handicapped people not only have to overcome the struggles that are indentured by the pursuit of academic excellence, but they also have to contend with whatever difficulties their disability presents.



For a person who is confined to a wheelchair, taking notes can be a problem. At UB, some lecture halls are equipped with handicapped accessible tables. However, these tables are usually in the back of the room. For instance, if someone in a wheelchair happened to have a class in Knox 20, they would have to sit in the back of the room. That is quite a distance from the instructor. Most students prefer to sit up closer so they can learn better, although, there are a few students who prefer the "cheap seats" back in the "orange" section. But why force the handicapped students in wheelchairs to sit there. They would most likely prefer a seat in the "lower gold" section. This is a simple case of bad architectural design. Even worse, some rooms at UB don't have any type of accommodations available for students in wheelchairs.

One device that gives students in wheelchairs more freedom is the St. Aquinas Table. There are two different designs of this product. The first closely resembles a T.V. dinner tray made out of wood (usually). The other is simply a flip-up desk top that folds down to the side of the wheelchair. It is exactly like the desk tops that are on many of the chairs in Clemens Hall, only it is connected to a wheelchair. Both devices, however, are not popular among the handicapped students whom they are designed for.

The reason these products failed is 'probably because the designers of the devices weren't handicapped and they didn't receive nor solicit much input from the handicapped. When asked, several students in wheelchairs had the same complaints about the two devices. They are as follows.

Wooden St. Aquinas Table:

- 1) Too bulky -- not easily portable: The size of this device is quite large. It is a burden to carry.
- 2) Mobility difficult - when the device is in use, it makes it difficult to lean forward and wheel one's wheelchair.

Flip-up Desk Top Design:

Permanently connected to wheelchair:

Most people in wheelchairs do not like this, because they consider their chair as part of them. In comparison, no able-bodied person would like the idea of having to strap a desk top to their thigh so they would have a place to write.

The solution to this problem lies in the task of trying to redesign the St. Aquinas Table so that these existing flaws no longer exist. The concept of a small, portable, fold-up desk top that could be attached and detached easily to and from a wheelchair was pursued. This concept in living reality is called the PORTAQUINAS.

SUMMARY OF IMPACT

The PORTAQUINAS is a simple yet effective alternative to the previous designs available to the handicapped. It meets all the criteria stated in the problem. Most importantly, it does not possess the flaws that the other designs have. In fact, it is small and portable. When folded up, it is no bigger than a large text and in most cases lighter. It is not permanently attached to the wheelchair. It folds up and fits right in a **bookbag**. This allows the individual to have the freedom and independence to position themselves anywhere in the classroom that they wish. The PORTAQUINAS is a much needed answer to a long asked question.

There are several recommendations that can be made concerning the design of the PORTAQUINAS

- 1) The chair connections could be redesigned so that there would be no need to attach any connecting pieces to the chair. For example, a long triangular piece of metal could be positioned between the two legs. It would act as a clamp that could clamp onto the frame of the wheelchair along the arm section.
- 2) The supports that keep the legs and table top at 90° could be designed so that they can be disconnected from the table top. This would allow the user to flip the top up, where as now it can only be flipped down.

These two hindsights would further improve the design to a point where no custom fitting would have to be done.

TECHNICAL DESCRIPTION

The PORTAQUINAS has a very simple design. It is explained easiest by observing the photo. However, verbally it is explained as follows:

The device consists of four parts: the table top, the supports, the slide-hinge and the chair connections. The table top is a standard school desk top with indentations for pencils and a coffee cup. It is made of wood and Plexiglass. A light metal such as aluminum could be used in future production to increase strength and decrease weight. The supports are metal tubes. One set serves as the legs of the device and the other pair keeps the table at a 90° angle from the legs. The slide-hinge consists of two pieces of angle iron with a long slot in each, and a small diameter, solid, metal rod. The slide-hinge makes it possible for the legs to fold **up** underneath the table top. The chair connections are two pieces of tubing that are slightly bigger than the legs in diameter.

