CHAPTER 21
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GARDEN CAROUSEL

Designers: Arpita Dharma, Cheryl Ann Hughes, Flavia Juvvigunta, Jainu Champala Jogani, Mary K Cheeramvelil, and Swetha Jukanti
Client Coordinator: Eileen Whalen, Program Director of ConnectUs
Supervising Professors: Dr. Robert F. Erlandson, Dr. Donna Case
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INTRODUCTION

A mobile, wheelchair accessible, garden carousel was designed for clients of ConnectUs. ConnectUs, a Michigan non-profit 501(c) (3) corporation, was established to fill a need for quality day programming for adults who are severely multiply impaired (SXI). ConnectUs is based on the belief that the needs of one can be an opportunity for another. The Garden Carousel is designed to allow ConnectUs clients the opportunity to experience working with plants and gardening. It will be one component of an accessible garden work area.

SUMMARY OF IMPACT

Ms. Eileen Whalen, Program Director of ConnectUs, envisioned the participants wheeling up to the gardening carousel, and then pressing a switch which would water plants by activating a pump connected to an electric timer. ConnectUs staff or volunteers would rotate the plant trays. Ms. Whalen wanted her son (Michael) and other adults in the ConnectUs program to be exposed to and enjoy the beauty of gardening. The height and placement of the trays holding the potted plants enable participants to remove the plants and work with them.

TECHNICAL DESCRIPTION

The Garden Carousel has four trays that hold potted plants, displayed in Fig. 21.2. The trays are rotated manually by turning a large handle. A motorized tray rotation system was considered but rejected for safety and cost concerns. The basic design would have been much more complicated and expensive considering the error-proofing and safety features necessary for a motorized tray rotation system. A switch operated watering system is on a timer which controls the amount of water delivered to the trays. Plant lights can be placed on either side of the carousel. A water tank will be placed below the trays within the base of the carousel frame. The switch used to control the watering process is on a long cable and can be placed to accommodate a variety of users.

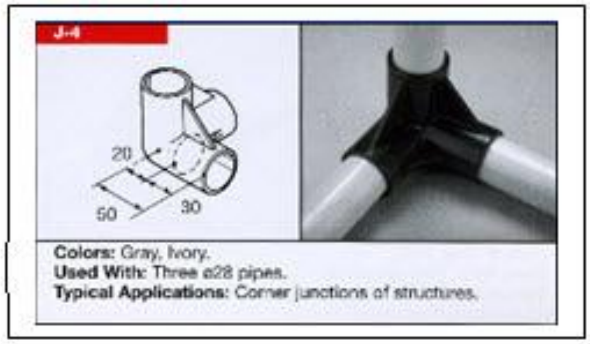

Fig. 21.1. Corner Junctions.

The frame of the Garden Carousel is made from Creform a pipe and joint, agile systems technology. Creform is used worldwide for industrial workstations, material handling, and storage systems. The Creform pipe is steel with a bonded plastic coating. The plastic coating comes in a wide variety of colors. The Garden Carousel uses purple and white pipe. There are over 500 standardized components that can be used in conjunction with the basic pipe material. These include a variety of metal and plastic joints (see Fig. 21.1) as well as casters, rollers, brackets, and shelving components. The Garden Carousel uses plastic joints so as to provide a waterproof seal to the steel pipe.

The total cost for the Garden Carousel is $570.

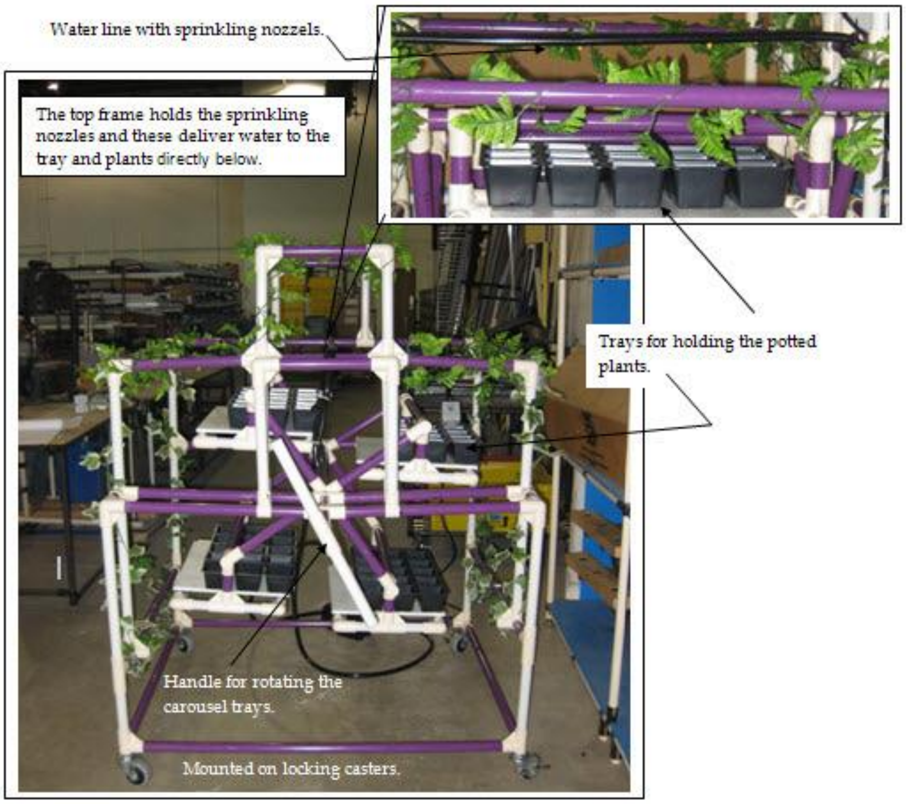

Fig. 21.2. Completed Device.

HANDWRITING ANALYSIS PROGRAM

Designer: Lovepreet Kaur
Client Coordinator: Dr. Gerry Conti, Ph.D., OTR, Director, Human Movement Laboratory, Occupational Therapy Program, Wayne State University
Supervising Professor: Dr. Robert F. Erlandson
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INTRODUCTION

The goal of this project was to design a software application that can be used for evaluation and analysis. The software application takes data from a Wacom electronic interactive pen and display. A person can write or draw items in free-form or conforming to specific constraints. Fig. 21.3 shows a Wacom tablet.

A data acquisition application collects raw data from the Wacom tablet. Another software application allows post-processing of the collected raw data. Such a system can be used to provide objective baseline and improvement data for people who are recovering from a stroke or traumatic brain injury. Furthermore, the system can be used to evaluate the effectiveness of different treatment protocols for people with diseases such as Huntington's disease, Parkinson's disease and Development Coordination Disorders in children. For example, a current study examines changes in force control and handwriting after treatment with Tetrabenezine in people with Huntington's disease.

Existing programs typically do not support the rehabilitation process and are focused only on analysis. They are expensive, complex and do not provide the desired analytical tools. This program is easy to use and provides a collection of powerful analysis tools specifically designed to address therapeutic evaluation needs. The program is written in LabView which provides a fast and cost effective development system. Being modular, the program easily allows the addition of new analysis modules.

SUMMARY OF IMPACT

The developed system provides a unique therapeutic and treatment evaluation tool for hand and fine motor control issues. The system uses a familiar task and a commercially available device,

Fig. 21.3. Wacom Tablet.

the Wacom tablet. Clinical trials by Dr. Conti, in the Human Movement Laboratory, Occupational Therapy Program, At Wayne State University, have demonstrated that people very quickly understand what they are to do. The system is being used on a regular basis.

TECHNICAL DESCRIPTION

Both the data acquisition program and the data analysis program are written in LabView. The data analysis program used previously collected raw data. The program allows the therapist to view either the actual letters or drawings created by the client as well as data analysis results and information. The program allows a user to see parameters such as peak velocity and acceleration, total trial time, force inefficiency, and character width on the front panel and also allows saving them in a text file which can then be imported into Excel for further analyses. Four graphs can be displayed on the screen to make the analysis easier to visualize and to confirm that calculated parameters indeed correspond to the graphical outlook. Clicking on different tab buttons allows user to see the four different graphs. Fig. 21.4 provides an example of the display – showing four and a half instances of the written letter "l ""and the associated velocity plot.

The application was run on a limited number of samples from different age groups of healthy subjects to see the variation with age. Additionally the healthy subjects were compared against people with Huntington's disease. Average values of force inefficiency, peak velocity and peak accelerations were calculated. The results show that force inefficiency dropped consistently with age and became worse with Huntington's disease. This is consistent with what was expected. Also, it can be observed that peak velocity and peak acceleration increased with age. The increase in peak velocity and acceleration with age was also expected because movements appear jerkier in older adults compared to youth and adults. When moving from healthy to Huntington disease patients it can be seen that the peak velocity and peak acceleration jumped to very high values which is again what is expected as the jerky movements are even worse in Huntington patients. However, note that all the above statements were based on observation alone; this analysis program now provides objective support for the above statements and an opportunity for quantitative measures of change with intervention. This is especially important as reimbursement for intervention is increasingly scrutinized.

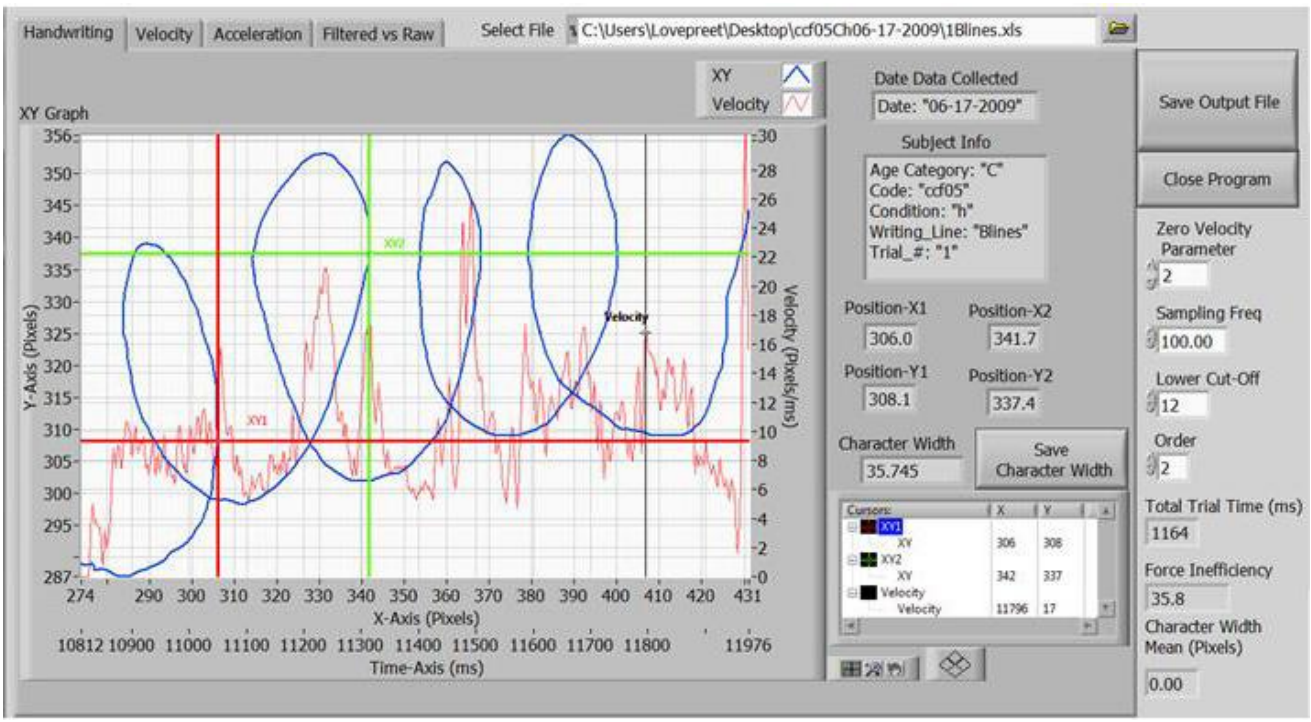

Fig. 21.4. Display of Device.

LOCATION DETECTION ENGINE

Designers: Sahiti Chukkapalli ,Jainu Jogani, Kadambari Bhasin, Anuja Vedpathak
Location Detection Engine – Part 2 Jennic: JN5139 and JN5148
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INTRODUCTION

This is the first part of a two phase project dealing with location detection inside a building. Part 1 explores the use of a commercially available location engine, the TI CC2431. Part 2 explores the use of the Jennic system and its signal strength indicator as the basis for a location detection engine. The Enabling Technologies Laboratory (ETL) has a long history of collaboration with Jewish Vocational Services, Goodwill Industries, and special education vocational training centers throughout Michigan. Most of these organizations provide janitorial and custodial vocational training to their respective clients or students. The clients and students have limited cognitive abilities and require significant job coaching and on-the-job support. Over the years ETL has, in conjunction with these agencies, designed and tested a variety of cognitive aids ranging from flipcharts coordinated with talking switches to programmed PDAs. A major problem with all these approaches is knowledge of where the worker is within the facility. ETL experimented with using passive RFID tags placed in the environment. The worker wears a reader which informs the worker of the room he or she is in and the tasks that need to be performed. However, none of these interventions has proven effective in the long run.

SUMMARY OF IMPACT

Recent advances in ZigBee wireless transceiver technology affords the opportunity to use the signal strength indicators associated with these chips to develop location detection engines for inside buildings.

TECHNICAL DESCRIPTION

Part 1

The TI CC2431 location engine development kit was used for the experiments. The kit contains both

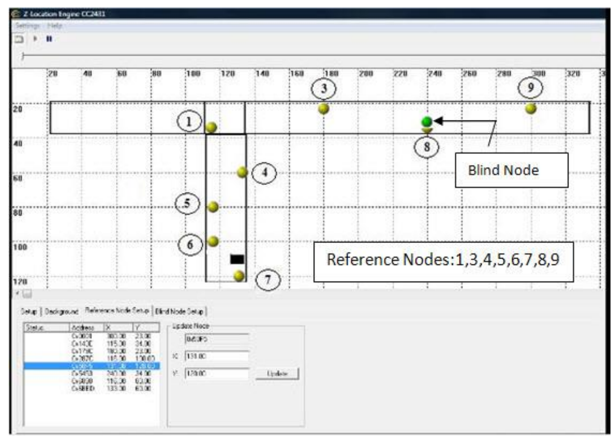

Fig. 21.5. Output of Blind Node Movement Experiment

CC2431 and CC2430 chipsets. The location algorithm uses a form of triangulation from a collection of reference nodes (3 or more up to 6 in this study). A blind node moves within the environment and gathers signal strength information associated with each of reference nodes. The blind node must be CC2431 while the reference nodes can be either the CC2431 or CC2430. The development kit also provides a Dongle which can communicate with the entire network. It can request or configure the position values of all Reference Nodes and the signal strength indicator parameter values of the Blind Nodes via the Z-location Engine PC Application. The Z-location Engine can also configure any Blind Node to automatically make a periodic position calculation and report rather than the default condition wherein the Blind Node waits for a command to perform a position calculation. A variety of CAD or sketching programs can be used to create a scaled map of the interior environment with placement of the Reference Nodes.

Ten experiments were conducted to try and replicate the results reported in the TI technical literature [1-3], with varying degrees of success. Experiments we conducted to empirically determine the values of

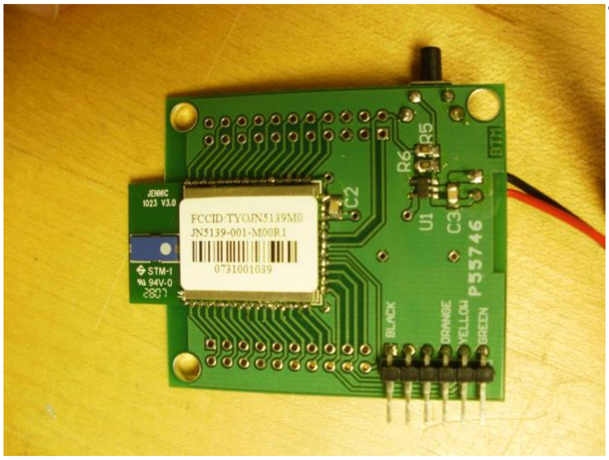

Fig. 21.6. Device.

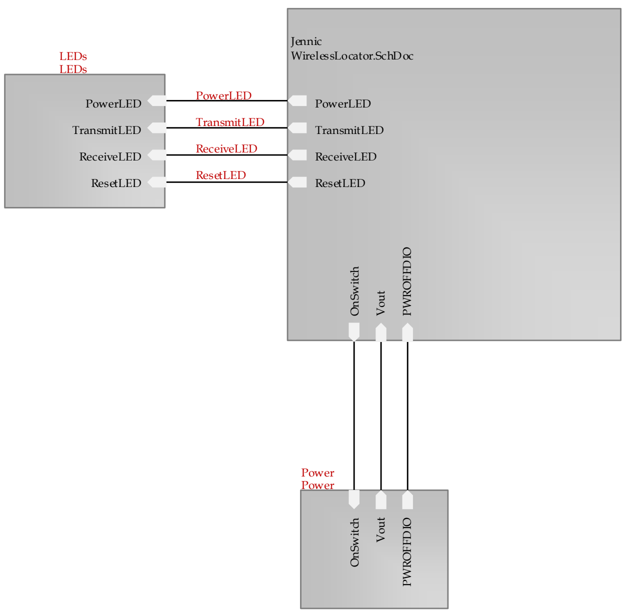

Fig. 21.7. Block Diagram of the Schematic Design in Altium Designer

the parameters in the received signal strength equation. The received signal strength is a function of the transmitted power and the distance between the sender and the receiver. The received signal strength (RSSI) will decrease with increased distance as the equation below shows.

$$RSSI=-(10n\log 10d+A)$$

n: Signal propagation constant, also named Propagation exponent.

d: Distance from sender.

A: Received signal strength at a distance of one meter.

The parameters A and n can be estimated empirically by collecting RSSI data (and therefore path loss data) for which the distances between the transmitting and receiving devices are known. A scatter plot of absolute value of RSSI data versus log (distance in meters) is determined. A least-squares best-fit line was used to acquire the specific values of A and n for the environment in which the data were collected. RSSI values were collected using Daintree SNA network software.

Other experiments used the empirically derived n and A values to observe and plot in real time the movement of a Blind Node through an interior office space. Fig. 21.5 shows the output of one such experiment.

The Blind Node needed to be calibrated prior to each experiment. This was a tedious procedure. The Blind Node's position was highly variable as it moved and tended to stabilize near the correct position when stationary. If the Blind Node was worn by a person the results were too variable for practical applications. These results were similar to those found by other investigators [4-7].

Part 2

Previous experiments to develop an indoor location system used the CC2431 chip developed by Texas Instruments. These experiments did not produce desirable node operation, as the measurement signal strength showed too much variability. This Part of the study used the Jennic JN5139 chip and the newer JN5148. These are low power wireless microcontrollers for the IEEE 802.15.4 and ZigBee applications. Both are 32 bit RISC processors. The units have 192kB ROM and 96kB RAM, 2 UARTS, up to 21 DIO, and a variety of other features. There was no development kit for the Jennic so a PCB had to be designed and built to hold the JN5139 and JN5148 chips and associated components for conducting the experiments. In this project the circuit schematic, foot prints and printed circuit board were designed using Altium Designer. Six PCBs were designed, built and tested; three for the JN5139 and three for the JN5148. One of the JN5139 PCBs had an operational RS-232 serial connector and was designated the coordinator. The Coordinator was attached to the control computer and received RSSI data from all the Reference Nodes (the Coordinator is also a Reference Node).

The Jennic-ICs are programmed in Java. Code is written to control these chips and the transmit/receive process. One board is programmed to be the blind node, one programmed as the coordinator node as well as a reference node and remaining four boards programmed as reference nodes. A communications protocol is designed and implemented for the RSSI signal and various debug and experiment feedback indicators.

The wireless system has the following operational procedure.

1. PC sends command to the coordinator to start.
2. All reference nodes and the blind node request to associate with the coordinator.
3. Coordinator sends confirmation to nodes, associating with the blind node last. (The blind node is powered on last so that it associates last.)
4. Endless Loop:

a. Blind node continually broadcasts a packet to all nodes

i. Reference nodes receive the packet, measure the link quality, and send the coordinator a packet containing the measured link quality between the reference node and the blind node as the data.

ii. The coordinator also serves as a reference node, receiving the packet broadcast by the blind node and measuring the signal quality as well, and passing that value to the PC.

b. The coordinator receives the packets from the reference nodes and automatically passes the measured link quality data to the PC.

5. The PC then takes the packets and reads the measured link quality and the corresponding address of the node it came from.

Knowing the fixed position of the coordinator and reference nodes, the computer has enough information to equate the link quality measurement (RSSI) to a distance value and triangulate the location of the blind node.

A LabView program is designed and implemented to analyze the real time RSSI signals sent by the coordinator node to the PC. The LabView program makes connection to the coordinator through the RS232 port. Using VISA VI file, the port is opened and bytes are read into the buffer.

Fig. 21.8 shows the signal strength between the second reference node which was placed at the 10m mark and the blind node. The signal strength starts increasing as the blind node moves towards the second reference node and becomes as high as 175 when it's around 10m. It starts dropping again as the blind nodes moves away and becomes as low as 50 at a distance of 36m from origin. These results are typical of the data collected at all the reference nodes.

The Jennic configuration performed better than the TI configuration – more stable and less noise. The data collected thus far suggests that a location engine can be designed for the Jennic system that is more robust than the TI system. The next step will be to design and implement different location detection algorithms and evaluate their performance in a laboratory setting. The best performing location engine will then be applied and tested in real work and office environments.

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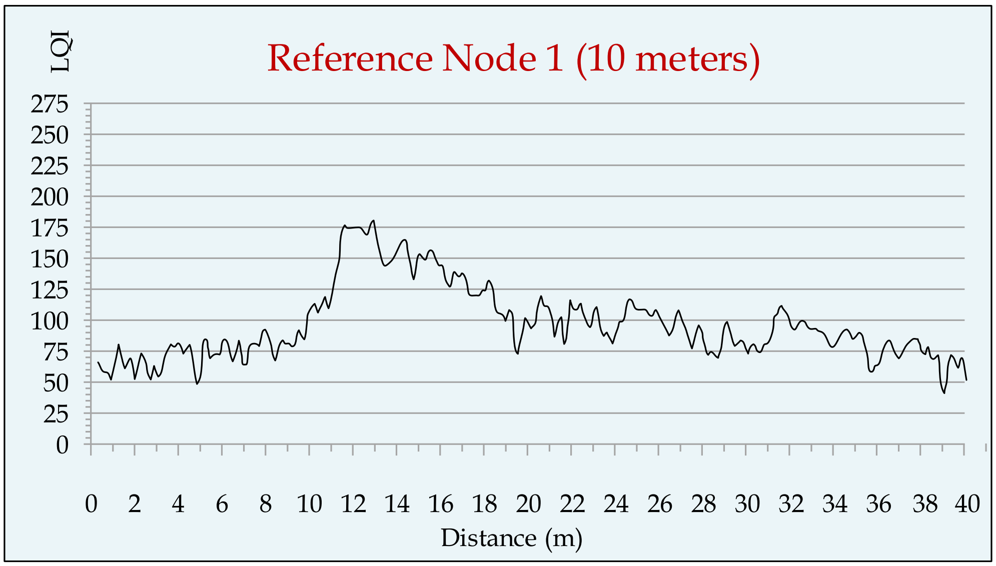

Fig. 21.8. Signal Strength between second and blind nodes

WORKSTATION FOR A MICROENTERPRISE PROJECT

Designers: Ibrahim Aleilani, Sindhuri Gummudala, Venkata Siva Sajja, and Bashar Somo
Client Coordinator: Lisa Knoop-Reed, President, Art For A Cause
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INTRODUCTION

Art For A Cause (AFAC) is a Michigan based small business whose mission includes the employment of people with disabilities. AFAC produces a product line called Cute Tools®. These include kitchen tools, garden tools, hammers, and screw drives. All these tools have a hand panted decorative pattern on wooden handles. AFAC distributes Cute Tools® worldwide through gift stores and as promotional pieces for major corporations.

Michigan Rehabilitation Services (MRS) is part of the Michigan Department of Energy, Labor & Economic Growth and is responsible for helping individuals with disabilities find meaningful employment. Toward this end, MRS staff works with clients as well as Michigan businesses. Art For A Cause submitted a proposal to an MRS solicitation for projects to employ people with disabilities funded by American Recovery and Reinvestment Act of 2009 (ARRA). The project will establish a network of microenterprise operations making and packaging the AFAC Cute Tools® product line.

MRS identifies individuals with disabilities who want to run their own microenterprise. Using ARRA grant money MRS would purchase a Cute Tools® workstation kit from AFAC for the entrepreneur. The Cute Tools® workstation kit contains all the materials necessary for production of a specific tool and pattern. The entrepreneur would be housed at one of many MRS employment centers across Michigan. Anywhere from 8-20 entrepreneurs would be operating out of a given center. Lisa Knoop-Reed, the President of AFAC and several of her associates would train the MRS sponsored entrepreneurs on the steps necessary for creation of specific lines of Cute Tools®. As the entrepreneurs became proficient in the creation of a specific Cute Tools® pattern, they could choose to be trained in the production of additional Cute Tools® products and patterns.

Fig. 21.9. Previous Workstation Design.

SUMMARY OF IMPACT

A prototype accessible Cute Tools® workstation kit was designed, built, and tested. The process has not yet started so the final impact cannot be assessed. However, MRS and AFAC are moving forward with the planning and training of MRS staff. Under the current plan, a variety of jobs will be created by this MRS/AFAC imitative. MRS clients will, under supervision of AFAC and MRS staff, produce the Cute Tools® workstation kits. The fully supplied kits will be shipped to an MRS center for assembly by MRS clients. AFAC staff will train the entrepreneurs.

AFAC will then subcontract work to these entrepreneurs for specific tools and patterns. The entrepreneurs will receive all the raw, unfinished, tools and supplies such as sand paper, paint, brushes, etc. for completing the order. Finished packaged tools will be sent to an AFAC distribution facility for shipment to the purchaser.

TECHNICAL DESCRIPTION

The workstation is built from Creform, a pipe and joint technology used worldwide in industrial settings. The pipe is steel with a bonded plastic covering. The pipe is available is a wide variety of colors. There are about 500 standard components available from Creform including; joints, casters, hinges, rollers, and a variety of pipe sizes and shapes. Fig. 21.8 shows an earlier workstation design. Based on several years' experience with this design, a number of design changes are required for the microenterprise workstation. Fig. 21.9 shows the new microenterprise workstation.

The workstations are mobile and mounted on lockable casters. Both designs are wheelchair accessible. Tools can be hung on the slot board back for drying as they are processed. The new design has two sets of slightly narrower drawers. The shelf tops over the drawers are plastic and easily cleaned. The new workstation will be shipped to MRS centers as kits that must be assembled. Therefore the new design incorporates features for error-proofing both the kit creation and packaging operations as well as the workstation assembly at the MRS center. For example, the new design color codes each length of pipe thereby providing an error-proofing feature for both the kit preparation and final workstation assembly.

Fig. 21.10 shows a workstation kit ready for shipping. The front and back slot board provide the top and bottom. The drawers contain supplies and provide separation to hold the pre-cut pipe. Tape holds the packaging together. An assembly instruction manual was prepared, written in a style that is easy to understand. Also visual aid materials are created and included with the directions.

Fig. 21.9. New Workstation.

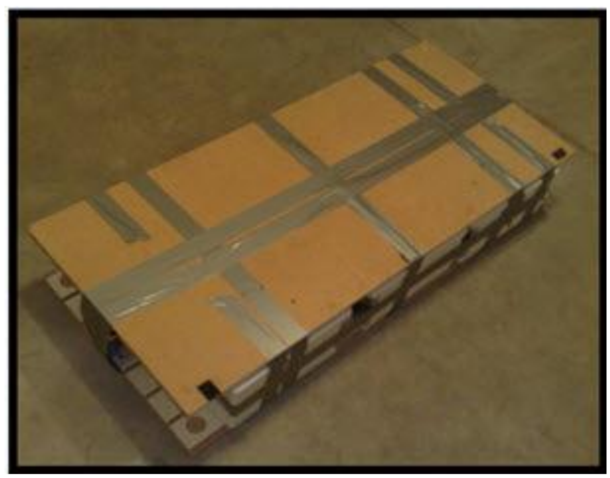

Fig. 21.10. Workstation Ready for Shipping.

Workstation assembly will be done by different workers than the entrepreneurs.

Total cost of the workstation is $710.