CHAPTER 20
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PACKAGING AND ASSEMBLY ENHANCEMENTS

Project 1: Semi-Automatic Wrapping System: Workstation and Turntable
Designers: Nanda K Doddapuneni, and Sivakumar Talla
Client Coordinator: Lisas Knoppe-Reed, President, Art For A Cause, Birmingham, MI
Supervisors: Dr. Robert Erlandson, David Sant, and Santosh Kodimyala
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Project 2: Semi-Automated Wrapping System: Turntable Controller and User Interface
Designers: Sandeep Jaswal, and Umer Yousuf
Client Coordinator: Lisas Knoppe-Reed, President, Art For A Cause, Birmingham, MI
Supervisors: Dr. Robert Erlandson, David Sant, and Santosh Kodimyala
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Project 3: Universally-Designed Assembly Fixtures
Designers: Peter Pisarski, Walid Yasin, Rachelle Dorsey, Jenn Guanio, and Eunice Osborne
Client Coordinator: Lisas Knoppe-Reed, President, Art For A Cause, Birmingham, MI,
Jane Resutek, Occupational Therapist, Warren Woods High School, Warren, MI
Supervisors: Dr. Robert Erlandson, Mr. David Sant, and Santosh Kodimyala
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INTRODUCTION

A collection of student design projects was targeted for a business in which artists with disabilities hand paint gardening, kitchen and household tools. The wooden handle of each tool must be sanded and primed several times before an artist applies the decorative layer. A final protective layer is applied before the tools are packaged. Two projects addressed the packaging of tools for shipment, and a third deals with methods for improving the quality and productivity of the employees with disabilities through improved tool-holding fixtures.

Figure 20.1. Example of Cute Tool hammer

SUMMARY OF IMPACT

The Semi-Automatic Wrapping System was delivered to the client. Workers that were previously unable to perform the wrapping operation are now able to do so at the required productivity levels and with the required level of quality. Both the Semi-Automated Wrapping System and the fixtures employ a universal design philosophy.

TECHNICAL DESCRIPTION

Projects 1 & 2: Semi-Automated Wrapping System

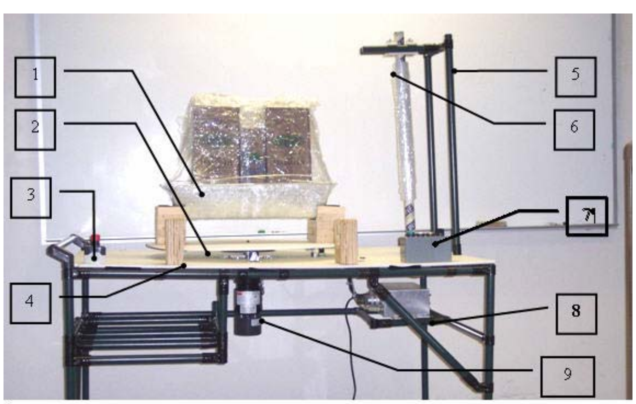
The wrapping process previously in place required two able-bodied workers to wrap a container of tools for shipping with a clear plastic material. The container is a metal flower box unit, about 2 feet long, 10 inches wide and 10 inches deep, with irregular and sloping sides. About 10 to 16 packages (depending on the mix) of tools were placed into the metal container. The metal container has a

Figure 20.2. Display container that must be wrapped - note irregular shape and decorations

decorative ribbon with a bow placed around its base, ready for display, as shown in Figure 20.2.

The design challenges for the wrapping operation included: the irregularly-shaped metal container added variability due to the box configuration; the decorations around the metal container; and the awkwardness of handling sticky shrink-wrap rolls to wrap such an irregularly-shaped package. The goal was to design and build a packaging system that would enable workers with disabilities to do the job at the required production rates with the desired quality.

Figure 20.3 shows the packaging system. The system includes a motorized turntable with a user interface, and two shrink-wrap dispensing units (one for horizontal wrapping and one for vertical wrapping). The system features two student design projects. A mobile Creform workstation was designed and built to hold the components. The workstation design and fabrication (including the two shrink wrap dispensers, bracketing and mechanical attachments of the turntable and motor as well as the design and machining of a customized slip clutch) was one project, and the design and fabrication of the electronic motor controller and user interface was the second. The turntable motor controller and user interface were implemented using relay logic.



Semi-automatic Wrapping System

1. Box to wrap	6. Positioning clamp
2. Turntable	7. Switch Box
3. Emergency switch	8. Control Box
4. Horizontal roller	9. Motor
5. Vertical Roller	

Figure 20.3. Semi-Automated Wrapping System

The work table is made up of Creform, which is a plastic-coated steel pipe joined together with metal clamps. This plastic-coated Creform steel pipe is adaptive, and any desired structure can easily be configured. The worktable is made of white nylon that is .32 inches thick, 55 inches long and 38 inches wide, affixed to the Creform pipes. The turntable consists of a 29-inch nylon (same material as the table top) disc with two blocks of wood to hold the container in place. The turntable rotates on four caster wheels, each with a 2-inch diameter. The disc has a hole in the center and is connected to the Parallel Shaft AC Gear motor. The turntable rotates in a clockwise direction. A custom-designed slip mechanism between the turntable and the motor is used to avoid injury to a worker or damage to the motor in the event that the turntable gets stuck.

Two fixtures hold the rolls of plastic wrapping material: one for the vertical wrap and one for the horizontal wrap. The vertical roller has a pivoting mechanism to enable angled wrapping. This is necessary to accommodate the irregular and slanted shape of the container. The horizontal roller consists of a dispenser lying on two wooden blocks, and is placed between the user and turntable.

The motor control and user interface control box consists of a power supply (24VDC, 60 W), a 3-amp fuse for the user interface circuit and a 10-amp fuse for the motor. The operation logic is realized by using four 24V SPDT relays and one 120V DPDT relay. A timer relay is used to adjust the number of rotations of the turntable. Given the power requirements, the wire harness consists of 22 AWG and 16 AWG wires. There are two toggle switches (SPDT 15A): one for the main power and the other to select the mode of operation (i.e., sequential or express mode). An emergency stop switch is prominently positioned to be used in the case of an emergency.

The Packaging System greatly simplified both the ergonomic and cognitive demands of the job. The system provides two modes of operation: sequential and express. The sequential mode uses prompting lights, built into the workstation, to guide the workers through the steps required for wrapping. More experienced workers would use the express mode, which does not stop and prompt at each step of the wrapping process.

The Packaging System uses a universal design approach wherein the goal was to design a process that would improve the production rate and quality of the packaging task for all workers and yet render the process more accessible for workers with disabilities. As the ergonomic process was simplified, it yielded a corresponding simplification of the cognitive demands.

Project 3: An assortment of fixtures

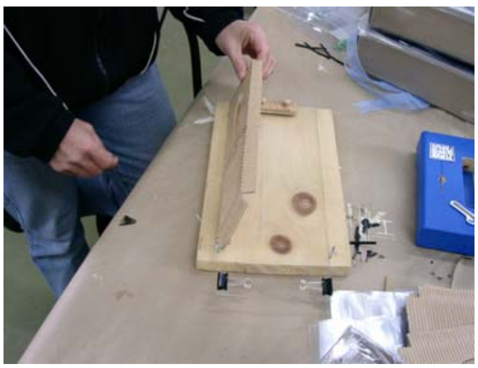
The group was charged with the task of designing or adapting existing materials for fixtures to assist workers in the process steps. Figure 20.4 shows some of the fixture concepts. Figure 20.4 (A) shows a fixture that can hold any one of four tools for the sanding, priming, or paint drying steps. The fixture in the foreground of 20.4 (B) was designed solely for the hammer. It has also been replicated and is in use. In the background of Figure 20.4(B), a simple drying rack for the spatulas, a Styrofoam sheet, is shown. Figure 20.4 (C) shows a folding fixture. All of the tools are packaged individually or in groups of two to four in a cardboard box that has a hard plastic cover slipped over it. The folding fixture was designed to aid in the cardboard folding process. This fixture handles all the cardboard boxes used to package the tools.

Fixture 20.4 (D) is a wedge-shape fixture mounted vertically with the sharp edge of the wedge pointing up. The hard plastic outer covers come flattened and must be opened and shaped. A worker can slip the flattened plastic cover over the sharp end of the wedge and slide the hard plastic cover downward. As it moves downward, the wedge widens into the final shape of the outer cover and forces the flattened plastic to open to the correct configuration. Figure 20.4 (E) shows brushes drying.

The total cost of projects 1 and 2 was approximately $860. The cost of the project 3 fixtures varied from a $3 to $6 each.

(A)

(B)



(C)

(D)

(E)

Figure 20.4. Fixtures

Disability Advocates and Community Action Using World Health Organization's New International Classification of Functioning, Disability, and Health (ICF)

Designer: Ravindar Koorapati
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INTRODUCTION

The WHO ICF is emerging as the internationally-recognized standard framework for describing human functioning. In the U.S., the Center for Disease Control (CDC) has been the leading organization with respect to U.S. involvement. Federal agencies are working to incorporate elements of the ICF into their operations and databases with the long term intent of creating ICF-compliant databases. From a disability community perspective, U.S. providers and third party payers of durable medical equipment are particularly interested in the ICF and have started moving their data collection and client monitoring in that direction. Such applications will have significant implications for people with disabilities.

The WHO ICF conceptual model of disability captures the broader influences of activities and environment in defining disability, in that disability is seen as an interaction of the person, activity and environment. The major components of the ICF model are Body Function, Body Structures, Activities and Participation, and Environmental Factors. These four components are quantified using the same generic scale.

It is important for disability advocacy and service support groups to be knowledgeable of the ICF and its future impact. The ICF also provides a powerful vehicle for organizing information and data and for survey construction and planning activities. This will be particularly true as more and more organizations start using the ICF framework. For this reason, a computer-based process was developed for displaying the ICF framework (over 9000 elements possessing a hierarchical tree structure), and a data management process for creating core groups or core areas of policy concerns from the ICF elements.

SUMMARY OF IMPACT

This system is the front end to what must eventually become a more comprehensive planning and organizational tool for disability rights and advocacy organizations.

TECHNICAL DESCRIPTION

The ICF Analysis and Planning Program is written in Visual Basic 6.0. The program has five main sections. Section 1 provides a view of the ICF taxonomy using a collapsing and expanding tree structure and associated display area. Figure 20.5 (B) provides an example of this section. Section 2 allows a user to define what is called a Category. One important Category is that of people with disabilities that require the use of durable medical equipment. The ICF program allows one to specify, for each major component the ICF, those taxonomy elements that characterize that category. Hence, categories would be established based on Body Structure, Body Function, Activities, and Environment.

The third section allows a user to construct what are called Scenarios. Scenarios are a collection of Categories, one from each of the four major components. For example, a scenario might be for a person with quadriplegia who requires a mobile ventilation device for attending a church service. The ICF components and sub-components used to define the categories and scenarios define people in their community who have needs as described by the scenarios.

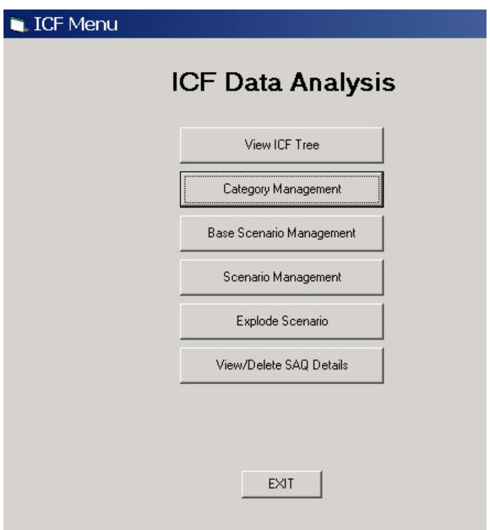
The last two Sections of the program are not implemented. The staff of a client organization wanted to gain experience with the first three sections before taking on more completed procedures.

It should be noted that a collection of professional organizations worldwide have joined together to define what they are calling "ICF Core Sets." These Core Sets will be published in the Journal of Rehabilitation Medicine as they become available. The Core Sets are essentially the same as the Categories and Scenarios structure. The Core Sets define broad demographics, i.e., recovering stroke patients, recovering heart attack patients, and those with senile dementia or Alzheimer's disease. The client's focus is much narrower, concerning itself with community issues and the concerns of local citizens with disabilities.

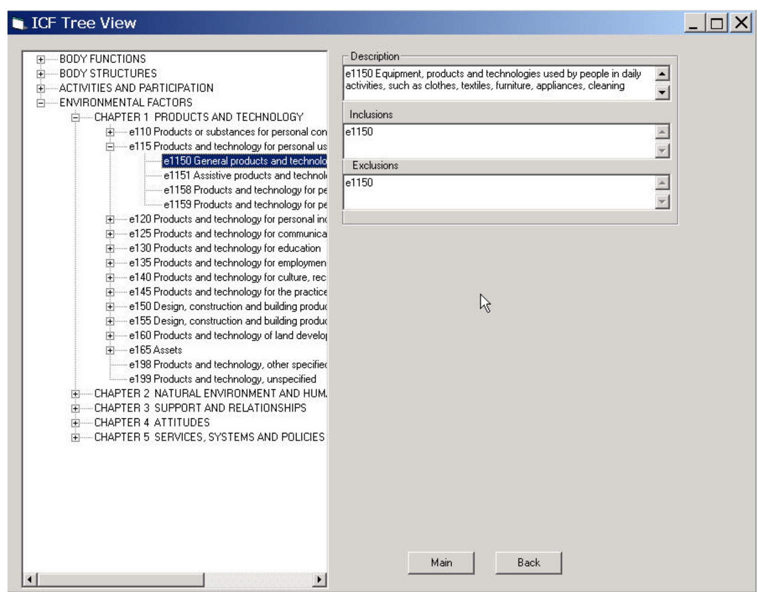
Being able to clearly specify community members and their needs within the ICF framework will allow organizations to formulate community-based surveys and databases that capture community needs and concerns. They will be able to do this in a language that is commonly shared by insurance companies, Medicaid, other benefactors and care providers.

The ability to communicate in a common language (the ICF framework) will empower community organizations to more clearly understand how policy makers and planners are using the ICF to delivery, monitor, and assess the services they provide.

The cost of this project involved purchase of the CD-based WHO ICF framework, which totaled $400. Also included in the cost was the cost of preparing CDs with the analysis and planning program for distribution to the client organization, which totaled $5 per CD.



(A)



(B)

Figure 20.5 (A) Main Screen and Access to Program's Main Functions (B) ICF View Function - Taxonomy Opened to Environment Section

USER INTERFACE AND ACTIVITIES FOR THE RF TAG EDUCATIONAL ACTIVITIES SYSTEM

Designers: Kathryn Potter, and Michael Sherman
Client Coordinator: Christine Erlandson, Teacher, Madison Elementary, Wayne-Westland, Michigan
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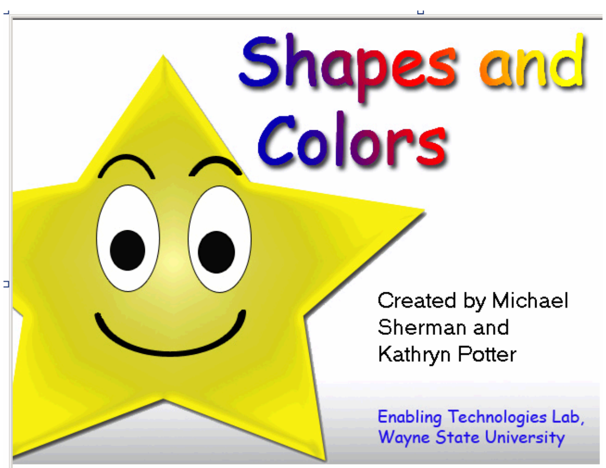
INTRODUCTION

An educational activities program was designed for the RF Tag Educational System hardware designed and built by an earlier design team. The aim of the project was to build a system that allows young children with cognitive impairments to develop pre-mathematical skills such as shape recognition, colors, patterning, sequencing and counting skills. The RF Tag Educational System is a multi-semester project, and this project builds on previous ETL student design projects where the following components were designed and built: essential system hardware, a reader/scanner (R/S) for RF tag detection and energizing, and an antenna. RF tags are embedded in a variety of shapes– squares, triangles, and circles. As the tags are placed onto the R/S, it transmits a code that is received by the antenna and the R/S sends the code to the PC and, hence, the game program. Each shape has a unique code. Example activities include identification of shapes, colors, sequencing tasks, and patterning activities. An experienced first-grade teacher served as a consultant for the activities. She identified four areas and the appropriate levels of complexity for each area. Each activity had three levels of difficulty: very supportive, to moderate support, to no support.

The game includes four activities: color identification, shape identification, a sequencing task, and a patterning task. The first two tasks are very basic in that the students are asked to recognize different colors and geometric shapes. The sequencing and patterning activities also deal with essential pre-math skills. Children need to be able to identify and construct simple sequences. For example, place two red circles on the table. Or place one red circle, one yellow triangle, and two blue squares on the table. Lastly, pattern recognition is an important pre-math skill. The child is presented



(A)

Figure 20.6A. Opening Screen to Shapes and Colors

(B)

Figure 20.6B. Selection Screen to the Four Games with two examples of a repeating pattern and shown only the first part of the pattern and asked to complete the pattern. For example, the child will see a red circle and a blue square, then another red circle and a blue square, and then the child will be presented with a red circle and asked to place the correct item on the table, i.e., the item that satisfies the preceding pattern. The program provides voice feedback and prompting.

SUMMARY OF IMPACT

The consulting teachers were favorably impressed with the implementation of their recommendations.

TECHNICAL DESCRIPTION

The program is written in Visual Basic 6.0, and communicates with the RF tag R/S hardware using a serial port. Figure 20.7 shows the R/S. A serial connector and power connector are shown at the rear of the device. This unit would sit on a table next to the PC. A collection of shapes (three are shown in Figure 20.7) are put on the table next to the R/S. As the child is prompted, he or she places a shape on top of the R/S. Each shape has an embedded passive RF tag. Each tag has a unique code that identifies the shape via the program's database.

The final version of the game will use either wooden or plastic shapes with an embedded RF tag. Given that this version of the system is still a prototype, the designers and teacher consultant decided to use a simpler approach. The RF tag is embedded between two layers of thermally sealed heavy plastic. Three different shapes were used: circles, squares, and triangles. There are also three colors: red, blue, and yellow. Each shape additionally has three sizes: small, medium, and large. Such a selection of shapes and colors was deemed sufficient to teach and evaluate the system.

Microchip Inc. donated approximately 50 RF Tags for this project. The RF tags are termed cow tags because they are designed for use with cattle. The tag has a hole through which a pin is used to affix the tag to a cow's ear, which avoids branding. The tag is rugged, designed to withstand considerable temperature variation and mechanical deformations.

The cost of the system, hardware, software, and RF tags was approximately $1,200.

Figure 20.7. Three Shapes on Reader/Scanner (Quarter to Show Relative Size)

MARK MY WORDS

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Client Coordinator: Carol Kitchen, Occupational Therapist, Special Education Teacher, Bovenschen School, Warren, MI
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INTRODUCTION

A game was developed to help moderately cognitively-impaired elementary-aged students develop the fine motor coloring and pre-writing skills necessary for writing. To help the students properly grasp and orientate the pencil to the paper, hand-over-hand assistance and utensil grippers are used. The students start by imitating vertical and horizontal lines. Eventually the students are ready to begin tracing vertical and horizontal lines, and shapes. With these emerging tracing skills, it is still difficult for the students to visually attend to the paper and the lines. To increase visual attending, the client coordinator on this project (who is also an occupational therapist and a teacher) developed a word tracing game. The game is based on car racing. A large colored block letter with a dashed line running through it, directional arrows and a start and stop icon. The students can be timed and scored for accuracy as they follow the dashed line tracing the letter. As the student gains proficiency with a single letter one can move to words. The game became so popular among the students that the developer was able to use this method to run pre-writing and handwriting groups. She could work with 10 students at a time with the help of a paraprofessional.

One of the main drawbacks of this pre-writing, tracing program is the time it takes to make up a name sample. The developer has created many shortcuts, but it still takes her about 30 minutes to complete an average name sample. She has a growing list of names and words, but the students are most engaged when they are tracing their names (first and last) and words of items special to them. Even though she has developed a method of word using PowerPoint and its drawing features, it is still a complex time-consuming task.

SUMMARY OF IMPACT

The program has been delivered and is being used by the client coordinator and her students. She and her colleagues are very pleased with program and the capabilities it affords them. The students love the writing games, and are using it more often since it is so easy for the teachers to prepare new material.

TECHNICAL DESCRIPTION

Mark My Words is a software program designed to produce stylized words created by special education teachers. It is written in Visual basic 6.0. These words are to be used by children with disabilities to improve the fine motor skills necessary for writing. The words are big block letters with a dashed line running through them. A green light represents the starting point and arrows placed along the dashed line indicate the direction for tracing. A red light indicates the end of the tracing path. Figure 20.8 shows and example a stylized word.

The block letter with the desired icons is saved as an image, which is the central point. As an image, it can be scaled to a desired size. It can be inserted into documents. In this way the teacher can recall the word and resize the entire word with the dashes and embedded icons changing size in proportion to the block letters.

While this sounds quite simple this process was technically quite sophisticated and complex. The Mark My Words program will allow many more teachers to construct easily a wide variety of customized words for use by their special education students.

Figure 20.9 shows the startup screen. The user is asked to type in a word. The lower portion of the screen shows the default letter color and the dashed (tracing line) color. The Edit menu in the toolbar allows the user to change font styles, letter color, and tracing line color. To create image with dashes, the user clicks the button "Create image with dashes" or "Tools"->"Create dashed image." A customized program using a positioning algorithm then creates the block letter and draws the dashed line in the center of each letter.

Figure 20.8 shows the icon insertion window. After the program creates the block letter and the centered dashed tracing line, the teacher must add the start, stop and direction tracing icons. A palette of icons is provided and these can be dragged and dropped onto the letter. Once on the letter, the icons can be resized to fit the letter. In this way, the program provides a natural and familiar procedure for block letter creation and marking.

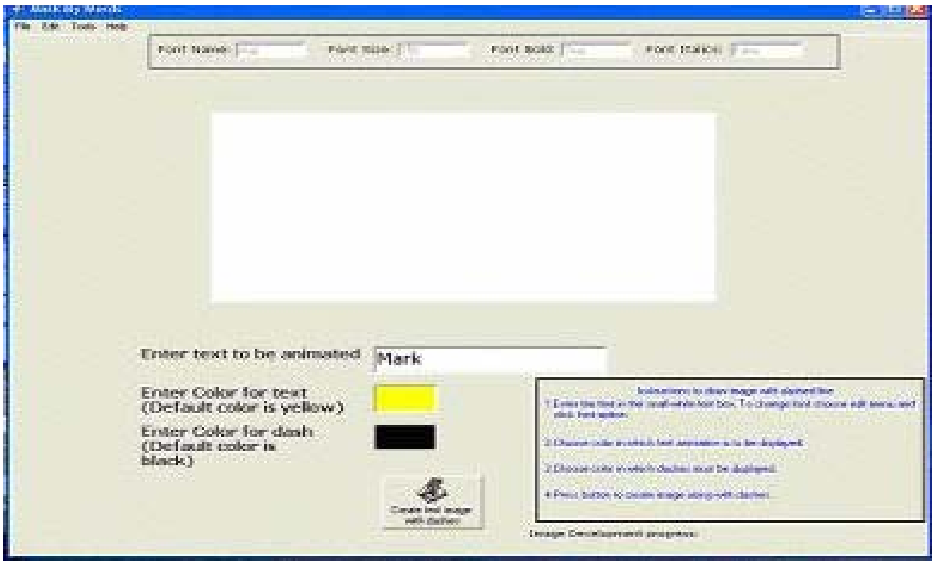

Figure 20.8. Example of a Stylized Word, Shown on a Design Screens

Figure 20.9. Start-Up Screen with Word Typed by a Teacher