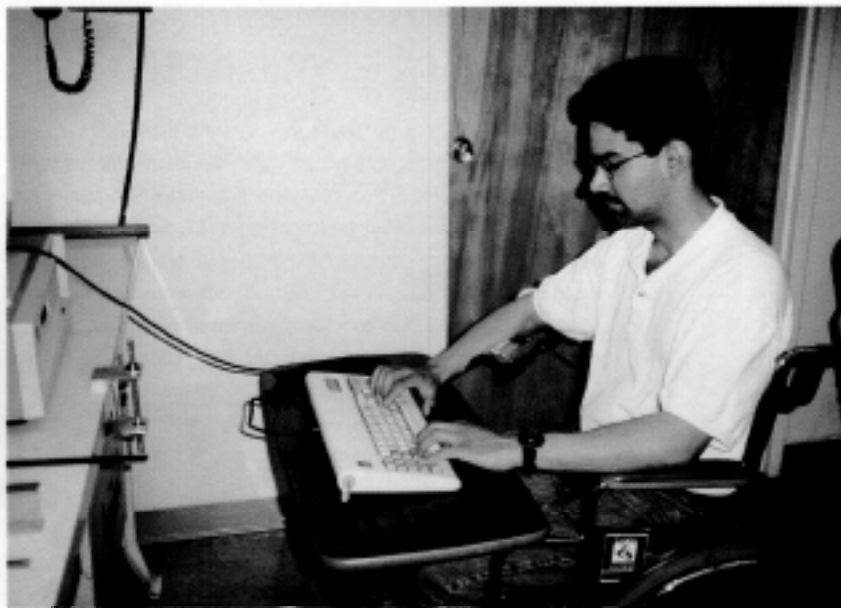


# Up in Arms



Rehab engineer Vicente Vargas, BSME, demonstrates the arm support model the RERC has developed. Its linkage system prevents the support arm from bending either too far out or in.

## Designing Mobile Arm Supports

By Nancy Hays

*Editor's Note: The National Institute on Disability and Rehabilitation Research has set up a system of rehabilitation engineering research centers on various rehab-related subjects, such as wheelchair technology, transportation and augmentative communication. The RERC on Technology for Children with Orthopedic Disabilities is one of the major programs of the Los Amigos Research and Education Institute, Downey, Calif. It is currently involved in five projects. The one closest to completion, with the ultimate goal of having a cost-effective product to manufacture, is a new design for a mobile arm support. TeamRehab Report Managing Editor Nancy Hays recently visited with Sam Landsberger, ScD, technical director for the RERC, to find out the status of its projects and to examine the mobile arm support in more depth.*

**M**obile arm supports enhance function and independence of people with flaccid paralysis or paresis of the shoulder and elbow flexor muscles. These

devices are mounted on a person's wheelchair and support the client's arm while he or she uses a joystick or keyboard or performs self-care. A large percentage of people using these supports have Duchenne's muscular dystrophy or other neuromuscular disorders.

These aren't new products; in fact, they were quite popular in the 1960s and 1970s. Available models—despite offering good function and being adaptable to the needs of a wide range of user strengths—are complex to set up, difficult to adjust and cosmetically unappealing. In addition, when in the outward “bent” position, the arm extends beyond the chair, making access through doorways difficult; and when in the inward “bent” position, the arm can hit the user's torso.

Typically, the user's forearm is placed in a “trough” that has a pad for elbow support. Then, using shoulder strength or slight body manipulation, the person moves the arm from side to side in a horizontal plane. Current models allow the user to go from plane to plane, raising or lowering the arm for eating or self-care, such as brushing teeth or combing hair.

These devices, however, go out of alignment easily. Hitting a door frame or someone bumping into it while walking by can cause

## From Hands to Feet Other RERC Research Projects

**T**wo other projects under development at the RERC are a body-powered toddler hand and a lower-extremity orthosis for children with myelomeningocele (a type of spinal bifida). Both are still being tested.

The toddler hand is designed

for children 1 to 4 years old to use with minimal harness force and excursion. The study is being conducted in cooperation with the Child Amputee Prosthetics Program at Shriners' Hospital, Los Angeles.

To study the needs of this age

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the support to go out of adjustment, limiting the user's range of motion. Readjustment requires an understanding of the support's mechanics, and most lay people—and even some therapists—find it a challenge. In fact, Rancho Los Amigos Medical Center, Downey, Calif., conducts an extended workshop just on mobile arm supports so therapists can learn not only what clients will benefit from them, but also how to adjust or repair them. Setting them up correctly requires extensive knowledge of the client's capabilities. Sometimes even a slight adjustment can be the difference between the highest possible range of motion and client dissatisfaction.

The Los Amigos Research and Education Institute received a grant from the National Institute on Disability and Rehabilitation Research in 1995 to study children's orthopedic needs (see "The RERC—What Is It?"). One of the center's projects was to study mobile arm supports and develop a usable model. The idea for the arm support project grew from discussions with practicing occupational therapists at Rancho. One idea they were most enthusiastic about was a better mobile arm support. They indicated these devices had declined in usage

because of specific problems, which they felt could be addressed and overcome.

## The Survey

The first part of the study consisted of a survey of present users of mobile arm supports and their families, the names of which were obtained from the Rancho Orthotics Department. The survey of 28 users or caregivers was conducted over the telephone.

Users were of both sexes, 4 to 43 years old, and had either one or two mobile arm supports.

Seven of those respondents were visited at home or brought to LAREI to check their range of motion. This group also agreed to test prototypes.

Users' complaints about the support included needing frequent readjustment; difficulty in adjusting the support to properly balance the arm; the device being

uncomfortable; the device's width being more than the chair's; and lack of cosmetically appealing appearance. Also mentioned was the lack of an easily engaged lock to secure the support while driving a power chair. Other requests included the ability to quickly relocate the support from the wheelchair to a pre-adjusted mount on a desk or table. The adults, especially, were interested in a device that made self-care easier.

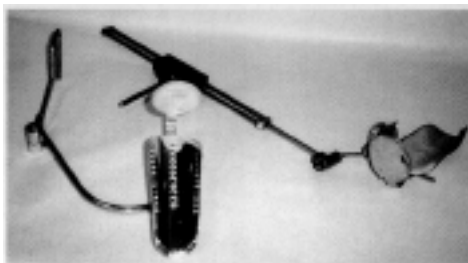
More than half of the 28 respondents indicated they benefit from having their mobile arm support. They use it for a variety of activities including eating and typing. They also said the device gave them a feeling of freedom of movement. Seven use it to help them drive their power wheelchairs.

## The New Support

The RERC team's mission is to develop a prototype device that meets the needs of a majority of the population who could benefit from it—and to make it cost-effective to manufacture. The design goals, based on the survey, are to preserve good function while providing ease of setup and mount adjustment, doorway clearance, and a more attractive appearance.

The new design incorporates a linkage geometry that enables the support arm to maneuver away from obstacles such as door frames or the user's torso. A mount and setup calibration system is being engineered to simplify the setup and alignment procedure and save time. This system provides direct feedback to the user and caregiver as to the arm support's alignment. The trough has been offset slightly from the arm to prevent it from interfering with the arm's maneuvering.

The center began testing this prototype in September 1996, and, at press time, eight people, mostly children, have successfully used it. Testing includes three kinds of tasks: tabletop activities (e.g., using a keyboard); body midline activities (e.g., eating and brushing teeth); and, if applicable, driving a power



These two versions of mobile arm supports are currently available. One bends in the middle to allow range of motion, the other slides along a metal bar.

## The RERC— What Is It?

The RERC of the Los Amigos Research and Education Institute, is a rehabilitation engineering research center funded by the National Institute on Disability and Rehabilitation Research. It is housed on the grounds of the Rancho Los Amigos Medical Center, Downey, Calif. The center focuses its research on technology for children with orthopedic disabilities, with the intent to provide an avenue for getting products to market. In 1995, it received a five-year, \$2.5 million grant to study orthotics and prosthetics for children with long-term disabilities and amputations. The center had already been functioning as an RERC under a previous NIDRR grant.

Besides the mobile arm support, the NIDRR proposal included developing a body-powered toddler's hand with the Child Amputee Prosthetic Program at Shriners' Hospital, Los Angeles; defining the optimum orthotic system for children with myelomeningocele (a type of spinal

bifida); developing a lower-extremity orthosis for children with myelomeningocele; and identifying via an intensive survey child and parent beliefs, functional needs and goals regarding orthotic and prosthetic devices.

The center is under the leadership of



The RERC engineers on the mobile arm support project are (from left) Andrew Lin, Samuel Landsberger, and Vicente Vargas

Donald McNeal, PhD. Its medical director is Yoshio Setoguchi, MD. Samuel Landsberger, ScD, is technical director. Faculty working on current projects includes Julie Shaperman, MSPH, OTR; Vicente Vargas, BSME; Andrew Lin; David Eckhous, CO, OTR; Carin Caves; Kevin Caves, BSME; and Richard Fite, CP. The RERC also works closely with the clinical staff of RLAMC.

chair. So far, the testing results have been favorable, and everyone has indicated they like the new design and functionality of the device. Besides additional testing, the center is forming a user group of about 12 people who will consult with the team as the device is refined.

The team's current goals are to refine configuration of the arm, ensure parents will be able to adjust the mounting system relatively easily, and make sure the device is adequately rigid. It anticipates having several devices available for home testing by early summer and manufacturing shortly thereafter (a prosthesis manufacturer has expressed interest in the device). ■

*Donald McNeal, PhD, Samuel Landsberger, ScD, and Julie Shapeman, MSPH, OTR, are interested in hearing about your experiences with mobile arm supports. They can be reached at LAREI, Rehabilitation Engineering Program, Bonita Hall, 7503 Bonita St., Downey, CA 90242; 562/401-7994; fax: 562/803-6117; e-mail: ranchorererc@aol.com; Web site: <http://members.aol.com/ranchorererc>*

# From Hands to Feet

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group, the project team filmed nondisabled youngsters at a local preschool to document how they typically hold and use objects. The project team then compared their actions to those of children with unilateral below-elbow prostheses. From these videos, as well as literature searches and performance tests, goals were devised for the prosthesis, as was a list of objects to use for testing, such as bicycle handlebars or a ball.

Initial design objectives included prehensors able to grasp objects with 2.5 inches of span with less than 1-inch harness cable excursion and mechanisms using diverse power sources from the child (e.g., the energy developed by the sound hand as it places objects into the prehensor).

The team has a prototype hand in development. Some of the team's research was

presented April 25-27 at the annual conference of the Rosemont, Ill.-based Association of Children's Prosthetic-Orthotic Clinics.

Orthotic support for children with myelomeningocele has always been difficult. The RERC is attempting to develop a stronger, lighter AFO shell to improve ankle joints and an improved KAFO with easily operated knee joints. The design objectives are for it to be lightweight, easily fabricated, relatively attractive and low cost.

An initial cantilever prototype has been developed with carbon-fiber and epoxy materials. However, several challenges remain, including custom-fabricated vs. modular construction; wet vs. prepreg; making carbon-fiber prepreg available to the orthotist; and flaccid and spastic limb considerations. The design team is using composite materials and is presenting some work at an advanced materials symposium. It is also canvassing the defense and space agencies for assistance in finding suitable materials.