Capabilities

Communicating the Science of Prosthetics and Orthotics

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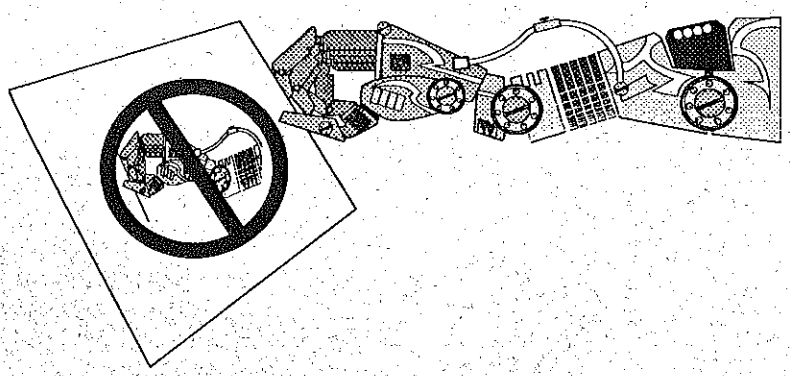

Prosthetics/Orthotics Advancement and Development: *Unlimited but Bounded*

by Dudley S. Childress, Ph.D.

In this age of computer-guided missiles, moon landings, space stations, personal computers, portable phones, and FAX machines, there is sometimes a tendency to feel that technology can do almost anything. In actual fact we are bounded in what we can do. We cannot construct anything that we can imagine. Fortunately, however, within the bounds the possibilities for advancement are unlimited. It's similar to painting a picture. The artist is bounded by the painting medium, by the dimensions determined, and perhaps even by the subject matter. Nevertheless, what can be created in the painting remains essentially unlimited.

In what ways are we bounded? Firstly, we are bounded by the laws of nature. We cannot build prostheses and orthoses that violate principles of the universe, even though we may be able to conceive of devices of this kind. For example, we cannot build an artificial leg in which we get more energy out than we put in each cycle. Secondly, we cannot build prostheses or orthoses for which technology has not been developed. We could only have practical myoelectric prostheses after the discovery and development of the transistor. We could only have plastic orthoses and prostheses after polymer chemistry developed these materials.

Thirdly, in prosthetics and orthotics we are constrained by the human organism itself, by what it will tolerate in the way of weight, size, temperature, or appearance. Consequently, things that can be done with robotics in Disney World may be impossible in prosthetics and orthotics. It also has to be remembered that designing quality replacements for the human body can be much more difficult than designing equipment for technical systems. Hans Mauch, who worked on the design of rockets during WWII, and who subsequently was involved with the design of widely used artificial knee mechanisms, once said that designing rockets was sheer simplicity itself compared with designing knee mechanisms.

Engineering has been described as *design under constraint conditions*. Engineers and others must seek designs

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In This Issue

ISPO Update

(ISPO Update will contain regular news about the upcoming Seventh World Congress of the International Society for Prosthetics and Orthotics in 1992.)

Chicago has been chosen as the site for the Seventh World Congress of ISPO (International Society for Prosthetics and Orthotics.) The Congress is organized in collaboration with INTERBOR, AOPA, AAOP, APTA, and other North American Societies. Dudley S. Childress, Ph.D. is the General Secretary of this Congress, which will be held from June 28 to July 3, 1992 at the Hyatt Regency Chicago Hotel.

The theme of the 1992 Congress is **Find the New World of Prosthetics and Orthotics Developing Around the Globe.** This theme acknowledges the past and the 500th anniversary of Columbus' voyage to America, but more importantly it directs us to the future and to the new world of prosthetics and orthotics that people are developing around the globe. These people will be coming to Chicago to share their new knowledge, new developments, and new visions.

The Congress will consist of scientific, technical, clinical and surgical papers; plenary sessions; instructional courses; scientific and commercial exhibits; poster sessions; a video and film program; and technical tours. Social and accompanying persons programs will also be provided.

Topics to be discussed at the Congress include amputation and surgical procedures, biomechanics, CAD/CAM, gait analysis, lower and upper limb orthotics and prosthetics, rehabilitation in developing countries, wheelchair issues, spine management, physical and occupational therapy, and many others. In addition, this will be the first Congress where a special Consumer Session is planned.

For more information on this important event, including registration, presentation, and exhibition forms, contact the Congress Secretariat at: Moorevents, Inc., 400 N. Michigan Avenue, Suite 2300, Chicago IL 60611. ◆

Resource Unit

(Resource Unit will contain regular news from the Resource Unit for Information and Education.)

The *Resource Unit for Information and Education* (RU) at Northwestern University's Rehabilitation Engineering Program provides information in prosthetics and orthotics to a wide audience of consumers, researchers, and service providers. The RU was formed under a grant from NIDRR in 1987/88.

The RU maintains databases which contain information on amputation management, amputee support groups, state-of-the-art research, recreational resources, self help groups, prosthetic/orthotic schools, service providers, prosthetic/orthotic publications, and manufacturers' information.

A Help-Line is available on (312) 908-6524 where callers can ask for information and receive helpful materials. All help-line services and materials are free of charge. The Help-Line also refers callers to alternative resources; however, no recommendation or endorsement is made.

The RU's quarterly newsletter, *Capabilities*, provides state-of-the-art research information, consumer interest articles, publication reviews, and other items of interest to persons involved with P & O.

The RU networks regularly with other information sources and sponsors educational opportunities. It maintains contacts with amputee support groups and strives to create cooperative interactions between manufacturers, service providers, researchers, and consumers. Consumer feedback to the Resource Unit is formally acquired through meetings with the Rehab Engineering Program's Consumer Advisory Panel.

For more information, clip and mail the coupon in this issue or write to Northwestern University, Rehab Engineering Program, Resource Unit for Information and Education, 345 E. Superior St., Room 1441, Chicago IL 60611, (312) 908-6524. ◆

CAP Provides Input

The Consumer Advisory Panel (CAP) of Northwestern University's Rehabilitation Engineering Program in Prosthetics and Orthotics is a group of individuals whose

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Capabilities (ISSN 1055-7156) is published in April, July, October and January by Northwestern University's Rehabilitation Engineering Program. Program Director: Dudley S. Childress, Ph.D.

Subscription is free to all individuals interested in prosthetics and orthotics. For contribution guidelines and advertising inquiries, write to the address below. Send subscription information, address changes, correspondence and contributions to: Capabilities, Northwestern University-REP, 345 East Superior St., Rm. 1441, Chicago, IL 60611, (312) 908-8560.

(S.O.A. or State-Of-the-Art will feature regular reports on prosthetics/orthotics research at Northwestern University's Rehab Engineering Program and Prosthetics Research Lab.)

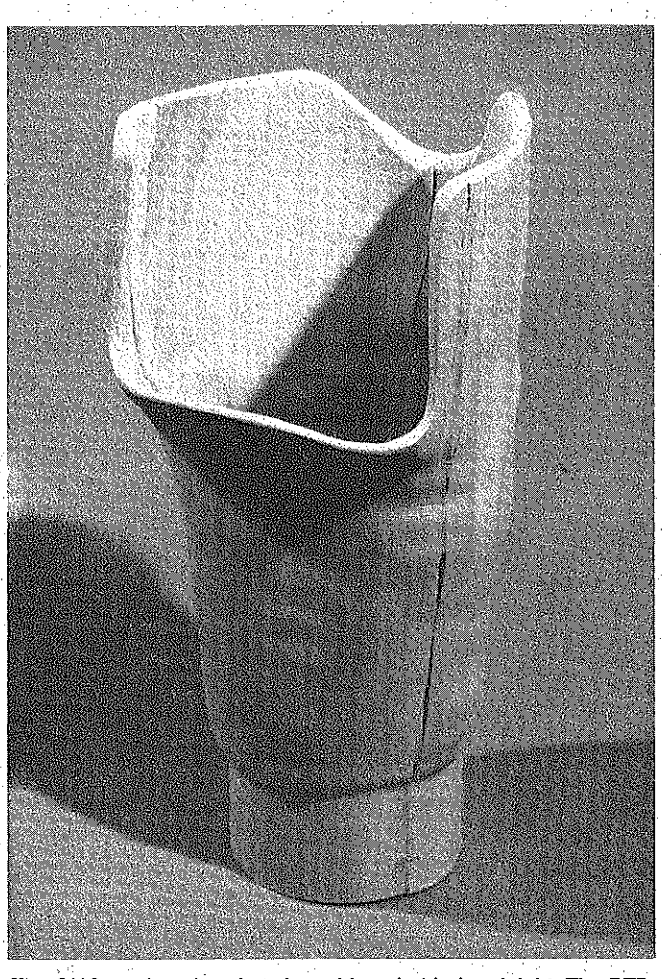
CAM of Prostheses Using Stereolithography and CNC Milling

The CAE/CAD/CAM revolution (computer-aided engineering, design, and manufacture) is now encompassing the Prosthetics and Orthotics (P&O) community. The CAD/CAM tools developed and marketed thus far appear to be performing well. These new tools basically replicate, in automated ways, the current and commonly used practices (hand tools, positive plaster model, etc.) of prosthetics fabrication. Other design and manufacturing options are available, and we believe some of these options may be used in the future in the P&O field. Our research and development teams at Northwestern are currently investigating a number of these options.

One of the options is *stereolithography*. Stereolithography creates a plastic object from a bath of plastic resin by selectively hardening the resin using ultraviolet light from a laser beam. The light traces the desired shape of the object on the surface of the resin bath. The object is built up layer by layer in the resin. The tracing is under computer control and the object is built directly from computer data, without intervening steps. Working with the Advanced Engineering/Design Center of the Baxter Healthcare Corp. we have produced the first prosthetic socket using this technique (equipment of 3D Systems, Inc.). However, the socket took many hours to produce and the resin now used results in a socket that is too brittle for actual use in prosthetics. These drawbacks are considered temporary since faster machines and more versatile materials are already under development.

Another option is to use a CNC (computerized numerical control) milling machine to create prosthetics sockets directly by milling procedures. This enables us to explore alternative materials that are not possible or not practical to use with more manual techniques. Current techniques pretty much limit prosthetics sockets to thermoplastic materials or to thermosetting resins.

We have recently acquired a standard industrial CNC milling machine with the idea of investigating direct socket creation from various kinds of materials. For example, we have fabricated a patella tendon bearing (PTB) below knee (BK) socket from wood. Wood is a material that was used in the past in prosthetics. However, a highly skilled artisan is needed to shape wood and an intimate fitting PTB socket of wood would be almost impossible to do by hand. A CNC milling machine, through its computer control, can easily make a wooden socket of almost any complexity and accuracy. We have fabricated a PTB socket of wood. This was partially an exercise to demonstrate direct production of a socket from a block of material by CNC techniques. Nonetheless, wood is a material of biological origin that is compatible with the human body. It has strength, durability, and is fatigue resistant. It is a thermal insulator, yet is reported to "breathe." Consequently, we feel it is one material, *among many*, that should be investigated for prosthetics sockets.



The CNC produced socket viewed from behind and right. The PTB socket has a 7mm uniform wall thickness.

Our wooden socket was made in three pieces and bonded together. The socket is unique in two ways: (1) it is the first socket we know of that was produced using standard industrial machining practices, and (2) it is the first PTB BK socket ever made of wood in this manner. ◆

This article is adapted from material in the laboratory's 1990 Annual Report. For more information on this research work, contact Joshua Rovick, M.S., at Northwestern University, 345 E. Superior St., Room 1441, Chicago IL 60611.

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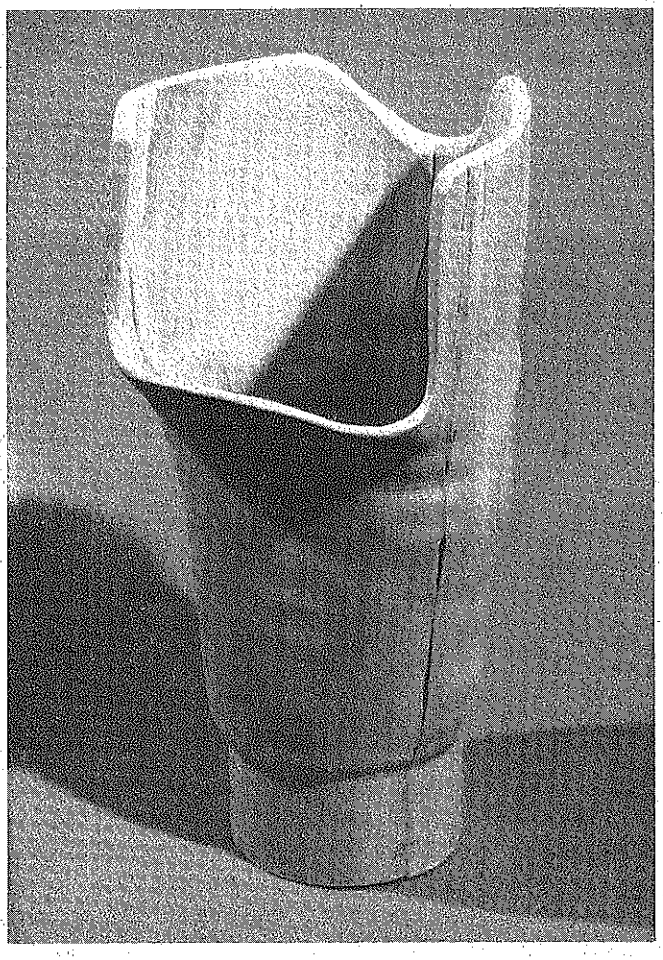

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Consumer View

(Consumer View will feature regular editorials written by consumers of prosthetic/orthotic products. Opinions expressed in this column are not necessarily views held by Northwestern University and its staff.)

Empowering People: A Rehabilitation Goal

by Carol Young Scholar, M.S., R.N.

Seven years ago I was challenged "to the max" when my right arm was amputated above the elbow because of a malignant tumor. During this time, I had to cope with three major stressors.

First, I knew that I had a disease that might be life threatening. Second, my body image was changed forever. Third, I discovered that my pride and dignity were hurt. I now could be categorized as one of "those poor handicapped people." I knew that those with disabilities are often stigmatized, devalued and excluded in our society.

In my work in *Independent Living*, I met people who were recipients of blatant prejudice and discrimination. They were ignored in conversation; segregated in classrooms; passed up for jobs; excluded from restaurants, voting places, and social functions. For me and many others, this reality is the hardest part of having a disability. Fear and grief involved in the loss of a body part or function tend to lessen in intensity over time, but this stressor goes on and on, day after day. It is easy to come to the conclusion that the actual problem is the disability itself: "it's my disability, my imperfect body that keeps me from participating fully in life." Nothing, of course, could be further from the truth. Society does not welcome or address the needs of people with disabilities.

Rehab professionals need to understand that from a patient perspective, disability is much more than a medical phenomenon. The disability itself is not nearly as limiting as the societal barriers that accompany it. To be truly helpful, professionals need to go far beyond the physical restoration phase.

The most important goal of rehabilitation should be to help the individual feel empowered enough to speak up for his or her rights as a human being. It is essential that people with disabilities have self-advocacy skills and regain a feeling of mastery and control over their lives. People gain self-esteem and confidence if they are active and involved in meeting their own needs.

This self-advocacy can start from Day One if professionals allow and encourage the patient to become an active "consumer": by educating them about their disability, and by teaching them how to negotiate service systems and evaluate products and services. As a consumer, one plays an active role in rehab planning and has a respected voice as a member of the rehab team.

People are truly rehabilitated when they return to the mainstream of life in their own community. People who are secure in their self worth will strongly believe that they are entitled to nothing short of total access and total participation. ◆

Carol Scholar is Associate Director of ARISE, Syracuse, New York. She has 14 years' experience in independent living work, and 17 years' experience in nursing.

Review

(Review will regularly feature information on publications, programs, educational opportunities, and resources for those interested in prosthetics and orthotics.)

The *Children with Limb Loss* Booklet Series

Children with Limb Loss: A Handbook for Families
Book One: Birth to 5 Years
Book Two: 6 to 12 Years
Book Three: Adolescents
Children with Limb Loss: A Handbook for Teachers
Children with Hand Differences: A Guide for Families

The first three titles, coauthored by Area Child Amputee Center staff and Mary Point Novotny, R.N., M.S., focus on providing information about normal child development as it is impacted by limb deficiency and prosthetic treatment. The booklets grew out of the authors' experience in working with child amputees and are designed to fill a gap in informational materials for families.

Later, in a team effort led by Ann Swagman, R.N., M.P.H., the Area Child Amputee Center staff developed two additional booklets. The *Handbook for Teachers* draws heavily on the medical and prosthetic sections of the family handbooks, and also includes information on facilitating a normal school experience. *Children with Hand Differences* focuses primarily on children with hand anomalies that do not lend themselves to prosthetic treatment. Again, the emphasis is on developmental considerations, both fine motor and psychosocial.

All five booklets provide the reader with basic anatomical, medical, and prosthetic/orthotic information. In-

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Review, from page 4

cluded are illustrations, diagrams, definitions and information on other resources. Sue Taylor's delightful drawings make the booklets "user-friendly."

The books are published by the Area Child Amputee Center, Grand Rapids, Michigan. For more information and order forms, contact ACAC, Mary Free Bed Hospital and Rehab Center, 235 Wealthy St. S.E., Grand Rapids MI 49503. ◆ *Review by Char Greer*

CAP, from page 2

purpose is to advise on research program development and to provide input to the Resource Unit for Information and Education. The CAP is formally a part of the Resource Unit for Information and Education, another part of this Program.

Panel members, as well as being consumers of prosthetic and orthotic products, are involved and interested in consumer-related activities in P & O, committed to promoting quality lives for persons with disabilities, and able to communicate effectively with P & O professionals. They are also recognized representatives of their constituencies. This year's Panel includes

C. Chadderton, *The War Amputations of Canada*
E. Eckenhoff, *Nat'l Rehabilitation Hospital*
W. Gablin, *Congress of Organizations for the Physically Handicapped (COPH)*
J. Kemp, *United Cerebral Palsy Assns, Inc.*
W. Lintz, *Central Ohio Amputee Support Team, Inc.*
M. Pfrommer, *Technical Aids & Assistance for the Disabled*
C. Scholar, *ARISE*
W. Vercellotti, *Wisconsin Amputee Golf Assn.*
R. Wilson, *COPH.*

The CAP meets formally once a year. In February of this year, the Panel met in Chicago, Illinois at the *Rehabilitation Institute of Chicago* for a two-day agenda of seminars and meetings. CAP members presented talks on consumer-oriented topics such as the medical model of rehabilitation, current needs in orthotics, peer visitation programs, and computers for persons with disabilities. Rehab Engineering Program staff presented state-of-the-art research including human mechanics, wheelchair headrests, upper limb components, fitting of high-level upper limb amputees, computer-aided engineering and computer-aided manufacturing. At the annual business meeting, the CAP and laboratory staff met for discussion and an exchange of ideas.

For more information on the CAP, or if you would like to serve on the Panel in the future, contact Dr. Dudley Childress, Northwestern University-REP, 345 E. Superior St., Room 1441, Chicago IL 60611. ◆

Resource Unit Information Request

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within the bounds of nature's laws, even though they may even try to bend nature to their advantage. However, Nature is a taskmaster and usually operates with a balance sheet. When we gain an advantage in one area, we usually give up something in another. In common parlance this is summed up by statements like, "you can't get something for nothing" and "there is no free lunch." As a result, engineers and others who design prostheses and orthoses must make tradeoffs. To make something stronger may require that it be heavier or more bulky. Making something more reliable may mean higher cost and additional testing. Not everything that can be hoped for in an orthosis or prosthesis can always be designed and produced; at least not without compromise.

By this time, you may wonder how anything can actually be designed. In fact, the bounds that have been discussed still leave much freedom for imagination and innovation. It's as if the space for advancement is unlimited, even though it's bounded. Indeed, there have been many dramatic advances and improvements in prosthetics and orthotics over the last 45 years; some of which can be traced to the high technology that we read so much about in current publications. New developments appear regularly as the result of research and development.

Advancement in science and technology seems to proceed in a step-like fashion, with breakthroughs at intervals that result in fast-paced advancement. These periods of rapid change are usually linked by intervals of ramp-like advancement, where progress is slow but continuous. Advancement in the field of prosthetics and orthotics seems to follow a similar pattern. Possibilities for advancement are unlimited, as long as they are "in bounds." ◆

Dr. Childress is Director of Northwestern University's Rehab Engineering Program and Prosthetics Research Laboratory, and Professor of Orthopaedic Surgery and Biomedical Engineering at Northwestern University.

Special Thanks

go to Don and Gretchen Hall of Oak Lawn, Illinois for the donation of an above-knee prosthesis to the Prosthetics Research Laboratory and Rehab Engineering Program. The prosthesis will be used for research and demonstration. The prosthesis was used by the Halls' daughter, Donna Lynn, from 1964 to 1967. Read about Donna in the next issue of *Capabilities*. ◆

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