



Capabilities

Communicating the Science of Prosthetics and Orthotics

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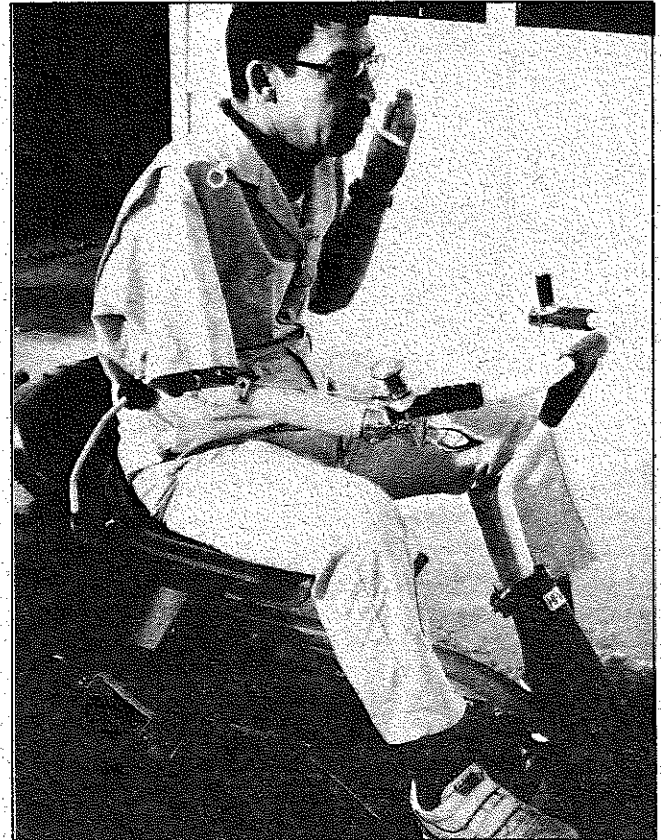
Ken Fenstermacher: An Exemplary User of Bilateral Arm Prostheses

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In October 1989, Ken Fenstermacher began using the first of two arm prostheses developed through a collaborative project between the Northwestern University Rehabilitation Engineering Program (NUREP) and the Prosthetic/Orthotic Clinical Services of the Rehabilitation Institute of Chicago (RIC). Ken had lost both arms at the shoulders as a result of an accident five months earlier while working as an electrical lineman. He had been referred to the RIC Amputee Program for prostheses and comprehensive training.

At the time of Ken's referral, engineers at NUREP and prosthetists at the RIC were developing a systematic approach to prosthesis design for persons with high-level bilateral amputations. They sought to combine the advantages of body-powered components and of electric-powered devices in ways that the two systems complemented each other's function. The goal was pragmatic: to improve a person's ability to manipulate the physical environment.

The NUREP/RIC goal was mirrored in Ken's personal objective to restore as much of his independent function as possible. He came to the RIC with a "laundry list" of skills he wanted to develop and became part of the rehabilitation team. He defined the tasks against which the success of his therapies and prosthetic designs were measured. Ken's attitude fit well with the exploratory



research and development spirit of the NUREP/RIC collaboration.

State-of-the-art prosthetic components and control schemes remain far from the ideal defined by the biological arm and hand. The viewpoint that total arm prostheses are not arms but tools was fundamental to the design of Ken's prostheses. To enhance manipulative function, the NUREP/RIC team worked to improve the functional attributes of the "tools" and to intimately link the "tool" to the user.

The resulting bilateral shoulder disarticulation prostheses are a hybrid configuration. The "dominant" prosthesis (the one preferred for tasks requiring care and skillful handling) utilizes all body-powered components. This was Ken's right prosthesis. The "non-dominant" (or assistive) prosthesis incorporates several electric-powered components. This left prosthesis provides

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functional characteristics not achievable with the body-powered prosthesis.

Ken began using the body-powered prosthesis in October 1989. He uses a single control cable, which he pulls by rounding his shoulders using bicipital abduction, to position four components: a mechanical elbow, a mechanical wrist rotation unit, a wrist flexion unit, and the opening of a split hook prehensor [1]. The elbow and wrist components are locking components. By releasing the lock of any one of these components, Ken is then able to position the component by movement of the control cable.

Positioning of the mechanical components can be very smooth and precise because Ken's shoulder motions directly operate them through the control cable linkage. The position of his shoulders and the speed at which he moves them determines the position and speed of the components. The cable also allows Ken to feel forces exerted against the components through the senses associated with his shoulders. The linkage of the cable provides both control and feedback and is an essential aspect of control by extended physiological proprioception [2]. We believe this control method offers the best possibility for dextrous manipulation using multi-functional arm prostheses [3].

Certain characteristics of the body-powered prosthesis, such as the gripping force of the prehensor and the weight which can be lifted while flexing the elbow, are limited by Ken's strength and range of shoulder motion and by the mechanical arrangement of the components. To provide higher grip force and greater lifting capacity, Ken's non-dominant prosthesis incorporates an electric-powered prehension device and an electric elbow. An electric-powered wrist rotator is also used to provide continuous rotation and higher rotation torque than is possible on the body-powered side. All three devices are controlled by switches mounted on the socket and actuated by Ken's left shoulder or his chin. Ken received the electric-powered prosthesis in December 1989.

The method of controlling the two prostheses avoids the common problem of cross-coupling, or cross-control. Cross-coupling occurs when control actions used to operate one prosthesis unintentionally affect the other prosthesis. By using body-powered components on one side and electric components on the other side, together with careful selection of control actions, it has been possible to de-couple the two prostheses. The benefit is more reliable control without increasing the attention given to operating each prosthesis.

VIDEO AVAILABLE

The RIC Biomedical Media Department is developing a videotape showing how Ken carries out many common activities including personal care, dressing, food preparation, lawn care, and driving. The video will also show home adaptations used for showering, dressing, and driving. For information on this tape, contact:

E. Wydeven

Public and Professional Information/Rehabilitation Institute of Chicago
345 E. Superior Street, Chicago IL 60611 USA
Phone (312) 908-2859

In October 1990, Ken summarized his experiences with the hybrid system in this way: "...you have much better manipulative control of the manual arm than you do the electric arm. For any kind of fine work, the manual arm is much easier to operate. Now, you get into heavier work, the electric arm works well for that. The combination works real well together. Each arm complements the other."

Ken continues to seek efficient ways of carrying out his activities and improvements to his prostheses (such as the addition of locking shoulder joints in 1991). He is committed to developing methods for independence in a variety of situations. As he says, "You have to adapt to figure out how you can make things around you work for you rather than against you."

The NUREP/RIC team expresses its appreciation to Jim Lane, C.P., of the University of Kansas Medical Center. Mr. Lane participated in the development of Mr. Fenstermacher's prostheses and continues to provide local support. ♦

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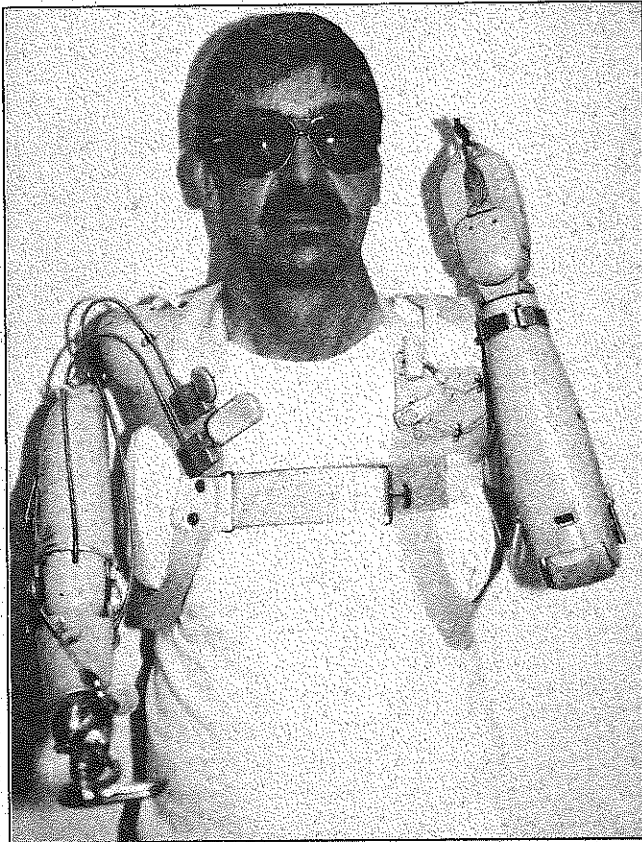
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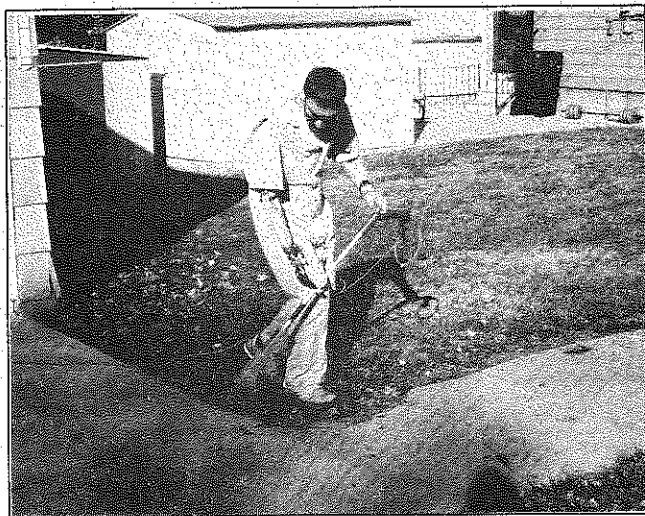
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3. Heckathorne, CW, "Manipulation in unstructured environments: extended physiological proprioception, position control, and arm prostheses," *Proceedings of the International Conference on Rehabilitation Robotics*, 25-40, 1990.



Ken Fenstermacher showing his hybrid bilateral prostheses. His right prosthesis is completely body-powered and his left prosthesis has several electrical joints.



Using bilateral prostheses in complementary fashion.

RU Question & Answer

What are Neuromas, and How Can They Be Treated?

A neuroma is a mass of nerve fibers growing from a nerve severed during amputation. All amputees will develop neuromas of varying degree, although not all are painful. When the nerve is cut, it attempts to regenerate (grow back), and thus forms a neuroma. Pain at the neuroma site is caused by pressure on the neuroma and it is real pain, as opposed to any kind of phantom sensation.

When amputation occurs, the surgeon will bury severed nerves back into the remaining muscle mass. This is done so resulting neuromas are less sensitive to pressure. Other techniques, intended to keep the nerve from growing back, have also been tried to keep neuromas from forming. None of these techniques have been very successful; and apparently any procedure which traumatizes the nerve more results in a more painful neuroma.

Some treatments for painful neuromas are: cortisone injections; injections which anesthetize (numb) the neuroma; solutions injected to destroy nerve tissue; and nerve cauterization at a spinal level. Surgical treatment includes having the surgeon locate and bury the neuroma so that pressure on it is diminished. ♦

Publications on Neuromas, Pain, and Phantom Pain & Sensation

Phantom Pain Relief. *AAM News* 11, Sept 1992. Order from Amputee Assn of Maryland, Inc., 2200 N. Forest Park Ave, Baltimore MD 21207.

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Bhole, D. Separating fact from fiction: post amputation pain syndromes (phantom pain). *AFGA Newsletter* 1(2): 3, 1992.

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Johnsen, D. Neuromas and pain. *North Texas Amputee Support Group News* 56: 2, May 1993. Order from NTASG, 3714 Lisa Lane, Mesquite TX 75150.

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Melzack, R. Phantom limbs. *Scientific American* 120, April 1992.

Rickhuss, PK; Crufts, SL; Stewart, CPU. Phantom pain-spinal anesthesia: a prospective study. *ISPO Newsletter* 18, Summer 1992.

Rubin, G. Phantom Limb Pain. *The Amp*, February 1979.

Phantom Pain: Relief without Medication? Columbia: Amputees in Action. Contact AIA, c/o Don Jones, PO Box 335, Columbia MO 65205.

The Gift

by Kirk Douglas. ©1992, Kirk Douglas & Anne Douglas. New York: Warner Books. \$21.95, hardcover.

"Miguel said, Hey, Patrizia—people are almost as important as animals..."

The Gift is not just about an amputee bullfighter, it is about people with disabilities rising above their disability to find meaning in life, and to treasure it. When Miguel Cardiga loses his leg below the knee in the Portuguese bullring, he believes his life is over. The book gives us a touching portrayal as Miguel struggles with an image of himself as "not whole," as he struggles to overcome the stigmas he faces from friends and family, and as he struggles "to be the best"—better than his father, Paolo, the country's top riding champion and trainer of horses.

The book is also about Patricia Dennison, a young heiress who is constantly disabled by her past, its emotional and mental effect on her which results in inadequacy and lack of self confidence, and the series of codependent relationships she finds herself in. Miguel and Patricia, two persons with disabilities of different natures—but with the same consequences—meet through their mutual love of horses, and their story and growing relationship gives testimony that there is more to life than a disability—that living is the most important thing of all.

The Gift is adept at integrating persons with disabilities as human, three-dimensional, main characters in a story. It deals sensitively with self-image issues, descriptions of prosthetic practice in other countries, and the painful but necessary self-realizations that all those with some sort of handicap, be it physical or emotional, have to face. It describes with insight the exhilaration Miguel experiences when he finally finds the right prosthetic device which enables him to re-enter the bullring. Finally, as his life unfolds as an amputee, as a person, and as a lover of Patricia, Miguel realizes how much more life means because of the gift of his amputation, and how much he would have missed without it.

When writing this book, Mr. Douglas carefully researched his topic: in his credits he thanks the inventor and manufacturer of the Seattle foot, Ernest Burgess and M+ND respectively, and amputees Albert Rappaport and Jim MacLaren, the latter whose article also appears in this issue of *Capabilities* on page 5.

It is encouraging to see the continuing portrayal of persons with disabilities in all types of media, from

Benny in *LA Law* to Miguel Cardiga in *The Gift*, and the support given by those who have an influence, such as Mr. Douglas. *The Gift* is, above all, a good story, encouraging, warm, entertaining—and enlightening. Don't miss it.

For Children— A Very Special Critter

by Gina & Mercer Mayer. © 1992, ISBN 0-307-12763-X. New York: Golden Books, Western Publishing Company, Inc., Racine WI 53404. \$1.95, paper. For ages K-Grade 2.

In Little Critter's world, being special is a way of life, for all "critters" look different. But when a critter in a wheelchair arrives in Little Critter's class as a new student, "different" takes on a new meaning.

In this charming children's book, the Mayers recreate the challenge of not only accepting a new student into class, but one with a disability, as well. In short, easy-to-read text and fun illustrations, Little Critter and his friends learn about differences, acceptance, and issues on disability such as devices (wheelchairs), accessibility, modified vans, and the like.

Little Critter tells his father about the special critter, Alex. Father says, "Just because he's in a wheelchair doesn't mean he's any different than the rest of you. He probably just needs some special help once in a while." Little Critter thinks this makes sense. So will you. ♦

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You're Worth Five Minutes

by James E. MacLaren

Jim MacLaren lost his left leg in a motorcycle accident in 1985. He was in a coma for six days, and that near death experience changed his life forever. He has since become the fastest amputee in the world in triathlons and distance running. He is also an actor, businessman, inventor and sought-after motivational speaker.

I believe that by finding success and joy within ourselves, there will be a "cross-over" into our external lives. I have accepted this to be true for myself, and the results have been astounding—astounding to such a degree that every facet of my life has changed.

Let me begin with waking up in the morning. How many of us woke up, looked out the window, breathed and said, "Wow, I'm alive! I'm alive and I believe in my ability to accomplish whatever it is that I want today!" How many of us woke to the raucous sound of the alarm, hit the snooze button numerous times, only to begin our day in a completely chaotic mental state? Did we feel as if we were in a rut? Perhaps going to a job that depresses us? But first having to shower, feed the family, go to school?

After days and months of living life in these ruts, we go on a two-week vacation where we "forget it all." We relax, leave all of our problems and tragedies at home, and when we return to the real world, all of our "stuff" is still there.

Bottom line: we can't go to a mountain top or a beach and live our lives in isolation. We're here with all of our problems. I think this is what has always bothered me

about the phrase, "Today is the first day of the rest of your life." Well, sure it is, but with a heck of a lot of baggage towed behind.

What if, instead of looking at the problems in our lives as tragic, we chose to perceive them as gifts instead? Is it possible that it's not the problems that are holding us back, but rather ourselves? Do you really believe that having the seemingly perfect lives of wealthy Arsenio Hall or supermodel Cindy Crawford, would bring you happiness? I believe that those of us who are miserable now would be miserable within two years—even in our new, "perfect" lives.

Satchel Paige once said, "It's great to pray when it's raining, but you damned well better pray when the sun is shining, too." If we haven't taken the time for ourselves personally, no matter how "good" or "bad" our lives are on the external level, we are destined for unhappiness.

So, when you wake up in the morning, consider taking five minutes to visualize some sort of success for yourself during the day. Maybe a career goal, a relationship, or such. This visualization gives you a rock to hold onto for the entire day. Perhaps your five-minute visualization is a time to take personal inventory. I saw the value of this after coming out of a week-long coma. My

mother kept a diary during that period, and after reading it, I was amazed to find how many people visited me in the hospital. It was like going to my own funeral. I realized that I had touched many lives. The fact is that you have done more in your life and touched more people than you realize. Let something like that empower you for the rest of the day. Regardless of what happens to you, all you need to do is recall the image of that five minutes and in ten seconds you are able to center yourself. Aren't you worth five minutes? ♦

If we haven't taken the time for ourselves...no matter how good or bad our lives are...we are destined for unhappiness.

Resource Unit

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New Things

New things are happening at the Resource Unit, as well as at Northwestern University's Rehabilitation Engineering Program. The program was recently awarded a new five-year grant from the National Institute on Disability and Rehabilitation Research (NIDRR) to continue state of the art advancements in prosthetics and orthotics. Some of the exciting projects to be pursued will include work on:

Ambulation • Mobility
Measurements • Interface Mechanics
CAD/CAM • Materials in P&O
Manipulation and Upper Limb Prostheses
Education • Information Dissemination

The last two are of particular relevance to the Resource Unit as the RU will be responsible for their success. Some of the new things the Resource Unit will be offering include:

Free information packets on 30 P&O topics
"Quick Information Sheets"
Large Print & Audiotape versions of information
Videos resulting from Research
Courses & Seminars for Professionals & Consumers
Multimedia Presentations.

In the next quarter you will receive a listing of the standardized packets you can order FREE from the Resource Unit on topics ranging from children's P&O to post-polio information. The first Quick Information Sheet, "Funding Ideas for Prosthetic-Orthotic Devices," is now available. It lists ideas and resources for alternative financing for prostheses and orthoses. We hope this sheet will be useful to you. The courses for professionals and consumers will be held in conjunction with Northwestern University Medical School's Prosthetic-Orthotic Center. To receive the 1993-1994 Course Bulletin, call (312) 908-8006.

The RU will continue offering this newsletter, as well as the HelpLine Service on (312) 908-6524 for P&O information. The annual Consumer Advisory Panel meeting will occur in August, as well as a meeting of the newly-formed Technical Advisory Panel. Look for a report on these meetings in the next issue of *Capabilities*. ♦

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