Capabilities

Communicating the Science of Prosthetics and Orthotics

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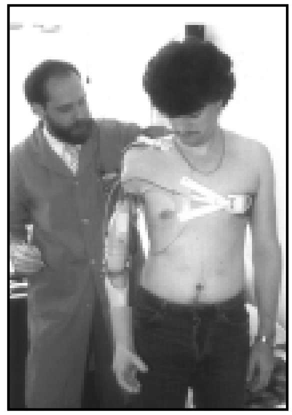
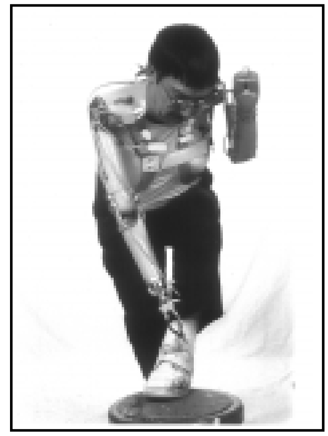
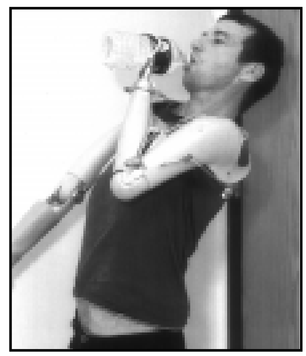
Engineering Research and Clinical Collaboration in Upper-limb Prosthetics





By Craig W. Heckathorne, M.S.E.E.



We work closely with Jack Uellendahl and the Rehabilitation Institute of Chicago (RIC) to restore as much manipulative function as possible. Our work has benefited from the input of 23 persons with high-level bilateral arm amputations with whom we have worked over the past ten years.

The following article is based on the keynote presentation given July 23 at the opening of the 1997 MyoElectric Controls / Powered Prosthetics Symposium sponsored by the Institute of Biomedical Engineering, University of New Brunswick, Fredericton, New Brunswick, Canada.

In our work as designers and researchers, we have always sought opportunities for contact and interaction with persons who use prosthetic devices. Their observations and experiences help us to identify problems that are meaningful to prosthesis users and that are compatible with our skills and capabilities. One method of interaction is through collaborative work with a clinical prosthetic service. By collaborating in the process of developing and providing a prosthetic fitting, we place ourselves in routine and persistent contact with individual prosthesis users. We have the opportunity to observe difficulties or problems that might occur as the fitting progresses. Through the process, we become better informed about the advantages and shortcomings of different prosthetic options.

Over the years, we have worked with a number of private and hospital-based clinical prosthetic services. In our upper-limb prosthetics work, we have had a particularly long term relationship with the Prosthetic/Orthotic Clinical Services Department of the Rehabilitation Institute of Chicago (RIC). Collaboration with the RIC clinical service intensified during the past ten years as a consequence of funding support from the National Institute on Disability and Rehabilitation Research (NIDRR). As a priority for our Rehabilitation Engineering Research Center in Prosthetics and Orthotics, NIDRR mandated the development of improved prosthesis prescriptions and fitting techniques and improvements in the availability of these techniques for clinical application.

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Engineering Research and Clinical Collaboration in Upper-limb Prosthetics
Continued

Responding to the NIDRR mandate, we chose to focus on the development of fitting guidelines for persons with higher level (i.e., proximal to the elbow) and bilateral amputations. Because the number of persons with higher-level bilateral amputations is small relative to the total population of persons with amputations, a broad empirical foundation for fitting these persons had not developed. We also believed that these people, who lacked any intact physiological arm and hand, would put concepts of functional prosthetic restoration to the most rigorous test.

Our goal in developing upper-limb prosthetic systems is to provide manipulative function with minimal mental loading. In other words, we do not want the operation of the prosthesis to dominate the mental resources of the user. We want the activity in which the person is engaged to be foremost in his or her mind, not the control of the prosthesis to carry out the activity.

To reduce the mental load of operating a prosthesis to carry out an activity, we apply the principles of:

- physical correlation
- direct (or dedicated) control
- isolation of control

Through physical correlation, we attempt to select a control method that is functionally correlated with the action of the prosthetic component so as to provide an intuitive cue for the operation of the component. To provide direct or dedicated control, we have separate control sources for each component. The various control sources are functionally isolated so that operation of one component does not inadvertently operate or alter the state of another component.

The hybrid trans-humeral prosthesis with a body-powered cable-actuated elbow and a myoelectrically-controlled prehension device is an excellent example of all three principles applied. Each component — the elbow and the prehension device — has a dedicated control source. The elbow is controlled by glenohumeral flexion. The prehension device is controlled by myoelectric signals from the biceps and triceps muscles in the residual limb. Control of both devices is physically correlated. Flexion of the arm at the shoulder causes flexion of the prosthetic elbow with the position and speed of the shoulder movement directly controlling the position and speed of movement of the elbow. The act of grasping with the prehension device can be correlated with the contraction of muscles in the residual limb. Control of the elbow and control of the prehension device are isolated from one another. With proper adjustment of the myoelectric controller, flexion of the arm at the shoulder to operate the elbow does not produce myoelectric signals of sufficient amplitude to change the state of the prehension device. Contraction of the biceps or triceps to produce myoelectric signals can be done without changing the position of the arm at the shoulder.

When faced with the need to restore many functions with relatively few control sources (the situation of the person with high level bilateral amputations), it isn't possible to apply these principles in as pure a form as illustrated by the hybrid transhumeral prosthesis. At that point, prosthetics becomes a discipline of compromises. Trade-offs are made but always with the intent of maximizing the functional ability of the prosthesis user while minimizing the mental load of operating the prosthesis.

Over the course of ten years and the collaborative fitting of twenty-three persons who have high level bilateral arm amputations, we have evolved a hybrid approach to the bilateral fitting [Heckathorne 1990; Meredith, et al. 1993]. The dominant prosthesis, the one used for the majority of manipulative tasks, is completely body-powered. Positive locking components are used for the elbow, wrist rotation unit, wrist flexion unit and, if applicable, at the shoulder. Opening of a split hook prehensor and positioning of the elbow, wrist rotator and wrist flexion unit are done with a single common control cable. Whichever component is unlocked is positioned by the cable. The non-dominant, or assistive prosthesis, incorporates electric-powered components to complement the function of the body-powered prosthesis. Electric-powered compo-

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nents provide greater lifting capacity, higher prehension forces, and greater range of wrist rotation than is generally possible with the body-powered componentry.

We have applied this hybrid configuration for persons with bilateral shoulder disarticulations and for persons with mixed level amputations (shoulder disarticulation on one side and trans-humeral amputation on the other side). We have also used the hybrid configuration for persons with bilateral trans-humeral level amputations but with some exceptions [Uellendahl and Heckathorne 1997]. Several persons with mid to long trans-humeral amputations bilaterally have elected to use positive-locking body-powered prostheses on both sides.

Our clinical success with multi-functional body-powered prostheses and hybrid configurations is consistent with results from the TIRR Upper-extremity Bilateral Prosthetic Survey [Heckathorne, et al. 1997]. For amputation levels at or higher than the trans-humeral level, 76% of prosthesis users utilized either body-powered prostheses alone or body-power in some combination with electric-powered components. Only 14% used electric-powered prostheses exclusively.

We believe that the preferential use of body-powered and hybrid systems is a consequence of the type of control used in body-powered prostheses and the choice and arrangement of the componentry. Cable actuation of body-powered components is an example of mechanically-linked position control. The position and movement of an intact physiological joint is used to directly control the position and movement of a prosthetic component. The linkage is significant because it maintains the coupling between the physiological movement and the movement of the prosthetic component, maintaining a one-to-one relationship between the position, velocity, and acceleration of the physiological joint and the position, velocity, and acceleration of the prosthetic joint.

In the early 1980s, our research laboratory evaluated a variety of control techniques using intact subjects operating virtual or simulated prostheses [Doubler and Childress 1984]. More recently, we have evaluated persons with amputations using standard control harnesses and persons using direct muscle attachment through cineplasty sites [Weir 1995]. In all cases, the intact physiological joint was superior to any prosthetic control method for the tested tasks. Among prosthesis control methods, the best performance was achieved with joint-actuated position control (like what is used in body-powered prostheses) or with muscle-actuated position control (like what is used in the control of cineplasty-actuated prostheses). There was no statistical difference between joint-actuated and muscle-actuated position control. Lesser performance was achieved using velocity control (the control of speed and direction of a prosthetic component). Velocity control is the method commonly used in commercial myoelectric control systems. Proportional velocity control was better than switch-type control.

These results suggest that in choosing control sources, position control with a mechanical linkage should be used whenever a controlling joint is available as a control source. When such sites are not available, or when additional sites are needed, then myoelectric or other types of velocity control should be considered. The research results reflect and support the successes of our collaborative clinical work.

We believe that mechanically-linked position control produces superior performance because of the direct physical correlation between the action of the controlling joint (or attached muscle) and the action of the prosthetic component. Furthermore, the coupling through the cable provides intrinsic proprioceptive feedback regarding the action of the prosthesis. This type of position, speed, and force feedback is not available in velocity control systems, such as commercial myoelectrically-controlled prostheses or prostheses that use force-actuated speed control.

In a clinical fitting, we do not have a separate intact physiological joint for controlling each component of a trans-humeral or shoulder disarticulation prosthesis. We can, however, as already described, use a common position control source to selectively operate components sequentially. The rationale for doing this is based on our understanding of physiological control of joint motion as first put forward by Nicholai Bernstein [1967]. It appears that control of movement is not specific to the muscle group actuating a joint but rather more to the task being performed.

By example, a person can write his or her name using wrist and finger movements, or using shoulder motion while keeping the elbow, wrist and fingers rigid, or using trunk and leg motion while keeping the arm rigid at the shoulder. Regardless of how the writing is produced, the appearance of the characters in the script is similar. For the same reason, a person with a high level amputation can produce writing using shoulder and/or trunk motion that is very similar in appearance to their pre-amputation writing even though they are using very different muscle groups. This characteristic of physiological joint control allows us to use one group of muscles for multiple component position control because it is the action being controlled not the specific component type that matters.

Though I have emphasized body-powered position control as our preferred control method, the significant

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When There is No Funding.... Alternate Means of Paying for Prostheses

People with amputations develop programs to aid those without the means to buy the products and services needed

By Jan Little

Getting used to a prosthesis — whether for the first time or the changes of a new model — is probably enough challenge for anyone. What if the first challenge you have to meet is how to find a reliable source of funding? In some situations, you won't even be able to make an appointment without assuring the prosthetic service that your visit will be reimbursed by your carrier. If your carrier is the Department of Veterans Affairs or Medicare/Medicaid, you're in luck. According to *O & P Business News*, 58% of the prostheses sold by the prosthetics facilities surveyed in a national poll were paid for by Medicare and Medicaid. DVA provides in-depth services in prosthetics and orthotics.

What about the person who doesn't have coverage as a veteran — or isn't old enough nor poor enough to qualify for Medicare or Medicaid — or doesn't have the increasingly rare traditional health care insurance — or has an HMO which does not cover prosthetics and orthotics — or who, like a growing number of Americans, has no health care insurance at all? The adage, "Necessity is the mother of invention" has held true in the matter of providing means for people who need prostheses to obtain them. We found several interesting and innovative programs to put people with amputations together with the prostheses they need. Here are the stories of two Foundations. ❖

Not-for-Profit Foundations

The Barr Foundation

The Barr Foundation is the result of the problems incurred when a father and son sought lower limb prostheses to answer their personal needs. William G. Barr became an above the knee amputee as the result of a car bombing in 1970. In 1972, his son, Tony, had a foot amputated in a train accident. William wrote a book, *Whole Again*, describing his search for a comfortable prosthesis. He used the proceeds from this book and money he had made developing houses and apartments to establish the Institute for Advancement of Prosthetics in Michigan. After William Barr's death in 1987, his son, Tony, sold the Institute for Advancement of Prosthetics to the J. E. Hanger Orthopedic Group in 1992 for $2 million. He used those funds to establish the Barr Foundation.

The Barr Foundation, headed by Tony Barr , joined with the United Amputee Services Association (UASA) of Orlando, Florida to provide services not otherwise available to certain people with amputations. A goal of the Foundation at its inception was to "provide limbs for 80 to 100 amputees across the country" who, for one reason or another, were unable to find funding for their prosthesis.

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Limbs for Life Foundation

Craig Gavras was an officer in the Dallas, Texas Police Department when, on December 3, 1994, his leg was amputated as the result of an injury incurred in the line of duty. Gavras, like most amputees, had a long time to think about what came next. His days as a police officer were over. He needed something else. "As I lay in the hospital recuperating, I made a decision: I was going to take this negative event in my life and turn it into something positive." Craig's positive ideas resulted in the Limbs for Life Foundation.

Literature from Limbs for Life, headquartered in Oklahoma City, OK, describes the Foundation's purpose as encouraging research and providing a financial bridge between low income amputees and the quality prosthetic care needed to restore their lives. To encourage even small gifts, the Foundation has devised an eye-catching fund-raising chart that shows even $20 will benefit someone.

Fund raising has been aided by the fact that Craig Gavras arranged for the national spokesperson for the Foundation to be Ted Kennedy, Jr, whose right leg was

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The Barr Foundation

Continued

By October of 1997, the Barr Foundation/United Amputee Assistance Fund (BF/UAAF) had purchased prosthetic limbs for 127 people.

The BF/UAAF enlists the participation of prosthetists to help make the funding available serve more people. Many prosthetists donate all or part of their time when working with recipients of BF/UAAF funding. Because designing, fabricating, fitting and refitting prostheses represents a significant portion of the overall cost of a prosthetic limb, the donation of time and labor is a sizable contribution to the Foundation and the recipient. The not-for-profit status of the Foundation allows the prosthetist to consider his time and labor as a tax-deductible expense.

Are the services of BF/UAAF really needed? According to two prosthetists who participate in the Foundation's work, there are numerous amputees without funding for prostheses.

Prosthetists contribute time and labor

Alan S. Ross, CPO, whose facility is in Florida, said, "Rarely does a single month go by when we are not asked to see an individual for prosthetic restoration who has no insurance coverage of any kind. Neither (sic) Medicare, Medicaid, Vocational Rehabilitation or any other funding source is available to assist these individuals...." David A. Blackman, CPO, in Nevada, said, "Many of the folks I see here in rural Nevada 'slip through the cracks' when prosthetic care is needed."

The Barr Foundation has two other projects to improve the lives of people with amputations. In 1997, Tony Barr was a leader in the campaign to pass legislation mandating licensing of prosthetic and orthotic practitioners by the State of Florida. The legislation was enacted, making Florida one of the few states to require licensing. (NOTE: Licensing differs from certification in that certification of prosthetists, orthotists and O & P facilities may be a requirement of the funding agency. However, uncertified practitioners could theoretically do business if a state does not require licensing. ABC certification (see Elaine Uellendahl's article on page 7 of this issue) will aid a practitioner in obtaining a license to practice in Florida.)

The Barr Foundation is also working on a program to coordinate the recycling of prostheses and prosthetic components. Currently, prosthetic feet, knees, joints and other components are thrown away when they are replaced for an amputee. At this time, product liability insurance stipulations are such that reusing components is not possible in the United States. In Mexico and other nations, such components often make it possible to provide a prosthesis to a person. To effectively send components to other nations, central warehousing and distribution facilities will be necessary. Tony Barr hopes to organize such establishments.

For more information on how you can support the Barr Foundation, contact Anthony T. Barr at 516/394-6514. To learn more about benefiting from the services of the BF/UASA, contact the UASA office at 407/678-1920. ❖

Limbs for Life

Continued

amputated as a result of bone cancer. Kennedy has spent a number of years working for expanded opportunities for amputees and facilitated national media coverage for Limbs for Life on the morning television shows, CNN and Discovery. Press appearances have featured Senator James M.Inhofe, (R-OK), Daina Bradley, an amputee as a result of injuries incurred in the bombing of the Murrah Federal Building in Oklahoma City, and Ivy Gunter, top fashion model and amputee, in addition to Gavras and Kennedy.

Stories of recipients help in fund raising

Stories of people who have received prostheses as a result of Limbs for Life funding are key elements in the fund raising effort. The Foundation has chosen its stories well. Two people who have been featured in Foundation appeals are a ten year old whose right leg was severed above the knee when he fell under a train. His family had no medical insurance and the boy's school principal appealed to the Foundation. Another human interest story that aided the Foundation's effort was that of the young wife of an animal trainer, whose right arm had to be amputated after she fell near an animal cage and her arm was mauled by a tiger.

Another project pursued by the Foundation is the operation of a limb bank. The bank collects used limbs for distribution to amputees in third world countries.

Does it work? According to records kept by Limbs for Life, in the period between January 1, 1996 through June 30, 1997, 2,421 people received assistance from the Foundation. In addition to funding prostheses, Limbs for Life provides counseling in 22 medical facilities to people who have recently become amputees.

For more information about Limbs for Life, contact the Foundation at 120 North Robinson, Suite 1913, Oklahoma City, OK 74102. ❖

The Amputee Coalition of America Annual Meeting in Chicago in June:

A Time to Learn, Share and Grow

If you or a member of your family have experienced amputation of an upper or lower limb, it can be hard to find information about how to make your life easier and more fun -- or just how to cope better from day to day. Spending three days with other people with amputations from across the nation lets you network, compare concerns and learn how others have enhanced their lives. The Annual Meeting of the Amputee Coalition of America, June 12-14, 1998 in Chicago, Illinois will give you those opportunities and more.

Information sessions during the Annual Meeting offer a range of topics. Attendees may choose from —

Consumer Advocacy
Resources, Materials, Videos and More
Recreation and Fitness Classes
Gait Analysis and Improvement Clinic
Prosthetic Advances
Physical Fitness for Everyone
Running & Golf Clinics
Enhancing Emotional Well-Being
Self-Esteem & Wellness Program

To make sure the entire family enjoys their visit to the Meeting, held in the Chicago suburb of Rosemont, a number of events are planned. Children, young adults and family members may tour Chicago, visit the Shedd Aquarium or one of Chicago's famed museums or maybe attend a Cubs or Sox baseball game. Technical and professional exhibits give those attending the meeting the chance to see and handle the latest in prosthetics, orthotics and other products.

For information about how you can attend the Amputee Coalition of America Annual Meeting, contact ACA, 900 East Hill Avenue, Knoxville, TN 37915. Toll free number - (888) AMP-KNOW. ❖

National Limb Loss Information Center Opens

The day long worked for by staff, members and friends of the Amputee Coalition of America arrived on December 12, 1997. The National Limb Loss Information Center was officially opened at 900 East Hill Avenue, Knoxville, TN. The Center is the headquarters for many activities to benefit amputees and their families including the expansion of data bases of information and resources, production of resource materials, maintenance of rosters of peer support groups and peer counseling training and much more. For a brochure describing the benefits and services of the Amputee Coalition of America, please contact ACA at 1-888-AMP-KNOW. ❖

The professions of prosthetics and orthotics are more challenging and rewarding than ever before.
Northwestern University Prosthetic-Orthotic Center Instructor, Elaine Uellendahl outlines the

Educational Avenues and Credentialing Criteria for Prosthetists and Orthotists

By Elaine N. Uellendahl, CP
Instructor, Prosthetic-Orthotic Education,
Clinical Director
NUPOC

Programs

For individuals interested in entering the professions of prosthetics and orthotics today there are exciting opportunities and a few different pathways to achieve these goals. The journey takes one from being an applicant, to a student, a resident and, ultimately, a board certified practitioner. Educationally, one may choose to enter a program that, upon graduation, will give that individual a bachelor's degree in prosthetics and orthotics. An individual who already has a baccalaureate degree may enter a certificate program and achieve a post graduate certificate in either prosthetics and/or orthotics.

Requirements

The program at Northwestern University Prosthetic-Orthotic Center (NUPOC) offers a certificate program in both disciplines. The selection process is very competitive, therefore, only the most qualified candidates are accepted into the programs. To be accepted, the candidate must have a bachelor's degree and have successfully taken courses in such areas as human anatomy and physiology, biology, chemistry, physics, computer sciences and other applicable subjects. Although the bachelor's degree does not have to be in a specific area, applicants with engineering and premedical backgrounds are viewed most favorably by the review board. Grade point average, professional references and essays are also evaluated, but the distinguishing characteristic between whether well-qualified individuals are accepted into the program or not is work experience. The students who enter the program at NUPOC have an average of three to five years of experience. We have found that our evaluation procedures have identified individuals with the best academic and clinical background combinations.

Glossary

American Board for Certification (ABC) - *a credentialing body established to identify those practitioners who have satisfied minimum qualifications to render essential public health services in these disciplines.*

Orthotist - *One who provides care to patients with congenital or traumatic disabling conditions of the musculoskeletal structure of the body by evaluating, designing, fabricating, fitting and aligning "braces" known as orthoses.*

Prosthetist - *One who provides care to patients with partial or total absence of a limb by evaluating, designing, fabricating, fitting and aligning those artificial limbs known as prostheses.*

(From the Practitioner Book of Rules*, ABC, September 1993)*

Duration

Once accepted into a program, the length of the program will vary depending on the structure and type of program. Certificate programs vary from six to ten months per discipline. Baccalaureate programs will last for two years of study concentrated on prosthetics, orthotics and related subject following completion of the first two years of work toward a baccalaureate. Degrees combine prosthetics and orthotics. All programs credentialed by the National Commission on Orthotics and Prosthetic Education (NCOPE) meet the same stan-

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Educational Avenues and Credentialing Criteria for Prosthetists and Orthotists

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dards regardless of the duration, but some programs are more condensed than others. For example, at NUPOC, students are in class all day every day for six months, so the program is very intense over a shorter period of time. In a baccalaureate program, the students have other core class work to apply to their degree in addition to their prosthetic and orthotic course work, so their education is spread over the last two years of their college education.

Post Graduate Education

Once the student has fulfilled the educational requirements in an educational institution accredited by NCOPE, and completed either a certificate or baccalaureate program in prosthetics and/or orthotics, they must enter the residency portion of their training. The residency programs contribute to the continuing education of future orthotists and prosthetists. The goals of the residency program are to impart expertise and to promote competency of the resident in the management of patients requiring orthotic and prosthetic care. The facility the person works at upon graduation must be an approved residency site and the person must work under the supervision of an American Board of Certification (ABC) certified practitioner. The residency will last for one year, during which time the resident will be exposed to a variety of clinical and laboratory situations which will add to the foundation of knowledge acquired in school. The resident will have quarterly assessments of their performance as the director evaluates the resident's knowledge, skills, and professional growth. The resident also must complete a research project during the residency program.

Exams

Once the residency is complete, the person is eligible to sit for the ABC board exams. The overall exam consists of three parts, all of which must be successfully completed. The parts are: A written exam with multiple choice answers; a written "clinical simulation" exam which places the examinee in simulated clinical experiences and requires him or her to make clinical choices for care and recommendations and, finally, a practical exam. The Clinical Patient Management Exam — or practical exam — is an intense four day exam in which the person must prove their clinical competency with patients and in front of an examiner.

CP, CO or CPO

Once the person has successfully completed the educational requirements, a residency program and has passed the ABC exams, the person will now receive the designation CP (Certified Prosthetist), CO (Certified Orthotist) or CPO (Certified Prosthetist and Orthotist). Persons seeking the care of a prosthetist or orthotist should look for the ABC certification since it ensures rigorous training and qualifications for that individual.

Learning How to Apply

Persons who are interested in applying for an educational opportunity in a prosthetic and/or orthotic school should contact NCOPE for a list of schools. NCOPE, ABC and the AAOP (American Academy of Orthotists and Prosthetists) may all be reached at

1650 King Street, Suite 500
Alexandria, VA 22314-2747
(703) 836-7114 FAX (703) 836-0838 ❖

Childress is Member of NIH Panel on Bioengineering

Dudley S. Childress, Ph.D., Director of the Northwestern University research and education programs in prosthetics and orthotics, was a member of the panel on Rehabilitation and Assistive Technology at a seminar sponsored by the National Institutes of Health in Bethesda, MD, February 27 and 28, 1998. The goal of the seminar was to examine the needs and challenges in rehabilitation medicine and identify areas which could be enhanced by NIH sponsored research.

During the month of February, Childress also participated in projects to further research in rehabilitation as a member of the Board of Directors of the Chicago Institute of Medicine. He also addressed the Women's Board of the Rehabilitation Institute of Chicago.

NUPOC Launches Winter Semester

The NUPOC Winter Semester Certification Courses began on January 12, 1998 with 18 students studying for the certification course in prosthetics and 20 students studying for the orthotics certification course. In addition to the NUPOC staff, topics in the certification courses are taught by NUPRL&RERP research engineers. Educational tracks presented include: Research Methods, Dudley S. Childress, PhD; Upper Limb Prostheses, Craig W. Heckathorne, MSEE; Fundamentals of Biomechanics, Steven A. Gard, PhD; and Fundamentals of Biomaterials, Richard F. *ff* Weir, PhD. The certification preparation courses will continue until May 22, 1998.

Edwards Lectures at University of Ottawa

Mark L. Edwards, CP, Director of Prosthetic Education at NUPOC, was a member of the faculty for the "Prosthetics Review Course" at the University of Ottawa, January 30-31, 1998. The courses were held at The Rehabilitation Center of the University in Ottawa, Ontario, Canada.

NUPOC Faculty Address PM&R Residents

Doctors completing residency requirements in Physical Medicine and Rehabilitation at the Rehabilitation Institute of Chicago attended lectures presented by NUPOC faculty members. Bryan Malas, CO, Director of Orthotic Education at NUPOC, presented the topics: Normal Gait Analysis, Lower Extremity Orthoses, Pathological Gait, and Spinal Orthoses. Elaine Uellendahl, CP, lectured on the topic of Upper Extremity Prostheses.

NUPRL&RERP Staff to Present Research Projects at ISPO

Research conducted at NUPRL&RERP will be shared with scientists attending the 9th World Congress of the International Society for Prosthetics and Orthotics (ISPO), to be held in Amsterdam, The Netherlands, June 28 to July 3, 1998. The ISPO review committee chose six NUPRL&RERP projects for presentation: "A Century of the Sauerbruch-Lebsche-Vanghetti Muscle Cineplasty: The US Experience", R. F. *ff*. Weir, PhD ; "Design for Humeral Rotation Mechanisms, Craig W. Heckathorne, MSEE, E.C. Grahn, R. McCall, MS, and D.S. Childress, PhD; "Assumptions in Calculation and Interpretation of Inverse Dynamics", L.A.Miller, MS, V. Sanchez-Urrutia,PhD, and D.S. Childress, PhD; "The Trans-Humeral Four Function Forearm Set-Up", C. W. Heckathorne, MSEE, S. Duff, J.E. Uellendahl, CPO, and D.S. Childress, PhD, "A Portable, Real-Time, Ultrasound Ranging Device for the Clinical Evaluation of Gait", R. F. *ff*. Weir, PhD, and D. S. Childress, PhD; and "A Microprocessor Based E.P.P. Controller for Electric-Powered Prostheses", Y. S. Bertos, R.F. *ff*. Weir, PhD, C.W. Heckathorne, MSEE, and D. S. Childress, PhD.

Rolock Keynotes CAD/CAM Society Session at AAOP

Joshua S. Rolock, PhD, presented the keynote address at the Computer Aided Design/Computer Aided Manufacturing (CAD/CAM) Society meeting. Rolock's topic was "Prosthetics CAD/CAM: Review and Future View". The CAD/CAM Society met during the American Academy of Orthotists and Prosthetists meeting in Miami, FL, April 1-4, 1998.

Heckathorne Lectures at Marquette

Craig W. Heckathorne, MSEE, was guest lecturer at Marquette University, Milwaukee, WI on April 1, 1998. Heckathorne's lecture to students in biomedical engineering studies focused on upper limb prostheses. ❖

Engineering Research and Clinical Collaboration in Upper-Limb Prosthetics
Continued

feature is not the source of power but position control through cable actuation. In current prosthetic practice, this is most readily achieved with body-powered components, but it can also be done with electric-powered components. This has been demonstrated through our laboratory [Heckathorne, et al. 1992a; Heckathorne, et al. 1992b] as well as by other researchers.

Summary: Through our collaborative work with the Prosthetic/Orthotic Clinical Services of the RIC, we believe that we have made progress toward establishing guidelines for the development of clinical trans-humeral and shoulder disarticulation fittings, especially for the person with bilateral involvement. Our research supports the use of cable-actuated position control whenever an appropriate control source is available as the preferred method for prosthetic joint control. This control method provides intrinsic feedback of prosthetic joint position and speed and of forces acting on the distal part of the joint. To achieve multiple component position control using a single control action, we utilize positive-locking components that can be selectively actuated through a common positioning control cable. Body-powered components are complemented with electric-powered components to enhance overall manipulative ability with the bilateral prostheses. Separate control methods are generally used for each prosthesis of the bilateral pair to eliminate or minimize inadvertent operation of one prosthesis while the other is being intentionally controlled.

Through these guidelines and encouraged by our clinical experiences we believe that we have been able to improve manipulative function by selecting control strategies that minimize the mental load of controlling a prosthesis. Our ultimate goal is expressed in the words of the pioneer aviator Antoine de Saint-Exupery:

"There was a time when a flyer sat at the control of a complicated works — But in the machine of today we forget that motors are whirring; the motor, finally has come to fulfill its function, which is to whir as a heart beats — and we give no thought to the beating of our heart."

We want to develop prostheses that are so intuitive and intimately coupled to the user that the user no longer gives any thought to the control of the prosthesis but is entirely focused on the task at hand. This is our hope and the driving force of our work. Critical to this achievement is continued opportunities for clinical collaboration and frequent contact with users of upper-limb prosthetic systems. ❖

Acknowledgment

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Master Shoemaking - A good fit with vets

By: Gary Roberts, Editor, Hines Times

The adage “shoes make the man,” is more than a mere fashion statement; it is a medical truism. It is widely recognized that proper shoes aid the mobility and comfort, promoting quality of life. But it is even more true for a disabled veteran who needs specially designed orthotic footwear.

Fortunately, there is William Follmer, “master shoemaker.” Trained in Austria, with 30 years experience at Hines, Follmer of the Prosthetic Treatment Center is a craftsman who cares. “You have to be able to put yourself in their position,” he says of his clients. “What can you do for them? You must understand their disability.”

Today, there are just eight “master shoemakers” in the Department of Veterans Affairs, with most being foreign born. Follmer, who also worked for 10 years under the widely known Dr. William Scholl, of foot fame, has met just one such American-born artisan at Hines. The designation of “master shoemaker” involves both Follmer’s training in the Old World, as well as his continuing medical education when he arrived on U.S. shores. But first he had to overcome postwar retaliation because he was German.

In 1947, at 12 years of age, Follmer and his mother escaped from a concentration camp in Yugoslavia, where they had been imprisoned in retaliation for Germany’s role in World War II. They then lived for the next 12 years in a refugee camp in Australia, where Follmer grew to be an adult.

Follmer completed his mandatory three-year training while in Australia, becoming a qualified custom shoemaker and skilled in custom-designed orthopedic work. In his first year as a trainee, Follmer earned just $1.00 a month, with his salary going up to $4.00 a month when he completed training in 1952. Three years later, he and his mother came to this country and settled in Chicago, where he opened his own shoemaker’s shop and continued his medical education. In 1967, he came to Hines VA Hospital as a shoe orthotist.

However, there is more involved in his work at Hines than just skilled hands and anatomical knowledge of the foot. “You have to have skill, imagination, and motivation as to why you are doing this. You also must have an interest in creating something unique,” Follmer says.

“Every patient is different. Yes, you have certain guidelines you can go by, but it all comes back to the individual and his/her particular deformity.”

Patients from all over the Midwest come to Hines for custom-designed, orthopedic shoes. Furthermore, Follmer is also very involved in other clinics in the VA Chicago Health Care System. Most clients with whom he works were injured during combat. Follmer takes all the measurements of the foot, and performs the evaluation of what type of shoe is required. Typically, it takes 22 to 25 hours of work to make a pair of shoes, start to finish.

“I still enjoy it,” Follmer says. “It gives me pleasure to help people be able to enjoy a more active lifestyle. ❖

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