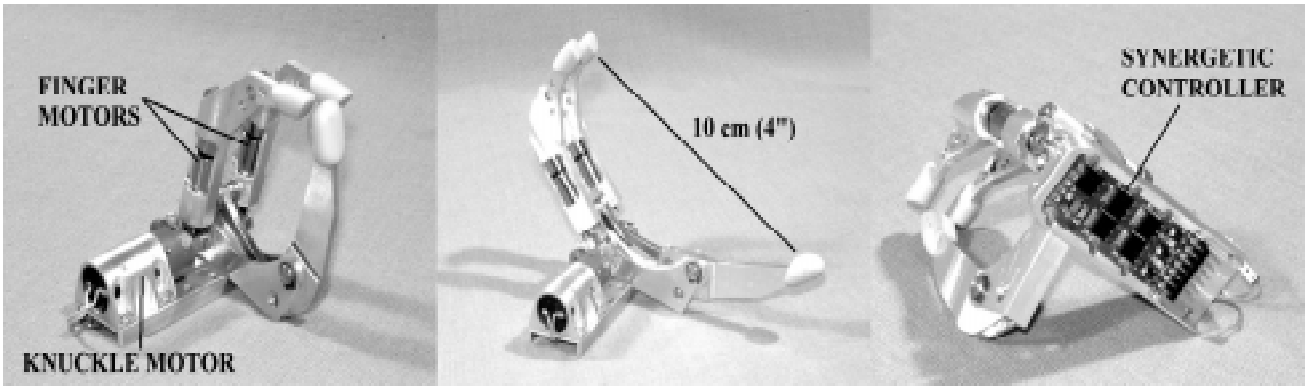
Capabilities
Communicating the Science of Prosthetics and Orthotics
Volume 10, Number 2, April 2001

Development of a New Partial Hand Prosthesis

By Richard F. ff Weir, PhD



(A) *(B)* *(C)*

Figure 1: *Our new trans-metacarpal prosthesis mechanism. (A) Photograph shows the location of the motors in the hand. (B) Photograph showing the width-of-opening of the hand [10 cm (4")]. (C) Photograph showing the motor controller located in the back of the mechanism.*

Our laboratory has been involved in the design of an externally-powered partial-hand prosthesis since the mid-eighties. This involvement resulted in the development of a new transmetacarpal partial hand prosthesis **(Figure 1)**. Our interest arose initially from a temporary fitting our laboratory performed for a patient of the Rehabilitation Institute of Chicago (RIC) (**Figure 2**). This person had partial-hand, shoulder disarticulation and transfemoral amputations. The temporary fitting provided some degree of independence while he was receiving treatment at the RIC. Conventional harness or wrist flexion/extension-driven devices could not be used due to the presence of hyper-sensitive scar tissue. At the time, no externally-powered partial-hand prostheses were available.

The prosthesis used in this initial temporary fitting consisted of a Michigan Hook, electronics for single-site myoelectric control, and a battery mounted on a socket. It was a self-contained, self-suspended, electric powered prosthesis that permitted free movement of the wrist. A single-site myoelectric controller using the muscles of the thenar eminence was used to control the device opening and closing.

The key observation that arose from this fitting was that the freedom of the wrist relieved the person of many of the compensatory movements necessary when the wrist is fixed. No attempt had been made at cosmesis, the

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emphasis being on providing function, yet the patient's movements were not "amputee-like", which was attributed to the nearly normal wrist function retained by the amputee. The eye is tuned to the unexpected. If a prostheses is moved in a "normal" way it will be perceived as "normal" by the casual observer. The wrist is essential to this "normal" motion.

***Figure 2**: A close up of the original temporary fitting fabricated by our laboratory, showing how the Michigan hook, electronics, and battery were attached to the socket. Single-site myoelectric control was used to control hook opening and closing.*

The observation concerning the unhindered motion of the wrist combined with the availability of small DC motors only 10mm in diameter from MicroMo Electronics Inc. led us to develop a prototype externally-powered partial hand prosthesis (**Figure 3**) [Weir, 1989 a&b]. This hand had motors in the thumb, index and middle fingers. Because the motors are so small, and of limited power, the principle of Synergetic Prehension (Childress, 1973) was used to achieve reasonable speed and prehension (grip) force for the hand as a whole. For synergetic operation the motors were configured such that the thumb motor used all its power to provide speed while sacrificing the ability to develop force, and the motors in the index and middle fingers used all their power to generate force but at the expense of not being able to move quickly.

The resulting prototype hand was able to achieve grip force in excess of 12 lbs_f and speeds of opening/closing in excess of 1 radian/sec (i.e. 60^o in 1 sec). While this prototype generated much attention it was too large and the width-of-opening too small for it to be clinically viable. Our new partial hand prosthesis is an evolution of this prototype that will be a clinically viable device (**Figure 1**). This new partial-hand prosthesis also uses three motors. As in the original prototype, there are motors in the index and middle fingers to provide force. However, unlike the original prototype, the third motor lies in the line of the knuckles (not in the thumb) to provide speed of opening of the fingers. The finger drive mechanisms use MicroMo MM1016 motors while the knuckle motor drive mechanism consists of a MicroMo MM1516 (15mm diameter) motor. The finger drive mechanisms are mounted in two housings made of aluminium to reduce the weight.

Current surgical and prosthetics practice for partial hand amputations can be found in the *Atlas of Limb Prosthetics* (1992) by Ouellette, et al. and Michael respectively. In addition, Otto Bock, GmbH., Germany has recently introduced an externally-powered system suitable for transcarpal partial hand amputees. In general, a functional hand prosthesis is only recommended for those cases where all digits (thumb and all four fingers) have been lost at a level equal or proximal to the metacarpophalangeal joint. Our new partial hand prosthesis will be suitable for fitting individuals meeting these criteria.

In order to preserve residual wrist motion in an effort to maximize the function of our new prosthesis we are also working on developing a soft

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New Partial Hand Prosthesis Development

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Figure 3: *Photograph of the "Powered Finger" Hand. This prototype is a myo-electrically controlled synergetic hand with two independent electric-powered fingers and an electric-powered thumb. The "palmar" volume contains no mechanisms. This was a proof-of-concept device that demonstrated the feasibility of powered fingers, but was too large to be clinically viable.*

and flexible prosthetic interface (**Figure 4**). The idea is to have a self-suspending silicone sleeve-socket in which the control electronics are embedded and to which the hand mechanism is attached. Incorporating nylon into the silicone at the time of lamination reinforces the silicone. The nylon provides tear resistance, enabling electrodes to be placed through the silicone sleeve. The associated electrodes, electronics and wires are embedded into the silicone socket while the myoelectric and synergetic controllers are mounted in the partial hand mechanism. An outer cosmetic glove is rolled over the inner silicone sleeve socket. The sleeve socket and cosmetic glove are rolled on and off together in a fashion similar to that used in donning and doffing transtibial silicone suspension sleeves.

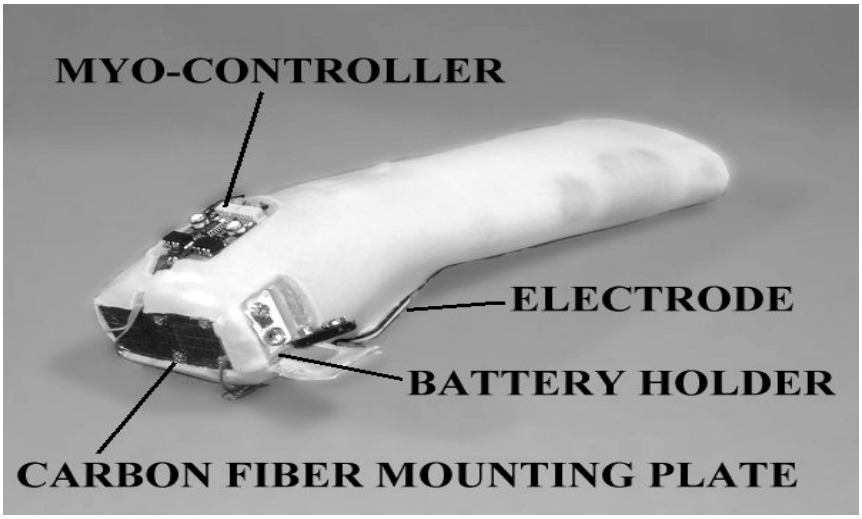

Figure 4: *Photograph of silicone sleeve socket. Due to the shortness of the residual limb the battery was placed behind the carbon fiber mounting plate to allow for more discrete packaging of the system.*

The preferred mode of control is two site proportional myoelectric control using electromyographic (EMG) sites from intrinsic muscles of the partial-hand. If two site control is not possible then single site control can be used. The power source is a rechargeable nine-volt transistor battery. We prefer to use a rechargeable battery in the standard nine-volt transistor battery shape so that 'off-the-shelf' batteries can be used should the rechargeable battery lose its charge during use.

Currently we have completed an initial prototype version of our new partial hand prosthesis (**Figure 5**). The new mechanism has a large width of opening [≈10 cm (≈ 4")]. Each finger can generate at least 26 N (6 lbs_f). The total force generated by the hand is the vector sum of the force from each finger [≈ 53 N (≈ 12 lbs_f)]. The speed-of-closing for this hand is ap-

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Summer 2001 Will Feature Conferences Focusing on Prosthetics and Orthotics

Amputee Coalition of America Will Meet June 14-16, 2001

Kansas City, Missouri will be the site of the 11th Annual Educational Conference and Exposition of the Amputee Coalition of America from June 14 through June 16, 2001. Attendees at the ACA Conference will include people with amputations, their families and many health care professionals. The theme of the conference, "Exploring New Frontiers" reflects the wide range of topics for the scheduled presentations and events.

The keynote speaker at this year's conference, Robert David Hall, will emphasize the ever-widening horizons of opportunity for people with amputations. Hall, who has played starring roles on television shows including ABC's "The Practice" and CBS's "CSI: Crime Scene Investigations", has a transfemoral amputation and a transtibial amputation as a result of a gasoline tank explosion 22 years ago.

Sessions at the ACA Conference are interactive and present the participants with information to learn new skills in optimizing his or her life style. A selection of the courses offered includes:

• Gait Analysis – emphasizing use of foot/ankle components and what to look for when alignment problems occur with a prosthesis • Recreational/Fitness – self-defense, running clinic, yoga, golf clinic, wheelchair dancing and dancing on prostheses • Fashion Show • Posture, Image and Self-Esteem • Handling Emotions with Amputation • Pain Management/Alternative Medicine • Vascular Disorder Management • Diabetes Facts and Management • Cancer • Insurance/Advocacy • Support Group Leadership Training • Assistive Technology. Each topic 'track" includes several sessions and features participation by leaders from advocacy and health care.

Additional sessions will present discussions of the latest technology being used in the prosthetic industry. People attending the conference may also see the new technology first-hand at the many manufacturers' exhibitions. Other sessions offer practical information about selecting and working with a prosthetist, changes in the individual's needs in prostheses as he or she ages and care, rehabilitation and devices for the non-prosthesis user.

Conference attendees will have the chance to relax and socialize at the Heartland BBQ and Hoedown on Friday night. Golfers will compete in the First Annual ACA Golf Tournament on Wednesday. ■

Northwestern PRL & RERP Staff Will Share Their Research Findings at ISPO

ISPO 2001

The Clyde Auditorium in Glasgow, Scotland will be the site of the 10th World Congress of the International Society for Prosthetics and Orthotics (ISPO) from July 1– 6, 2001. As in the past, ISPO will provide a vehicle for exchange of information and ideas about all aspects of prosthetics and orthotics with participation by individuals engaged in research, education, application and use of prosthetics and orthotics. Clinical issues and new developments will be discussed in 35 symposia by over 80 speakers.

Northwestern University research staff will be among those presenting information about a variety of topics. Investigations in one of NUPRL & RERP's three core areas of research, human walking, will be reviewed in the presentation, "Studies and Modeling of Human Walking with Practical Applications in Prosthetics and Orthotics," by Dudley S. Childress, Ph.D.

Andrew H. Hansen, MS, will also report on studies of Human Walking with two presentations: "Effects of Shoe Heel Height on the Roll-Over Shapes of Foot/Ankle Systems" and "Roll-Over Shapes of Prosthetic Feet and an Alignment Hypothesis for Trans-Tibial Prostheses".

Laura A. Miller, MS will also present two papers: "Crutch Ambulation: the Hold-and-Swing Mechanism" and "Errors in Inverse Dynamic Analysis of a Polycentric Knee".

Richard F. *ff* Weir, PhD, will review work in two of NUPRL & RERP core research areas: Upper Limb Prostheses and Ambulation Studies. His presentations are: "A New Externally-Powered Hand Prosthesis for Persons with Partial-Hand Amputations" and "A Three Dimensional Single marker Gait Analysis System for Real-Time Use in Small Clinical Facilities".

Craig W. Heckathorne, MSEE, will be one of the three presenters in the Symposium: "Advances in Upper Limb Prosthetic Systems – the Challenges for the 21st Century". Mr. Heckathorne will also be presenting two papers on NURERP upper-limb prosthetics research: "Advancements of the Prosthetic Arm Design and Simulation System" and "Progressive Prosthetics Management of a Person with Bilateral Shoulder Disarticulations Over an Eleven Year Period". ■

Sixth Annual Gait and Clinical Analysis Meeting

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Northwestern University PRL & RERP staff were also among those presenting topics at the Sixth Annual Gait and Clinical Analysis Meeting, held April 25 to 28, 2001 at Sacramento, California. Presentations were: "The Influence of Prosthetic Shock Absorbing Pylons on Transtibial Amputee Gait," by Steven A. Gard, PhD and Regina J. Konz, MS, and, "Vertical Excursion of the Trunk during Gait is Determined by Step Length," by Steven C. Miff and Dudley S. Childress, PhD. Stefania Fatone and Rebecca Stine also attended the conference in addition to Gard and Miff. ■

Steven Gard and Richard Weir Present Topics at AAOP

Steven A. Gard, PhD, and Richard F. *ff*. Weir, PhD, were among the researchers presenting results of their projects at the 2001 Annual Meeting and Scientific Symposium of the American Academy of Orthotists and Prosthetists (AAOP), Dallas, Texas, March 7-10.

Dr. Gard presented in two sessions, delivering "What Determines the Vertical Displacement of the Body During Normal Walking?" and "The Influence of Prosthetic Shock Absorbing Pylons on Transtibial Amputee Gait."

Dr. Weir presented his work with "A New Externally Powered Myoelectrically Controlled Hand Prosthesis for Person with Partial Hand Amputation".

Craig Heckathorne is Instructor for Courses in Hong Kong

Again this year, Craig Heckathorne, RERP/PRL Research Engineer and specialist in upper-limb prosthetics, joined the staff of the Hong Kong Polytechnic University as a Visiting Lecturer from March 5 – 9. Mr. Heckathorne was invited to teach the week-long course in "Myoelectric Control" as part of the Bachelor of Sciences (Honours) in Prosthetics and Orthotics. The degree program was developed by the Jockey Club Rehabilitation Engineering Centre, a department within the University which has an interest in applying engineering principles in rehabilitation.

The 28-hour elective course taught by Mr. Heckathorne included lectures, student case presentations, and three laboratories. The lectures covered the theory and practice of myoelectric control, electric-powered components, socket design, suspension systems, and alternatives to myoelectric control for control of electric-powered components. In the laboratories, the students worked with patient demonstrators on myotesting, casting, and construction and fitting of a preparatory myoelectrically-controlled trans-radial prosthesis.

RIC Amputee Support Group Meets at NUPRL & RERP

The Amputee Support Group of the Rehabilitation Institute of Chicago (RIC) chose the Northwestern University Prosthetics Research Laboratory and Rehabilitation Engineering Research Program for the site of both their February meeting and their March meeting.

On Saturday, February 17, the group heard Todd Kuiken, MD, PhD, discuss "New Frontiers in Amputee Research: or What Dr. Kuiken's Cooking up in Amputee Research". Dr. Kuiken is director of the RIC clinical services for amputees.

On Saturday, March 17, the group was given a tour of the laboratories and a discussion of the research projects being conducted by NUPRL &RERP. Dudley S. Childress, PhD, Director of the research and professional education programs in prosthetics and orthotics and Brian Ruhe, graduate student in biomedical engineering, conducted the tour.

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NUPRL & RERP News

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Stefania Fatone, Post Doctoral Fellow, Adds to International Aspect of the Research Staff

Stefania Fatone, joined Margrit Meier as the second Post Doctoral Fellow currently on the NUPRL&RERP staff to choose Northwestern as a venue to continue her research and experience in prosthetics and orthotics. Stefania was born in Italy and moved to Australia with her family when she was six years old. Her PhD, in the biomechanics of gait and prostheses, was awarded to her by La Trobe University, Melbourne, Australia. She had earlier earned her Bachelor of Prosthetics and Orthotics with Honours from La Trobe. La Trobe is the only institution in Australia which offers a degree in prosthetics and orthotics.

Stefania conducted most of the research toward her doctoral study at the Hugh Williamson Gait Laboratory at the Royal Children's Hospital in Melbourne. She says that, although her research was in prosthetic management of congenital limb deficiencies, most of her clinical experience has been in pedicatric orthotics.

Stefania has traveled extensively to professional meetings in New Zealand, The Netherlands, and the United States. An outdoorswoman, two of her more energetic activities have been bush walking through most of the national parks in Victoria, Australia and riding her bike the length of Tasmania.

Engineers Engaged in Prosthetic and Orthotic Manufacturing in India Visit Northwestern PRL & RERP

R.P. Garg, Manager of Production, and Anil Kumar Singh, Assistant Manager of Electronics, of the Artificial Limbs Manufacturing Corporation (ALIMCO) of India visited the NURERP & PRL laboratories April 16-18. ALIMCO is a government operated manufacturing facility that produces assistive devices for person with disabilities. Their products include prosthetic and orthotic components, indoor and outdoor wheelchairs, devices for persons with blindness, tooling for the fabrication and fitting of prostheses and orthoses, and hearing aids. Mr. Garg and Mr. Singh were accompanied by C. Kiran Dhawan, Science Officer with the U.S. Embassy in New Delhi.

The visit was a joint arrangement of the National Institute for Disability and Rehabilitation Research (NIDRR) and the Ministry of Social Justice and Empowerment of the Government of India (GOI). The purpose of the visit was to collect information for modernizing the design and production of prosthetic and orthotic components in India. In addition to the NURERP and PRL laboratories, the Indian delegation visited a variety of clinical and manufacturing facilities in the U.S., concluding their visit at the NIDRR-funded Rehabilitation Engineering Research Center for technologies for Children with Orthopaedic Disabilties, Rancho Los Amigos National Rehabilitation Center, Downey, California.

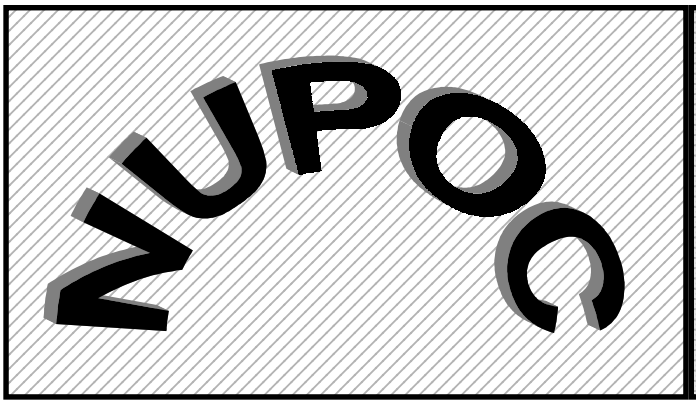
Last September, Craig W. Heckathorne, Research Engineer at NUPRL & RERP, participated in a NIDRR/GOI Joint Working Group as an engineering consultant on prosthetic components. Members of the Joint Working Group evaluated the ALIMCO facility, and several other P & O production and clinical facilities in India.

For more information on ALIMCO, please visit their website at: http://www.artlimbs.com/

Visitors Come to Our Web Sites for Many Types of Information

Each day, health care professionals, researchers, teachers, students and people who use prostheses come to one of the two Northwestern University web sites focusing on prosthetics and orthotics. Questions left in the e-mail box for NUPRL & RERP (www.repoc.northwestern.edu) range from where to find specific prosthetic components or treatments to requests for help. One recent request was from a woman in Greece, whose cousin had undergone amputation of her leg following an accident. Georges Bertos, candidate for his PhD in Biomedical Engineering, acted as our resource and could even direct the woman to a physician and treatment in Athens, Greece.

Other visitors seek further education in prosthetics and orthotics. By visiting the NUPOC web site (www.nupoc.northwestern.edu), they may take a virtual tour of NUPOC's classes and laboratories, review prerequisites and begin application to NUPOC courses via e-mail form



A Snapshot of Contemporary Practice in the Orthotics and Prosthetics Profession.

By Mark L. Edwards, CP
Director, Prosthetics Education
NUPOC

The American Board for Certification has produced a report titled "Practice Analysis of the Disciplines of Prosthetics and Orthotics". This report describes the contemporary practice of ABC certified practitioners and ABC registered technicians in the United States. The report represents a culmination of two years of planning, execution, data analysis and writing.

The information in the report came from a number of different sources including panel discussions, critical incidence interviews with ABC credentialed practitioners, and a survey of 1,500 ABC orthotic and prosthetic practitioners, associates, and technicians in the United States.

The Report helps identify profiles of practitioners

The purpose of the practice analysis aspect of the report was to describe the profession as it stands today and to provide profiles of what professionals do and the knowledge and skills that they need. In addition to these objectives, the report attempted to gather information describing in terms of age and etiology the clients to whom orthotists and prosthetists provide direct care.

The overall return rate of the survey portion of the report was 28%. This response rate was considered acceptable when compared with other professions collecting survey data. The detailed and comprehensive survey took much time and effort for those who completed the instrument.

Some interesting demographic numbers show that the percentage of women in orthotics is slightly higher than in prosthetics. Women in orthotics account for 12% of the profession and only 7% in prosthetics. The age of respondents ranged between 35-54 and made up approximately 70% of the profession. In general most of the respondents were males over the age of 35.

About 73% of ABC certified practitioners in the profession have attained at least a BS/BA degree included in their training. About 70 % of ABC certified practitioners have at least 10 years of working experience in their respective disciplines. 57% of orthotists work in either a public or private multi-facility O&P service organization, while about 69% of prosthetists work in a public or private multi-facility O&P service organization.

Less than a third of orthotic clients are pediatric

The survey also asked about direct client care or services delivered. Two-thirds of orthotics care services was provided to either adult or geriatric clients. Slightly less than a third (29%) of services were provided to pediatric orthotic clients. About one-half (49%) of all prosthetic patient care services were provided to individuals who fell into the geriatric category. Only 12% of prosthetic patient care services were delivered to the pediatric individual. Conditions reflecting disease-related etiologies made up 46% of orthotic services. In contrast, disease related etiologies comprised 67% of prosthetic practices. Trauma-based conditions in orthotic and prosthetic practices made up 28% and 23% of services respectively.

ABC certified orthotists spent 64% of their practice in managing lower limb orthotic cases. 46% of their lower limb practice was spent in designing and fitting Ankle Foot Orthoses (AFO's). The survey looked at the use of articulated versus non-articulated AFO's. The two designs were almost evenly split, 47% to 53% respectively. Managing spinal pathologies took up 21% of their practice in orthotics, and 10% specifically was used in taking care of scoliosis. Treating idiopathic scoliosis consisted of 70% of diagnostic category. Managing upper extremity cases accounted for 9% of orthotic practice.

In prosthetic practices, almost two thirds of practioners' time (62%) is spent managing persons with

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Snapshot of O & P Practice

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transtibial amputations. The two most common types of prostheses used for this level of amputation were the patella-tendon-bearing (43%) and the total surface bearing (45%) designs. Most contemporary prosthetic practices use silicone sleeves and pin suspension systems. These systems are used in 51% of transtibial prostheses. 24% of the time an external elastic-type suspension sleeve is used and 17% of the time a supracondylar type of suspension is incorporated into the transtibial prosthesis.

27% of the time is spent in direct prosthetic management of transfemoral amputations. The ischial containment type of socket was used 77% of the time. Quadrilateral shaped sockets accounted for 22% of transfemoral prostheses. The most common method for suspension of the transfemoral prosthesis was volumetric or suction suspension. This method of suspension made up 51% of transfemoral designs. Silicone sleeves with pin locking systems accounted for 25% of suspension designs for transfemoral prostheses.

Management of upper limb amputation accounted for approximately 8% of prosthetic patient-care services. When looking at transradial types of designs, most practices were equally likely to incorporate myoelectric or body-powered systems. More transhumeral prostheses are designed with body-powered contols and harness suspension.

This document provides some interesting data and information that can be used by the profession. ABC has already taken some of this information and changed the emphasis of the certification examination. Looking at contemporary practice can aid education, residency, and credentialing organizations in providing programs that reflect what is actually happening within the profession.

For more information about this report, or to request a personal copy, contact the American Board for Certification at (703) 836-7114.■

Visiting Fellows Exchange Information at Northwestern Prosthetic and Orthotic Programs

Five Visiting Fellows from Germany, Austria and Switzerland spent April 5, 6 and 7 at Northwestern University PRL&RERP and NUPOC during their visit to the United States. The Fellows are: Bettina Grage,C.O., Federal School of P&O, Dortmund/Germany; Dr. med. Gerd M. Ivanic, Orthopaedic Surgeon, Landesklinik Stolzalpe, Stolzalpe/Austria; Dr. med. Thomas Boeni, Klinik Balgrist, Zürich/Switzerland; Dr.med.Armin Koller, University Klinikum Münster/Germany; and Dr. med. Stefan Middeldorf, Klinikum Staffelstein, Staffelstein, Germany.

Topics of lectures presented on April 5 to members of Northwestern and Rehabilitation Institute of Chicago (RIC) by the Visiting Fellows included:

- Orthoses for Scoliotic Patients - Quality Standards of Fitting and Trouble Shooting – Bettina Grage, CO.
- Mobilisation following Forefoot Surgery - Is There an Indication for Special Post-Op Shoes in Postoperative Care – Dr. med. Gerd M. Ivanic.
- Skeletal Anchorage of Prostheses in Amputees: Evolution and Current Results – Dr. med. Thomas Boeni.
- Orthopedic Footwear in the Treatment of Chronic Plantar Ulcers – Dr. med. Armin Koller.
- Quality Management for Prosthetic Fitting after Amputation in the Light of DIN EN ISO 9001 – Dr. med. Stfan Middeldorf.

On Friday, April 6, two of the Visiting Fellows made presentations at Orthopaedic Grand Rounds at Northwestern Memorial Hospital.

Dr. med. Thomas Boeni, presented “Anchorage of Prostheses in Amputees: Evolution and Current Results” and “Orthotic and Surgical Treatment in the History of Achilles Tendon Rupture”. Dr. med. Armin Koller presented “Limb Salvage by Modified Syme Amputation”. Following a discussion of the Outcome Studies being conducted at RIC and Northwestern by Allen Heinemann, Ph.D., Stefan Middeldorf**,** reviewed a similar study in Germany, “Outcome evaluation of rehabilitation following amputation of the lower limb by the AmputPro-Scorer”.

The trip was organized by Prof. Dr. med. Georg Neff of Berlin. The Fellows also visited Los Angeles, San Francisco, and Palo Alto, California, Salt Lake City, Utah, Minneapolis, Minnesota, and Miami, Florida . ■

The VA Presents

News from the Department of Veterans Affairs

Mobility, the Key to Independence

Coordinated by Robert M. Baum
Prosthetic Network Manager, P&SAS SHG,
VA Headquarters, Washington D.C.

The Department of Veterans Affairs (VA) Driver Rehabilitation For The Disabled Program was established in response to Public law 93-538, passed in December of 1974. The legislation supports eligible veterans in the ownership and safe operation of motor vehicles modified, equipped or adapted to meet individual requirements as a result of a disability and/or certain medical conditions.

The VA has established over 40 driver rehabilitation centers nationwide. Eligible veterans or active duty personnel are provided a clinical program of primary services that include:

Driving Assessments – An initial evaluation includes a medical history review and perceptual-cognitive, vision, reaction time, strength and range of motion testing. Most centers offer a vehicle simulator evaluation.

Patient & Family Education – This program consists of classroom instruction in defensive driving techniques, road sign and marking identification, all in accordance with State Department of Motor Vehicle (DMV) regulations. Assistance with the DMV licensing process may include: filing of medical reports, license restriction updates or providing an adaptive vehicle to take a road test examination.

Videos showing types of vehicles and equipment modifications are available for instruction

Information is available on financial assistance programs for vehicle conversion reimbursement.

The Safe Passenger Program provides consultation on what vehicles and modifications are needed for the client to travel safely as a passenger only with family members or attendants providing the driving service.

Behind the Wheel Road Instruction – Clients perform vehicle operation in a multitude of traffic settings utilizing adaptive controls when necessary**.**

Vehicle & Equipment Evaluation/Prescription – Assistance is provided to clients in making decisions regarding vehicle selection, vehicle modifications, and adaptive driving controls specifically required to meet individual needs.

Often clients who are referred for services come from the following diagnostic groups:

- **Spinal Cord injury**
- **Hemiplegic**
- **Amputee**
- **Neurological**
- **Orthopedic**
- **Psychiatric**
- **Mature Driver (Geriatric)**
- **Visually Impaired**

Please note, clients who may not be limited in their ability to access a vehicle or use conventional driving controls may be eligible for services.

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The VA Presents

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Internal and intra-VA referrals from primary care physicians or providers, treatment teams or other accepted referral sources are welcomed by the Physical Medicine and rehabilitation Service.

For further process or referral information, please contact your local VA Medical Center's Physical Medicine and Rehabilitation Service; or Prosthetic and Sensory Aids Service. Information is also available on the VA Driver Rehabilitation Website at www.va.gov/health/rehab/dvrehab.html.■

Please send us your articles, success stories, comments or suggestions for future issues in the VA Presents. E-mail: Robert.Baum@Mail.VA.Gov. Address: PSAS SHG (113), 810 Vermont Ave., NW, Washington, DC 20420. Phone (202) 273-8515. Fax: (202) 273-9110.

Development of a New Partial Hand Prosthesis

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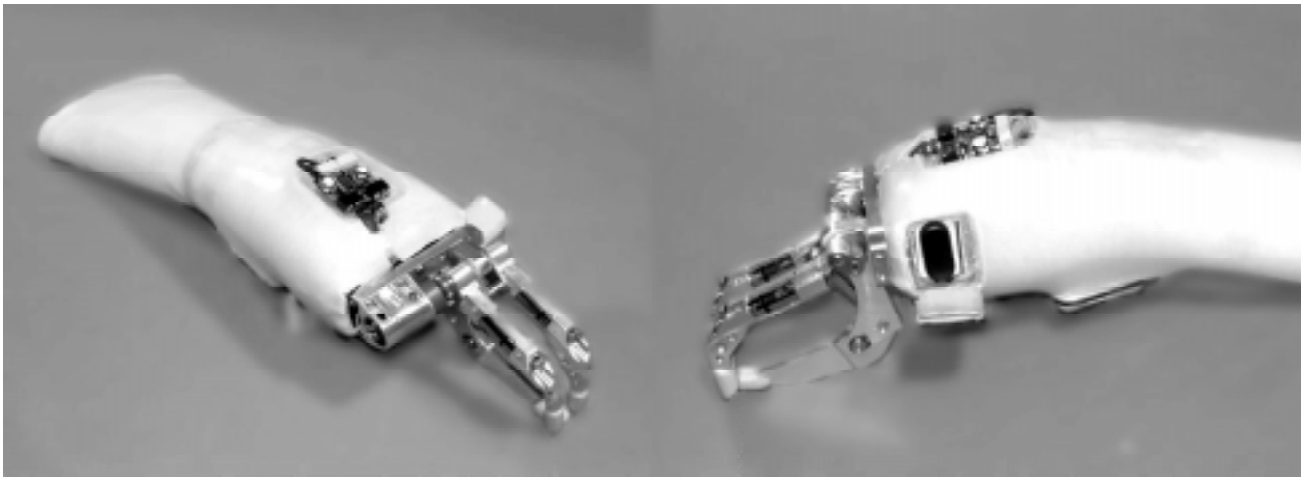

Figure 5: *Photographs of new partial hand mechanism and prosthetic interface seen from the right side and a close up of the left. The hand mechanism and associated electronics are mounted on a carbon fiber plate embedded into a silicone-sleeve-socket prototype. In operation, a liner and glove would be pulled over the mechanism and sleeve and the sleeve would be appropriately colored.*

proximately 2 radians/sec (≈ 105^0/sec). The weight of mechanism w/ battery and electronics is 210g (0.46 lbs). Total weight of mechanism and current silicone interface is 425g (0.937 lbs) [Less than 0.5 kg]. We are in the process of preparing the mechanism for an initial clinical fitting.■

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Resource Unit Information Request

Northwestern University PRL & RERP
345 E. Superior St., Room 1441
Chicago, IL 60611 USA
Allow two to three weeks for delivery

- ☐ Send me a copy of the latest *Activity Report*
- ☐ Start my subscription to *Capabilities*
- ☐ Association of Children's Prosthetic-Orthotic Clinics List
- ☐ Video List

Bibliographies of NUPRL&RERP Publications Available on the Following Topics:

- ☐ Above Knee Prosthetics
- ☐ Ambulation, Gait & Posture
- ☐ Biomaterials
- ☐ Below Knee Prosthetics
- ☐ Computer Aided Engineering/Design/Manufacturing
- ☐ Pediatric Prosthetics
- ☐ Prosthetic Feet
- ☐ Prosthetics & Orthotics: General
- ☐ Upper Limb Prosthetics & Orthotics

Other Sources for Prosthetic & Orthotic Information:

Consumer Information:
National Limb Loss Information Center
900 East Hill Avenue - Suite 285
Knoxville, TN 37915
Toll Free: (888)AMP-KNOW

Prosthetic-Orthotic Education:
National Association of Prosthetic & Orthotic Education
1650 King Street - Suite 500
Alexandria, VA 22314
e-mail: opncope@aol.com

General Information about Prosthetics & Orthotics:
American Orthotic & Prosthetic Association
1650 King Street - Suite 500
Alexandria, VA 22314

Name_____

Address_____

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