



Capabilities

Communicating the Science of Prosthetics and Orthotics

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Historic Merger of NUPOC and NUPRL



NUPOC moves to Chicago landmark building, 680 North Lake Shore Drive.

The **Northwestern University Prosthetics Research Laboratory (NUPRL)** has merged with the **Northwestern University Prosthetics Orthotics Center (NUPOC)**. For the past 50 years, these two entities have interacted cooperatively with overlapping interests. Henceforth, under a single name, NUPOC will represent both missions, combining education and research. The autumn issue of *Capabilities* will be issued from our new location:

NUPOC
680 North Lake Shore Drive
Suite 1100
Chicago, IL 60611

This lakefront Chicago landmark was built in 1923 and became the American Furniture Mart. Subsequent renovations improved its infrastructure. Today Northwestern University is a high profile presence in the 680 building, which is located adjacent to the NU Chicago campus. This elegant building houses professional offices for Northwestern University, Northwestern Medical Faculty Foundation, and Northwestern Memorial Hospital, as well as other businesses, restaurants, and luxury condominiums.

The union of NUPRL and NUPOC is the first stage in developing new opportunities for collaborative education and research in P&O. NUPOC's suite is designed to accommodate new growth as it initiates a Master's Degree in Prosthetics and Orthotics. NUPOC's new home is custom designed and features enhanced facilities for both P&O education and research, including the expanded **Jesse Brown Veterans Affairs Chicago Motion Analysis Research Laboratory (VACMARL)**, research laboratories, a smart classroom fully equipped for distance and on-site learning, conference rooms, and offices for faculty, staff and researchers. NUPOC will continue to build on its reputation for excellence in training new prosthetists and orthotists, while integrating state of the art research into clinical practice. NUPOC deeply appreciates the support and contributions of many people who helped to realize this vision.

Practice Makes Perfect:

Clinicians' Experiences Collecting Outcomes Data

Allen W. Heinemann, PhD, Linda Ehrlich-Jones, PhD, and Dustin Williams, MS

The NURERC project with the **Center for Rehabilitation Outcomes Research (CROR)**, *Enhancing the Quality of Prosthetic and Orthotic Services with Process and Outcomes Information*, provides clinicians with an opportunity to implement outcome measures while receiving quality improvement consultation. Project participation consists of

clinics implementing the **Orthotics and Prosthetics User Survey (OPUS)** as a standard clinical outcome measure and asking up to 100 patients to complete OPUS at three different times: 1) before fitting a new lower limb prosthetic device, 2) at device delivery, and 3) two months after device delivery.

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In return, clinicians receive quality improvement consultation based on their patients' data. They also have access to an educational curriculum focused on implementing quality improvement initiatives. This article highlights the perspectives of clinicians who are participating in this project, their experience implementing the outcome measures, their interest in the project, the burden of implementing data collection, and how clinicians see outcome measures fitting into the practice of prosthetics and orthotics (P&O).

Experience Implementing Outcome Measures

When asked about implementing outcome measures, each site representative presented a unique story. **Walter Afable**, CP (Clinical Operations Manager, the Rehabilitation Institute of Chicago (RIC), Prosthetics and Orthotics Clinical Center), reported having used standard hospital satisfaction surveys but asserted that nothing to date provided the *“global perspective of outcomes that are captured in OPUS.”* **Jane Wolking**, CP (Facilities Director, Actra Prosthetics and Orthotics, Madison, WI), similarly expressed that she had used healthcare-focused patient satisfaction surveys, but *“none of the surveys provided the breadth of coverage”* of OPUS. **Stephanie Sheedy** (General Manager at Monroe BioTechnology, Inc., Green Bay, WI) indicated that their facility had *“contracted an accounting firm to conduct an impartial blind study...regarding patient perspectives of their quality of care, but had not tackled a project this unique.”* **Chris Robinson**, MBA, CPO, ATC (Staff Practitioner at the Center for Orthotics and Prosthetics Excellence (COPE), St. John, IN), stated that COPE had never endeavored to collect outcome information until participating in this project. Interestingly, none of the clinics have previously implemented a prosthetic-specific outcomes measure aimed at tracking patient perspectives of quality of care through an episode of care.

Desire to Participate

While experiences using outcomes measures varied, the clinicians presented a clear and unified response regarding their desire to participate in this project. **David Jolly**, CP, FAAOP (Monroe BioTechnology, Inc., Monroe, WI), indicated, *“Our motivation is to participate in a carefully devised outcomes program and gather the experience and mindset that allows us to integrate outcomes based evidence in our day to day practice. For instance, we utilize an intensive early prosthetic adaptive process that we call our*



Chris Robinson, CPO, a clinician participant in the NURERC/CROR Outcomes Data study, noted, *“Outcome measures will provide clinicians with the information we need to make informed decisions in patient care.”*

Dynamic Trial Process (DTP). We believe that participating in this outcomes study will help us identify efficiencies and help improve this and other protocols. This should lead to overall improved quality of care.” Mr. Robinson also indicated a desire to learn *“how our prosthetic and orthotic interventions impact the lives of our patients day-to-day. As clinicians, we are trained to evaluate gait and other objectively measurable parameters, but the OPUS provides clinicians with a tool to measure patient perceptions of how our treatments impact them.”* Several factors influenced Mr. Afable's desire to participate in the project, such as recognizing *“the value of documenting outcomes in a reliable and repeatable fashion,”* and identifying areas where the RIC Prosthetics and Orthotics Clinical Center does well and where practice

could be improved. Ms. Wolking identified the desire to learn more about her practice as an individual clinician and to think from an outcomes perspective. A consistent theme was evident in these responses: Clinicians desire a process that provides a dependable and reliable means for collecting P&O-specific outcomes information that can improve clinical care.

Burden of Project Implementation

Clinicians reported positive but varied perceptions regarding the burden of project implementation. Mr. Afable indicated that *“the tools have not been disruptive or burdensome.”* He said that it was important to structure time for survey completion during a standard clinic visit. Ms. Wolking noted that front office staff is critical to implementing the process and reminding clinicians to collect OPUS forms. Mr. Robinson reported that the greatest burden was coordination between COPE clinics. Mr. Jolly said, *“It is likely that certain clients will find the scope and length of the surveys to be burdensome.”* Comments like these demonstrate that while implementation may be initially burdensome, a steadfast commitment to the process can overcome hesitation.

Outcomes within P&O Clinical Practice

Finally, we asked clinicians how they see outcomes information impacting the practice of P&O in the future. Mr. Afable believes that clinicians are *“trying to figure out how outcomes will bring the most value”* to clinical practice. Mr. Jolly suggested that at some point funding sources will require this type of information to justify reimbursement and *“we will see some version of this survey process as an ongoing part of our way of doing business.”* Ms. Wolking observed that using outcomes data within P&O illustrates an evolution of the field. Mr. Robinson succinctly summarized the potential

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for outcomes information in the field, “*For better or worse, outcomes will be directly related to reimbursement and justification of our services. Clinically relevant outcome measures will provide clinicians with the information we need to make informed decisions in patient care and help us provide the best possible solutions for our patients.*”

In summary, clinicians described their participation in *Enhancing the Quality of Prosthetic and Orthotic Services with Process and Outcomes Information* as a positive challenge in their P&O practices. It has challenged clinicians

to gain the support of their staff in collecting outcomes data, and to consider where and how outcomes data collection fits in their practice. Clinicians are able to perceive their practice from their patients’ perspectives. This project prepares clinicians for the possibility of mandated outcomes data collection and quality measure implementation that already is the reality in other healthcare arenas.

For more information about NURERC / CROR Outcome Measures research in P&O, please contact the authors at +1.312.238.2802.

NURERC High Profile at ISPO

R. J. Garrick, PhD



Steven A. Gard, PhD, presented NURERC research at the ISPO meeting in Leipzig. (Photo courtesy of K. Zissimopoulos.)

NURERC research was well represented at the **13th International Society for Prosthetics and Orthotics (ISPO) World Congress** held May 10 to May 15 in Leipzig, Germany. **Steven A. Gard, PhD, Stefania Fatone, PhD, BPO (Hons), Craig Heckathorne, MSc, Angelika (Kiki) Zissimopoulos, MS, Lexyne McNealy**

discussant in a Symposium on *Upper Limb Prosthetic Outcome Measures*.



Stefania Fatone, PhD, presenting NURERC research at ISPO.

Jackson, MS, and Allen Heinemann, PhD, attended the Congress and presented research that is conducted at NURERC with the support of the **National Institute on Disability and Rehabilitation Research (NIDRR)** of the Department of Education under grant number H133E030030. See below for a list of those presentations. **John Michael, CPO,** (Associate Director, Northwestern University Prosthetics Orthotics Center) is Honorary Secretary of ISPO. He moderated a basic Instructional Course (IC) on *Friction Management for Neuropathic Foot Problems*, presented *Clinical Applications of Stance Control Orthoses* for an advanced IC on *Orthotic Stance Control*, and was a



ISPO presented opportunities to exchange ideas and renew collegial associations with European colleagues. **Lexyne Jackson, MS** (left) met with Fraunhofer Institute's **Felix Starker** (right), who was a visiting researcher at NURERC in 2009 (See *Capabilities* v18(1)1-3). (Photo courtesy of L. Jackson.)

The Congress attracted approximately 1000 internationally recognized speakers from the fields of orthopaedic and rehabilitation medicine and engineering. Physicians, therapists, and P&O suppliers from more than 37 countries attended the presentations and exhibits. Daily, the Congress featured two keynote speakers, symposia, instructional courses, free papers, and structured poster sessions that culminated in a poster prize. American practitioners who attended specific instructional sessions garnered continuing education credits recognized by the American Board for Certification (ABC) in Orthotics and Prosthetics. Pre-eminent among the keynote speeches is the **Knud Jansen Lecture**, named for the ISPO founder and president (1970-1977). This year's presenter was **Lloyd Feinberg, U.S.**

Continued on page 4

Agency for International Development (USAID), who spoke on *ISPO and USAID's Leahy War Victims Fund - A Fifteen Year Partnership to Strengthen P&O Services in Developing Countries*.

The ISPO World Congress is the largest and most interdisciplinary forum for prosthetics and orthotics. This year it ran parallel to the trade show ORTHOPÄEDIE + REHA-TECHNIK 2010.

NURERC Presentations at ISPO

[Underline indicates presenter.]

Papers

Fatone, S, Stine, R, Gard, SA. Randomized Cross-over Study of AFO Ankle Components in Adults with Post-stroke Hemiplegia.

Hansen, A, Fatone, S, Klodd, E, Meier, MR, Edwards, ML, Sessoms, P, Childress, DS. Use of Experimental Prosthetic Feet to Improve Understanding of Prosthetic Foot Function for Lower Limb Prosthesis Users.

Gard, SA, Su, PF, Lipschutz, RL, Kuiken, TA. The Effect of Prosthetic Ankle Units on the Gait of Persons with Bilateral Transtibial Amputations.

Heckathorne, CW. Assessment Tools Used in Upper-limb Prosthetics Research and Development.

Johnson, W, Fatone, S, Gard, SA. Dynamics of Reciprocating Gait Orthosis (RGO) Assisted Gait.

McNealy Jackson, L, Gard, SA. Do Prosthetic Ankle Units Benefit Persons with Bilateral Transfemoral Amputations?

Ruhe, B, Hansen, AH, Gard, SA. Investigation of the Effect of Prosthetic Foot/Ankle Properties on Balance Efficiency while Standing on Inclined, Declined, and Level Surfaces.

Waldera, K, Heckathorne, CW. Utilization of Lower-limb and Upper-limb Prostheses by Farmers and Ranchers in the U.S.

Zissimopoulos, A, Gard, SA. Pilot Investigation of Movement Smoothness in Post-stroke Hemiplegia: Evaluations with and without Ankle-Foot Orthoses.

Posters

Hansen, A, Fatone, S, Wang, CC. Effective Rocker Shapes Created by Able-bodied Ankle-foot Systems for Fore-aft Swaying and Walking: Implications for Improved Ankle-foot Prostheses.

Hansen, A, Fatone, S, Wang, CC. Effects of Rocker Shoe Radii on Ankle Kinematics and Ankle-foot Roll-over Shapes.

Fatone, S. Literature Review on Sub-Atmospheric Suspension for Prosthetic Sockets.

Heinemann, A, Ehrlich-Jones, L, Williams, D. Enhancing Quality of Prosthetic Services with Process and Outcome Information.

Zissimopoulos, A, Fatone, S, Gard, SA. Effects of a Stance-control Knee-Ankle-Foot Orthosis on the Gait of Able-bodied Subjects.

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News from the VA Focus on Adaptive Surfing



Brian Ruhe: Bioengineer, Prosthetist, Hockey Champ...Gnarly Surfer! R. J. Garrick, PhD

Brian L. Ruhe, PhD, earned his doctorate (2009) in bioengineering at **Northwestern University** under the current NIDRR grant that supports the **NU Rehabilitation Engineering Research Center (NURERC)**. He is working at a year long residency in prosthetics at the **Long Beach Veterans Affairs Medical Center**, after having completed his prosthetics training at **California State University, Dominguez Hills (CSUDH)**. Adept at combining his academic and life experiences into new and positive outcomes, Brian recently has synthesized his skills in biomechanics and prosthetics with surfing!



(From left to right) **Heather Worden**, adaptive surf champion **Jean-Paul Veaudry**, and **Brian Ruhe**.

After a car crash in his teen years, Brian has lived with the challenge of bilateral, transfemoral amputations. He became a paralympic gold medalist in sled hockey (2002), a hand-cyclist, and is a burgeoning surfer. Brian participated in a Learn to Surf clinic that was sponsored by the **Association of Amputee Surfers** (www.ampsurf.org), an adaptive sports nonprofit organization that helps disabled veterans learn to surf. At San Clemente Beach, Dr. Ruhe translated his sled hockey skills to maneuvering a surfboard in the waves. He responded enthusiastically to the experience, saying, *"It was a lot of fun, and I will definitely do more surfing. I'll probably get my own board."*

Always filtering his physical experiences through the sieve of prosthetics, biomechanical principles, and engineering, Brian's friendship with South African surfer, **Jean-Paul Veaudry**, enabled him to combine his expertise in prosthetics and biomechanics with surfing. Earlier this year, Jean-Paul had sustained a transtibial amputation in a motorcycle accident and was eager to return to upright surfing. Brian and his fellow prosthetists decided to build him a surf leg.

Activity specific prostheses are available for sports and work. Upper limb prostheses with quick attach and release features have been designed for specific jobs such as bricklaying or carpentry. Lower limbs also have been designed for running, rock-climbing, snowboarding, swimming, and surfing. Water

resistant prostheses are essential for mobility and stability, whether in transfers to bath, shower, pool, or surf.

As more veterans and others with amputations participate in water sports, prosthetists seek to address these issues with novel prosthetic designs, components, and materials. Water sports like swimming, parasailing, and surfing are popular, but they expose prosthetic components and materials to damage from sun, salt, and sand. Prosthesis users need devices that can withstand high forces and environmental elements; as well as suspension systems that prevent abrasive debris from lodging between the suspension sleeve and the residual limb and do not water log.

In the CSUDH Prosthetics Lab, Brian and colleagues **Scott Hornbeak, Mark Cromer, Seth O'Brien, Charlie Kelly** and **Heather Worden** worked together to design, fabricate, and align a surf-specific prosthetic leg.

Brian explained the surf leg. *"Forces are accounted for through the socket design and foot alignment. The rigidity of the carbon socket, combined with the radical alignment, allowed Jean-Paul to surf without excessive forces on his residual limb."* The team designed the prosthesis to be water-tight. Using a standard sleeve suspension, Jean-Paul wore the silicon liner from his walking leg over the residual limb. Brian noted, *"To suspend and seal the surf prosthesis, on the outside of the socket we rolled a neoprene sleeve up over the socket trim lines and onto the liner. Jean-Paul's wetsuit created a waterproof seal and further strengthened the sleeve suspension system."* Water legs designed for showering or swimming lack dynamic feet. However, for Jean-Paul's surf leg, the team used a dynamic carbon graphite foot with almost no metal. *"We applied Performix® PlastiDip to protect the metal connection between the socket and the foot from rust and corrosion. To reduce drag, we did not use a shell on the foot; and for traction on the surf board, we glued rubber matting to the bottom of the foot."*



Adaptive surf leg. (Photo used with permission.)

With subjective feedback from Jean-Paul, the team aligned the leg according to biomechanical principles that allowed him to surf upright, using his prosthetic leg as the plant leg. In surfing, the plant leg is the rear, anchor leg, while the forward leg is the directional, steering leg. After successive trials and adjustments,

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NURERC Welcomes Ms. Colleen Farrell

R. J. Garrick, PhD

Ms. **Colleen Farrell** is a summer intern at **Northwestern University Prosthetics Research Laboratory (NUPRL)**, where she is processing motion analysis data on normal subjects to fulfill an independent research credit. In August she will graduate with a Bachelor's of Science in biomedical engineering from University of Wisconsin-Madison (UW-Madison). Education and training is an important component of the **National Institute for Disability Rehabilitation Research (NIDRR)** grant to **Northwestern University Rehabilitation Engineering Research Center**

(NURERC). Internships provide training in prosthetics and orthotics (P&O) and help to disseminate new knowledge about advances in rehabilitation research for P&O.

As a senior, Ms. Farrell concentrated in biomechanics, conducted work in gait and motion capture, ran the computers, applied markers, processed data, and created MATLAB programs, so she already feels comfortable working with the **VA Chicago Motion Analysis Research Laboratory (VACMARL)**. She remarked, *"I like data processing and programming. I am learning a lot working in this research lab."*

When asked how she chose biomedical engineering, Ms. Farrell noted that she grew up surrounded by scientific interests and conversations with her mother who is a nurse and her father who is a prosthetist. Her father, Mr. **Dennis Farrell**, CP, graduated from NUPOC in 1982. As a young student Ms. Farrell attended P&O conferences with her father and toured NUPOC.

As an undergraduate at UW-Madison she discovered that biomedical engineering was the best fit for her interests. Ms.



Ms. Colleen Farrell

Farrell reflected, *"The field of biomedical engineering is diverse and I enjoyed working in every aspect from genetic modification to motion capture. At Madison, I had unique opportunities in design. Every semester we chose a design project where four students worked with a faculty advisor and a professional who brought real world client problems for us to solve. One semester I designed and built an MRI-compatible leg exerciser for persons with pulmonary hypertension. Another semester I worked to map skin regions of neuropathic pain, applied*

motion capture to a stylus, processed the data, and wrote a MATLAB program to generate the map." Ms. Farrell has a patent pending on an Endotracheal Tube Cuff Pressure Monitor for pediatric patients that she designed as an undergraduate. Keeping the doors to her future open, she noted, *"I have not yet decided whether I will go to graduate school. For the time being, I will continue to explore job opportunities. I like product development, but it is good to diversify, so I am eager to build strengths in other areas of engineering."*

Besides her academic skills, she has been a leader in extra-curricular activities, including VP of Community Service for the National Society of Collegiate Scholars (NSCS). At NSCS she developed community service opportunities, recruited participants, scheduled transportation, and handled communications. She also enjoys outdoor activities, especially kayaking. Later this summer she will camp, fish, and kayak in upstate Wisconsin.

NURERC is delighted to welcome Ms. Farrell to the laboratory for the summer.

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Brian Ruhe, PhD, surfing at San Clemente, CA (May 2010).

Jean-Paul again surfed standing upright on his board. Two days later, wearing the prosthetic surf leg that Brian and the team had fabricated and aligned in a flexed and abducted stance, Jean-Paul won 1st Place (Challenged Athlete Division) in the 2010

WSA West Coast Championship, Hoppy Swartz Memorial Event at Church Beach in San Onofre, CA. The prosthetics team exulted with Jean-Paul over his win and his return to surfing. The surf leg restored Jean-Paul's access to surfing and Brian demonstrated the unexpected confluence of prosthetics, biomechanics, and surfing!

*This project owes special appreciation to **Scott Hornbeak**, MBA, CPO (Director, CSUDH O&P Program), and to **CSUDH** for use of the CSUDH Prosthetics Laboratory and materials for the surf leg.*

NURERC Bids Reluctant Farewell to Joshua Rolock, PhD

R. J. Garrick, PhD

Joshua Rolock, PhD, a respected researcher and engineer, closed his long association with the Northwestern University Prosthetics Research Laboratory (NUPRL) to pursue other directions in biomedical engineering and science.

Trained in biomedical engineering at Northwestern University (MS 1982; PhD 1993) and in mechanical engineering at the University of Illinois (Urbana, BS 1980), since 1984 Dr. Rolock contributed to the development and completion of many prosthetics and orthotics research projects at NUPRL. His doctoral dissertation addressed *Direct, Automated Fabrication of Sockets for Artificial Limbs* (1993). From 1997, Dr. Rolock was a Research Associate Professor at NUPRL and, concurrently from 2003 he was a Research Health Scientist with the Jesse Brown VA Medical Center, Chicago, IL. He has served as *ad hoc* scientific reviewer for the *Journal of Orthopaedic*



Joshua Rolock, PhD

Surgery and Research, IEEE Transactions on Neural Systems and Rehabilitation Engineering, Medical and Biological Engineering and Computing, and many others.

A beacon of clear thought and diplomatic expression, Dr. Rolock's personal qualities and intellectual contributions will be sorely missed by all the members of NUPRL. Adept at translating his ideas into applications, he developed his interest in surface curvature analysis into a rapid, plastic deposition fabricator for computer-aided manufacture (CAM) of prosthetic sockets. This became the Squirt Shape System, which has proven useful for many research projects at NURERC.

Everyone at NURERC will miss Dr. Rolock, his ideas, resourcefulness, and intellectual clarity. Joshua, from all of us at NURERC, we wish you happiness and success in your future endeavors!

NURERC News

Meetings

Stefania Fatone, PhD, BPO(Hons) was an invited participant in the **National Institutes of Health (NIH)** Special Emphasis Panel/Scientific Review Group (Rehabilitation Sciences) in Alexandria, VA, on March 12.

Stefania Fatone, PhD, **Steven A. Gard**, PhD, and **Andrew Hansen**, PhD, were invited participants at the **VA/DoD State of the Art Meeting on Prosthetics and Orthotics** held in Baltimore, MD, on March 15-17. Dr. Fatone participated in the planning committee for this meeting and Dr. Gard acted as scribe for the work group on Standards.

Stefania Fatone, PhD, and **Steven A. Gard**, PhD, were invited speakers at the **1st Annual Research Symposium** at the **Jesse Brown VA Medical Center** on April 30. Dr. Gard presented "Investigation of Shock-absorbing Components for Lower-limb Prostheses." Dr. Fatone presented "Prosthetics and Orthotics Research." This symposium was held during the National VA Research Week.

Stefania Fatone, PhD, and **Craig Heckathorne**, MSc, were invited to chair sessions at the **13th World Congress of the International Society of Prosthetics and Orthotics (ISPO)** in Leipzig, Germany, on May 10 through 15. Dr. Fatone co-chaired a free paper session on "Orthotics – Stroke and Central Disorders" and Mr. Heckathorne co-chaired a symposium on "Customized Upper-limb Prostheses: Art, Design, and Rapid Manufacturing."

Patent Applications

Hansen, A., Wang, C. Rocker shoes for prescribed ankle motion. [USSN 61/211,976]. Final patent application filed at the United States Patent and Trademark Office on April 6, 2010.

Hansen, A., Sensinger, J. Improvements to Passive Ankle-foot Prosthesis Capable of Automatic Adaptation to Sloped Walking Surfaces and Methods of Use. Provisional patent filed at the United States Patent and Trademark Office on April 12, 2010.

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Zissimopoulos Awarded OPERF Fellowship



Ms. **Angelika (Kiki) Zissimopoulos, MS**, received a 2010 Fellowship Award from the **Orthotic and Prosthetic Education and Research Foundation, Inc. (OPERF)** for her proposal “Mediolateral Stability in Post-Stroke Hemiplegic Gait:

Dynamic Influences of Ankle-Foot-Orthoses and Torso Weighting.” Ms. Zissimopoulos is conducting research about this topic and will report these findings in her doctoral dissertation. Congratulations, Kiki!

NURERC Advisory Panel Meets

The NURERC Advisory Panel convened its 2nd meeting on June 10. The Panel consists of 23 researchers, clinical prosthetists and orthotists, and knowledgeable consumers who volunteer their time and expertise. This meeting focused on topics and themes for the upcoming NURERC State of the Science (SOS) Meeting that is slated to be held in 2012. NURERC appreciates the time, effort, and intellectual contributions of each member of the Advisory Panel.



Dulcey Lima, CO (left), and **David Rotter, CPO** (right), are members of the NURERC Advisory Panel.