



Capabilities

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NUPRL/RERP Celebrate Career Contributions of Dudley S. Childress, Ph.D.



Dudley S. Childress, Ph.D.

In October, the Northwestern University Prosthetics Research Laboratory (NUPRL) and Rehabilitation Engineering Research Program (RERP) celebrated the 40-year career accomplishments of **Professor Dudley S. Childress, Ph.D.**, who has produced devices and systems that assist people with disability, allowing them to live independently. A specialist in biomedical engineering and rehabilitation engineering research, Dr. Childress has mentored many scientists, engineers and physicians who have become leaders in the field of prosthetics and orthotics.

Dr. Childress' former students returned to Northwestern University from many parts of the United States and as far away as Panama to attend *The Dudley S. Childress Scientific Symposium*. Conducted during two afternoon sessions, featured speakers were current colleagues and former students who had worked with Professor Childress during a formative portion of their careers. These scientists discussed their research and innovations in areas that include neural control in prosthetics, inexpensive biomimesis, theories of ambulation, and gait analyses of prosthesis and orthosis users. Testament to the importance of Dr. Childress' scientific mentorship, these stimulating presentations illustrated advancements in the fields of biomedical engineering and rehabilitation engineering.

Social occasions punctuated the two-day series of events. Friday, October 6, began with an Open House at NUPRL/

RERP. Luncheon was followed by the first session of the Scientific Symposium. Among the guests who toasted Childress at the Friday evening champagne reception were **Henry B. Betts, M.D.**, (former Medical Director of the Rehabilitation Institute of Chicago and current Chairman of the Rehabilitation Institute Foundation), **Elliot Roth, M.D.**, (Senior Vice President for Medical Affairs, Paul B. Magnuson Professor and Chairman of Physical Medicine and Rehabilitation at Northwestern University Medical School, and Chairman of Rehabilitation Medicine at Northwestern Memorial Hospital) and **Matthew R. Glucksberg, Ph.D.**, (Professor and Chair of Biomedical Engineering).

On Saturday, October 7, Dr. Childress conducted a tour of Northwestern University's Evanston Campus, including the new Ford Engineering Design Building. After luncheon in the University Guild Hall, the second session of the Scientific Symposium was conducted in Cahn

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Pictured left to right, Henry B. Betts, M.D., Dudley S. Childress, Ph.D., Matthew R. Glucksberg, Ph.D., and Yeongchi Wu, M.D., at a reception honoring Dr. Childress.

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Auditorium. The events culminated Saturday evening with a gala reception and dinner that featured comments by **Matthew R. Glucksberg, Ph.D.**, (Professor and Chair of Biomedical Engineering); **Robert Linsenmeier, Ph.D.**, (Professor of Biomedical Engineering); **Clint D. Gibler, Ph.D.**, (Senior Vice President and Chief Information Officer, The Western and Southern Life Insurance Company, Cincinnati, Ohio); **Victor Sánchez Urrutia, Ph.D.**



Dudley S. Childress, Ph.D. at the gala dinner hosted in his honor.

(Professor, College of Mechanical Engineering, Universidad Tecnológica de Panamá); **Edward R. Vresilovic, M.D., Ph.D.** (Beth Israel Deaconess Medical Center, Harvard Medical Faculty); **Pamela Y. Shuck, M.S.**, (Clinical Engineer, McLaren Health Care, Flint, Michigan), **George Bertos, Ph.D.**, and others.



Steven A. Gard, Ph.D., (right) presents to Dudley S. Childress, Ph.D., (left) a book of memoirs that were written for him by his former students.

Steven A. Gard, Ph.D., (Director of NUPRL/RERP), presented a book of recollections, essays, letters and photographs that were written by Dr. Childress' former students for this occasion. The book is dedicated to Dr. Childress: *"With admiration, appreciation and affection from your students, colleagues and friends for all that you have taught us and for all that you have helped us to become."*

Childress' Work and Vision Developed Northwestern University Prosthetics Research Laboratory

Dudley S. Childress, Ph.D., developed the engineering-based program (NUPRL/RERP) from a small laboratory to a current leader in rehabilitation engineering research. NUPRL/RERP focuses on the design, development and evaluation of prosthetic and orthotic (P&O) devices that benefit persons with physical disability. Research conducted at NUPRL/RERP aims to increase understanding about how prostheses and orthoses affect human movement; to improve the fitting and manufacturing processes for prosthetic/orthotic systems; and to expand knowledge of human interactions with these systems.

Northwestern University has been a major presence in the field of P&O since 1945 when the Surgeon General of the USA convened a meeting of the National Research Council in Thorne Hall on the Chicago campus to discuss the provision of prostheses for returning World War II veterans. This initial meeting launched federally funded research and educational programs that contributed to advances in P&O.

Prosthetics research at Northwestern University began in 1956 in the basement of the Rehabilitation Institute of Chicago (RIC). **Clinton Compere, M.D.**, a member of Northwestern's Department of Orthopaedic Surgery, **Colin McLaurin**, and **Fred Hampton** established the research program. In 1958, Dr. Compere began prosthetics education at RIC. Today, the Northwestern University Prosthetics Orthotics Center is the oldest and largest P&O school in the United States.

In 1954, the same year that Dr. **Paul Magnuson** founded RIC, Professor **Richard Jones** founded what now has become the Department of Biomedical Engineering on the Evanston Campus. A graduate of Northwestern University's Department of Electrical Engineering, **Dudley S. Childress** was the first graduate to specialize in rehabilitation engineering when he joined the Prosthetics Research Laboratory in 1966 at the urgings of Professor **Richard Jones**, Professor **John Jacobs** and Professor **Christina Enroth(-Cugell)**.

The Dudley S. Childress Scientific Symposium

The Dudley S. Childress Scientific Symposium was conducted during two afternoon sessions. **Steven A. Gard**,



Todd Kuiken, M.D., Ph.D., presented "A New Neural Machine Interface for Prosthetic Control."

Ph.D., (Director of NUPRL/NURERP) was Moderator and offered closing remarks for each day's program. Symposium speakers were current colleagues and engineers, many of whom Professor Childress had mentored.

The Friday Symposium featured the following presentations: "A New Neural Machine Interface for

Prosthetic Control" by **Todd Kuiken**, M.D., Ph.D.; "From Extended Proprioceptive Perception (EPP) and Muscle Tunnel Cineplasties to Neuroelectric Control for Artificial Arms and Hands" by **Richard F. Weir**, Ph.D.; "On the Role of Scrutiny and Critical Evaluation in Research" by **Steven A. Gard**, Ph.D.; "Inexpensive Biomimesis – The Shape&Roll Prosthetic Foot" by **Andrew Hansen**, Ph.D.; "Putting the 'O' in P&O Research" by **Stefania Fatone**, Ph.D., BPO(Hons); "The Bridge Between Development and Commercialization: What's Kept Me from Reaching the Other Side, and Will I Cross It Next Time?" by **Joshua Rolock**, Ph.D. (presented at a later date due to unavoidable circumstances); "Northwestern University Prosthetics Orthotics Center (NUPOC): Initiatives in Blended Education" by **Mark Edwards**, MHPE, CP; and "Everything Can Be Made Better, Cheaper, Faster" by **Yeongchi Wu**, M.D.

The Saturday Symposium featured the following presentations: "Achieving a Level Playing Field" by **Brian Ruhe**,

M.S.; "Theories of Human Ambulation" by **Laura Miller**, Ph.D., CP; "Gait Initiation and Termination in Non-disabled Ambulators and in People with Unilateral Lower Limb Loss" by **Steve Miff**, Ph.D.; "A New Shock Absorption Model of Walking" by **George Bertos**, Ph.D.; "Shaping' Our Future" by **Erick Knox**, Ph.D.; "Improving Prosthetic Prehension" by **Larry Carlson**, Ph.D.; and "Auto-Stimulation to Degenerative Disc Disease" by **Edward Vresilovic**, M.D., Ph.D. **Dudley S. Childress**, Ph.D., presented the concluding lecture of the Symposium, "What Makes Prosthetics and Orthotics Difficult?"



Andrew Hansen, Ph.D., presented "Inexpensive Biomimesis-The Shape&Roll Prosthetic Foot."

Symposium speakers reflected on their education while working with Dr. Childress and frequently remarked on Childress' intellectual

passion for collaborative and innovative work, high scientific ethics, sense of humor, love of art, architecture, history and language. Students and colleagues alike expressed appreciation for how Childress' ideas have influenced and

inspired them. These leaders in the field of biomedical engineering discussed the innovative work they conducted under Dr. Childress' mentorship and described new directions their careers have taken since they left Northwestern University's Rehabilitation Engineering Research Program. The two-day scientific symposium sparked informal, collegial conversations filled with ideas and memories, both fitting tributes to Dr. Childress' long and productive career.



Following Dudley S. Childress' presentation, "What Makes Prosthetics and Orthotics Difficult?," Steven A. Gard, Ph.D., Moderator of the Scientific Symposium, offers comments and invites questions.

NURERC Welcomes Members of ASME International 2006 Congress

International members of the American Society of Mechanical Engineers (ASME) 2006 Congress toured NURERC on November 7, 2006. About twenty engineers, representing North and South America, Europe and Asia, visited NURERC to learn about present research and development activities in biomechanics, human walking, artificial limbs, ambulation aids and rehabilitation engineering.

The NURERC tour provided ASME participants with a better understanding of the mechanical interactions

that occur between humans and prosthetic and orthotic systems. At each of the laboratory's four demonstration stations, NURERC engineers presented aspects of the design and development of modern technological systems for persons with amputation and other disabilities. Laboratory personnel explained and discussed scientific approaches to the analysis and description of human movement and physical disability. A key goal of the NURERC tour was to disseminate knowledge about P&O research to mechanical engineers.

NURERC Researchers Invited to Keck Conference

Steven A. Gard, Ph.D., and **Andrew Hansen, Ph.D.,** were invited participants in the 4th Annual National Academies (consisting of the National Academy of Sciences, the National Academy of Engineering, the Institute of Medicine, and the National Research Council) Keck Futures Initiative (NAKFI) Conference, "Smart Prosthetics: Exploring Assistive Devices for the Body and Mind" held on November 9-11, 2006 at the Academies' Arnold and Mabel Beckman Center in Irvine, CA. Invitees to NAKFI participated in a novel and challenging think-tank approach to solving problems.

Participants worked in one of eleven possible interdisciplinary Task Groups: Replacing Damaged Cortical Tissue; Smart Prosthesis to Grow with a Child; Develop a Prosthesis that Can Learn Better or Faster; two sections for Brain Interfacing with Materials; Create Active Orthotic Devices; Structural Tissue Interfaces; Sensory Restoration of Perception of Limb Movement; Design a Functional Tissue Prosthesis; Create Hybrid Prostheses; and Can Brain Control, Guide or Refine Limb Control? Dr. Gard chose to participate in "Smart Prosthesis to Grow with a Child" and Dr. Hansen selected "Create Active Orthotic Devices."

Prior to the actual meeting, each invited participant prepared for Task Group interaction and discussion by

reviewing hours of webcasts that were prepared from multiple perspectives and disciplines about current knowledge and vocabulary associated with the challenge problem.

At the meeting, each Task Group included researchers from science, engineering and medicine, as well as representatives from private and public funding agencies, university and business leaders and science journalists. For eight hours, participants worked with their group to develop recommendations to their Task Group's challenge. A graduate student in science journalism wrote each Task Group's summary. Summaries described the problem, the state of knowledge related to the problem, and reasoning that supported the group's proposal. Summaries concluded by identifying ways society would benefit from solving the targeted problem.

Each participant met the challenge of interacting with scientists and professionals from diverse backgrounds and interests. Their interaction required intellectual flexibility, open-mindedness and a nimble approach to problem-solving and application. Overall, the Keck Conference stimulated creative thinking and innovative proposals.



NEWS FROM THE DEPARTMENT OF VETERANS AFFAIRS

In this two-part article, Robert Baum provides an overview of the VA's role in providing assistive technology and restoring abilities to disabled veterans. Look for Part II in Capabilities (Spring 2007).

VA's Prosthetics and Sensory Aids Service: Advocacy and Assistive Technology (Part I)

**By
Robert M. Baum
Program Manager
Prosthetics and Clinical Logistics**

Restoring Abilities to Disabled Veterans

A strategic goal at VA is to restore to the greatest extent possible the abilities of disabled veterans, and the Prosthetics and Sensory Aids Service (PSAS) works to fulfill that mission. The VA headquarters in Washington, D.C. serves as an advocate for veterans with special needs, including those with amputation, spinal-cord injury, blindness, and other visual, hearing and speech impairments. PSAS meets the needs of disabled veterans by acting as case manager for their prosthetic equipment and as pharmacy for their assistive aids. Veterans who have a service-connected disability and are enrolled in VA health care can receive prosthetic equipment, sensory aids and devices, and have them maintained by VA.

VA helps veterans with disabilities to live independently by providing assistive items ranging from simple \$2 foam shoe inserts to hi-tech \$30,000 iBOT wheelchairs. Since 2001, the number of veterans seeking PSAS services has increased 45 percent to 1.5 million in 2006. The budget has increased with demand, from \$635 million in 2001 to

\$1.2 billion in 2006 when almost \$73 million of the expenditures went to providing over 12 thousand veterans with artificial legs, arms and associated components.

Disabled veterans can receive products other than prostheses, including: wheelchairs, scooters, orthoses, shoes, oxygen and respiratory equipment, and other medical equipment and supplies including beds, lifts, computer equipment, and telehealth products. Surgical implants include pacemakers, cardiac defibrillators, stents, dental devices, etc. In 2006, at a cost of about \$55 million, PSAS issued more than 772,000 prescriptions for sensori-neuro aids such as eyeglasses, hearing aids, or restorations to veterans. Prosthetics and Sensory Aids Service also administers the Home Improvement and Structural Alterations (HISA) Program and furnishes automobile adaptive equipment to eligible veterans who have purchased or leased a vehicle.

Prostheses Linked to Wars

Historically, wars have spurred developments in medicine, including technical advances in mobility aids and assistive devices for wounded soldiers. During the Civil War, Union surgeons performed up to 30,000 amputations. After the war, some amputees sought to improve their military-issue prostheses and formed their own mail-order companies. By the time World War I broke out, many skilled craftsmen were making prosthetic limbs, but materials, fabrication and fit were unreliable.

Prosthetics fabrication in the United States remained unchanged through World War II. Typically, amputee

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veterans received a temporary prosthetic limb upon discharge from service and were referred to VA for a permanent limb. At VA, often veterans received a prescription for a prosthesis that was supplied through a contractor, always the lowest bidder. Eventually, veterans stormed the Capitol in protest when they could not receive prostheses of the same quality that non-veterans could purchase. In 1945 VA responded by centralizing its prosthetics operations and Congress gave VA more flexibility in providing prosthetics.

That same year, a national meeting of prosthetics experts launched federal research into the new field of prosthetics. In 1947, VA began managing research contracts and established a development and testing laboratory at the VA Prosthetics Center (New York City). Manufacturers began using plastic laminates instead of wood. One VA-funded study examined locomotion; another looked at suction-sockets for above-knee prostheses. In 1949, VA established 30 multi-disciplinary amputee clinics across the country, as well as an education program for the specialists who staffed them.

During the years following World War II, VA led a rapid advance in limb design, fabrication and fitting. In the 1960s, Dr. Ernest Burgess (Seattle VAMC) initiated the practice of fitting prosthetic devices immediately after amputation, a technique that eventually was adopted nationwide. Burgess and his team also developed the Seattle Foot, a prosthesis made of energy-absorbing, spring-like material, and pioneered computer-aided design software for fitting prostheses.

Today, work groups at the VA develop clinical practice recommendations for prosthetic devices as well as national contracts to purchase them. The PSAS has more than 40 national contracts that ensure consistency in continuity of care and quality of items furnished to veterans throughout the USA. Competition among suppliers allows VA to take advantage of economies of scale.

Technologies for Future Advances

VA helps more veterans gain access to new, assistive technology, such as the C-Leg. Although today's typical amputee is a middle-aged male whose amputation is due to vascular disease, in the past, most VA patients who required prostheses had lost limbs in combat. Recently, VA prosthetists are fitting increasing numbers of amputee veterans from Afghanistan and Iraq with high-tech

prostheses, particularly the C-Leg, that have become increasingly available to disabled veterans.

The C-Leg is a computerized leg that allows people who have above the knee amputations to approximate a normal gait. It employs a computer-controlled hydraulic system regulated by internal feedback. Fifty times per second, sensors in the pylon (shank area) of the prosthetic limb route electronic signals to an onboard microprocessor located just below the mechanical knee, and provide information regarding knee position (angle), velocity, toe-load and other data that can determine variations in the wearer's gait and enable the knee to respond appropriately.

From 2002, PSAS has provided C-Legs to more than 530 disabled veterans at a total cost of \$19.3 million. Since 2000, when the C-Leg was introduced to the United States, additional microprocessor knees and a microprocessor ankle/foot system have been introduced. It is expected that VA will continue to develop and utilize microprocessor and other new technologies to enhance disabled veterans' function and outcomes.

Robert M. Baum is Program Manager of Prosthetics and Clinical Logistics at the VA Central Office (10FP) in Washington, D.C. 20420.

Contact Mr. Baum at the above address (Tel: 202-254-0440 or Fax: 202-254-0470) to ask questions about this article or to suggest future articles.

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NURERC News

Meetings

Steven A. Gard, Ph.D., was invited to participate in a meeting hosted by the American Orthotic and Prosthetic Association (AOPA) entitled "O & P Leadership Conference: Developing a Shared Vision," held in Chicago, IL, on November 15-17, 2006. The meeting examined important challenges that now confront the O & P community.

Dudley S. Childress, Ph.D., attended a Committee meeting on Rehabilitation hosted by the Institute of Medicine, National Academy of Sciences in Washington, D.C., on September 11-12, 2006. Dr. Childress is a member of the Institute of Medicine, National Academy of Science's Committee on Disability in America.

Richard F. ff. Weir, Ph.D., attended the Defense Advanced Research Projects Agency (DARPA) Prototype Preliminary Design Review, held in Columbia, MD, on September 18-19, 2006.

Dudley S. Childress, Ph.D., Steven A. Gard, Ph.D., Brian Ruhe, M.S., and Richard F. ff. Weir, Ph.D., attended the Cleveland Clinical Needs Assessment Workshop: Discovering Real Needs, Designing Real Solutions, held in Cleveland, OH, on September 21, 2006.

Invited Lectures and Presentations

Stefania Fatone, Ph.D., was invited to speak to therapists at Children's Memorial Hospital on Tuesday, September 19, 2006. Her topic was "Normal Human Locomotion: Biomechanics of Lower Limb Function and Gait." Also, she was invited to speak at the American Academy of Orthotists and Prosthetists Ohio Chapter Annual Fall Scientific Meeting in Columbus, OH, on October 14, 2006. Dr. Fatone presented "Orthotics Research: Where We Are Now and Where We're Headed."

Andrew H. Hansen, Ph.D., was invited to speak at the Mechanical Engineering Seminar Series held at The Ohio State University on October 20, 2006. Dr. Hansen presented "Roll-over Shape: A Tool for Design, Evaluation, and Alignment of Prosthetic Ankle-Foot Mechanisms." Also, he was invited to speak at the American Academy of Orthotists and Prosthetists (AAOP) workshop on Prosthetic Foot/Ankle Mechanisms, held in Chicago, IL, on October 23, 2006. Dr. Hansen presented "Mechanical Analysis of Feet and How Feet are Studied 'In the Lab.'"

Johnson, B., Fatone, S., and Gard, S. "Preliminary Findings for a Pilot Study on the Mechanics of RGO Gait." Presented at the 15th Annual Visiting Professor

Symposium, Motion Analysis Center, held at Children's Memorial Hospital, Chicago, IL, November 10, 2006.

Koehler, S.R., Gard, S.A., and Meier, M.R. "An Investigation of Shock Absorbing Components in Persons with Unilateral Transfemoral Amputations." Poster presentation, 4th Annual National Academies Keck Futures Initiative on "Smart Prosthetics: Exploring Assistive Devices for the Body and Mind," Irvine, CA, November 9-11, 2006.

Hansen, A.H., Gard, S.A., Childress, D.S., Ruhe, B., and Williams, R. "Prosthetic Ankle Joint with Automatic Adaptation to Surface Inclination." Poster presentation, 4th Annual National Academies Keck Futures Initiative on "Smart Prosthetics: Exploring Assistive Devices for the Body and Mind," Irvine, CA, November 9-11, 2006.

Publications

Konz, R., Fatone, S., Stine, R., Ganju, A., Gard, S., and Ondra, S. "A Kinematic Model to Assess Spinal Motion During Walking." *Spine*, Vol. 31, No. 24, 2006, pgs. E898-E906.

Moosabhoy, M.A., and Gard, S.A. "Development and Analysis of Methodology for Determining the Sensitivity of Swing Toe Clearance and Effective Leg Length to Swing Leg Joint Angles During Gait." *Gait & Posture*, Vol. 24, No. 4, 2006, pgs. 493-501.

Hansen, A., Meier, M., Sessoms, P., Childress, D. "The Effects of Prosthetic Foot Roll-over Shape Arc Length on the Gait of Trans-tibial Prosthesis Users." *Prosthetics and Orthotics International*, Vol. 30, No. 3, 2006, pgs. 286-299.

Instructional Manuals

Meier M.R., Steer S.A., Hansen A.H., Sam M., Childress D.S. (2006) *Shape&Roll Prosthetic Foot Manual 1—Fabrication of a Lever Compression Mold*. SpectraGraphics Printing Inc., La Crosse, WI, ISBN: 0-9785898-0-7.

Meier M.R., Steer S.A., Hansen A.H., Sam M., Childress D.S. (2006) *Shape&Roll Prosthetic Foot Manual 2—Fabrication of the Core*. SpectraGraphics Printing Inc., La Crosse, WI, ISBN: 0-9785898-1-5.

Provisional Patent Application

A. Hansen, S. Gard, D. Childress, B. Ruhe and R. Williams filed a provisional patent application with the United States Patent and Trademark Office for "Equilibrium-Point Prosthetic and Orthotic Ankle-Foot Devices" on October 17, 2006.

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