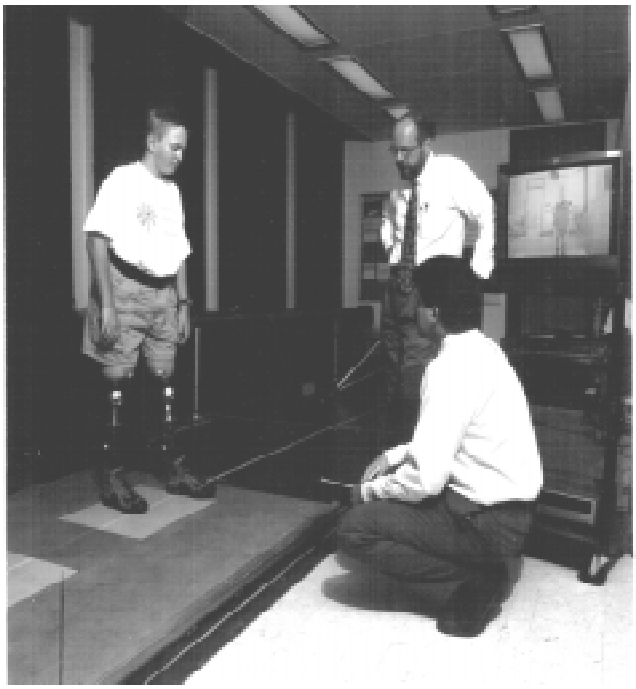
Capabilities
Communicating the Science of Prosthetics and Orthotics
Volume 6, Number 3, July 1997

Studying Ambulation: NUPRL&RERP Tests the Hypotheses

A Review of Current Research Projects

By Steven A. Gard, PhD



Steven Gard, PhD (left) , Jack Uellendahl, CPO , Director of Prosthetic-Orthotic Clinical Services at the Rehabilitation Institute of Chicago, (center) and Daniel Kalabus-Lagos use one of the many computer tools available to them in the Human Mechanics Measurement Laboratory to study ambulation.

"Common knowledge tells us..." or "it is generally believed..." are phrases often heard when walking is discussed in clinical settings or professional conferences. Two of the three core areas of research at the Northwestern University Prosthetics Research Laboratory and Rehabilitation Engineering Research Program (NUPRL&RERP) include research projects designed to test the hypotheses upon which "common knowledge" and "general beliefs" are based.

NUPRL&RERP focuses on the core areas of upper limb prostheses, ambulation and aided-ambulation, and computer-aided engineering. Projects in the core area of ambulation and aided-ambulation investigate and analyze the walking patterns of people with and without disabilities including walking with and without such aids as crutches, orthoses or prostheses. Computer-Aided Engineering is applied to projects as diverse as analyzing the interface pressures between a prosthesis and a residual limb, and fabricating a socket using computer design and manufacturing processes.

Northwestern's comprehensive approach to analyzing various aspects of human ambulation was developed by Dudley S. Childress, PhD and involves a number of graduate students conducting research for advanced degrees in biomedical engineering and several full-time staff members, who have various areas of specialization. The approach to research projects that explore commonly held beliefs about ambulation is open-minded. Often, new directions for research projects evolve from initial studies. For example, studies of toe clearance, described in this article, led the investigators to examine the effects of pelvic obliquity on the vertical displacement of the trunk, which questioned long-held beliefs. This work with pelvic obliquity then led to an investigation to determine how stance-phase knee flexion affects the trunk's vertical displacement.

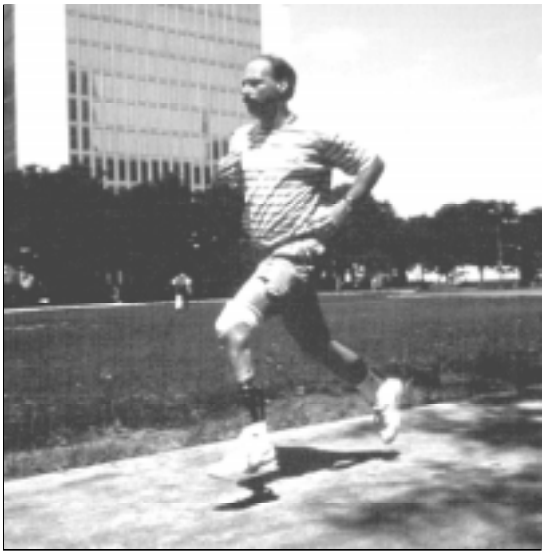
The Northwestern research team feels that understanding all aspects of normal ambulation will increase

Continued on page 2

Studying Ambulation...

Continued

knowledge about how to better use and design prostheses and orthoses. For example, studies done by Janet Jhoun, PhD candidate, focused on the factors which enable people to transition from standing still to walking. Studies were conducted with six healthy young adults who had no balance or musculoskeletal disorders. Each subject was asked to perform five tasks from a standing position: gait initiation forward, gait initiation backward, gait initiation sideways, transferring body weight from a bipedal stance to a single limb stance, and walking in place.



The ultimate goal of Northwestern research into the various components of ambulation is to provide a base of knowledge to assist in constantly improving lower limb prostheses

Jhoun created mathematical models of each subject performing the prescribed tasks. Investigation of these models will help to establish new insights into the mechanisms involved in standing balance and walking. People with bilateral lower limb amputations or those with Parkinson's disease frequently have trouble as they stand and start to walk. It has been noted that people with bilateral lower leg amputations often have good ability to stand but have a "fall-stop" type of gait. This research project is intended to provide a better understanding of the mechanisms involved in walking for the therapists who train people with amputations and other pathologies which affect gait initiation such as Parkinson's disease.

Learning why toe clearance is important to gait

Research investigators at Northwestern have analyzed many specific movements that comprise ambulation. Although some of these may seem commonplace or obvious to the casual observer, even small actions are important if ambulation is to be thoroughly understood. For example, stubbing your toe during the forward stepping movement is usually an accident. But it is important to understand the mechanics which caused your toe to hit the ground prematurely if toe clearance of a person using a lower limb prosthesis is to be analyzed and, eventually, improved. One project in Northwestern's ambulation core area is investigation of the mechanisms which affect toe clearance during normal ambulation. These studies analyze the actions which people unconsciously incorporate in their gait to assure that their toe clears the ground during gait.

Steven Gard, PhD, has conducted a series of investigations on the mechanisms of toe clearance. He has analyzed how small changes in the angles of the joints of the legs and the pelvis affect swing-leg toe clearance and the effective leg length. Gard has used these models to investigate the characteristics of components of lower limb prosthetic systems. One of his studies was of a comparison of the swing phase toe clearance characteristics of eight models of commercially available 4-bar linkage knees with a single axis knee. The studies showed a major benefit of 4-bar knees is that they can provide significantly more toe clearance during the swing phase that a single axis knee. The results of these studies have been discussed in detail in an article by Gard, Childress and Uellendahl in the *Journal of Prosthetics and Orthotics*, Spring 1996, Vol. 8, #2.

Applying knowledge to aided ambulation

The investigations of toe clearance during walking led Childress and Gard to reexamine accepted theories about the effects of pelvic obliquity and stance-

Continued on page 10

Capabilities (ISSN 1055-7156) is published in April, July, October and January by Northwestern University's Rehabilitation Engineering Research Program. Program Director, Dudley S. Childress, Ph.D. Editor & Designer, Jan Little

Subscription is free to all individuals interested in prosthetics and orthotics. For contribution guidelines and advertising inquiries, write to the address below. Address subscription information, address changes and other correspondence to: *Capabilities,* Northwestern University RERP, 345 E. Superior St., Room 1441, Chicago, IL 60611.

Northwestern University Prosthetic and Orthotic Programs Celebrate Anniversaries

Five Decades of Education and Research

By Jan Little

In the April 1997 issue of *Capabilities*, we shared the beginning years of the programs in prosthetics and orthotics with three pioneers: Hildegarde Myers, RN, RPT, Robert Thompson, MD and Colin McLaurin, ScD. Working with Clinton Compere, MD, these three pioneers were instrumental in establishing the Northwestern University Prosthetic-Orthotic Center (NUPOC), which has provided education leading to certification and continuing education for practitioners in all areas of care in prosthetics and orthotics since 1958. Their efforts also resulted in the Prosthetics Research Laboratory, initiated in 1956, and built the foundation for the Rehabilitation Engineering Research Program, established in 1972.

Part II:
• NUPOC: The third prosthetic school in the nation
• The Prosthetics Research Laboratory continues to grow

In this issue, we share the memories of others who worked to build these programs. Together, they give us a glimpse at the great amount of time and talent invested to move prosthetics and orthotics from primarily a craft to a potential science, which gives people with amputations and other disabilities high-tech tools to meet life's challenges.

The Prosthetics Research Laboratory was funded by the VA — now the Department of Veterans Affairs

According to those who knew him, Dr. Compere had great skill in choosing the people who would be best able to bring his concepts to reality. When he established the Prosthetics Research Laboratory, funded by the Veterans Administration, he chose Colin McLaurin for his excellence as an engineer and his capability to quickly develop an elegant solution to needs others had puzzled over for years. McLaurin in turn drew upon his experience to add people with the needed skills and interests to his staff.

Fred Hampton, CP, recalls that it was not very long after McLaurin had left Sunnybrook Hospital in Toronto, Canada before he wrote to Hampton telling him about the potential of advancing prosthetics at the new Northwestern University laboratory. Hampton had worked with McLaurin in many projects including developing mechanical hands and cosmetic gloves, prostheses for people with hip disarticulations and various prostheses for foot amputations such as Symes.

Both Hampton and McLaurin were well acquainted with other leaders in the field, such as James Foort, who with Charles Radcliffe at University of California/Berkeley, brought forth a new version of a prosthetic foot. The SACH foot, with a solid ankle and cushioned heel, was an early effort to provide more normal gait for amputees.

Fred Hampton remembers his years at Northwestern as "the most exciting time of my life". The opportunities offered ranged from working with Dr. Compere in the postoperative wards of the Lakeside VA Medical Center to teaching at NUPOC. "We had a unique situation," Hampton recalls. "We could introduce prostheses and methods that had just been developed in our labs to the doctors attending our classes."

The direct work with patients also was fulfilling for Hampton. "I particularly remember working with Dudley Childress in preparing a prosthetic hand for a young woman whose hand had to be amputated because of cancer. When she woke up, she had her new hand — just as she had been promised."

Continued on page 4

Five Decades of Education and Research

Continued

Many of the developments referred to by Hampton were keystones of the structure of research at the Prosthetics Research Laboratory into the 1990s. Work with children who had upper limb deficiencies was a predecessor to today's work. During McLaurin and Hampton's time, a linked elbow and wrist were developed to enable such children to hold their prosthetic hand in a position that let them bring a cup to their mouths.

Fred Hampton stayed at NU Prosthetics Research Laboratory after Colin McLaurin returned to Canada until he was recruited by Jackson Memorial Hospital in Miami, Florida to lead their prosthetics laboratory. He also taught prosthetics at Florida International University and founded a commercial prosthetics-orthotics laboratory with Mark Schultz. He is now retired and lives with his wife, Lillian, in a suburb of Miami.

The Compere method of recruitment brought to the Prosthetics Research Laboratory a man who stayed on until today. When **Edward Grahn** joined the Army, he was stationed at the Army Prosthetic Research Laboratory at Walter Reed Army Medical Center, Washington, DC because of his education and background in engineering. Grahn found work in prosthetics an ideal way to use his skills in engineering and satisfy his desire to make worthwhile contributions to the lives of others.

Dr. Compere, with his strong involvement with the Veterans Administration and the Army, became acquainted with Grahn. When it came time for Grahn's discharge, Dr. Compere asked if he would like to work at Northwestern University in Chicago. For Grahn, a native Chicagoan, assuming the position of project director/engineer in 1964 was another serendipity in his life — returning home and becoming involved in research in his chosen field.

"Our laboratory was located between the laundry room and the boiler room in the basement of the old Rehabilitation Institute of Chicago at 401 E. Ohio," Grahn notes. "We had a staff of six people including myself — Fred Hampton in prosthetics, Fred Sammons — who was an occupational therapist, Walter Horiuchi, our technician and Gus Weiskopf, our machinist, and Paula Hamilton, our secretary."

Grahn remained Director of the Prosthetics Research Laboratory until 1972, when changes on the national scene resulted in the funding for research from the Veterans Administration being augmented by funding from the new National Institute for Handicapped Research (NIHR), housed in the Department of Health, Education and Welfare. Grahn remains Associate Director of the Northwestern University Prosthetics Laboratory and Rehabilitation Engineering Research Center. During his career at Northwestern, he has been a part of remarkable changes in both the prosthetic-orthotic area and the emergence of assistive technology to aid people with disabilities other than amputation.

In the next issue of Capabilities, we will explore the history of the Rehabilitation Engineering Research Center, sponsored in 1972 by the agency that is now National Institute for Disability and Rehabilitation Research (NIDRR).

NUPOC — 40 years of Quality Education in Prosthetics and Orthotics

The Northwestern University Prosthetic-Orthotic Center (NUPOC) was the third prosthetic education program to be established in the nation. Following the meeting held at Northwestern University's Thorne Hall in 1945 to encourage advancements in prosthetics and orthotics, prosthetics education programs were funded by the Veterans Administration at University of California at Los Angeles (1952) and New York University (1956). NUPOC was funded by the Vocational Rehabilitation Administration (VRA) in 1958 to serve the center of the country. The roots of NUPOC were programs established by Dr. Clinton Compere when he worked with Dr. Paul Magnuson in the early stages of the Rehabilitation Institute of Chicago (RIC).

Over the past 39 years, many people have contributed to the growth and excellence of the educational programs. In writing this story, we have had the great fortune of having conversations with many of those people.

H. Blair Hanger (center) was recruited by Dr. Clinton Compere to serve as Director of Prosthetic Education in 1959. Hanger served until 1977.

Charles Fryer played a significant role in the development of the school and provided much of its history for this article. Fryer spent 26 years at NUPOC between 1962 — four years after the founding date — and 1988. Prior to coming to Northwestern, he had taught at both the New York University and the UCLA schools. After earning his Bachelor's degree in biology from NYU and his Master's degree in physical therapy, Fryer became Director of Physical Therapy at the Hospital for Joint Diseases in Manhattan. He was invited to give lectures in anatomy and biomechanics for physicians attending New York University (NYU) so frequently that he joined the faculty, where he taught for five years. He then accepted an invitation to lecture at the prosthetics school at the University of California at Los Angeles (UCLA).

Fryer recalled that the original programs for research and education in prosthetics were joint effort between several departments or colleges in the universities where they were established. At the University of California at Berkeley, Vern Inman, MD, from the Department of Orthopaedic Surgery, shared the direction of the program with Charles Radcliffe and Howard Eberhardt, of the Department of Mechanical Engineering. At UCLA, Charles Bechtol, MD, an Orthopaedic Surgeon, and Miles Anderson, a PhD in Education, directed the program. NYU was organized by Walter Thompson, MD, Chairman of Orthopaedic Surgery in cooperation with the College of Engineering department and the College of Education. Sidney Fishman, Ph.D., a psychologist with much experience in evaluation of prosthetic devices directed the NYU program.

According to Fryer, when the Vocational Rehabilitation Administration (VRA) provided Northwestern University with the initial funding to establish a prosthetics education program, Clinton Compere, MD, worked with **Warren Perry**, a PhD in psychology to develop the course work and structure of NUPOC. Shortly after NUPOC was launched, Dr. Perry was offered a position in the Department of Health, Education and Welfare in Washington, DC. He introduced Dr. Compere to **Jack Armold,** who had recently earned his PhD from Northwestern. Dr. Armold accepted the position of Director of NUPOC in 1962 and served in that position until 1968 when he was offered a position in Washington and Fryer was named Director.

The Northwestern P & O school grew rapidly in the early days

The school quickly grew both in number of students attending and number of courses offered. As illustrated by a letter dated July 1958 to **H. Blair Hanger** from Dr. Clinton Compere, faculty were recruited from across the country. Hanger, then in his early 40's, had extensive experience in prosthetics. As a member of the family that founded the J.E. Hanger Company shortly after the Civil War, he had been involved in prosthetics for his entire life. Not only had Hanger managed the New York office of J.E. Hanger, he had lectured about prosthetics at Temple University and Kessler Institute.

Compere's letter offered Hanger "the more relaxed pace of Northwestern" and in late spring of 1959, Hanger joined the Prosthetic Education program as Chief Prosthetist and Associate Director of the school. Hanger served as Director of Prosthetics Education until his retirement in 1977.

In 1977, when Hanger retired, he was followed as Director of Prosthetics Education by **Gunter Gehl**, who had joined NUPOC in 1966. Born in Neumunster, Germany, Gehl received a four-year degree from a trade school in Hamburg,

Continued on page 6

Five Decades of Education and Research

Continued

Germany, before attending New York University and Northwestern University to study advanced courses in prosthetics. He worked as a prosthetist in both Germany and the United States before joining Northwestern as an instructor at NUPOC. He became Director of Prosthetic Education in 1977, a post in which he served until his retirement in 1992.

Gehl echoed Charles Fryer's enthusiasm for the work at NUPOC. "We were a happy family," Gehl said. "I'm prejudiced, but I don't think there was ever a better teaching team than Blair Hanger, Fred Hampton and Gunter Gehl."

Like Fryer, Gehl indicated that teaching was exhilarating because so many developments were happening in prosthetics in the 1960s and '70s. Fryer noted that there had been little or no development in prostheses from the Civil War until, in the decade of the 1950's, plastics replaced wood as the predominant material from which prostheses were fabricated. New styles of prostheses such as the Patella-Tendon-Bearing (PTB) prostheses and quadrilateral socket developed by Radcliffe and others at the University of California at Berkeley, were being introduced. The change in materials and styles of prostheses meant that all fitting and fabrication techniques had to be redeveloped — and taught to the students at NUPOC.

In a short time, both the number of courses offered and attendees increased to the point that another location for classes had to be added. Courses for doctors were still held at 401 E. Ohio, but the orthotic and prosthetic students and the teaching laboratories were moved to 461 E. Ohio.

Northwestern gave orthotics equal status with prosthetics

Although some courses had been taught in orthotics at some other schools, Northwestern was the first to institute courses in orthotics parallel to those in prosthetics. Comprehensive courses in lower limb orthoses, upper limb orthoses and spinal orthoses were offered for doctors and orthotists. **Jim Russ** received his training in orthotics at the polio treatment center at Warm Springs, Georgia, and gained extensive experience during the polio epidemics of the 1950s. In 1967, Russ brought this experience to NUPOC when he became the Director of Orthotic Education, serving until 1992.

Charles Fryer claims he spent 70% of his time engaging in his chief interest of teaching. When asked how the Director of NUPOC could find the time needed to do that, he replied that he had a strong support team. "Gunter Gehl called all the shots on prosthetics courses, Jim Russ handled orthotic courses and May Cotterman organized all the courses for physicians and therapists."

May Cotterman, accepted a position as an instructor at NUPOC in 1970. Cotterman had worked as a physical therapist under the direction of Hildegarde Myers after joining the Physical Therapy staff of the Rehabilitation Institute of Chicago (RIC) in 1961. The students studying prosthetics had long had the opportunity to practice fit prostheses to actual users, but Cotterman helped to recruit clients who used various orthoses to introduce demonstrators in orthotics classes. She also worked closely with Gunther Gehl and Jim Russ to refine the courses as needed by those who came to NUPOC for education. For example, courses offered to physicians and therapists were three, one-week long sessions in upper limb and lower limb prosthetics, and upper, lower and spinal orthoses.

"The physicians had trouble finding time to attend two separate courses, so we combined upper and lower limb prosthetics and orthotics for upper and lower limbs and spine into a one-week course," Cotterman recalls. It was during this period that she also helped develop a course manual for physical therapy students and pedorthists and initiated changes in the critique forms and schedules for physician and therapist courses to assure that those courses evolved in response to needs and demands.

Prerequisites for entry into certificate programs for orthotists and prosthetists became more stringent. Students were required to have earned a bachelor's level degree, where formerly they were accepted if they had earned a degree at the associate level. To be eligible for admission, students must also have completed certain required courses in college, such as anatomy and other biological sciences.

NUPOC students enjoyed highly advanced education practices implemented by the Northwestern team. For one thing, each student worked with an individual patient to learn about residual limbs, sockets, harnesses, prostheses, orthoses

and, most of all, working with the person. For 24 years — from 1960 to 1984 — **Eleanor Manikowski** recruited and "mothered" people who worked as class demonstrators.

Ms. Manikowski recalls she joined the program in "1959 or '60 — I'm not quite sure because I was working at RIC when I moved upstairs to the NUPOC program". She had learned much about prosthetics when she ran the office for the J.F. Rowley Company, a prosthetic-orthotic "shop" located between the Northwestern and Union train stations on the west side of Chicago's Loop. "Gunter Gehl was my personal prosthetist," Ms. Manikowski told us. "I didn't go through rehab when I lost my leg. I was just fitted with a prosthesis." Although she liked the job she took in the RIC billing office after Rowley merged with another prosthetics firm, she missed the contact with patients, doctors and prosthetists. When her friend Betty Martell, physical therapist and registered nurse, announced that she was leaving her job as coordinator of patient demonstrators, Ms. Manikowski asked her supervisor to be allowed to leave RIC and take a position with NUPOC.

NUPOC moves to the new Rehabilitation Institute of Chicago

Fryer noted that, in the early days of NUPOC, funding was from grants and other government monies including the Veterans Administration. He could foresee that this source of funding could make the status of the young program tenuous at times. Indeed, Gehl related memories of the time when the NUPOC staff went on vacation knowing the program had no money and doubtful that it would open in the fall. "The VA bailed us out," Gehl explained.

Fryer continued, "My objective during my tenure was to make NUPOC independent — to generate our own income to run our own program." As part of this strategy, prior to the opening of the new RIC building at 345 E. Superior, he had proposed that Northwestern consider purchasing one of the very reasonably-priced buildings near 401 E. Ohio to be used not only for NUPOC, but for other Northwestern programs such as the School of Physical Therapy. He also proposed that the University consider establishing clinical services that would generate income to support the educational programs.

NUPOC moved on to the 17th floor of 345 E. Superior in the fall of 1974. Gunter Gehl recalls that the entire school — laboratories, class equipment and everything — was moved in one weekend. The moving crew was Gehl and his fellow NUPOC faculty members Blair Hanger and Charles Fryer. "I remember sitting in the middle of the floor putting together some of the lab equipment when a visitor came to see how the move was going. It was Casper Weinberger, who was then Secretary of Health, Education and Welfare. He seemed impressed by our 'shirtsleeves' approach." As the rehabilitation programs developed, RIC established their prosthetic and orthotic clinical services on one third of the 17th floor, which provided NUPOC a close proximity to a clinical practice.

In 1988, Charles Fryer retired. When Interim Director, Michael Brncick felt that he could not do justice to both NUPOC and his private practice, **Dudley S. Childress,** PhD, was appointed the Executive Director. Director of Prosthetics Education is **Mark Edwards**, CP and **Bryan Malas**, CO directs Orthotics Education. H. Blair Hanger has retired to North Carolina. Charles Fryer, Gunter Gehl, Jim Russ and Eleanor Manikowski continue to make Chicago their home in their retirement years. May Cotterman continues to work at NUPOC.

For nearly 40 years, NUPOC has been a significant factor in expanding and elevating the quality of prosthetic and orthotic service to people with amputations and physical conditions requiring orthoses. Several thousand prosthetists, orthotists, doctors, therapists and pedorthists and others proudly claim that they trained at NUPOC and that — in addition to the technical knowledge they gained — the faculty gave them something else. NUPOC alumni refer to commitment to excellence, understanding and care for the client and desire to solve the most difficult problems. No matter how they define the intangible benefits from their time at NUPOC, alumni agree on one thing — the faculty was a major influence on their lives. ❖

In the next issue, the history of the Rehabilitation Engineering Research Program will be told.

Special thanks to Mrs. Dolores Carrizosa, NUPOC Administrative Assistant, for combing NUPOC files for facts.

NUPRL&RERP, NUPOC faculty and staff present at meetings in Germany

Three members of the NUPRL&RERP staff shared results of their research conducted in the application of computer technology to prosthetics and orthotics with colleagues from many nations at the International Symposium, CAD/CAM Systems in Pedorthics, Prosthetics & Orthotics held May 4 and 5 in Nuremberg, Germany. The meeting was supported in part by the Otto Bock Foundation and organized by Prof. Dr. Ing. U. Boenick, of the Technical University of Berlin. Keith Oslakovic, MS discussed analyzing various aspects of socket design and interfacing with the human body using finite element analysis. Joshua Rolock, PhD, reported research results in the development, evaluation and use of a computer-aided manufacturing technique based on rapid prototyping principles. This process has been named Squirt Shape by the Northwestern staff and has drawn interest from commercial manufacturers of prosthetic components.

Dudley S. Childress, who was co-moderator of the meeting, concluded the event with an overview presentation titled, "Future Possibilities of CAD/CAM in Pedorthics, Prosthetics and Orthotics".

Thomas Karolewski, CP, NUPOC instructor, was an invited speaker at the 1997 World Congress for Orthopadie Rehab-Technik held in Nuremberg, May 6-9. He presented one paper on establishing parameters for ischial containment socket designs and another on clinical indications for body-powered prostheses. On May 5, Karolewski held a day-long workshop at the Bunde-sfachschule fur Orthopadie Technik in Dortmund, Germany. His report of that workshop is on page 9.

Childress is Featured at Special Seminars

Dudley S. Childress, PhD was a featured speaker at two seminars held in April. He addressed Northwestern University alumni at the NU Seminar Day held April 19 at the Norris University Center in Evanston, Illinois. In his presentation titled "Assisting and Replacing Human Limbs: Human Performance and the Biomechanics of Ability and Disability", Childress traced biomechanics in movement science, walking and prosthetics from the Renaissance to Dr. Paul Klopsteg's work on artificial limbs at Northwestern University. Dr. Klopsteg's work is generally regarded to have marked the inception of prosthetics work at Northwestern.

At the seminar, "Assistive Technology: Issues in Prosthetics and Orthotics", held April 24 in Charlottesville, Virginia, Childress' topic was "Directions for Advancements in Limb Prosthetics: A Personal View". The seminar was sponsored by the University of Virginia Department of Physical Medicine and Rehabilitation and the Virginia Rehabilitation Technology Training Project. The seminar was also supported by the National Institute of Disability and Rehabilitation Research (NIDRR).

Stephanie Michaud Receives an MS in Biomedical Engineering

Completion of the research project in pelvic obliquity in transtibial and transfemoral amputees has fulfilled all requirements and earned Stephanie Michaud a Master's Degree in Biomedical Engineering from Northwestern University. Ms. Michaud will leave the Northwestern campus for the campus of the NIKE Corporation near Portland, Oregon where she has accepted the position of research engineer with the manufacturer of athletic shoes. Among the areas she will study for NIKE are shock absorption and foot/shoe interfacing.

NUPOC Staff Continues Lecture Schedule

Bryan Malas, CO, presented lectures "Spinal Components and Biomechanics" and "Orthotic Considerations for the Pediatric Population" to the Northwestern University Physical Therapy School students during May. He presented the topics of "Foot Orthoses" and "Components and Biomechanics for AFOs, KAFOs and HKAFOs" to the NU Medical School residents in Physical Medicine and Rehabilitation in May. In April, Malas lectured to the Northern California Chapter of the American Academy of Orthotists and Prosthetists in Monterey, California.

Mark Edwards, CP, presented the topic "Establishing Parameters for Ischial Containment Socket Shapes" to the Oklahoma Association of Orthotists and Prosthetists in Oklahoma City in April. May Cotterman, MS, LPT, discussed "Pre-Prosthetic Management: Shaping and Shrinking" with members of the UnLIMBited Potential Group. This amputee support group organized at the Rehabilitation Institute of Chicago, met May 17. ❖

Instructor exchange between P & O schools in the U.S. and other countries promises benefits

By Thomas Karolewski, CP
Instructor, NUPOC

In May of this year, I was invited to the Bundesfachschule in Dortmund, Germany to teach a one-day seminar on upper limb body power including components, work sources, harnessing techniques and trouble shooting.

In the United States, the trend in orthotics and prosthetics education seems to have shifted more towards didactic learning with reduced emphasis on technical skills. Such is not the case in Germany, where patient care and technical skills are important parts of the curriculum.

The Bundesfachschule is the federal school for orthopaedic technique in Germany. The locals abbreviate the name to Bufa. In order to enter the Bufa, the student must have earned a bachelors degree and have three years of documented experience. The one year program includes both orthotics and prosthetics with 1,000 hours of lectures and 900 hours of practical training.

In Germany, the emphasis is clearly on the technical skills coupled with didactic learning. Once a student enters the Bufa, he or she is tested on every aspect of technical skills during each section. Professor Detlef Kokogei showed corsets the orthotic students were making. If the instructor is unhappy with the stitching of the corset, the student must start over. Sewing is no longer a part of the curriculum in the United States. German students still learn to carve wood sockets in their courses in transfemoral prosthetics. My hosts at Bufa told me that 50 percent of the transfemoral amputees in Germany still wear wood sockets.

Although craft work that is no longer taught in the U.S. is still a major part of the German schooling, not all of the curriculum is dedicated to craft work. The Bufa also has an impressive curriculum in CAD/CAM and laminating with modern resins and fabrics.

When a student is ready to graduate from the Bufa, he must pass a series of written and oral exams which are more difficult than those in the meister exams given by the German federal government. The student must pass the Bufa exam if they are to receive their certificate. Bufa is extremely strict about maintaining the highest level of quality in their graduates.

When I gave my lectures, I found out quickly that German ideas about harnessing transhumeral amputees differed from ours as much as their theories of training. I assumed that every school taught figure eight harnessing principles. When I received many questions about the cabling and number of straps in the figure eight harness, I realized that the Germans learn the Otto Bock harnessing, which uses a different approach to transhumeral harnessing. The practitioners and faculty attending the lecture discussed the comparative merits of the Otto Bock and the harnessing I described. I realized how different our practice was when the patient model laughed at the thought of wearing a prosthesis with the figure of eight harnessing with dual controls.

I realized how much opinions differed when the patient model laughed at the thought of a figure of eight harness

Once the seminar reached the troubleshooting phase, the audience was more receptive and I realized that the students had not had experience in solving problems involving force versus excursion. Then I explained that the figure of eight technique was not intended to replace the Otto Bock system, but, rather an alternative to make the practitioner more versatile in problem solving.

To me, the success of the seminar was that, not only did the students learn about different approaches, but my curiosity was piqued about upper limb harnessing in Germany. I feel that more exchange programs between schools in the United States and Germany would be an exceptionally effective way to bridge the gap of theoretical differences. Practitioners from both countries would have broadened experience. ❖

Studying Ambulation...

Continued

phase knee flexion on the vertical displacement of the body. Pelvic obliquity and stance-phase knee flexion were measured in three adult male subjects, of approximately the same age, weight and height, who were considered to be normal ambulators. From this data, the effect of these two movements on the trunk's vertical displacement were calculated. Childress and Gard recently presented preliminary findings of these studies to the North American Society of Gait and Clinical Movement Analysis 1997 Conference and in a paper published in *Gait and Posture*, Vol. 5, No. 3, 1997. Their report challenged the commonly held theory that stance phase knee flexion and pelvic obliquity reduce vertical movement of the body during walking. Data presented showed that pelvic obliquity and stance-phase knee flexion peak early in the swing phase — almost at toe off — and contribute very little to the trunk's vertical position after 25% of the stride cycle.

Sharing Study Results

Abstracts of the North American Society of Gait and Clinical Movement Analysis 1997 meeting, published in *Gait and Posture,* 5 (2), illustrate ongoing dissemination.

Chan, R.C., Jhoun, J.H., and Childress, D.S. (1997) A Simple Equation describing Standing Balance.

Gard, S.A., Childress, D.S., and Knox, E.H. (1997) How Two-Dimensional Representations of Three-Dimensional Human Movement can be misleading.

Jhoun, J.H. and Childress, D.S. (1997) Pelvic Obliquity during Gait Initiation.

Weir, R.F. ff., Childress, D.S., and Licameli, J.N. (1997) A Low Cost Direct Ultrasound Ranging System for the Analysis of Gait.

The knowledge gained in the study of pelvic obliquity was augmented in an investigation by Stephanie Michaud, MS, who studied pelvic obliquity in unilateral transtibial and transfemoral amputees. The results showed that the magnitude of pelvic obliquity decreased with higher amputation levels. Some of the amputees exhibited an obliquity pattern in which the hip on the prosthetic side was raised above the stance-side hip during prosthetic swing, indicating hip hiking. The transfemoral amputees also exhibited this hip-hiking pattern during sound-limb swing. Results from this project suggest that a normal pattern of pelvic obliquity may possibly be restored in amputees through new socket/prosthesis designs and training techniques. By restoring pelvic obliquity, amputees may be able to take better advantage of the natural dynamics of the locomotor mechanism, which could improve gait, reduce shock and decrease energy expenditure for people with lower limb amputations.

Another study, being conducted by Laura Miller, a PhD candidate, draws upon the knowledge of characteristics of ambulation developed at Northwestern is an investigation of crutch ambulation. Crutches have been used since the earliest days of civilization, as indicated by ancient artistic depictions of man. These drawings show hunters using tree branches as crutches while they pursue game. However, other than some rather cosmetic or manufacturing changes, the form of the crutch has changed little.

Research projects and clinical observation confirm that long-term use of crutches frequently results in structural damage to wrists, elbows and shoulders of the users. In addition, crutch users tend to walk slower, with shorter steps, and experience higher ground reaction forces and larger energy expenditures than normal ambulators. Research conducted by Miller will use data from Northwestern studies of the mechanisms of normal ambulation as a basis for analyzing how aspects of crutch design influence ambulation.

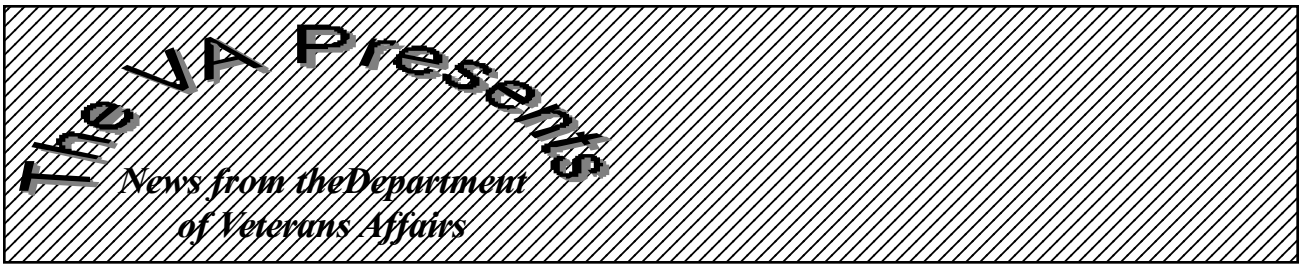
Prior studies of crutch ambulation exist in the form of clinical evaluations of different commercial designs or investigations of gait techniques using standard crutches. Our work acknowledges these studies but proposes to test theories of the principles of bipedal locomotion. Other portions of the crutch studies will investigate the effect of how rocker bases for crutches, springs for shock absorption and energy storage, and changes in the suspension system affect the user's ambulation characteristics.

Studying components of lower limb prostheses

Vertical compliance has been recently added to prostheses for transtibial and transfemoral amputees through the use of specially designed pylons. A Northwestern University study that investigated how the Flex-Foot Re-Flex Vertical Shock Pylon (VSP) contributed to the gait of a person with an amputation were reported by Laura Miller, MS, and Dudley S. Childress, PhD in the *Journal of Rehabilitation Research and Development,* Volume 34, No. 1, January 1997.

This article discusses the results of a study comparing the ground reaction forces, vertical trunk movement, event timing, and pylon compression when the subject walked with the Re-Flex VSP™ Foot to when they walked without the VSP. These gait parameters were studied dur-

Continued next page



We are proud announce that a new section devoted to the Department of Veterans Affairs (VA) has been established in *Capabilities*. If you are part of the Department of Veterans Affairs or a veteran, please share your news about–

- legislation
- success stories of veterans with amputations
- results of studies you've conducted
- new assistive technologies being used
- procedures being conducted

The sharing of information can help others in caring for this select group of persons with disabilities. Please send your stories to: **Mr. Robert M. Baum, Chief, Prosthetic & Sensory Aids Service, VA Chicago Health Care System – Lakeside Division, 333 East Huron Street, Chicago, IL 60611**. You may FAX them to: **312/640-2247** or send via e-mail to **Baum. Robert_M @ Forum. VA.Gov**

Attention Veterans
New Prosthetic Eligibility
Public Law 103-262

The Veterans Health Care Eligibility Reform Act of 1996 has significantly simplified the elegibility criteria for providing prosthetic services. Veterans now eligible are:

- service-connected veterans seeking care for a service-connected disability;
- veterans with compensable service-connected disabilities rated 10% or more;
- former prisoners of war, veterans discharged or released from active military service for a compensable disability that was incurred or aggravated in the line of duty, and veterans who are in receipt of Section 1511 benefits;
- veterans who are in receipt of increased pensions based on the need of regular aid and attendance or by reason of being permanently house bound;
- veterans who have annual income and net worth below the "means test" threshold;
- veterans who must pay a copayment for their care; and
- all other veterans who are not required to pay a copayment for their care.

The provision of sensory-neural aids: Needed eyeglasses and hearing aids will be provided to veterans who qualify under the first four provisions mentioned above. Eyeglasses and hearing aids will be provided to all other veterans – as mentioned in the last three provisions – if the visual or hearing impairment is a direct result of the primary medical diagnosis and /or treatment for which the veteran is receiving VA care. ❖

Studying Ambulation

Continued

ing walking, jogging in place and curb descent. The Department of Veterans Affairs has recently funded studies on two additional models of vertical shock pylons, the Ohio Willow Wood Stratus Impact Reducing Pylon and the Seattle Limb System AirStance Pylon.

Other Northwestern University projects have contributed to the basic knowledge of ambulation and aided ambulation. The July 1995 issue of *Capabilities* reported the results of research into the role of dynamic response feet conducted by Erick Knox, PhD and Laura Miller under the direction of Dr. Childress.

Computer technology has enabled the Northwestern research team to investigate new methods of analyzing factors which affect gait. In the January 1996 issue of *Capabilities*, an overview of studying the interfacing of the residual limb and the socket using finite element analysis was presented by John Steege and Keith Oslakovic. The April 1997 issue featured work done on development of a Direct Ultrasound Ranging System to measure gait.

Future issues of *Capabilities* will carry articles further discussing Northwestern University studies in areas including gait analysis, finite element analysis and other aspects of ambulation. ❖

Capabilities
ISSN 1055-7156
Northwestern University Prosthetics Research Laboratory
and Rehabilitation Engineering Research Program
345 E. Superior Street, Room 1441
Chicago, IL 60611-4496

Phone Help Line: 312/908-6524
E-mail: reiu@nwu.edu
web site =>http://www.repoc.nwu.edu/

Non-Profit
U.S. Postage
PAID
Northwestern
University

Address Correction Requested

Resource Unit Information Request

All information is free. *Check off what you need and mail this coupon back to*:
345 E. Superior St., Room 1441
Chicago, IL 60611 USA

Allow two to three weeks for delivery

- ❒ Send me more information on lab activities.
- ❒ Start my subscription to *Capabilities.*
- ❒ Send me one copy of *P&O Resource Directory*.
- ❒ Send me the information packets checked below.

Information Packets (limit - one copy of each item)

- ❒ Quick Info Sheet: Funding Ideas for Prosthetic-Orthotic Devices
- ❒ ADA List of Publications
- ❒ Above Knee Prosthetics
- ❒ Amputation
- ❒ Braces & Crutches
- ❒ Below Knee Prosthetics
- ❒ Children's P & O
- ❒ Choosing a Prosthetist
- ❒ Congenital Conditions Book List
- ❒ Feet
- ❒ Gait
- ❒ Hands
- ❒ Hip Disarticulation/Hemipelvectomy
- ❒ Lower Limb Prosthetics (general)
- ❒ Lower Limb Orthotics (general)
- ❒ Myoelectric Packet
- ❒ Publications for the New Amputee
- ❒ O & P School
- ❒ Orthotics (general)
- ❒ Pain and Phantom Pain
- ❒ Prosthetics (general)
- ❒ Sockets
- ❒ Sports/Recreation
- ❒ P & O Statistics
- ❒ Support Groups
- ❒ Symes
- ❒ Upper Limb O & P
- ❒ Video List
- ❒ What is P & O ?

Name_____

Address_____

_____