VA Center of Excellence for Limb Loss Prevention and Prosthetic Engineering

The mission of the Center is to provide broad based investigators the opportunity to conduct basic and clinical research and effectively disseminate their findings in an effort to impact the quality of life and functional status of veteran amputees and veterans who are at risk for amputation.

Back Row (L to R): William Ledoux, Joseph Czerniecki, Bruce Sangeorzan, Mathieu Assal, and Chimba Mkandawire
Front Row(L to R): Eric Rohr, Randy Ching, Glenn Klute, Tonja Hagen, Janice Pecoraro, and Jocelyn Berge

The Center has the following objectives:

1. Establish a community of clinical and basic scientists to pursue research objectives in the area of amputation prevention and prosthetic engineering.
2. Create an effective program for prevention of limb loss by developing a better basic understanding of the deformities that lead to ulceration, the role of prophylactic correction of deformity, and the role of protective footwear.
3. Improve prosthetic design by comparing suspension systems, measuring the effect of impact absorbing prosthetic shanks in below knee (BK) prostheses, and investigating the development of a powered prosthesis.
4. Develop more effective outcomes tools to assess the benefits of salvage vs. amputation and the quality of life of the amputee.

VA Center of Excellence for Limb Loss Prevention and Prosthetic Engineering
VA Puget Sound
1660 S. Columbian Way
Mailstop 151
Seattle, WA 98108

206.764.2991
UW Box 358280 (151)
tonja.hagen@med.va.gov
http://rehabctr.vamc.washington.edu/

Bruce J. Sangeorzan, MD[1]
Director
bsangeor@u.washington.edu

Joseph M. Czerniecki, MD[2]
Associate Director
Joseph.Czerniecki@med.va.gov

BIOMECHANICS RELATED RESEARCH PROJECTS

Amputation Prevention:

<u>Effect of Motor Imbalance on Bony Deformity and Plantar Pressure in the Foot</u>[1,3,5,7]

To better understand the relationship between the structure of the foot and the function of the foot, we are studying subjects with flat feet (pes planus), high arched feet (pes cavus), and neutrally aligned feet. Radiographic, computerized tomographic (CT) and gait analysis measurements will be performed to obtain structural and functional parameter for each subject. As the shape of the foot determines its function, understanding the differences between foot types can proved insight into clinical treatments such as shoe fabrication and surgical reconstruction.

<u>A Computational Model of the Human Foot</u>[1,3,5,7,15]

To more efficiently study the biomechanical phenomena underlying foot structure and function, our research team has undertaken the development of a 3-D, finite element model of the foot and ankle. The results of the simulation were preliminary validated using data from cadaveric experimentation. Future work will include modifying the material properties of the cartilage, ligaments and plantar soft tissue. Dynamic simulations of various pathological states will be conducted as well.

William R. Ledoux, Ph.D.[3]
Research Scientist
wrledoux@u.washington.edu

Glenn K. Klute, Ph.D.[4]
Research Scientist
gklute@u.washington.edu

Eric S. Rohr, MS[5]
Research Engineer
Eric.Rohr@med.va.gov

Mathieu Assal, MD[6]
Research Fellow
familleassal@hotmail.com

Randal P. Ching, Ph.D.[7]
Affiliate Investigator
rc@u.washington.edu

Dan P. Ferris, Ph.D.[8]
Affiliate Investigator
dferris@u.washington.edu

Blake Hannaford, Ph.D.[9]
Affiliate Investigator
blake@u.washington.edu

Robert Price, MS[10]
Affiliate Research Scientist
pricer@u.washington.edu

Per G. Reinhall, Ph.D.[11]
Affiliate Investigator
reinhall@u.washington.edu

Allan F. Tencer, Ph.D.[12]
Affiliate Investigator
atencer@u.washington.edu

Eric Baker, BS[13]
MS Candidate
bakere@bsci.com

Jocelyn S. Berge, BS[14]
MSE Candidate
jberge@u.washington.edu

Chimba Mkandawire, BS[15]
Ph.D. Candidate
bluntme@u.washington.edu

Effect of Custom Orthoses on Hindfoot Kinematics of the Foot and Forefoot[1,5,7]
Pressure distribution data from flatfoot specimens is being used by researchers to determine if the constraint provided by orthoses alters the kinematics of the hindfoot to understand a potential cause of foot ulcers.

Equinus Contracture of the Ankle and its Relationship to Foot Plantar Pressures[1,2,3,5,6,10]
We are evaluating whether or not there is a relationship between equinus contracture and foot plantar pressures in three groups of patients: subjects without equinus contracture, subjects with diagnosed contracture, and diabetics with history of plantar ulcers.

A System for Real Time Plantar Pressure Adjustment[1,2,3,4,13]
Our research group will develop an orthotic insert that can be formed dynamically using measurements of the pressure distribution on the plantar surface of the foot while the patient is standing in a normal upright posture.

Quasi-linear Viscoelastic Model of Foot & Ankle Ligaments[1,3,7,15]
We are generating a nonlinear mathematical representation of ligament mechanical behavior during stress relaxation experiments.

Hierarchical Cluster Analysis of Foot & Ankle Ligaments[1,3,7,15]
Our research team is blocking foot and ankle ligaments into mechanical-testing groups based on area and length properties.

Prosthetic Engineering:

Characterization of Shock Absorbing Pylons Used in Transtibial Prostheses[2,4,14]
Our research team will make use of mechanical and human subject testing to determine the performance of commercially available shock absorbing pylons to ultimately provide clinical pylon prescription guidelines.

Development of Lower Limb Powered Prostheses[2,4,9]
The development of an artificial musculo-tendon actuator that mimics the function of the triceps surae and Achilles tendon has been accomplished by researchers. This artificial musculo-tendon actuator will now be incorporated into a transtibial prosthesis and the effects upon amputees' gait will be studied.

An Ankle-Foot Orthosis Powered by Artificial Muscles[2,4,8,9]
We have designed a pneumatically-powered, myoelectrically controlled ankle-foot orthosis as a tool for rehabilitation and studying human locomotion adaptation.

Evaluation of Transtibial Prosthetic Foot Stiffness[2,4]
We will measure the stiffness profiles of commonly prescribed transtibial limbs and develop a second order, empirical model to describe the differences within and between limbs.

Variable Stiffness Transtibial Prosthesis[2,4]
Detailed knowledge of the measured properties of commonly prescribed transtibial limbs will be used by researchers to establish stiffness control laws (i.e. performance criteria) These control laws will be used to govern its real-time operation through the used of an existing digital signal processor, forced and position sensors, and muscle-like pneumatic actuators. This variable stiffness limb will then be used to explore how stiffness impacts the locomotion performance of the transtibial amputee.

Note: Numbered footnotes match researchers with their projects.