Capabilities

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Evaluating the Validity and Reliability of the Berg Balance Scale for Use on Individuals with Lower Limb Amputation

Matthew J. Major, PhD

Lower Limb Amputation and Falls

One in three older adults will fall at least once per year (Hausdorff, et al. 2001). Treatment costs for fall-related injuries in older adults in the U.S. health care system top $19 billion dollars in 2000 ((CDC) 2006); and by 2020 are projected to increase to $54.9 billion (in 2007 dollars) (Englander, et al. 1996). As in the aged population, falls also are a significant health hazard to individuals with lower limb amputation (LLA).

Figure 1: RERC Scholar Kyle Swensen, BS (left) demonstrating BBS task with rater Matty Major, PhD (right).

One study reported that more than half (52.4%) of community-dwelling individuals with unilateral LLA fall within one year. Of those individuals with unilateral LLA who fell, 75% fell more than once and 40% sustained a fall-related injury (Miller, et al. 2001b). Causes for falling in this population have been categorized in the literature as "intrinsic patient related," "prosthesis related," and "environmental" (Kulkarni, et al. 1996) and described as "limited ambulation," "loss of balance," and "body mechanics" (Pauley, et al. 2006). Interviews with lower limb prosthesis users conducted at the Northwestern University Prosthetics-Orthotics Center (NUPOC) have revealed that specific circumstances preceding a fall include tripping upstairs, slipping on a wet surface, prosthetic knee buckling, and walking unexpectedly onto an uneven surface.

Falls also possess relationships with psychological factors. About half (49.2%) of community-dwelling individuals with unilateral LLA report a fear of falling and 76% of these individuals deliberately avoid activities due to this fear. The combination of falls, reduced balance confidence, and fear of falling results in reduced participation in daily activity and quality of life (Kulkarni, et al. 1996; Miller, et al. 2001a; Miller, et al. 2001b; Norvell, et al. 2011). Clearly, falls pose a significant health hazard to individuals with LLA. The ability to maintain upright balance during standing minimizes fall risk (Quai, et al. 2005) and relates to walking performance (van Velzen, et al. 2006). Accurately and precisely measuring balance in individuals with LLA can help assess rehabilitation progress and identify individuals at a greater risk of falling.

Berg Balance Scale

The Berg Balance Scale (BBS) is a well-established clinical outcome measure that was originally developed to assess the balance of elderly individuals (Berg, et al. 1989) and has been validated for use on individuals with stroke, spinal cord injury, multiple sclerosis, brain injury, Huntington's disease, and Parkinson's disease.

The BBS is comprised of 14 performance tasks (Figure 1) to be completed in a set sequence (Table 1). Each performance task is scored from 0-4 based on the ability of the patient to complete the task successfully, with a maximum total score of 56. The BBS requires minimal, inexpensive equipment (chairs, stool, ruler, stop watch and a slipper) and only 20 minutes

1.	Sitting to standing
2.	Standing unsupported
3.	Sitting with back unsupported
4.	Standing to sitting
5.	Transfer between seats with and without arm-rests
6.	Standing unsupported with eyes closed
7.	Standing unsupported with feet together
8.	Reaching forward while standing
9.	Picking up an object from the floor
10.	Turning to look over left and right shoulders
11.	Turning 360°
12.	Alternately stepping up on a stool while unsupported
13.	Tandem standing while unsupported
14.	Standing on one leg

Table 1: Berg Balance Scale task sequence.

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to administer.

The BBS has demonstrated relationships with falls in older adults, and persons with stroke, multiple sclerosis, brain injury, Huntington's disease, and Parkinson's disease. Patients benefit from clinicians' ability to accurately identify increased fall risk and prescribe appropriate therapeutic interventions and monitoring.

Given its success as a clinical outcome measure in other patient groups, the BBS has the potential to serve as an appropriate and effective standardized instrument for assessing balance in individuals with LLA. Discussions with clinicians at the Rehabilitation Institute of Chicago (RIC) and NUPOC suggested that the BBS may be used to address the significant issue of falls faced by lower limb prosthesis users.

As a pilot study, RIC medical students administered the BBS to four individuals with LLA, all of whom successfully completed the BBS within 20 minutes. These initial data set the stage for researchers (Matthew Major, PhD; Stefania Fatone, PhD, BPO(Hons); and Elliot Roth, MD) to evaluate the validity and reliability of the BBS for assessing balance in individuals with LLA. Prior to advocating any clinical outcome measure, it is critical to establish its validity and reliability, as well as its utility when applied to a specific population (Portney and Watkins 2009).

Study Protocol and Data Analysis

Participants with unilateral or bilateral lower limb loss at or proximal to the ankle were recruited for this study. From the participants, we collected information on limb loss, frequency of prosthesis use, and fall history in the previous 12 months. In addition to completing the BBS twice (assessed by two different raters), participants also completed the Activities-specific Balance Confidence (ABC) Scale, Prosthesis Evaluation Questionnaire-Mobility Subscale (PEQ-MS), Frenchay Activities Index (FAI), BBS, L Test, and two-minute walk test (2mWT). Scores from these additional outcome measures were compared to the BBS to assess its validity.

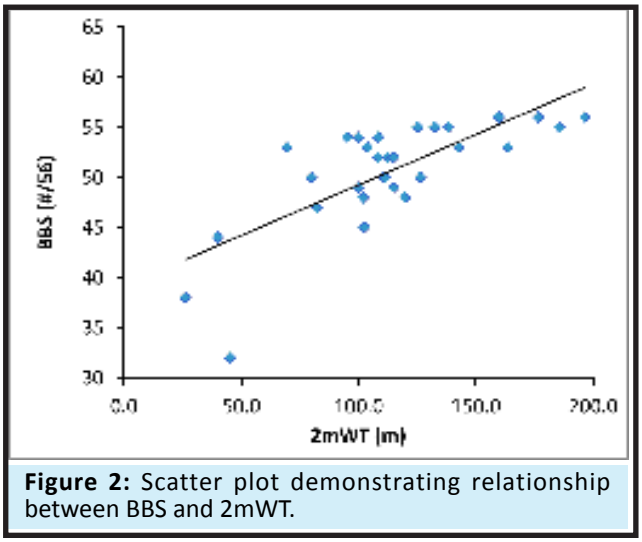

Figure 2: Scatter plot demonstrating relationship between BBS and 2mWT.

Study Results and Clinical Relevance

Thirty individuals with unilateral transtibial (n=13), unilateral transfemoral (n=14), or bilateral (n=3) LLA of dysvascular (n=7), traumatic (n=14), infectious (n=6), or congenital (n=3) origin participated in the study. The average BBS score was 51±5 and all participants completed the BBS within 20 minutes. All other outcome measures demonstrated good relationships with the BBS (Figure 2), thereby validating the BBS as an instrument for assessing balance in individuals with LLA. Additionally, a high level of absolute agreement was observed between the scores of the two raters across all participants (Figure 3), suggesting excellent inter-rater reliability.

The results from this study also revealed that participants experienced the greatest difficulty performing tasks 8 (reaching forward), 11 (turning 360°), 13 (tandem standing), and 14 (standing on one leg). Most likely this was a result of the limited range-of-motion and passive nature of lower limb prostheses. For example, limited frontal plane foot motion may have prohibited the foot eversion required during tandem standing, whilst difficulty in controlling passive prosthetic motion may have limited sustained forward

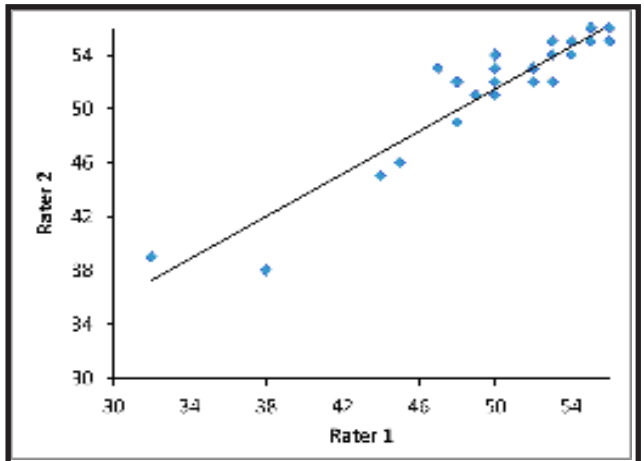

Figure 3: Scatter plot demonstrating relationship between scores of Rater 1 and 2.

reaching and 360° turning. Notably, even though all unilateral amputees elected to stand on their sound leg whilst standing on one leg, 40% of all subjects could not stand for more than 10 seconds. As single limb stance is commonly performed during activities of daily living, this emphasizes an important balance impairment that may negatively affect safe ambulation. Consequently, it

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may be to the patient's benefit if rehabilitation therapy included targeted training to improve single limb stance ability.

In summary, these results suggest that the BBS is a meaningful and appropriate clinical instrument for assessing balance in lower limb prosthesis users. The BBS appears useful in exposing the challenges to balance that individuals with LLA face due to constraints in prosthetic design. Further studies are recommended to explore the responsiveness of the BBS, particularly regarding its ability to assess the effectiveness of therapeutic interventions and prosthetic componentry for improving upright balance, and to refine items further for individuals with LLA.

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Quai, T. M., S. G. Brauer, and J. C. Nitz. 2005 Somatosensation, circulation and stance balance in elderly dysvascular transtibial amputees. Clinical Rehabilitation 19(6):668-76.

van Velzen, J. M., et al. 2006 Physical capacity and walking ability after lower limb amputation: a systematic review. Clinical Rehabilitation 20(11):999-1016.

An extended manuscript about this research has been submitted and is in review at the *Archives of Physical Medicine and Rehabilitation*.

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Subscription is free to all individuals and institutions interested in prosthetics and orthotics. Issues are archived on the NUPOC website, **www.nupoc.northwestern.edu**. Send subscription requests and address changes to: *Capabilities*, Northwestern University RERC, 680 North Lake Shore Drive, Suite 1100, Chicago, IL 60611.

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Zissimopoulos Defends Dissertation

Angelika (Kiki) Zissimopoulos, PhD

On May 29, 2013 in partial ful-fillment of a doctorate in Biomedical Engineering at Northwestern University, **Angelika (Kiki) Zissimopoulos**, PhD, successfully defended her doctoral dissertation, "An Investigation of Mediolateral Foot Placement during Post-Stroke Gait".

She conducted her work under the direction of her academic advisor, **Steven A. Gard**, PhD.

Congratulations, Dr. Zissimopoulos!

NURERC Hosts 2013 NURERC Scholar Kyle Swensen

R. J. Garrick, PhD

The Northwestern University Rehabilitation Engineering Research Center (NURERC) welcomes **Kyle Swensen**, BS, as the 2013 NURERC Scholar. NURERC established the Scholars Program during the 1998-2003 NIDRR-funded grant cycle and modeled it after the NIDRR Scholars Program that was discontinued. Annually, NURERC designates a portion of its RERC funds to host a NURERC Scholar with a physical disability. NURERC actively recruits candidates, enables them to become involved in rehabilitation research projects at NURERC, and encourages them to pursue career work in rehabilitation research. To date, NURERC has funded seven NURERC Scholars with a physical disability

Kyle Swensen, BS

Kyle has a transtibial amputation due to a traumatic accident. As the 2013 NURERC Scholar, Kyle will be mentored by **Stefania Fatone**, PhD, BPO(Hons) as he works on several NIDRR-funded projects, including preparation of an in-depth literature review and contribution to an invited, published article about prosthetic outcome measures. Kyle completed his Bachelor of Science (2013) in Exercise Science with a concentration in Kinesiology at Brigham Young University. In June 2013, Kyle will join the inaugural class of the **Master's in Prosthetics & Orthotics (MPO) at the Northwestern University Prosthetics-Orthotics Center (NUPOC)**. His career goals are to become a clinical Prosthetist-Orthotist, conduct research, and improve evidence based practice in P&O.

See more about the NURERC Scholar Program at: www.nupoc.northwestern.edu/research/NIDRR_RERC/nu_rerc_scholars.html.

NUPOC Scholars Present Work at Landsberg Research Day

NUPOC researchers presented their work in the poster session at the 9th Annual Lewis Landsberg Research Day at the Northwestern Memorial Hospital Conference Center (Chicago Campus) on April 4, 2013.

Jose Zavaleta (right) discusses his research poster.

NUPOC presenters and their projects were: **Pranitha Gottipati**, PhD, *Reduction in Shock Absorption Capacity of the Spine during Gait after Spinal Reconstruction Surgery*; **Matthew Major**, PhD, *Upper Body Kinematics of Bilateral Transtibial Prosthesis Users During Gait;* **Jose Zavaleta**, MS, *Modular Prosthetic Ankle for Adapting to Slope Walking*; **Oluseeni Komolafe**, PhD, *Characterization of Mechanical and Electrical Vacuum Pumps for Use in Vacuum-Assisted Suspension*; and **Brian Robillard**, BS, *Design of a Process for Fabricating Prosthetic Sockets with Rapid Prototyping Technology*.

The Research Day program included keynote talks, Mentor of the Year awards, faculty awards for translational science, and research prizes.

NUPOC Researchers Present Posters at GCMAS Meeting

NUPOC research posters by **Pranitha Gottipati**, PhD; **Erin Boutwell**, MS; and **Kiki Zissimopoulos**, MS, were presented at the 2013 Gait and Clinical Movement Analysis Society (GCMAS) Conference on May 14-17, 2013 in Cincinnati, OH.

Pranitha Gottipati, PhD (left) and Erin Boutwell, MS (right) at GCMAS meeting.

In the section on Trunk and Upper Extremity, Dr. Gottipati presented *Reduction in Shock Absorption Capacity of the Spine during Gait after Spinal Reconstruction Surgery*, co-authored by S Fatone, R Stine, A Ganju. In the section on Posthetics/Orthotics/Assistive Devices, Ms. Boutwell presented *Effect of Prosthetic Stiffness on Impact Forces during Walking and Sudden Limb Loading*, co-authored by S Gard. In the section on Pathologic Motion, Ms. Stine presented *Effects of a Non-rigid AFO on ML Foot Placement during Post-stroke Locomotion*, co-authored by A Zissimopoulos, S Gard, S Fatone.

Boutwell Awarded OPERF Fellowship and NU Graduate Writing Fellowship

The Orthotic and Prosthetic Education and Research Foundation (OPERF) has awarded a 2013 OPERF Fellowship Award to **Erin Boutwell**, MS, for her doctoral research project, "How Prosthesis Stiffness Influences Impact Forces during *In Vivo* Impact and Level Walking". The award is made based on the quality of the submission and the recommendations of external peer review committees.

Erin Boutwell, MS, has been awarded OPERF and NU Writing Fellowships.

Ms. Boutwell is conducting this research in partial completion of her PhD in biomedical engineering at Northwestern University under the mentorship of **Steven A. Gard**, PhD.

Ms. Boutwell also has been awarded a Northwestern University Graduate Writing Fellowship. Doctoral candidates can compete for this award based on their *Curriculum Vitae*, a writing sample of 8,000 to 12,000 words that has been submitted to a peer reviewed journal, and a personal interview with faculty.

As a Graduate Writing Fellow, Ms. Boutwell will participate in training and mentoring with Writing Program faculty; teach student writers from a diverse range of backgrounds and disciplines; and become a recognized writing leader through the development and presentation of writing workshops.

NUPOC Welcomes Anne Thurber

R. J. Garrick, PhD

Anne Thurber, BA

Anne Thurber, BA, has joined NUPOC during the summer quarter and is conducting research under the mentorship of **Steven A. Gard**, PhD, and **Matty Major**, PhD. She is examining able-bodied gait characterization at multiple speeds and slopes. She expects to complete her Master's of Science degree in Biomedical Engineering at Northwestern University in 2013.

Anne hails from Maryland and Taiwan, where she spent her formative years and became bilingual in Mandarin. She said, "*From an early age, I knew I wanted to design and invent*." Growing up, she recognized that her father could lose a limb to diabetes. This experience engendered an acute awareness about the need to make accessible and affordable lower limb prostheses. As an undergraduate at Mt. Holyoke College (South Hadley, MA), she majored in Biological Engineering. She was eager to apply her knowledge but unable to decide between medicine and engineering. While considering her options, she spent a year teaching English in Fuzhou, Fujian, PRC. Ultimately, she set her course on biomedical engineering.

Ms. Thurber has been a research assistant for various projects, including developing electronic equipment to decrease noise in transmission of neural signals; planning smart temperature-sensitive hydrogels to control the absorption and release of drugs in biosensor devices; characterizing semiconductor wires using optical and scanning electron microscopes; and maintaining databases for Patient Safety & Quality at the Children's Hospital, Boston.

Considering her future, Ms. Thurber said, "*I'd like to work with innovation design and implementation in any field. Another possibility is to utilize my linguistic and engineering skills to conduct collaborative and applied work in Asia. Ideally, I would like to be a prosthetics engineer in an international setting where I can apply my knowledge and innovate.*"

She likes Chicago, "*It's an exciting city and there is always something interesting to do here.*" In her uncommon leisure time, she enjoys sailing on Lake Michigan. She also is a violinist who used to practice seven hours a day. She reflected, "*I still love music, but my heart is in science."* Welcome to NUPOC, Anne!

NUPOC NEWS

Publications

Major MJ, Stine RL, Gard SA. "The effects of walking speed and prosthetic ankle adapters on upper extremity dynamics and stability-related parameters in bilateral transtibial amputee gait." Accepted for publication, *Gait & Posture*.

Dillon M and **Fatone S.** (2013) Editorial Commentary: "Deliberations about the functional benefits and complications of partial foot amputation: do we pay heed to the purported benefits at the expense of minimizing complications?" *Archives of Physical Medicine and Rehabilitation*. PMID: 23583347.

Zissimopoulos A, Gard SA, Fatone S. "The Effect of Ankle-Foot Orthoses on Self- Reported Balance Confidence in Persons with Chronic Post-Stroke Hemiplegia." Accepted for publication, *Prosthetics & Orthotics International*.

Komolafe O, Wood S, **Caldwell R**, Hansen A, **Fatone S.** "Methods for Characterization of Mechanical and Electrical Prosthetic Vacuum Pumps." Accepted for publication, *Journal of Rehabilitation Research and Development*.

Hoskins R, Sutton E, Kinor D, Schaeffer J, **Fatone S**. "Using Vacuum Assisted Suspension to Manage Limb Wounds in Persons with Transtibial Amputation: A Case Series." Accepted for publication, *Prosthetics & Orthotics International*. PMID: 23685916.

Fatone S. Invited Commentary on "The swing phase of walking with above-knee prostheses by Dr. Eugene F. Murphy." Accepted for publication, *Journal of Rehabilitation Research and Development*.

Presentations

Fatone S. (2013) A new socket for persons with above knee amputations. Monthly Veterans Research Forum, Jesse Brown VA Medical Center, March 7, Chicago, IL.

Lynch D, **Fatone S,** Irwin M, Barua C, Young J. (2013) Working with the Northwestern Office of Sponsored Research (OSR). NUCATS Seminar Series on Navigating the Research Enterprise. Northwestern University, April 1, Chicago, IL.

Gottipati P, Fatone S, Stine R, Ganju A. (2013) Reduction in Shock Absorption Capacity of the Spine during Gait after Spinal Reconstruction Surgery (poster). Presented at the 9th Annual Lewis Landsberg Research Day, held April 4, Chicago, IL.

Komolafe O, **Fatone S, Wood S, Caldwell R,** Chen W, Sun C, Hansen A. "Characterization of Mechanical and Electrical Vacuum Pumps for Use in Vacuum-Assisted Suspension." Presented at the 9th Annual Lewis Landsberg Research Day, held April 4, Chicago, IL.

Major MJ, Stine R, Hodgson M, Gard SA. "Upper Body Kinematics of Bilateral Transtibial Prosthesis Users during Gait." Presented at the 9th Annual Lewis Landsberg Research Day, held April 4, Chicago, IL.

Robillard B, Komolafe O, Caldwell R, Fatone S. "Design of a Process for Fabricating Prosthetic Sockets with Rapid Prototyping Technology." Presented at the 9th Annual Lewis Landsberg Research Day, held April 4, Chicago, IL.

Zavaleta JL, Major MJ, Gard SA. "Modular Prosthetic Ankle for Adapting to Slope Walking." Presented at the 9th Annual Lewis Landsberg Research Day, held April 4, Chicago, IL.

Komolafe O, Caldwell R, Fatone S. (2013) An Analytic Approach to Assessing Transfemoral Socket Flexibility. Texas Association of Orthotists and Prosthetists Annual Meeting, April 19-20, Dallas, TX.

Major M, Fatone S, Roth E. (2013) Validation of the Berg Balance Scale for Individuals with Lower Limb Amputation. Texas Association of Orthotists and Prosthetists Annual Meeting, April 19-20, Dallas, TX.

Robillard B, Komolafe O, Caldwell R, Fatone S (2013) Design of a Process for Fabricating Prosthetic Sockets with Rapid Prototyping Technology (poster). InNUvations Applied Research Day, Northwestern University, May 2, Evanston, IL. Awarded 3rd prize.

Boutwell E, Gard S. (2013) Effect of Prosthetic Stiffness on Impact Forces during Walking and Sudden Limb Loading (poster). Gait and Clinical Movement Analysis Society Annual Meeting, May 14-17, Cincinnati, OH.

Gottipati P, Fatone S, Stine R, Ganju A. (2013) Reduction in shock absorption capacity of the spine during gait after spinal reconstruction surgery (poster). Gait and Clinical Movement Analysis Society Annual Meeting, May 14-17, Cincinnati, OH.

Zissimopoulos A, Fatone S, Stine R, Gard S. (2013) Effects of a non-rigid AFO on foot placement accuracy during post-stroke locomotion (poster). Gait and Clinical Movement Analysis Society Annual Meeting, May 14-17, Cincinnati, OH.

Fatone S, Stine R, Tillges R. (2013) Effect of Socket Characteristics on Coronal Plane Stability During Gait In Persons With Unilateral Transfemoral Amputation. Midwest Chapter of the American Academy of Orthotists and Prosthetists, May 30-June 1, Lake Geneva, WI.

Komolafe O, Caldwell R, Fatone S. (2013) An analytic approach to assessing transfemoral socket flexibility. Midwest Chapter of the American Academy of Orthotists and Prosthetists, May 30-June 1, Lake Geneva, WI.

Major M, Stine R, Gard S. (2013) The effects of walking speed and prosthetic ankle adapters on upper extremity dynamics and stability-related parameters in bilateral Transtibial amputee gait. Midwest Chapter of the American Academy of Orthotists and Prosthetists, May 30-June 1, Lake Geneva, WI.

Tucker K, Fatone S. (2013) Development of a Three-Dimensional Simulation Tool to Investigate the Effects of Ankle Foot Orthotic Joint Misalignments. Midwest Chapter of the American Academy of Orthotists and Prosthetists, May 30-June 1, Lake Geneva, WI.

Grant Submissions

Hansen A, **Fatone S, Major M.** "Determining the Causes of

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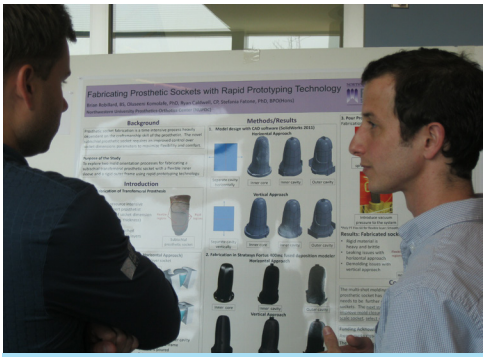
Brian Robillard Wins NU-Invo Prize

R. J. Garrick, PhD

Brian Robillard, BS, won the 3rd place cash prize for his research poster, "Fabricating Prosthetic Sockets with Rapid Prototyping Technology", presented at the InNUvations Applied Research Day (Evanston) on May 2, 2013. NUPOC Postdoctoral Fellow **Oluseeni Komolafe**, PhD has mentored Mr. Robillard throughout the Department of Defense-funded project "Development of Subischial Prosthetic Sockets with Vacuum-Assisted Suspension for Highly Active Persons with Transfemoral Amputations" (Principal Investigator **Stefania Fatone**, PhD, BPO(Hons)). The 3-year project aims to fabricate maximally flexible transfemoral sub-ischial prosthetic sockets using automated processes that can be adapted to the large-scale fabrication of sockets. Dr. Komolafe noted, "*Brian is working to adapt additive manufacturing to prosthetic socket development*."



Brian Robillard (right) discusses his research.

Mr. Robillard summarized the results presented in his poster. "*I explored the feasibility of different approaches to the automated fabrication of prosthetic sockets. I developed a process by which NUPOC's Stratasys fused deposition modeling system can be used to fabricate prosthetic sockets by employing a multi-shot molding technique. I am trying to help automate the entire socket fabrication process, from the initial scan of the limb to the final fabrication.*"

In the future, the research team will evaluate the Stratasys fabricated sockets to examine the effect of precisely controlled dimension parameters on socket comfort and residual limb stress distributions. Mr. Robillard concluded, "*Although the sockets fabricated on the Stratasys mimic the appearance of manually fabricated prosthetic sockets, the design process must be further developed to fabricate wearable sockets that can be introduced to the marketplace*."

InNUvations provides a forum for students to share their research with scientists, entrepreneurs and investors and explore opportunities to commercialize their product. Congratulations, Brian!

NUPOC NEWS

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Falling in Veterans with Lower Limb Amputations." RR&D Small Project in Rehabilitation Research (SPiRE) submitted to the Department of Veterans Affairs for the March 10 deadline.

Gard S, **Boutwell E.** "Effect of prosthesis stiffness on impact force during *in vivo* step loads and gait", SPiRE submitted to the Department of Veterans Affairs for the March 10 deadline.

Gard S, Major M. "Fall risk and prosthetic influence on gait biomechanics in upper limb amputees", SPiRE submitted to the Department of Veterans Affairs for the March 10 deadline.

Letter of Intent Submissions

Gard S, Casanova H. "Evaluation of a Vacuum-Based Impression and Alignment Device (V-BIAD)." Submitted to the Department of Veterans Affairs for the May 15 deadline.

Gard S. "Development and Evaluation of the GroundControl Shoe." Submitted to the Department of Veterans Affairs for the May 15 deadline.

Fatone S. "Epidermal Sweat Sensors for Use within the Harsh Prosthetic Socket Environment." Pre-application submitted to the DOD Peer Reviewed Orthopedic Research Program (PRORP) on April 4, 2013.

NUPOC Bids Farewell to Kerice Tucker

NUPOC bids farewell to **Kerice Tucker**, BS, Research Engineer (far right). **Steven A. Gard**, PhD (far left) presents a book from the lab. Kerice contributed to many research projects and we wish him the best in his future endeavors.

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NUPOC Hosts "New Parts for New Life"

R. J. Garrick, PhD

Northwestern University Prosthetics-Orthotics Center (NUPOC) participated in the 19th annual Northwestern University "Take Our Daughters & Sons to Work Day" on April 25, 2013. NUPOC researchers presented three interactive sessions for each tour. Participants enjoyed manipulating artificial hands and arms while learning how body-powered and myoelectric prostheses work from **Craig Heckathorne**, MS. **Ingrid Masterton**, MPT, explained orthoses while the children tested their dexterity and physical movement using various orthoses. **Oluseeni Komolafe**, PhD, and **Matty Major**, PhD, talked about the features of prosthetic legs and feet. Participants wore simulated amputation boots to approximate the experience a person might have walking on prosthetic legs and feet.

Children of Northwestern University employees learned about prostheses and orthoses at NUPOC.

NUPOC appreciates College Park for the generous loan of their Demo Boots that are designed "to allow non-amputees to experience, indirectly, what a bilateral below knee amputee would experience" and to demonstrate anatomic motions of prosthetic feet. Some participants who walked in the simulated amputation boots remarked, "*It's hard to walk!*" and others exclaimed, "*This is like walking on stilts!*"

Dr. Zissimopoulos (left) and Dr. Major (right) steady a child walking in College Park Demo Boots.

Andrew Nader (12 years old) reported, "*I enjoyed the 'New Parts for New Life' program most!*"