Artificial limbs for a global need: the LC Knee™ project

Jan Andrysek[1,2]

[1]Holland Bloorview Kids Rehabilitation Hospital [2]Institute of Biomaterials and Biomedical Engineering

Abstract: Artificial limbs are a matter of necessity for people with lower-limb amputations. However, due to a lack of affordable and functional technologies, there is a large unmet need, especially in low and middle income countries around the world. With key research partners, we are developing affordable mobility technologies to reduce disability.

Background/Rationale: Lower extremity amputation is a major disability estimated to affect at least 10 million individuals globally. For these persons, providing functional artificial limbs is a key part of the rehabilitation process, restoring mobility and reducing the effects of the disability. Artificial limbs are crucial to facilitating independence and a productive participation in the community including the pursuit of social activities, education and work. However, there is currently a large unmet global need for artificial knee joint technologies that are functional and affordable.

Research Objectives: The goal is to develop artificial limbs that are (1) biomechanically appropriate and capable of facilitating a high-level of mobility function for active children and adults, (2) designed to be durable and resists a variety of environmental conditions; and (3) affordable so that they may be used internationally, including in under-resourced countries.

Methods & Analyses: This work is comprised of a number of projects relating to the technical development and clinical assessment of a new type of knee joint mechanism, termed the LC Knee™. Broadly, methods applied include computer-aided design, finite-element analysis and topological optimization, biomechanical modeling, and structural testing. Clinical assessments include instrumented biomechanical assessments, evaluation of mobility function, and long-term field trials.

Results: A unique application of topological optimization techniques was demonstrated resulting in a configuration with high strength-to-weight ratios, facilitating the use of polymers in the construction of the knee joint. The feasibility of a new stance-phase control mechanism was demonstrated, providing greater stability during weight bearing without inhibiting natural gait patterns. Pilot clinical testing revealing improvements in mobility function including faster walking speeds without increased energy expenditure. Long-term clinical field testing is revealing structural and functional integrity.

Conclusion: The LC knee™ is a promising emerging technology aimed at addressing a large and growing need for functional and affordable artificial limbs. Future work is focused on providing greater evidence about its appropriateness for use in under resourced regions of the world, as well as on ensuring adequate long term performance.

Relevance: This work is aims to deliver functional, durable, and affordable artificial limbs to individuals around the world, including low and middle income countries, and also children and adults participating in various recreational activities for which they are unable to use their conventional prostheses.

Jan Andrysek

Jan Andrysek graduated with a B.Sc. (honors) degree in Biological Engineering form the University of Guelph, a Masters degree in Biomedical/Mechanical and Industrial Engineering from the University of Toronto, and a Doctorate degree from the University of Utrecht, the Netherlands. He is a scientist in the Bloorview Research Institute of Holland Bloorview Kids Rehabilitation Hospital and an Assistant Professor at the Institute of Biomaterials and Biomedical Engineering at the University of Toronto. His primary research focus is on the development of mobility assistive technologies (MAT) for individuals with lower limb impairments. In broad terms, this involves the study of human biomechanics and human gait, the development and evaluation of mobility assistive technologies (MATs) including artificial limbs and orthotics, development and evaluation of quantitative gait and mobility measurement techniques, the application of design management systems in rehabilitation engineering, and studying clinical practices and the use of research evidence in the field of prosthetics and orthotics. He is the author on over 40 peer-reviewed publications including journal articles, conference proceedings and book chapters. Jan is also the holder of a number of patents which have resulted in the commercialization of two products. In partnership with various organizations around the world, including the International Committee of the Red Cross, Jan's recent efforts are focused on improving the availability of functional and affordable artificial limbs in under-resourced regions of the world.

.