Canadian Scientist Receives Grant to Continue Developing Innovative, Low-cost Prosthetic

Economically impoverished survivors of landmines and explosive remnants of war not only face psychological and physiological trauma but also economic upheaval as they may not be able to continue previous professions, especially those involving physically taxing work such as farming, manufacturing or construction. Furthermore, a survivor of a mine-related accident "typically requires amputation, multiple operations and prolonged physical rehabilitation," all of which are extremely time-consuming and costly.[1] The reality is harsh for many landmine and ERW survivors in the developing world who lack access to adequate health care and safe, effective and affordable prosthetic limbs. Thus, one of the most fundamental questions facing victim-assistance practitioners is how to produce low-cost and robust prosthetics for underprivileged amputees around the world.

For trans-femoral (above-the-knee) amputees, the outlook may be brighter. For the past six years, Jan Andrysek, an assistant professor at the Institute of Biomaterials and Biomedical Engineering and scientist at Holland Bloorview Kids Rehabilitation Hospital in Toronto, Canada, has been developing the Low-Cost Prosthetic Knee Joint, also called the LC Knee.[2] Through a barrage of computer modeling, testing and optimization, Andrysek has developed a prosthetic that costs US$50—considerably more affordable when compared with other prosthetics, which may cost as much as $3,000.[2]

Developing an affordable and effective prosthetic is immensely difficult. The prosthetic must be durable so that constant and costly repairs are not needed, but it must also use cheap and available resources so that impoverished amputees in the developing world can afford to purchase it. The prosthetic should also be lightweight so that the amputee's mobility is not inhibited, but it should be heavy enough to withstand weathering and difficult terrain. The prosthetic must provide adequate weight-bearing stability so as not to inhibit the patient's natural gait or stride.[3]

To facilitate low-cost production and higher functionality, Andrysek employed topological optimization, a process that tests the durability of objects through various degrees of deformation and pressure.[4] Through topological analysis of various knee configurations, one design provided superior strength-to-weight ratios, allowing Andrysek and his team to use cheaper thermoplastic polymers while maintaining the same level of durability as more expensive prosthetics. To address stability and gait issues, the team employed a new "stance-phase control mechanism," which allows patients to stand securely without sacrificing their natural walking stride.[3] Most prosthetics in the developing world use outdated manual-lock knees, which only lock by fully extending the limb. These traditional prosthetics are cosmetically inferior, as patients must walk with "stiff knees," and functionally inhibiting, as patients' strides are limited to avoid unintentionally locking the knees with an extended step. Andrysek's model, however, "automatically locks and unlocks itself depending on how the person is putting their weight on the limb," allowing the patient a more natural gait.[2] Initial testing also revealed that the LC Knee improves the patients' mobility, as they can walk faster with less effort and less energy.[3]

"We can now mold all the pieces for a knee for about $15," says Andrysek.[2] Using an optimized design, he and his team use inexpensive thermoplastics that can be mass-produced with injection-molding techniques. The injection-molding technique essentially consists of pouring melted plastic into a mold where the plastic sets into its final form.[5] This quick and efficient process allows for the cheap manufacture of parts; however, topological optimization of the design attempts to counter any sacrifice in performance that may associate with thermoplastic molding.

Thus, Andrysek and his team are well on their way to creating affordable and effective prosthetics for landmine victims and other persons with disabilities around the world. Their mission was further bolstered in February 2012 when the group received one of 15 US$100,000 grants from Grand Challenges Canada, an organization that promotes innovative projects to address health-care needs in the developing world. Andrysek and his group of researchers plan to use this money to continue testing the LC Knee in the developing world—Colombia, Ethiopia and Nicaragua, in particular.[2] Regardless of socioeconomic status, amputees worldwide will again inexpensively enjoy the freedom of mobility.

~ Jeremiah Smith, CISR staff

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Research scientist, Jan Andrysek, displays the low-cost mechanical prosthetic that he created at the Holland Bloorview Kids Rehabilitation Hospital in Toronto, Canada.
Photo courtesy of Rick Eglinton/Toronto Star.