

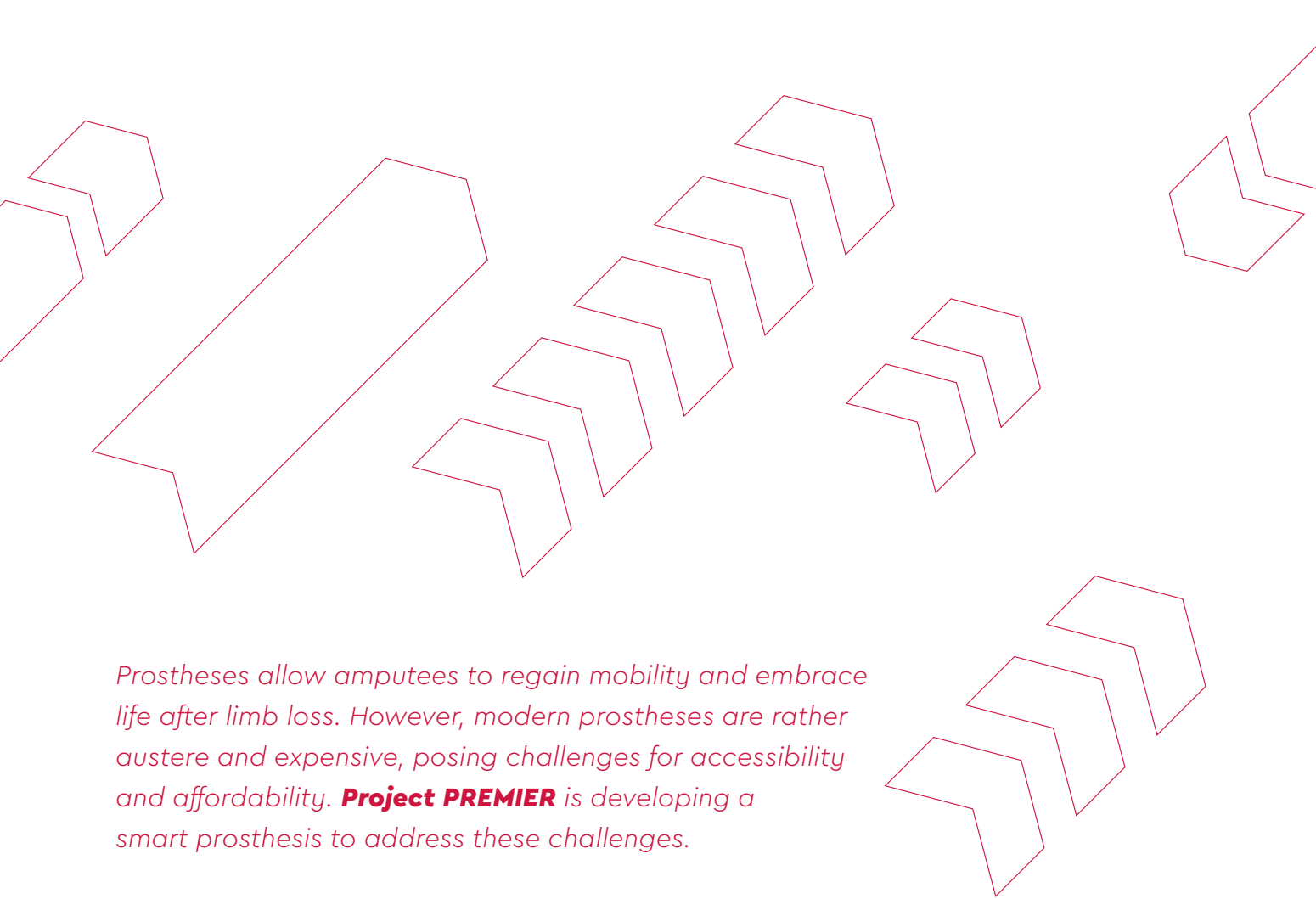
WALKING THE FUTURE

**PREMIER'S SMART
PROSTHETIC
INNOVATIONS**



Author: **Andrea Cuschieri**





*Prostheses allow amputees to regain mobility and embrace life after limb loss. However, modern prostheses are rather austere and expensive, posing challenges for accessibility and affordability. **Project PREMIER** is developing a smart prosthesis to address these challenges.*

In today's society, amputations are increasingly common, with individuals requiring amputations due to traumatic events or diseases such as diabetes and bone infections. Lower limb amputations, in particular, have seen a steady rise in numbers compared to upper limb amputations. This growing prevalence of amputations has ushered in a pressing need for innovative solutions, specifically, the development of smart above-knee prostheses. These aim to provide amputees with sufficient movement to perform routine activities while remaining affordable, aesthetically pleasing, and user friendly.

In response to this need, Project PREMIER has been initiated to pioneer ground-breaking research to improve the quality of life for above-knee amputees. **THINK**

sat down with Nicholas Patiniott, a Ph.D. candidate and research support officer forming part of the PREMIER project. The team is led by principal investigator Prof. Ing. Jonathan C. Borg from the Department of Industrial and Manufacturing Engineering.

UNDERSTANDING THE NEEDS OF AMPUTEES

Amputees face a myriad of challenges that evolve as they progress through various stages of recovery and adaptation. Initially, regardless of age or gender, the first challenge is often simply regaining the ability to walk. Standard prostheses allow for this simple functionality, albeit in rather spartan fashion, and they are typically designed with a limited lifespan and only cater to basic

functionalities. 'Everyday tasks like standing, sitting, or ascending stairs become Herculean feats, demanding extensive effort and patience,' explains Patiniott.

As amputees recover, they may aspire to enhance their posture, gain more stability, or even engage in activities like running. Unfortunately, prostheses are costly: a cost that dramatically increases as the prosthesis becomes more advanced in terms of functionality and aesthetics. Such financial constraints often leave amputees restricted in their pursuit of an improved quality of life.

MEETING AMPUTEES' UNIQUE NEEDS

The above-knee prosthesis developed by PREMIER transcends mere mechanical limb replacement; it represents a realm of smart



Some team members of Project PREMIER with the smart above-knee prosthesis. From left to right: Prof. Ing. Jonathan C. Borg, Mr Nicholas Patiniott, Prof. Alfred Gatt. Photo by James Moffett

applications with profound potential. These applications, while seamlessly monitoring user health beyond the prosthesis, have the capacity to revolutionise amputees' lives.

The smart PREMIER prosthesis makes use of sensors and AI algorithms that can detect potential issues, for example, excessive pressure on the stump arising from an imperfect 'socket' that can lead to ulcers and, eventually, muscle atrophy. Such pressure sensing can enable automatic and swift reporting to both the amputee as well as the prosthetist to enable them to take timely action to prevent discomfort.

Modularity is a fundamental aspect of PREMIER's design philosophy, breaking down the prosthesis into interchangeable components. This modularisation

is supported through the in-house manufacturing processes available within the Faculty of Engineering, thus allowing the replacement of specific parts, leading to reduced cost, reduced waste, and increased sustainability, without compromising on quality.

Furthermore, the project emphasises the emotional well-being of amputees, acknowledging that a prosthesis is not just a medical tool but a vital part of one's identity, advocating for aesthetic appeal, customisation, and positive impacts on self-esteem and social integration.

Central to PREMIER's pioneering approach is the creation of a digital twin of the prosthesis as part of an innovative product-service system (PSS). This PSS is a game-changing development that deserves special attention. This digital replica

provides clinicians and users with invaluable real-time insights into the prosthesis' performance. Perhaps most notably, it drastically diminishes the need for frequent clinic visits. This innovation isn't just about convenience; it's a profound shift in how amputees interact with their prosthetic devices and healthcare providers. By offering continuous performance monitoring, the digital twin empowers amputees to take more control over their prosthetic experience and overall health. It's a transformative leap forward in prosthetic care, enhancing not only accessibility but also the user's sense of agency and well-being.

Developing smart above-knee prostheses presents persistent challenges that the team is determined to conquer. Weight management is a crucial issue, ➔



Smart above-knee prosthesis developed by Project PREMIER
Photos by James Moffett

as finding the right balance between a prosthesis that's not too heavy to impede mobility and not too light to compromise stability requires meticulous engineering and design efforts. Environmental factors like the weather, particularly wind, can also impact the prosthesis' performance. Ensuring precise alignment of the prosthesis with the wearer's body is another intricate challenge addressed by the project, aiming to prevent discomfort and maintain a natural gait.

ONE SMALL STEP FOR PREMIER TOWARDS ONE GIANT LEAP FOR MANKIND

A smart product, such as PREMIER's above-knee prosthesis, is aimed at supporting both the amputee as well as their healthcare professionals. PREMIER is contributing to the concept of a smart prosthesis service system that will enable future research and refinement, becoming smarter, more adaptable, and more cost-effective. As this technology

matures, it is likely to transcend above-knee prostheses to address a wider array of limb-loss scenarios, including upper limb amputations. Furthermore, the integration of predictive and adaptive features into prosthetic devices has the potential to revolutionise healthcare by aiding preventive medicine, injury rehabilitation, and geriatric care, ultimately enhancing the well-being of diverse patient populations.

The PREMIER project's mission encompasses more than just engineering and technology; it embraces the holistic care of amputees. Consequently, it may serve as an inspiration for a shift in the healthcare paradigm, promoting a more patient-centric approach that emphasises the emotional and psychological aspects of rehabilitation. In summary, the PREMIER project's legacy extends far into the future, promising innovation, accessibility, and a brighter outlook for those grappling with limb loss and the broader healthcare industry. **T**

Disclaimer: The smart above-knee prosthesis discussed in this text, developed as part of the research project PREMIER, is not currently in production. The PREMIER prosthesis represents a visionary concept and functional prototype that will contribute to the future of prosthetic technology and related healthcare services. As with any research project, further work is necessary before such solutions become commercially available and approved by relevant authorities.

Funded through ERDF.01.124 as part of Project PREMIER – Development of a Low-Cost Product-Service System for a Smart and Modular, Emotionally Pleasing Above-Knee Prosthesis.

The PREMIER project is led by Prof. Ing. Jonathan C. Borg. Project members include: Nicholas Patiniott, Dr Emmanuel Francalanza, Dr Joseph P. Zammit, Dr Pierre C. Vella, Prof. Alfred Gatt, and Prof. Kristin Paetzold-Byhain at the Technical University of Dresden.