Topic: **Automated prosthesis socket fitting to each user**

Background:

Estimated more than 2 million people world-world are missing part or all of their lower arm. Prosthetic replacement is one of the most important rehabilitation methods for upper-limb amputees to restore function and/or appearance of a missing limb. The prosthetic replacement includes a socket interfacing to the remaining arm-stump and a terminal device (i.e hand, gripper) divided into three distinct groups – either body-powered, myo-electric controlled or passive.

It would be unrealistic to expect that the prosthesis can ever replace the functions of a normal limb from present rehabilitation technology. An estimated 20% of participants with absent upper-limb abandoned prosthesis use, whereby prosthetic comfort and function are critical factors. Comfort-related design issues, such as improved heat dissipation/perspiration, no overload on soft tissues, and most definitively, reduced weight, are paramount on patient's wish lists for all levels of prostheses. Function-related design should fulfill the following requirements: improve range of motion (ROM), provide smooth load and motion transition between the remnant and prosthesis, ease of don and doff, provide self-suspension, and so on. Improvement in comfort and function is considered high priority for individuals of all ages and all prosthesis types. Considering that the prosthetic interface or socket is the only point of force and motion transfer between the residual limb and prosthesis, the function and especially the comfort of the prosthesis have a close relation with prosthetic interface design. Therefore, prosthetic interface or socket design is the most important aspect in the decision criterion of upper-limb amputees.

Despite several innovations in the field the customer journey within upper limb prosthetics remains dominated by technologies which are decades old, such as simple myoelectric grippers and plaster-casted limb sockets. For the latter, the current approach involves an initial cast of the patient's residual limb made by wrapping plaster bandage around it. From this positive model, a test socket made from a thermoplastic is made, which is repeatedly heated, cut and reformed to get an intimate fit, in a laborious process not always resulting in a comfortable socket. Besides its limitations on optimizing the fit to the patient stump – hence ultimately compromising its comfort, the conventional "plaster-casting" approach is both laborious and costly, thus providing sizeable room for improvements.

Since all arm-stumps are different, most sockets often end up underutilized with lots of empty space while myo-electric terminal devices are usually heavy and complex.

A digital revolution has started from the installed cast-based paradigm to an automated workflow, not only increasing the overall process efficiency but also the reliability, durability and comfort of the resulting socket. We need to model the tacit knowledge used by prosthetists in the socket design process to fit on the individual arm-stump - necessary to find the non-trivial sweet spot on the trade-off balance between applying sufficient pressure to ensure self-suspension of the socket/prosthesis without causing pain to the user, while intrinsically adapting to anatomical variations of the stump during motion. We also need to optimize the way and where functionality is implemented to make a superior arm-system for the patient.

With state-of-the technology like scanning, automatic design and additive manufacturing the potential to revolutionize the workflow is better than ever.

Task:
The aim of the project is to explore how automatic design of an arm socket can help improve key parameters like weight, center of gravity, fit, comfort and look and feel.

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