A TOTALLY MODULAR ARM PROSTHESIS

Peter J Kyberd, Oxford Orthopaedic Engineering Centre, Nuffield Orthopaedic Centre, Oxford

OOEC, NOC, Headington, Oxford, OX3 7LD

David Gow Director of Rehabilitation Engineering Services, Edinburgh, UK.


Andreas Boman, Stellan Brimalm - Brimalm Engineering, Vadstena, Sweden

INTRODUCTION

While some groups and centres have attempted to promote greater levels of sophistication in exo-prosthetics [1,2,3], it is only in the past couple of years that the ideas of computer control to be applied in prostheses has received a more widespread acceptance, [4,5]. It is probable that those at the clinical end have only recently become aware of the potentials within the electronics field. Now there are some systems that do incorporate some technology into their products. The latest trainer from Otto Bock is an example of the capabilities of such systems [6]. The VASI systems with their reconfigurable set up has begun to show the extent to which the technology can progress [7]. The TOMPAW project also aims explore this area more fully.

TOMPAW stands for TOTally Modular Prosthetic Arm with high Workability. It is an EU project under the TIDE initiative (DE4210) The projects target is to produce a fully modular and functional prosthetic arm system that will enable the users and the clinical teams to customise the device to the user with the minimum of effort and time.

THE CONSORTIUM

The team that has been constructed combines the three most advanced prosthesis technology projects in Western Europe over the past thirty years with the most exciting surgical program.

The partners are:

Stiftelsen Institute for Management of Innovation and Technology

A research foundation controlled by universities in Gothenburg and Stockholm, Sweden. IMIT is coordinating the project and provides expertise in the fields of technology management, work performance and user training.

Lindholmen Utveckling

Lindholmen Utveckling works closely with the Chalmers University of Technology in Göteborg, Sweden. It includes members of the Sven hand project [8]. Specifically, members of the team who worked on the pattern recognition system for the hand. This work used signals from arrays of muscles on the forearm of individuals with a traumatic amputation and utilised the existing phantom arm to control the prosthesis. For the small numbers that used the hand it was a promising technique. Limitations included the ability to carry the electronics needed to undertake the pattern recognition and the difficulty in repeating the electrode placement accurately. Such problems need not prove a barrier today.

Brimalm Engineering

An engineering firm in Vadstena, Sweden, specialised in fine mechanical design and manufacture.
Princess Margaret Rose Hospital
The upper limb research program in Edinburgh has run continuously since its foundation in 1964, (originally under David Simpson, and more recently under David Gow). The team have developed and evolved the concept of Extended Physiological Proprioception (EPP), where the feedback is appropriate to the task and allows as much of the internal control pathways of the user to be utilised efficiently [9,10]. Additionally they have undertaken programs of mechanism design and testing resulting in compact hand designs and the worlds first clinically fitted powered shoulder unit [11] and the development of improved silicon glove techniques.

Oxford Orthopaedic Engineering Centre
Since 1968, the concept of hierarchical control of a hand prosthesis has been promoted by members of Jim Nightingale’s group in Southampton under the title of the Southampton hand [11,13]. More recently the concepts have been developed further towards a clinical system in Oxford at the Nuffield Orthopaedic Centre [14,15], while ideas exploring the control continue in Southampton [16].

The Institute for Applied Biotechnology
Professor Per-Inge Brånenmark has led a team that has successfully created Osseo-integrated attachments for both artificial arms and legs [17,18]. This remarkable technique is still in its earliest phase and requires caution to ensure that it is applied safely and appropriately to the users. The result of the attachment is an arm without the restrictions and limitations of a conventional socket, including range of motion limitation and the reproducibility of control sites. In addition the feedback through the bones (Osseo-perception) means that the limbs are more part of the user and give them additional information unavailable before.

Sahlgrenska University Hospital
Finally, the team includes highly experienced members of the clinical service in Gothenburg, Edinburgh and Oxford so that this knowledge and experience can be drawn on during every phase of the project.

THE PROJECT
The project is divided into three phases. The first is the design phase where knowledge and experience of users in the three centres along with the providers is collected and refined into a design specification [19].

The second phase is the production of the first prototypes for simple evaluation, before the final field prototypes are produced and users will try them for extended periods of time. At all points the user opinions will be sought and evaluations be made using the most appropriate tools, such as the Southampton Hand Assessment Protocol (SHAP), [20].

Users and professionals outside the project team will be invited to follow the progress of the project on the project web site: http://www.lindholmen.se/tompaw

A Modular arm
The arm will consist of standard modular units and builds on the experience of the PMR team, [11]. There will be separate modules for Hand, wrists, elbow, shoulder joint, spacer and cosmetic components. With these a prosthethist will be able to build any prosthesis ranging from a hand to upper arm, in a very short time. The whole system is then programmed according to the needs and abilities of the specific user.

The modularity extends to the software as well so it will be possible to control the arm from a wide range of different control philosophies and input methods. These will include intelligent arm control strategies, pattern recognition of EMGs and appropriate feedback systems. The ease of final configuration of the arm will allow the
potential user to choose the methodology at the time of fitting and easily modified later.

REFERENCES