

TECHNOLOGY FOR EVALUATION, FITTING AND TRAINING DURING THE PROCESS OF UPPER LIMB PROSTHESES MANUFACTURING

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EXECUTIVE SUMMARY

The paper outlines that a huge diversity of components and different control modes are necessary to satisfy patients' needs. Therefore, satisfaction is the critical factor whether a patient will wear his prosthesis or not. Consequently, technological effort is directed towards research and development departments to supply a product that can handle the amount of different configuration possibilities.

PAULA will assist certified prosthetists with all steps involved in manufacturing arm prostheses such as patient management and documentation, muscle signals evaluation, component selection and ordering service. In addition PAULA will provide beneficial features for users that will enhance both the quality of orthopedic fittings and the individual patient care. The complexity and opportunities of the product is a milestone in the field of arm prosthetics.

IDEA

The demand for better adaptability to individual patient needs has increased the variety of available components as well as the complexity of modern upper limb prostheses considerably. Several manufacturers offer many components and different programs for Myoelectric, BodyPowered and Hybrid prostheses as well as cosmetic fittings. This multitude is very complicated and needs a lot of knowledge and experience.

Building prostheses requires the consideration of many patient related influencing factors (size selection, myosignal quality, etc.) as well as knowledge of technical details (e.g. component sizes, compatibility of various components, and available control options). Simultaneously, the usability and acceptance of prostheses not only depend on selection of proper components and their optimal adjustment but also the correct fit of the socket is crucial.

With regard to these circumstances, the development of PAULA was initiated. It should handle the enlarged complexity of components for the upper extremity and provide an E-learning platform for the whole MYOBOCK[®] system. Additionally, the new software tool should guide certified prosthetists through the whole process and helps them to choose the best components and improve the outcome of the fitting. Occupational therapy can also be supported by the help of the new software.

There is no doubt: This software adds value for CPO, OT and patient.

STEPS OF DEVELOPMENT

In general, the development of Paula was realized in three fundamental steps:

1. In 2003 the computer assisted fabrication service (CAFS) team, an Otto Bock department for customer oriented software programming, was assigned to develop a new software tool depending on the requirements of the target groups. In other words, this software system should contain a patient management tool and a component selector for Otto Bock upper extremity products. Moreover, the software should assist prosthetists with the socket design for transradial amputees. The CAFS team essentially used the knowledge and experience gathered from the computer aided design for sockets for lower extremities. This know how was altered and adjusted to the circumstances of transradial amputees.
2. In 2004 the Otto Bock research and development department in Vienna, Austria, started to expand the existing MyoSoft[®]. This software program was used for testing and evaluation of patients' muscle signals and the subsequent myo-simulation. The idea of this project was the establishment of a new patient management and the introduction of new features of the MyoSoft[®] system in a new layout.
3. The final step was to join these parallel proceeding projects together to one common product. As a result, it was agreed that the features MyoSoft, socket design, patient management, component selector, and ordering service should not run as a stand alone product but rather as an integrated software solution with a common user interface and platform that permit easy handling and efficient workflows.

DESCRIPTION OF THE PRODUCT

This abbreviation stands for **P**rosthetist's **A**ssistant for **U**pper **L**imb **A**rchitecture. The product is a complex software program that supports certified prosthetists during planning, designing and manufacturing prostheses in the field of upper extremities. It can be used for both Myoelectric- and BodyPowered- prostheses for all levels of amputation as well as for passive arm prostheses. PAULA consists of five different modules integrated in one common platform. In detail, these applications are described as following:

1. Patient management

Manufacturing prostheses requires much information related to the patient such as personal details, amputation level and side, or gender. The patient management of PAULA uses these indications for documentation purposes. It also includes the administration of pictures of the patient and other patient related information that can be saved. Different jobs can be created for the same patient. This tool is beneficial for the justification of a new prosthesis because changes at the stump can be archived and therefore demonstrated.

2. Transradial socket design

Socket design is essential for both the fitting of prosthesis and the satisfaction of the patient. With the help of PAULA the fabrication of sockets for patients with transradial amputation levels can be realized without taking a plaster cast. The certified prosthetist takes pictures from the residual limb of the patient, digitalizes the socket and uses the software to

modify the socket in the personal computer. As a result, he gets a 3D socket design that can be sent online to an Otto Bock service fabrication for manufacturing a test socket.

3. Myotest, Training and Simulation

Myoelectric prostheses are controlled by muscle signals that can be measured on the skin of the patient in case of muscle contraction. Therefore, electrodes are required to measure the muscle tension. The muscle potentials will be transmitted to the computer screen where the prosthetist can choose from different programs and component depending on patients' indication. PAULA enables the certified prosthetist and the patient to see the movement of the prosthesis in real-time on the screen. The certified prosthetist can evaluate the muscle potentials and test the best components' configuration. The simulation helps the patient to understand the different functions and to train his muscles.

4. Component Selection

Depending on the indication and the muscle signals of the patient the system make proposals for suitable components and control modes where the prosthetist can choose from. This component selection guarantees component compatibility for the entire prosthesis. However, the expert mode allows certified prosthetists to determine another component configuration for the patient.

5. Ordering

The final step in manufacturing prostheses is the purchase of required components. With regard to the four prior steps, PAULA creates an automatic order form that can be sent via email to the Otto Bock service fabrication in order to receive a test socket with all functional components integrated in an alignment tool for a complete upper limb test prosthesis. Instead of receiving an entire test prosthesis, the certified prosthetist can also order the components and assembles the prosthesis by himself.

CONCLUSION

To sum up these points, PAULA is a composite software program that offers a guide line for experienced certified prosthetists to assemble prostheses for upper extremities with complex control modes in the right configuration. It provides an explicit component selection and an easy ordering procedure. Furthermore, PAULA supplies mostly automatic documentation features and patient management tools.

Finally, it simplifies and speeds up all tasks from muscle testing and evaluation, socket design, muscle training and simulation, till the appropriate configuration of the prosthesis. As a conclusion, PAULA assists, supports and submits proposals and recommendations. With regard to these benefits, the quality of arm prostheses supply will enlarge. Additionally, PAULA will improve individual patient care. And for this reason the customer satisfaction will increase.