

TECHNOLOGICAL ADVANCEMENTS IN PROSTHETICS – HOW FAR CAN WE GO?

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WORLD HEALTH ORGANIZATION

“With the aid of technologies, people with a loss in functioning are better able to live independently and participate in their societies”



TRAINING PROGRAM

- **October 2015**
- **Otto Bock Science Centre, Berlin**
- **Otto Bock Competence Centre Headquarters, Duderstadt**
- **To acquire and update the knowledge on cutting-edge prosthetic technology**

Power
and
Control



Sensation
and
Proprioception

TRANSFEMORAL AMPUTEE

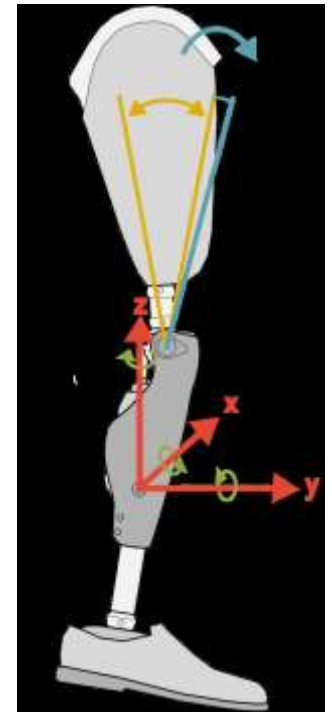
- **Less than 30% of new transfemoral amputees fitted with prostheses** (2010-2014, P&O/COC Internal Data)
- **Physical conditions and other constraints**
- **The prostheses are unable to fulfill the needs of the patients (functions and safety)**
- **The knee joint of the prosthesis is the biggest hurdle**



MICROPROCESSOR CONTROLLED KNEE



- Built in acceleration sensors and gyroscope
- Parameters measured: Knee angle and angular velocities, extension moment, linear acceleration, orientation of shank in space, etc.
- Adjust joint movement on a real-time as-needed basis



LATEST DEVELOPMENT

- **Optimized physiological gait**
- **Improve balance & reduce risk of fall**
- **Improve slope- and stair-walking ability**
- **Walking speed**
- **Sports mode**
- **Training mode**
- **Waterproof**



TRANSTIBIAL AMPUTEE

- High level of mobility
- Less demand on mechanical/electronic ankle joint
- Foot and ankle complex
- Performance over safety



MICROPROCESSOR CONTROLLED ANKLE JOINT

- Amputee who are low to moderately active (K2-3 level) and want to maintain an active lifestyle.
- Provide powered propulsion
- Automatically adjust the plantar flexion angle
- Faster walking speed
- Reduce energy expenditure
- More natural gait



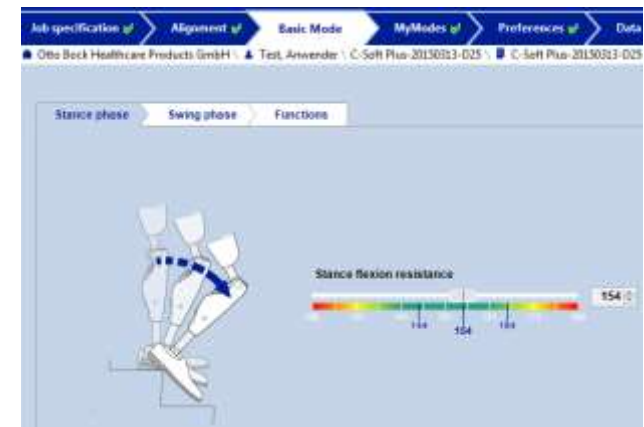
SPORTS PROSTHESES

- **Advancements in technology help to create prostheses adapting the different features of sports**
- **Factors to be considered: component selection, weight of prosthesis, energy rebound capacity, suspension, shock dampening, skin friction, etc.**
- **Sports: running, dancing, diving, cycling, golf, skiing, etc.**



ROLES OF PROSTHETIST

- Prosthetic prescription
- Biomechanical consideration in socket design
- Socket/skin interface
- Calibration of electronic components
- Dynamic alignment setting
- Sports mold setting
- Gait training
- To maximize the functions of the prosthesis to fit the needs/activities of individual amputee



MATERIALS SCIENCE AND TECHNOLOGY

- **Carbon fiber**
 - **Thin, lightweight but strong prosthetic socket**
 - **Foot and ankle complex with excellent rebound capability**
- **Gel liners as socket interface:**
Thermoplastic elastomer, Polyurethane and Silicone
 - **Cushioning and evenly distributing the pressure**
 - **Reduce skin friction and avoid breakdown when playing vigorous activities**
 - **Suspension**



UPPER EXTREMITY AMPUTEE

- Complexity of hand function
- High dropout rate, especially body power control hand user (mechanical)

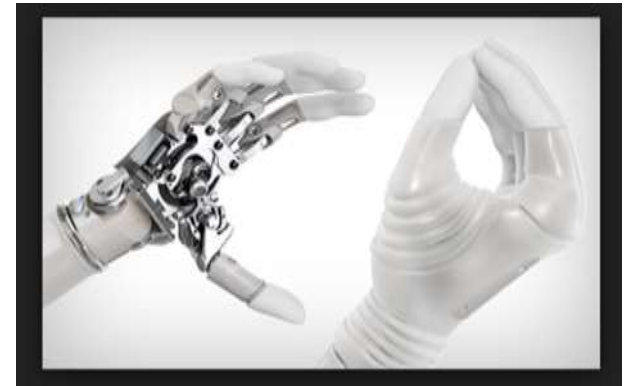
“53% of dropout rate of paediatric myoelectric hand users”
(Routhier 2001)

- Prevalent practice is fitting of cosmetic hand

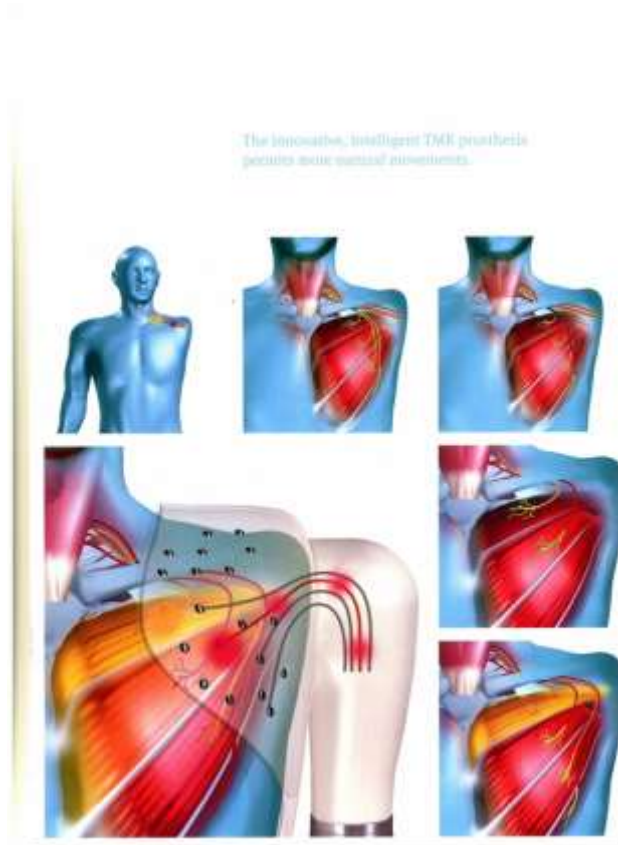


MYOELECTRIC HAND

- Has been made available in the market for more than 40 years
- Simple three jaw chuck opening and closing, wrist supination and pronation
- Latest development:
 - **i-limb**
 - **Michelangelo hand**
- Multi-axial movement, e.g. lateral pinch, lateral power grip, finger abd/adduction, tripod pinch, opposition power grip, open palm, neutral position



TARGETED MUSCLE REINNERVATION (TMR)

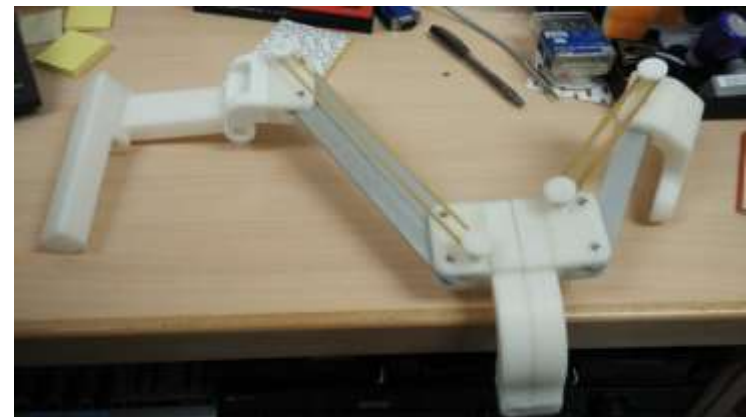


Otto Bock HealthCare GmbH

- **Connect the functioning nerves from the residual limb to other target muscles (selective nerve transfer)**
- **As the muscles contract, the resulting electric signals are measured by electrodes > translate them into the intended movement.**
- **3 degrees of freedom – controlled simultaneously**

3D PRINTING AND CAD CAM TECHNOLOGY

- **Additive manufacturing technology**
 - Synthesize a three dimensional object
- **Local experiences**
 - Maxillofacial prosthesis (ear)
 - Prosthetic socket
 - Mechanical exoskeleton robotic arm
- **Germany: Partnership with NGO and open to the community**
 - Private project or experiment
 - Provide training and assistance
 - Allowed to use 3D printers and other expensive equipment



WHAT IS THE GAP?

➤ **Knowledge and skill**

- Overseas training
- Certificate (e.g. Genium , Utah arm, Michelangelo hand)

➤ **Heavily subsidized by the government**

- Basic and essential

➤ **Patients' choice items**

- Easy access to information of high-end products but difficult to get appropriate recommendations / solutions from professionals

➤ **Limited exposure and practice**

- Confidence and motivation

WHERE ARE WE?



- **Standard of provision**
 - Validated assessment tools for prescription
 - AMP and K-Levels
 - Basic but appropriate
- **From product manufacturing to comprehensive healthcare services**
 - Functional assessment, training and outcome evaluation

THE WAY AHEAD ...

- **Consider to set up Regional Prosthetic Center in Hospital Authority**
- **Continuously review the coverage of the Samaritan Fund and Medical Fee Assistance scheme**
- **Partnership with NGO and Patient self-help groups, e.g. Hong Kong Amputees Sport Association**
- **Cooperate with the developers / P&O enterprises**



Duderstadt, Germany



Thank you

