DOI 10.1515/bmt-2012-0199 — Biomed Tech 2012; 57(6): 423–425

Editorial

Thomas Stieglitz, Hildegard Niemann and Marc Kraft

Technically assisted rehabilitation

In an aging society in the 21st century, technical aids are already perceived as devices of daily living in many fields. Even middle agers do not hesitate to use hearing aids and elderly people go shopping with their walking frame without shame. However, a lot of innovation hurdles have to be faced in translational research to bring basic findings and prototypes into the regulated market of medical devices. Europe has to compete with global players on the worldwide market.

In 2010, the National Science Foundation of the USA asked the World Technology Evaluation Center, Inc (WTEC; Lancaster, PA, USA; http://www.wtec.org) to conduct a study of research in the field of rehabilitation engineering in the European Union [4]. They tried to show how treatment paradigms have been changed or might change with new medical devices being available on the market.

The expert panel of the WTEC identified eight major trends in mobility technology research in Europe:

1. "Assistive technologies are being designed to integrate more closely with the user, decreasing user burden while increasing user capability [...]
2. Research on technologies for rehabilitation therapy is growing rapidly and beginning to transform clinical practice. At the same time, the need for therapy technology that can be used at home is largely unmet [...]
3. There is a fundamental need in mobility technology research for better neuromusculoskeletal models that can be personalized to predict on a case-by-case basis optimal treatments for individuals [...]
4. Wearable sensors and pervasive systems will improve health and wellness monitoring, safety monitoring, home rehabilitation, assessment of treatment efficacy, and early detection of disorders for people with mobility impairment [...]
5. Improvements in actuators and power supplies have not progressed as quickly as those in sensors; the invention of a stronger, lighter, and more efficient actuator and more compact power supply would accelerate assistive and therapeutic technology advances as well as spawn many new applications of mobility technology [...]
6. Eliminating physical impairment will ultimately require combinations of physical training and plasticity/ regenerative therapies [...]
7. Multidisciplinary teams that work closely with consumers and are embedded with scientists with an intimate knowledge of disability are best positioned to produce transformative mobility technology [...]
8. Finally, government support for research in mobility technology has led to substantial gains. Future and growing support is essential to continued advancement [...]" [4]

The biannual Technically Assisted Rehabilitation (TAR) conference focuses exactly on this field of "mobility technologies". It is completely in line with the WTEC study published recently [4]. Experts from academic rehabilitation research, companies active in the rehabilitation field, and the project executing organization of the German Federal Ministry of Education and Research, the VDI/VDE Innovation und Technik GmbH, inaugurated the first TAR conference on a European level in 2007. Over the years, the TAR conference has been established as a leading conference in Europe.

TAR helps patients to participate again in their desired activities of daily living. Different trends are nicely reflected in the TAR 2011. Microsystems engineering serves as enabling technology to technically support rehabilitation approaches. Miniaturized sensors and actuators, mechantronic systems, robotics, and information technology allow better and cheaper systems for patients, including novel approaches in endoprosthetics.

Experts from industry, medicine, natural, and engineering sciences meet on a biannual basis on the TAR conferences to discuss the state of the art of developments in rehabilitation and identify and develop approaches that are tailored to suit the market needs from both the patients' and the market's perspective. Results are communicated not only within the scientific community and medical device manufacturers market but also toward the government and its funding agencies to point out hurdles and offer advice.

This special issue of *Biomedical Engineering/Biomedizinische Technik* displays topics from the fields of orthotics, intelligent assistive technologies, implants, sensors, control and biomechanics aspects, prosthetics, and neurorehabilitation from the TAR 2011. We have assembled a collection of articles that cover the versatility of the use of technology in rehabilitation and show trends how treatment paradigms might change with new devices being available on the market.

The first article of Bellmann et al. [1] reports on the performance of a new microprocessor-controlled knee joint for a lower limb prosthesis. It allows the climbing of stairs step over step for above-knee amputees. A combination of several sensors and sophisticated switching algorithms were integrated into the knee joint. The performance of this novel knee joint was assessed in a biomechanical study. Callies and coauthors developed long-term stable "antimicrobial surface coatings for a permanent percutaneous passage in the concept of osseointegrated extremity prosthesis" [2]. The concept of bone-anchored, i.e., osseointegrated, extremity prostheses has been introduced in the 1990s for patients with either high amputation levels or severe complications when using a conventional socket. The major challenge still is to create surfaces on the titanium sockets for the bone that prevent the intrusion of bacteria and infection along the bone anchored socket. Callies et al. investigated the coating of the titanium with a variety of copolymers to reduce the adhesion of bacteria without influencing the adhesion of fibroblasts. *In vitro* studies of coated titanium proved that copolymer-based coating can be simultaneously antimicrobial and biocompatible. Future work will transfer these findings into *in vivo* models. The outcome of neurorehabilitation and the evidence of therapies using assistive devices in the rehabilitation process are discussed by Luft [3] on the example of stroke. Because stroke patients face a plethora of problems, each of them needs a different rehabilitation strategy. Movement, language, cognition, and other aspects need tailored approaches and outcome measures. Technical aids can help to support existing therapies but are also excellent research tools to investigate research hypothesis in smaller patient groups before large clinical trials have to be scheduled.

Microsystems engineering as an enabling technology is presented in a research approach to treat phantom limb pain by means of electrical stimulation with a new type of an implantable nerve electrode. Stieglitz et al. [5] review the concept and acute and chronic preclinical results on the selectivity and biocompatibility of a micromachined transversal intrafascicular multichannel electrode that allows graded and selective stimulation on the fascicular level.

The last contribution of the special issue articles addresses safety and efficacy issues in human-robot interactions in active assistive movement therapy. Wilkening et al. [6] developed novel soft fluidic actuators with rotary elastic chambers for compact, lightweight, and cost-effective therapeutic devices. In their approach, the interaction between the human and the devices is estimated without the use of force and torque sensors. Gravity compensation is implemented in separate models of the human extremity and the robot. Devices have been tested first in healthy subjects. Translation into therapies is still work in progress.

The collection of the articles represents different stages of research ranging from fundamental investigations on the *in vitro* level up to clinical applications that are in accordance with the major trends that have been identified by the WTEC. We wish you exciting insights and a lot of pleasure when you read through this issue of *Biomedizinische Technik/Biomedical Engineering* and hope to see some of you soon on the next TAR conference, which will take place March 14th–15th, 2013, in Berlin (http://www.tar-conference-eu).

References

[1] Bellmann M, et al. Stair ascent with an innovative microprocessor-controlled exoprosthetic knee joint. Biomed Tech (Berl) 2012; 6: 435– 444.
[2] Callies T, et al. Antimicrobial surface coatings for a permanent percutaneous passage in the concept of osseointegrated extremity prosthesis. Biomed Tech (Berl) 2012; 6: 467– 471.
[3] Luft AR. How to gain evidence in neurorehabilitation: a personal view. Biomed Tech (Berl) 2012; 6: 427– 433.
[4] Reinkensmeyer DJ, Bonato P, Boninger ML, et al. Major trends in mobility technology research and development: overview of the results of the NSF-WTEC European study. J Neuroeng Rehabil 2012; 9: 22.
[5] Stieglitz T, Boretius T, Navarro X, et al. Development of a neurotechnological system for relieving phantom limb pain using transverse intrafascicular electrodes (TIME). Biomed Tech (Berl) 2012; 6: 457– 465.
[6] Wilkening A, et al. Assistive acting movement therapy devices with pneumatic rotary-type soft actuators. Biomed Tech (Berl) 2012; 6: 445– 456.

Thomas Stieglitz
Associate Editor Biomedical Engineering/Biomedizinische Technik
University of Freiburg, IMTEK - Department of Microsystems Engineering, Georges-Köhler-Allee 102, 79110 Freiburg,
Phone: +49 761 203 7471,
E-mail: thomas.stieglitz@imtek.uni-freiburg.de

Hildegard Niemann
Technische Universität Berlin,
Innovation Center Technologies for Health and Foods (IGE)
Müller-Breslau-Straße 15 VWS4, 10623 Berlin, Germany,
Phone: +49 30 314 76674,
E-mail: hildegard.niemann@tu-berlin.de

Marc Kraft
Technische Universität Berlin,
Innovation Center Technologies for Health and Foods (IGE)
SG11, Dovestr. 6, 10587 Berlin-Charlottenburg,
Phone: +49 30 314 23388,
E-mail: marc.kraft@tu-berlin.de