The Symbionics programme looked into the possibilities of developing systems to support the trunk and head of patients with different types of muscular weakness,’ says programme leader Bart Koopman, Professor of Biomechanical Engineering at the University of Twente. The aim was to develop co-adaptive support systems, where not only do patients need to adjust to their support, but the support itself also adjusts to the patients’ abilities and needs. ‘Ideally, this would be a continuous process,’ Koopman comments. ‘Progressive diseases like Duchenne Muscular Dystrophy require devices that gradually increase the amount of support over time. But the amount of support needed may vary during the day too. When patients are fatigued, for example, the support should be able to take over more of the burden. An important challenge is to determine when that moment has come, and not to overdo it, since it is essential that patients keep using their muscles as much as possible in order to train them.’

The programme brings together experts from rehabilitation medicine, human movement science, modelling and control, and mechanical engineering. The nine PhD students and three PDEng students involved in the programme are focusing on arm and hand motion, trunk and head balance, and form adaptation aimed at preventing ulcers and treating clubfoot.
Aim
The objective of the Symbionics programme was to create systems that co-adapt automatically to the needs and possibilities of their user, either intrinsically by design, by control, or by a combination of both. The programme was designed in such a way that the patients have a central role in defining the requirements and priorities for developing the assistive devices.

What was investigated?
To be able to provide patients with tailor-made assistive devices, the researchers looked into personalised muscular models and the optimal way to support any deficiencies. Which muscles are used in what way during activities of daily living, and what would be the best way to assist them? How can hand, arm and trunk movements be supported in such a way that people who suffer from muscular weakness are able to perform activities of daily living independently, without overdoing it and by doing so worsening their condition?
In two projects, solutions were sought to alleviate foot sole pressure to prevent diabetic foot ulcers, and to treat clubfeet in new-born babies without having to apply plaster casts.

What has the programme yielded?
The programme has resulted in a very diverse set of possible solutions for clinical practice. Examples are an active hand orthosis; a promising concept for head support; an initial idea for trunk support; adaptive orthopaedic shoes for diabetics; the Bi-partner Robotic Setup (BROS), a robot that haptically couples two people together for therapeutic applications; and an alternative treatment for clubfeet that is more patient friendly.

The research even went beyond the Symbionics programme, Koopman adds. ‘In fact, we have taken it up a notch. Even more partners are involved in the new Perspectief programme Wearable Robotics, working on developing Exo-Aids: wearable technology that is soft, lightweight, comfortable, intuitive to control and affordable. And in the European Horizon2020 project eNHANCE, we have tried to detect the user’s intention, based on eye-tracking measurements and personalised behavioural models. Ultimately, our dream is to be able to help wheelchair-bound people get up from their wheelchairs and go to the toilet all by themselves.’

Facts & figures

- **Research institutions & universities**
  - Delft University of Technology
  - University of Twente
  - VU Amsterdam

- **University medical centres**
  - Maastricht UMC
  - Radboudumc
  - UMCG

- **Knowledge institutions**
  3

- **Companies**
  13

- **Public and societal partners**
  4

- **Top Sector**
  High Tech Systems and Materials

- **Total budget**
  4 million euro

- **Co-funding**
  1 million euro

- **Highlights**
  - New type of head support, assisting patients without restricting head and neck movements
  - SymbiHand, an active hand orthosis based on hydraulics that helps people grasp and pinch, even when all muscle power is gone (see image)

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