



# One wheelchair for all situations

**Students at ETH Zurich have developed a wheelchair that can climb stairs. Is this the future for people with walking disabilities?**

Test driver Raffael is the first person with a walking disability that gets to drive up a flight of stairs with the Scalevo wheelchair – in reverse on two caterpillars. He smiles and commented that it feels like he is floating. At the top, the journey continues on two wheels; the system is self-balancing.

The wheelchair is a prototype of ETH Zurich which is working to bring it to market in the near future. For many people with walking disabilities, everyday life is filled with barriers, such as circumventing curbs and stairs. Ten Swiss students want to change that, so in the future, no obstacle will prevent the freedom of movement for wheelchair users. The engi-

neers developed a new type of wheelchair, in only a year. A masterpiece that took up practically every free minute of the students' time, but it was all worth it. The first feedback received from people with walking disabilities all over the world was positive "and many want to purchase our wheelchair already," says machine engineer Carlos Gomes.

### It starts

Originally, Gomes and his colleagues only wanted to build a robot that could climb stairs. But their professor encouraged them to go a step further, so eight engineers from ETH Zurich started to develop a stair-climbing wheelchair in the summer of 2014. It had to be very maneuverable, easy to operate, attractive and, above all, safe. The team needed reinforcement adding two industrial design students from the Zurich University of the Arts to the team.

The basic principle was that during normal operation, the wheelchair should drive on two wheels, similar to a Segway. They planned to overcome the stairs with caterpillars that can be extended and retracted. The wheelchair, Scalevo, unites the two motion principles into one "hybrid" chair.

### Testing Scalevo

The wheelchair user approaches stairs and selects the appropriate function on the touch screen. With sensors and cameras, the chair measures the incline of the stairs and automatically drives up to them in reverse. The caterpillars lower, and they start to turn and move the wheelchair up the stairs, with speeds of one step per second. The driver stays in a straight position the entire time, then as soon as the sensors detect the end of the stairs, the stabilizing wheels move into position, preventing the wheelchair from tipping over. The caterpillars then lift up and the wheelchair continues the journey on two wheels.

The wheels and the caterpillars are equipped with two maxon electric motors that act as drives. Brushless DC motors are used in combination with ceramic gearheads. Ceramic is always a good choice when high forces act on the components, yet the gearhead has to be very durable. Carlos Gomes and his team are enthusiastic about the drives that maxon provided to them: "The motor-gearhead combination is strong, precise, quiet and, at 3.2 kilograms, relatively light. The maxon engineers gave us expert advice and the support was excellent."



A 3D model of the Scalevo wheelchair.  
Image ©Scalevo

### The key to success

The students are very satisfied with their work. "Good teamwork was the key to our success," says Gomes. Additionally, they implemented the suggestions of many people with walking disabilities. Some suggestions were: adding a belt or inclining the seat backward

slightly, so that the wheelchair user does not slip forward. "We would never have thought of such details ourselves."

### Time to face the competition

There is still much to be done. Even though the project could be considered finished. In the Fall of 2016, the engineers will compete in the Cybathlon in Zurich with their Scalevo wheelchair. This is a competition where people with disabilities compete against each other.

Technical aids are not only permitted but actually encouraged. After all, the intention of this event is to motivate researchers and engineers to invent better and more affordable wheelchairs, prosthetics and other aids.

### A vision for the future

The Scalevo team wants to win the Cybathlon in the wheelchair category but some modifications to their devices are necessary. The suspension of the caterpillars has to be made stiffer, the operation more intuitive, and the reliability has to be increased. Perhaps the young inventors will create a start-up, who knows? The idea is in place. If they do, the new wheelchair with its integrated caterpillar might be available on the market soon. Astonished glances? That'll be a thing of the past when it becomes normal that wheelchair users cruise up and down stairs as if it is the most natural thing in the world.



#### maxon GP 52 C Gearhead

The drive of the Scalevo wheelchair consists of a brushless DC motor from maxon, with a diameter of 60 millimeters. It is connected with a GP 52 planetary gearhead which is specifically equipped with ceramic components. This modification gives the gearhead a significantly longer service life.



#### EPOS2 70/10 Controller

The maxon EPOS2 70/10 controller ensures perfect control. It is a fast and precise digital positioning motor controller that is suitable for brushed as well as brushless DC motors.

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