

Bionics in Competition

Developers of innovative assistive devices compete as a means of networking with each other.

MOST PHYSICAL COMPETITIONS are based around the idea of participants pushing themselves physically, demonstrating to the world that they are the fastest, strongest, or otherwise physically gifted. For those with significant physical disabilities or injuries, however, simply accomplishing basic everyday tasks can be an Olympic-level feat.

That's where Cybathlon, a new competition designed to promote innovative assistive devices, may accomplish two goals: providing a competitive forum for disabled athletes, and highlighting the specific advances that are being made in robotic assistive aids designed to help those with significant physical disabilities.

Conceived and developed by Switzerland's ETH Zurich (a science and research university) and National Centre of Competence in Research (NCCR) Robotics professor Robert Riener, the first iteration of Cybathlon took place last October in Zurich. During this international competition, 66 technical teams (comprised of one pilot or operator, along with a number of researchers and scientists) from 25 countries came together to compete in six different disciplines of events.

Each team consisted of at least one technology provider, which was a member of a research lab or a company, and at least one pilot, a person with a specified level of disability that is being managed by using technology developed by the team. The overall competition consisted of six so-called "disciplines," each consisting of tasks that must be completed in the fastest time possible, and ahead of all other teams.

While each team can compete in any of the disciplines, which include the brain-computer interface race; the functional electrical stimulation bicycle race; the powered-arm prosthesis race; the powered-leg prosthesis race;



Silke Pan of Team PolyWalk EPFL in the powered exoskeleton race.

the powered-exoskeleton race, and the powered-wheelchair race, only one pilot can participate per team per discipline.

The disciplines are designed to showcase the technology that can be used to improve the lives of those living with a disability, by creating specific challenges that mimic the obstacles that are faced by such people every day. "Compared to the Paralympics, who are searching for the strongest and fastest, we are searching for those pilots who are most skilled to use a device for daily life activities," Riener explains. "We do not consider our event as a sport, though the participants have to train, and they have to perform well."

For example, the powered-wheelchair race includes six hurdles, such as entering a building with thresholds or narrow doorways, or crossing uneven pavement, that must be completed in as little time as possible.

Meanwhile, the brain-computer interface race provides a competition for teams who have developed methods for using brain waves to control avatars in a computer game, which is analogous to brain waves ultimately being used to control objects in the real world. This type of control ultimately will be useful to those with partial or total paralysis.

The powered-arm prosthesis race pits competitors against one another, making them complete daily tasks such as slicing bread or placing silverware on a table using only their prosthetic arms, as quickly and accurately as possible. These fine-motor coordination tasks are technically challenging for those with limb loss or damage, and many of the solutions highlighted in the competition could be further developed in the future for use in the real world.

Unlike other sporting or robotics competitions, the end goal goes beyond establishing a "winner." According to Riener, the goals of Cybathlon are to facilitate conversation between academia and industry, to engender discussion between technology developers and people with disabilities, and to promote the use of robotic assistive aids to the general public.

"A platform like Cybathlon allows people to see what is the state of the art and what is upcoming," says David Langlois, a team leader with Iceland-based prosthetics and orthotics developer Össur, which brought its Rheo Knee, an advanced learning prosthetic device that automatically adapts to the user and the environment, to Cybathlon, and took home the top prize in the powered leg prosthesis race. "This type of event is like going to a car show to see what is new. The only difference is that the manufacturers have to complete a series of mundane tasks to show what their devices are really about."

Furthermore, researchers praised Cybathlon as a platform to showcase interim advances in their work. "Cy-

bathlon sets a deadline and pushes for delivery of the innovation which has happened before,” says Knut Lechler, Össur’s other team leader. “The Cybathlon provided a platform to show what we have in the pipeline.”

Lechler’s colleague David Langlois noted that Cybathlon represents a new way for commercial providers such as Össur to market the real-world user benefits of their technologies prior to being released or sold to the public, rather than simply highlighting clinical results or technical specifications. Says Langlois: “You can see Cybathlon as a reversal of the usual innovation competition framework, challenging the manufacturers and innovators to showcase their contribution to the users.”

The structure of Cybathlon is also unique in that both the pilots who control the devices and the technology itself are of equal importance.

“Pilots have to show that they can complete a task that is integral to daily life,” Riener says. “The device needs the pilot, because it needs someone to control the device.”

According to Riener, most of the teams are from universities and other non-profit development groups, though about 25% were for-profit, commercial, or industrial groups. However, Riener says that the types of solutions presented by the corporate teams were generally simpler, but more robust in nature.

“The companies want to develop technology that can be commercialized quickly, and that’s why they develop solutions that can be considered to be more practical,” Riener says.

On the other hand, many competitors at Cybathlon are academic researchers, such as NeuroCONCISE, a non-profit group that has developed wearable neurotechnology. NeuroCONCISE’s solution noninvasively measures and translates brain waves into control signals that permit people to communicate and interact with computers without moving. The group took third place in the brain-computer interface race, and team leader Damien Coyle noted the competitive angle helped motivate and reinforce the team’s belief that its work is on the right track.

“This competition was going to re-

ally test and raise the bar to see what the technology could achieve,” Coyle says. “It also raised awareness among the public about the technologies that are out there, and put us all under pressure” to make sure the work they are doing is viable.

Another team that competed at Cybathlon came from the Florida-based Institute for Human and Machine Cognition, or IHMC, which has been working on an exoskeleton using torque-controlled actuators and powered joints to help people who have been paralyzed, or who have lost a limb. The group competed and earned a silver medal in the powered exoskeleton race, in which the pilot needed to complete six tasks that are common to everyday living.

Team leader Peter Neuhaus said care was taken by the organizers to make sure the tasks would be challenging, yet not so difficult to complete as to be unreasonable. Significant attention was paid to ensuring the tasks were as closely related to real-world scenarios as possible, which meant all technology designs needed to be practically focused, rather than focused on abstract concepts or movements. Indeed, the tasks in the exoskeleton race—getting up from a sofa, walking around obstacles, walking up a ramp to open and walk through a door, walking over stepping stones, walking over an uneven floor, and walking up and down stairs—are tasks likely to be encountered on a regular basis by people with impaired mobility.

“Our research group has been in other types of competitions before,” Neuhaus says. “The challenge with competitions is to ensure that the solution to the task advances the research field. The solutions developed for Cybathlon use advances that carry on beyond the competition, and can operate in the real world.”


All told, the significant amount of attention paid to Cybathlon—more than 4,600 spectators attended in person, and international media coverage of the event was strong—helped raise awareness of the research being done in universities and among for-profit companies. Participating in Cybathlon is “something you can tell people about,” Coyle says. “It’s quite

a unique thing, and it opened up further avenues for where the technology could go.”

Cybathlon is also helpful in eliminating some of the silos that often occur in research and commercial development labs.

“A competition like Cybathlon provides a great insight on what is the current thinking about real-life challenges associated with disabilities,” Langlois says. “Furthermore, since there is always a lot of ways to solve these problems and there is no book telling you how to resolve it, a friendly competition between innovators and engineers is always a good way to stimulate creative minds and drive out technology.”

According to participants, there aren’t any similar events being produced, either in the U.S. or around the world, that aren’t affiliated with Riener’s group; Cybathlon’s close ties with researchers and corporate entities involved in bionic prosthetics and brain research likely has consolidated support around the Cybathlon brand and event. Riener says smaller regional events that license the Cybathlon name may be launched around the world over the next four years, and another major event is slated to take place in Zurich again in 2020.

Interest remains high, as current assistive technology is not yet satisfactory, according to Riener. “The wheelchairs are still too bulky, and can’t go over uneven terrain,” he says. “The commercially available prosthetic devices are still not powered, which makes it very challenging to climb stairs or walk up ramps.” 

Further Reading

Cybathlon Championship for Athletes with Disabilities: <http://www.cybathlon.ethz.ch/>

Cybathlon 2016 Highlights: <https://www.youtube.com/watch?v=KAVcVfKoYwc>

Reiner, R.

Cybathlon: A bionics competition for people with disabilities, <http://robohub.org/cybathlon-a-bionics-competition-for-people-with-disabilities/>

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