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OCTOBER 2016



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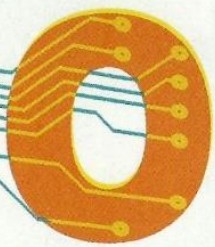
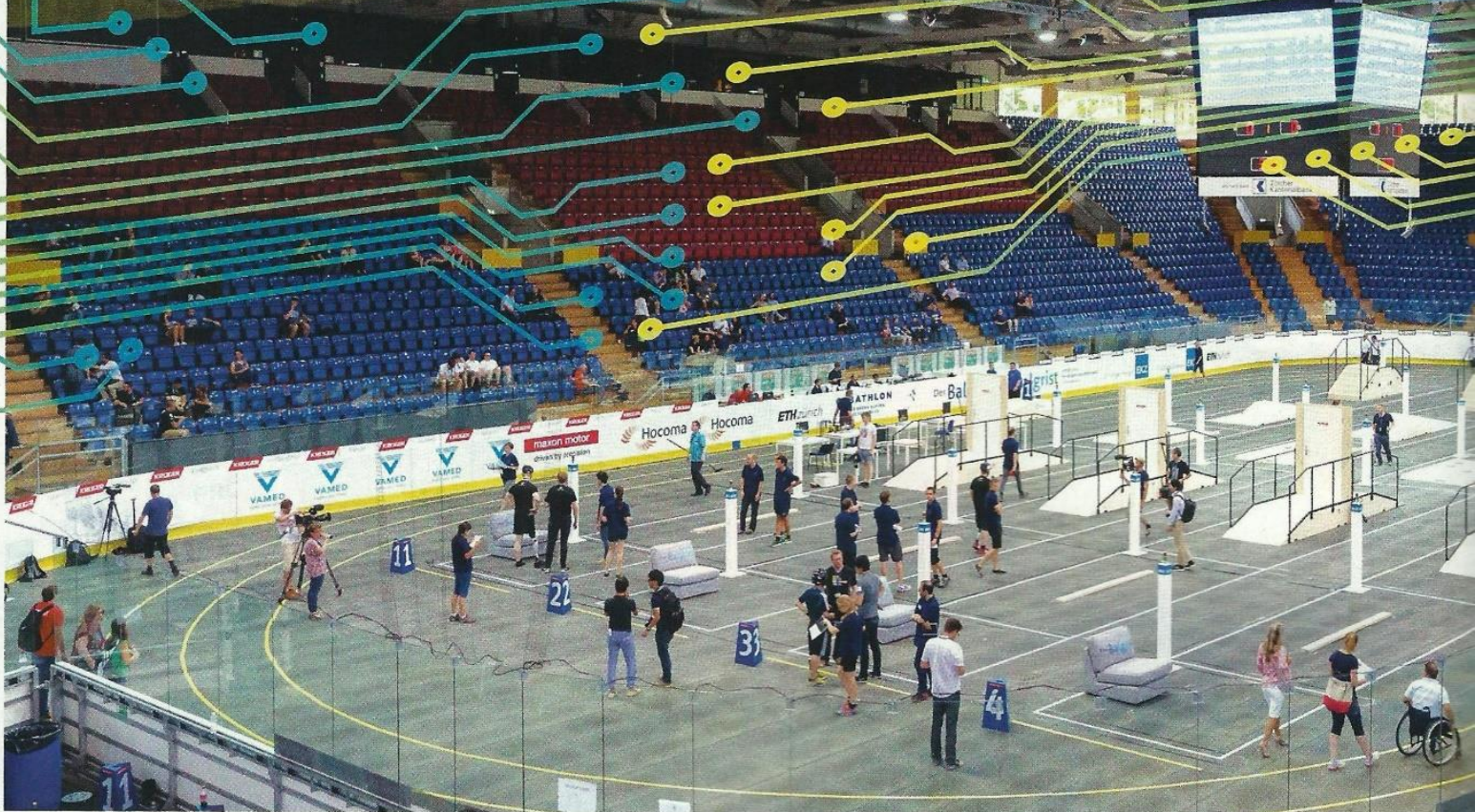
From Cricket Media

by Steve Murray

BATTLE OF THE BIONICS

Welcome to the Cybathlon, a new international competition that merges human effort with tech innovation.





On your mark, get set . . . go! The starter flag drops and the race is on. While their teams shout encouragement, the competitors reach their first challenge—a line of sofas. Each person sits down and stands up again. The exoskeletons that they’re wearing seem to be working well. Now it’s on to the next challenge: up a ramp and through a door, as fast as they can get there.



to go about their daily lives. These devices provide a lot of critical help, but there’s plenty of room for improvement.

Unlike the 2016 Olympic and Paralympic games, in which elite athletes competed in sporting events, the Cybathlon showcases non-athletes with physical impairments competing in the challenges of daily living. Participants are wholly human—and also part machine. “It’s less about force and speed, and more about control of the body and the device,” explains Riener. That’s why competitors are called “pilots,” rather than “athletes.” And because the technologies are so vital to competitor performance, both the winning pilots and their design teams receive awards in each event.

These competitors are here for the first international Cybathlon, occurring in Zurich, Switzerland in October 2016. This unique event is testing the latest assistive technologies for people with disabilities. While certain technology isn’t allowed in the Olympic or Paralympic games, it’s at the heart of the Cybathlon. Competitors and their design teams are pioneers, showing what people with physical impairments can accomplish with some high-tech help.

A WORLD OF CHALLENGES

The idea for the Cybathlon began with Robert Riener, a professor at the

Swiss Federal Institute of Technology in Zurich. Riener envisioned the Cybathlon as a way to push new engineering designs and to increase awareness about important human needs. “Unfortunately, many people without disabilities know very little about the challenges faced today by people with physical disabilities,” he said.

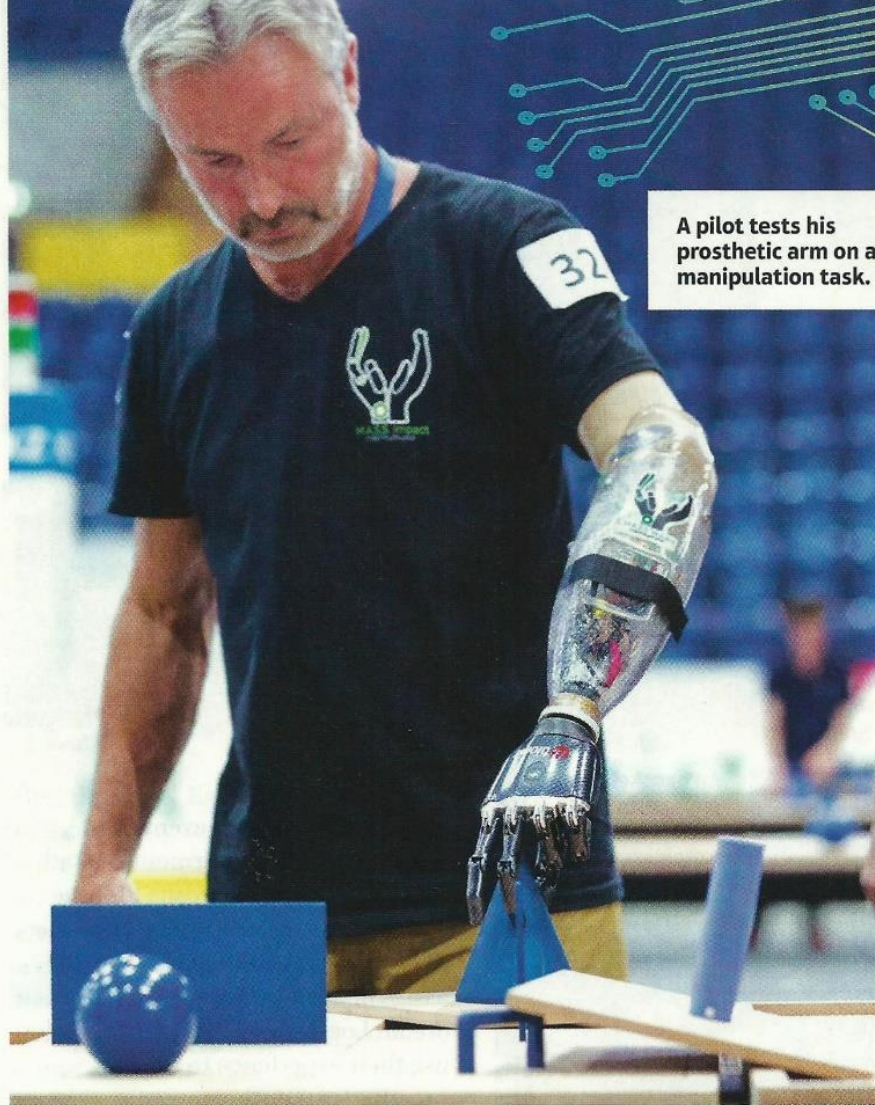
The World Health Organization reports that about 1 billion people—15 percent of the world’s population—have physical disabilities of some kind. Many people rely on technologies like wheelchairs or prosthetic limbs

UNCONVENTIONAL ARENA

Cybathlon events cover a wide range of technologies. Teams from all over



In the Cybathlon arena, a bike track surrounds four obstacle race tracks.



A pilot tests his prosthetic arm on a manipulation task.

the world compete in races designed for prosthetic arms, prosthetic legs, exoskeletons, and wheelchairs. Some pilots race bikes around the track by controlling their leg muscles with electrical signals. Others race through a computer game using the electrical signals they generate with their brains.

The Cybathlon arena is as different as its events. Yes, there is a racetrack around the floor, and seating along the outside for fans, but most of the action takes place along four parallel tracks in the center, each with rows of obstacles. This is where assistive technologies and their users are tested against the tasks of daily living.

Many people can make their own breakfast, open doors while carrying bags, or get up from a deep sofa. These common tasks can be big hurdles, however, for people with prosthetic arms or legs, or those who use wheelchairs.

AGILE ARMS, NIMBLE LEGS

People have been fashioning prosthetic limbs for thousands of years. Modern arm designs have flexible wrists and fingers and can even be controlled by muscle signals. New leg designs offer flexibility at the knee and ankle. The Cybathlon Powered Arm Prosthesis Race and the Powered Leg Prosthesis Race push both kinds of devices to their limits.

The arm race requires pilots to do things like preparing a breakfast tray and carrying it through a doorway, or hanging up clothes from a hamper. Pilots in the leg race must sit in and stand up from a sofa, step over and around obstacles, and walk on ramps and angled surfaces. Like any obstacle race, each task must be completed before moving on to the next one. The first pilot across





Ramp-climbing practice with an advanced prosthetic leg design



A wheelchair team faces a stair-climbing task.

motors that may assist in walking.

Exoskeletons have been called “shadow robots” because of the many kinds of help they provide to the people who wear them. Nevertheless, exoskeletons require a lot of effort to operate. Lucia Kurs became paraplegic after surgery to remove tumors on her spine. “I was always used to overcoming limitations,” she says. “When my doctors told me that I would never be able to walk again, I just did not accept it.”

Through daily training, Kurs was able to transition from a wheelchair to leg braces and, recently, to an exoskeleton. Now she is a pilot in the Powered Exoskeleton Race. The exoskeleton event involves most of the same tasks as the leg race.

ALL-TERRAIN WHEELCHAIRS

Wheelchairs are one of the world’s oldest assistive technologies, and they can still do a lot to restore personal mobility . . . if the ground is flat. Navigating uneven pavement, riding over ramps, and traveling up and down stairs are still huge challenges for wheelchair users. This is why the Powered Wheelchair Race presents exactly these kinds of tasks. Race pilots must steer around obstacles on a special slalom course, drive over rough surfaces, and maneuver up and down stairs.

Robi Bojanec is from Slovenia. He has been a wheelchair user since an accident left him without the use of his legs. Like many other pilots, Bojanec is competing in the

the finish line wins.

The pilots in each event must have a physical impairment related to the event, which means that the competitors already understand the difficulties of working with specific assistive devices. Many pilots, like Stefan Loesler and Patrick Mayrhofer, use their experience to improve prosthetics for others.

Loesler lives near Stuttgart, Germany and uses a prosthetic leg. He has tested products for a company that develops assistive devices. “The whole idea of the Cybathlon is really exciting and I also love challenges,” he says. “But what is more important for me is to meet nice people there.”

Mayrhofer lives in Vienna, Austria. He lost a hand in a work accident and uses an arm prosthetic. Mayrhofer now teaches other people how to use their new prosthetic devices. “The Cybathlon is a great chance to show what I’m able to do,” he says. “What makes it more exciting is the direct competition with other products, developments, and users.”

SHADOW ROBOTS

Many paraplegics—people who cannot use their legs—find wearing an exoskeleton to be helpful. An exoskeleton is a set of braces that support and stabilize their legs. Modern exoskeletons are often computer-controlled, with small

An exoskeleton pilot tests his team’s tech on a stair-climbing challenge.



wheelchair race for more than just himself. "What do I hope to gain from this competition? New knowledge and the opportunity to help those who cannot help themselves."

PEDALING WITH ELECTRIC LEGS

Functional electrical stimulation (FES) is a way to move paralyzed muscles. When an electrical current flows through electrodes on the skin, the muscles contract. By applying the current in certain patterns, FES can help people who are paralyzed to grasp, stand, and even walk. The Functional Electrical Stimulation Bike Race, the only Cybathlon event that uses the arena track, tests this technology.

Although FES is a useful way to move paralyzed muscles, electrical stimulation can be very tiring. Pilots will control the signals to their legs but must be careful to balance the need for fast pedaling with the risk of exhausting their muscles before they finish the race.

Greg McClure is an FES Bike Race pilot from Australia. After a spinal cord injury from a motorcycle accident, he has worked in spinal injury research. A strong competitor, McClure appreciates what the participants will take from the Cybathlon: "The excitement of the competition and the challenges, to meet and see other people, to participate inside the arena." He adds, "I think these experiences build character and make you stronger for it."

BRAIN RUNNERS

Almost everyone has played computer games, using a joystick controller to race through a video scene. What would it be like to get rid of the controller and play the game with only your thoughts? The Brain-Computer Interface (BCI) Race does exactly that.

Brain-computer interfaces detect signals from electrodes on a cap and convert them into commands that control devices like computers, wheelchairs, or even robotic arms. The technology can provide essential access to the world for people with severe impairments.

The BCI Race involves a specially designed multiplayer game called



A BCI team enjoys a BrainRunners training session.

BrainRunners. Each pilot sits in front of a computer screen wearing a cap with electric sensors to measure brain activity. Pilot brain signals create an electroencephalogram, or EEG, that a computer uses to control a running figure (or avatar) on the screen. By thinking about an action, pilots command their avatars to speed up, jump over spikes, or roll below laser rays on their way to the finish line. Fans watch the race on large displays over the arena floor.

David Rose, a BCI pilot from Great Britain, is especially excited about what brain interfaces might mean for people with disabilities. "Hey," he adds, "it will make computer games unbelievable for everyone too!"

GOING FOR THE GOLD

Teams attended a Cybathlon practice session in July 2015. They took in the arena, the tasks, and each other. Teams also practiced under realistic, but friendly, conditions. Many events are debuting in structured competition for the first time. Every team knows that the real competition will be stiff, and everyone is working hard to win.

Sebastian Reul, a BCI pilot who lives in Offenbach am Main, Germany, has been training weekly for more than a year to prepare for his race. "The Cybathlon is an amazing opportunity to present the technical state of the art," he explains. "And I



An FES Bike Race pilot

hope that it reaches a lot of people. ... I hope that research around paraplegia and neural diseases will also profit from it."

Cybathlon organizers expect to host 80 teams in 2016. If the event is a hit, the next Cybathlon could take place in Tokyo, together with the 2020 Olympic Games. Cybathlon organizers believe that competitions like this will inform the world what people can accomplish through ingenuity and effort.

A slogan on one team's T-shirts captures the Cybathlon spirit: "Redefining Ability."

Steve Murray is a freelance science and technology writer with a PhD in engineering. If a BrainRunners game is ever released to the general public, he'll be among the first to buy it.