At EPFL, Mother Nature meets the motherboard

In Western Switzerland, a new centre led by the Swiss Federal Institute of Technology in Lausanne (EPFL) is combining research in evolutionary software with robots that mimic animals.

BY FABRICE DELAYE

An automated grasshopper, a gyroscope that allows a robotic cricket to balance itself before bouncing again and again, a small glider that flies and clings to walls like a flying squirrel... When Mirko Kovac is displaying his ultra-light robots in the Laboratory of Intelligent Systems (LIS) at the EPFL, it almost feels like standing in front of one of Alexander Calder's graceful wire mobiles. Perhaps that's because these tiny automatons, so different from the bulky and complex androids of Star Wars, take their inspiration from nature itself.

The bio-inspired approach is one of the most promising avenues in robotics today, with the EPFL's pioneering researchers leading the way. Apart from the LIS, three other EPFL laboratories* are drawing inspiration from biology to design new robots. And since December 2010 all four have come together in a new dedicated robotics centre. Within two years they will even have their own building on the Lausanne campus.

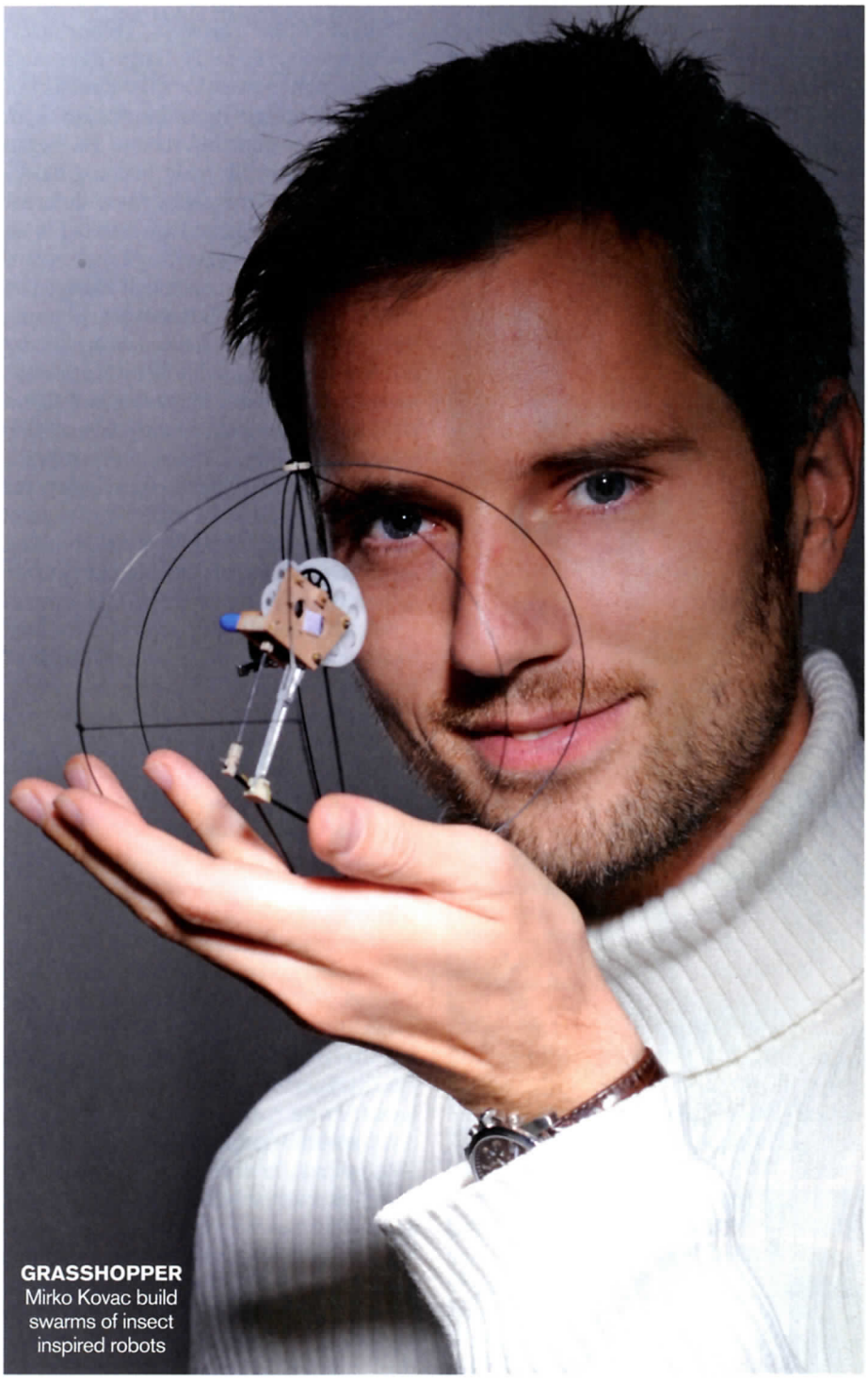
THE NUMBER

20.2 million

With CHF 13.3 million from the Swiss National Research Fund and CHF 6.9 million from EPFL the 4 years NCCR Robotics research program launched in december 2010 is raising robotics among the top priorities of Swiss strategic researches.

FOUR-YEAR FUNDING

Official recognition came in April 2010 with a four-year grant of CHF 13.3 million



GRASSHOPPER Mirko Kovac build swarms of insect inspired robots

PHOTO: OLIVIER EVARD

(€10 million) for a National Centre of Competence in Research (or NCCR, the leading program of the Swiss National Science Foundation), matched with CHF 6.9 million from the EPFL itself. The centre, known as NCCR Robotics, includes partners such as the ETH Zurich, the University of Zurich and the artificial intelligence institute IDSIA, and will be led by Lausanne. NCCR Robotics will begin with 17 leading researchers. However once the centre is fully operational the headcount should reach 80 to 100 experts, including PhD students, postdocs and new professors.

The NCCR's mission (see the article below) will be broader than just bio-robotics, but its creation underlines the exceptional potential of bio-inspired robotics in Western Switzerland. Instead of trying to program a set of complex functions – walking, vision, anticipation and so on– in a one-off human-looking android, biomimetic scientists like Mirko Kovac are betting on basic and cheap robots that can adapt as well as cooperate. "You may build a ten-kilogramme robot to carry out a specific task. But when it breaks down, it is all over. The alternative is to create a thousand microrobots weighing only ten grammes. Even if half of them fail, the assignment will go on," Kovac explains.

Behind Mirko Kovac's technological developments, there is Dario Floreano's breakthrough research. The director of the LIS, Floreano drew inspiration from nature to program his robots. He began with creating really basic building blocks of software. Progressively, these different bits of software mix and are selected in an almost Darwinian way. At a certain point during this evolution, a kind of intelligence (known as artificial life) emerged. Learning through a process of trial and error, the robot managed to pick the software combination most suited to its particular task – a bit like genes combining to regulate specific biological functions. Floreano's "evolutionary robotics" is currently focusing on the evolutionary synthesis of analogue electrical circuits, neural controllers that learn, the reverse engineering of genetic and metabolic networks, and biomedical signal processing.

But when robots work together, artificial intelligence reveals itself still further. Floreano and his team looked into the living organisms whose efficiency also emanated from combined intelligence – insects. This led them to collaborate with Laurent Keller, the renowned entomologist and ant specialist from Lausanne University (UNIL).

"What we notice with insects is that part of their intelligence actually lies in their body," explains Jean-Christophe Zufferey, Floreano's senior assistant. With this in mind, the researchers began to study the biomechanical properties of insects and then applied these properties to their robots. For instance, the Airburr project takes advantage of the principles behind the insect's exoskeleton to create a collision-resistant flying robot.

USEFUL INSECTS

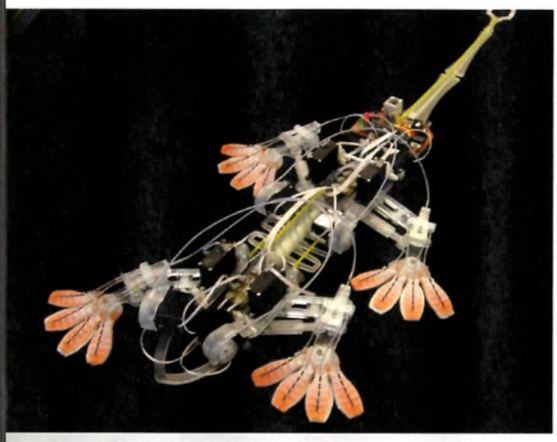
A passionate pilot and Swiss aerobatic champion, Zufferey created a miniature plane that imitates a fly. Weighing less than 10 grammes, the robot replicates the main sensors that allow a fly to avoid obstacles. "A camera mimics the fly's compound eye, inertial sensors its sense of direction and a micro-anemometer its hairs, which can sense the airflow," he says. The result is a micro-plane that can fly autonomously.

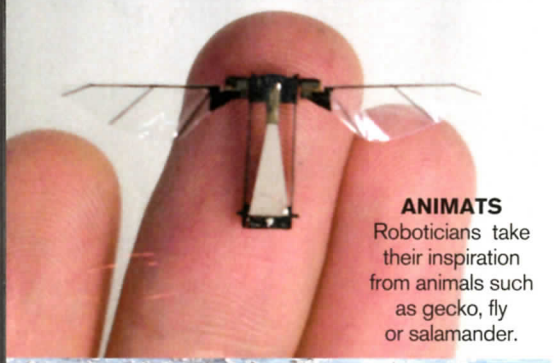
Late in 2009 the EPFL's success in bio-inspired robotics led to an economic milestone when Zufferey created a spin-off company called senseFly to market the Swinglet, a mini-drone that can monitor agricultural fields as well as sensitive industrial sites. He also uses a swarm of mini-drones to generate a temporary WiFi network – which could be vital to rescuers at a disaster site when all the traditional communication infrastructures are down.

Mirko Kovac is also looking into emergencies and the surveillance of sensitive sites, using a swarm of robot-crickets that can jump 60 centimetres in the air to locate their whereabouts, and get their balance back before bouncing again. The swarm could be deployed to look for victims at an earthquake site, or give warnings about the spread of a forest fire.

Because they can adapt to the natural environment but also see, sense and communicate, swarms of bio-inspired robots are probably more likely to become a practical proposition than the complex and energy-demanding C3PO-like androids.

* LASA – Learning Algorithms and Systems Laboratory, managed by Professor Aude Billard; DISAL – Distributed Intelligent Systems and Algorithms Laboratory, led by Professor Alcherio Martinoli; and BioRob – the Biorobotics Laboratory, run by Auke Ijspeert.





ANIMATS Roboticians take their inspiration from animals such as gecko, fly or salamander.

PHOTOS: HERZOG/EPFL, DR

HUMAN ORIENTED ROBOTICS

The new National Centre of Competence in Research (NCCR) "Robotics – Intelligent Robots for Improving the Quality of Life" encompasses a promising field of engineering which aims to develop new and human-oriented robotic technology to benefit society as a whole. According to its director, Dario Floreano, «in the near future, intelligent robots will play an important role in improving quality of life. For example, "care robots" will help elderly people stay in their familiar surroundings for longer; "neuroprosthetic" and "exoprosthetic" robots will increase the mobility and autonomy of people with disabilities; "educational robots" will support the training of a new generation of scientists and engineers; "environmental robots" will keep our world cleaner and safer.»

TENANTS Newly built private research facilities at EPFL are rapidly booked.

PHOTO: OLIVIER EVARD

EPFL's Innovation Square is a magnet for ICT companies

The new Innovation Square of the Swiss Institute of technology in Lausanne (EPFL) and its talent pool is attracting major information technology companies.

BY PASCAL VERMOT

Established next to the Science Park (PSE), the five new buildings of EPFL's Innovation Square are beginning to fill up with tenants. After Logitech announced its arrival in June 2009 and opened the "Daniel Borel Innovation Centre" in September 2010, its largest research centre, companies like Nokia and ELCA have followed through. Beyond the computer industry, companies such as Credit Suisse will also enjoy the neighbourhood with its new "Centre of IT development", to develop banking applications, in particular for cloud computing.

What are these companies up to? First, best in class scientific expertise. If the EPFL has a Faculty for ICT, the school favours multidisciplinarity, a very useful strategy when developing converging technologies, be it in signal processing, micro-components or software programming. For example, last year, Logitech announced that the research conducted in Lausanne will focus on next-generation interfaces "incorporating computers, television and smartphones," according to Julien Labrousse, Logitech Europe President. Thanks to the work in the field of acoustics carried out by a young defector from the Fraunhofer Institute, Christof Faller, Logitech has put his hand on MP3 Surround, an augmented version the of the audio compression standard that is now equipping its high-end webcams.

In recent years, the EPFL has set up a partnership model favourable to industries. A strategy that owes much to Adrienne Corboud Fumagalli, Vice President for innovation and development since 2008. "About 7% of our research budget is generated by industrial partnerships. That is equivalent to Stanford," says Adrienne Corboud Fumagalli. Her team has deployed various measures to facilitate the transfer of knowledge to market, especially "research contracts", which give industrial partners rights to file patents for invention resulting from their partnerships with the EPFL. Given the number of competencies on the Lausanne campus, opportunities seem infinite. The EPFL is also host to a national research centre on information systems and mobile communication in which Nokia, for example, is a partner.

TALENT POOL

While in Europe, software is not considered as a patentable invention, many areas lead to the creation of intellectual property. In this domain many tenants of the Innovation Square have experienced great successes while collaborating with the school. For example, ELCA established a longstanding collaboration in the field of data security that gave birth to SecuTix, a microscopic image technology used for the secure home printing of tickets, that has been adopted by the Swiss national railroads CFF-SBB.

Defined by Logitech as an "innovative ideas box that will allow the emergence of projects and solutions to distinguish ourselves from the competition," the EPFL also represents a very interesting talent pool. Therefore, the brains transfer from the school bench to the industrial partners' offices is a clear target. "Our goal is that the tenants of the Innovation Square favour hiring trained researchers from EPFL," says Adrienne Corboud Fumagalli. Talents all the more precious for ICT companies that they do not abound in Switzerland as elsewhere. ■

NEXThink signs with EADS

A strategic agreement with EADS in cyber security affirms the importance of NEXThink.

BY CHANTAL MATHEZ DE SENGER

"The 2010 results are worthy of our objectives," says Vincent Bieri, co-founder of NEXThink. "Besides the agreement we signed recently with Cassidian (the new name for EADS Defence & Security), the start-up concluded many contracts in Italy and the Middle East. And 2011 looks promising."

COMPUTER OPTIMISATION IN REAL TIME

Launched in 2005 by the Artificial Intelligence Laboratory at the Swiss Institute of Technology of Lausanne (EPFL), NEXThink is active in the field of computing resource management. With its software installed in over 500,000 work stations spread across a dozen countries, it has developed a unique and innovative technology that facilitates and improves computer monitoring of large companies or public organisations. The technology rapidly pins down glitches in individual work stations, and it can also carry out data and statistical analysis.

The swift centralisation of information saves between 18 and 36% of an organisation's computing budget – a definite plus for productivity. Customers include the Swiss Federal Roads Office, the canton and the city of Geneva, the French Ministry of Defence (accounting for 250,000 work stations), the EPFL, the University Hospital of Lausanne, Qatar Telecom, the Swiss Touring Club, BAT and a number of local private banks. Recently, the company signed contracts with the Banque Cantonale Vaudoise, the Swiss Federal Department of Finance and the Federal Pension Fund,.

At present NEXThink is managing over 80 clients on 1,000 sites worldwide. It employs about thirty people. NEXThink has been profitable since 2009 and continues to grow throughout the world. A turnover of CHF 20 million (€15 million) is expected by the end of 2012. ■