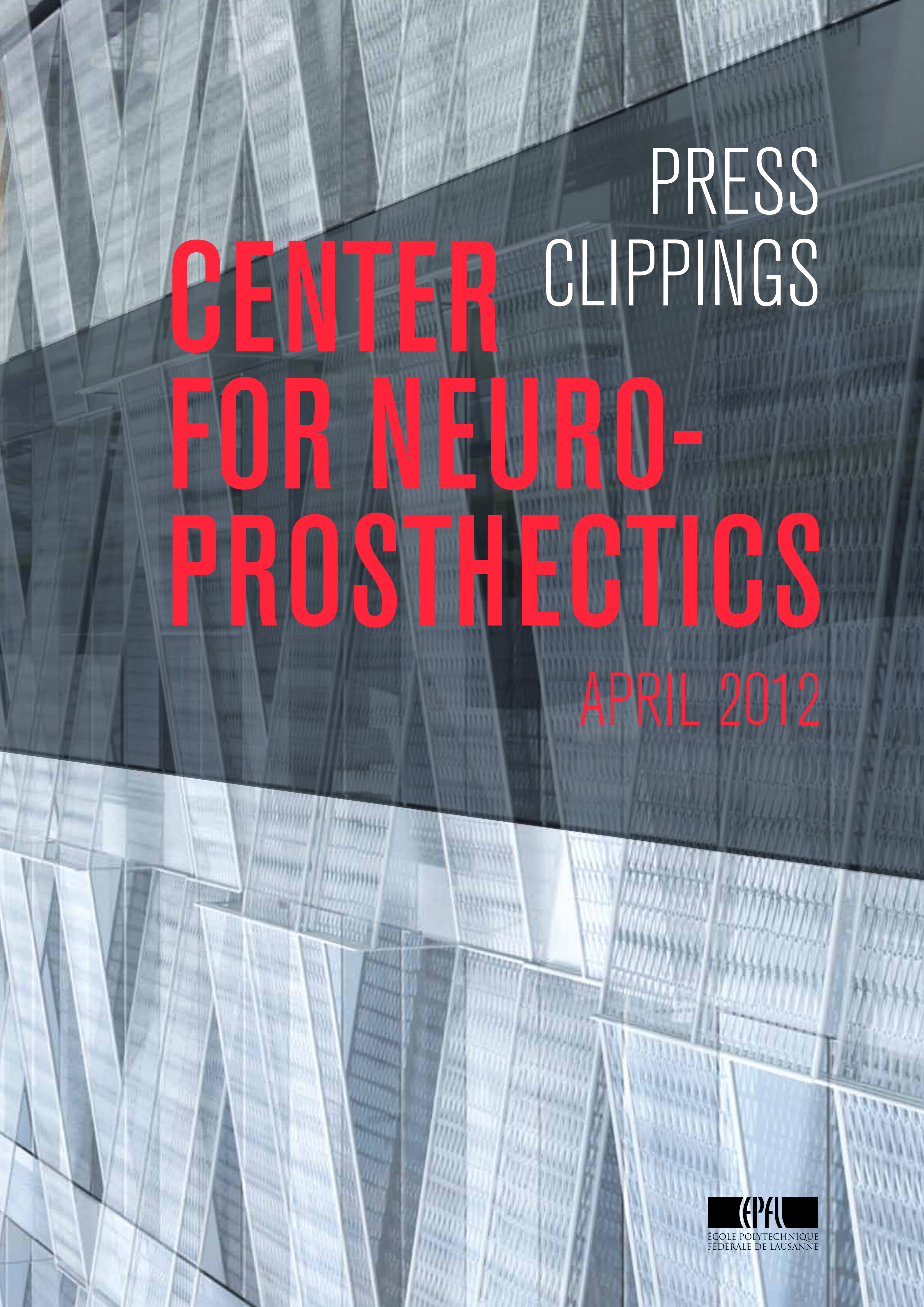

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## Possibilities of mind-controlled robots

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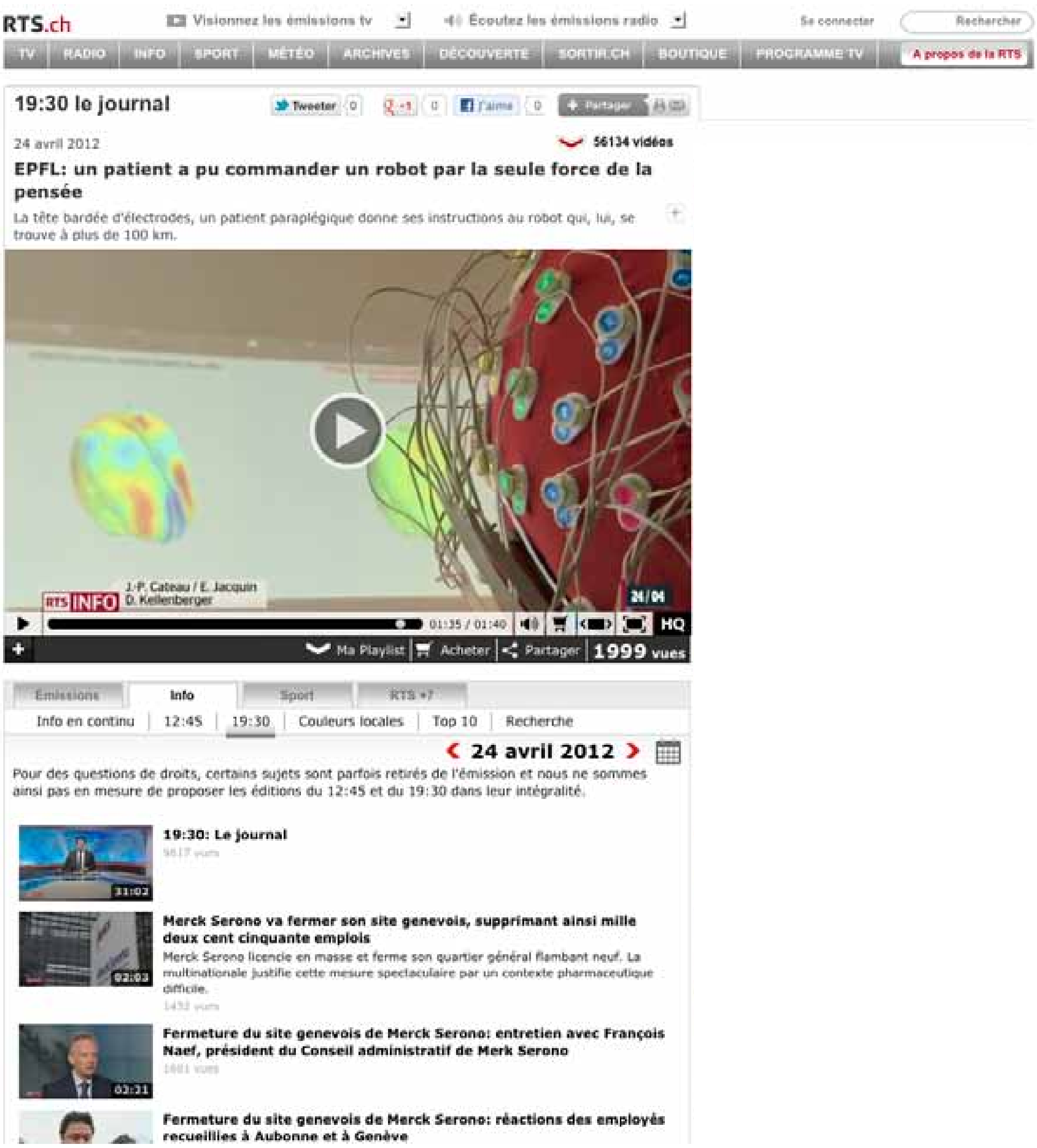

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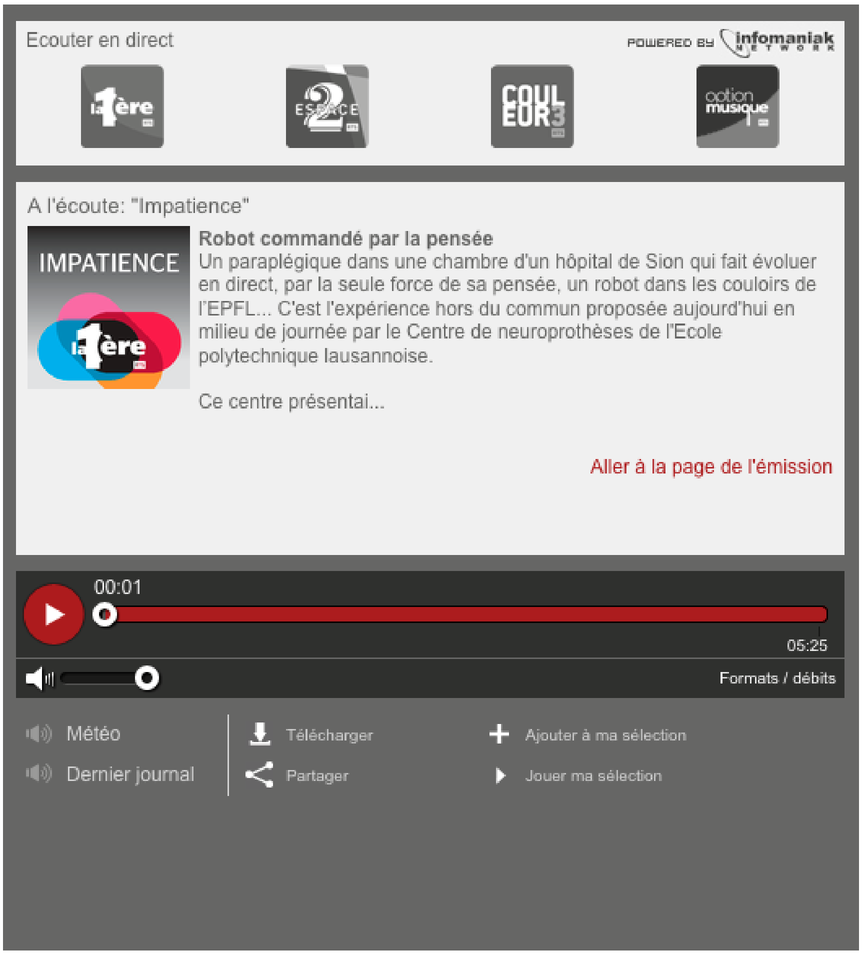
31:02
19:30: Le journal
02:03
Merck Serono va fermer son site genevois, supprimant ainsi mille deux cent cinquante emplois
Merck Serono licencie en masse et ferme son quartier général flambant neuf. La multinationale justifie cette mesure spectaculaire par un contexte pharmaceutique difficile.
02:31
Fermeture du site genevois de Merck Serono: entretien avec François Naef, président du Conseil administratif de Merk Serono
Fermeture du site genevois de Merck Serono: réactions des employés recueillies à Aubonne et à Genève

# RTS LA 1ÈRE - IMPATIENCE

CH
24 APRIL 2012

http://www.rts.ch/la-1ere/programmes/impatience/3912989-robot-commande-par-la-pensee-24-04-2012.html?f=player/popups



# RTS LA 1ÈRE - IMPATIENCE

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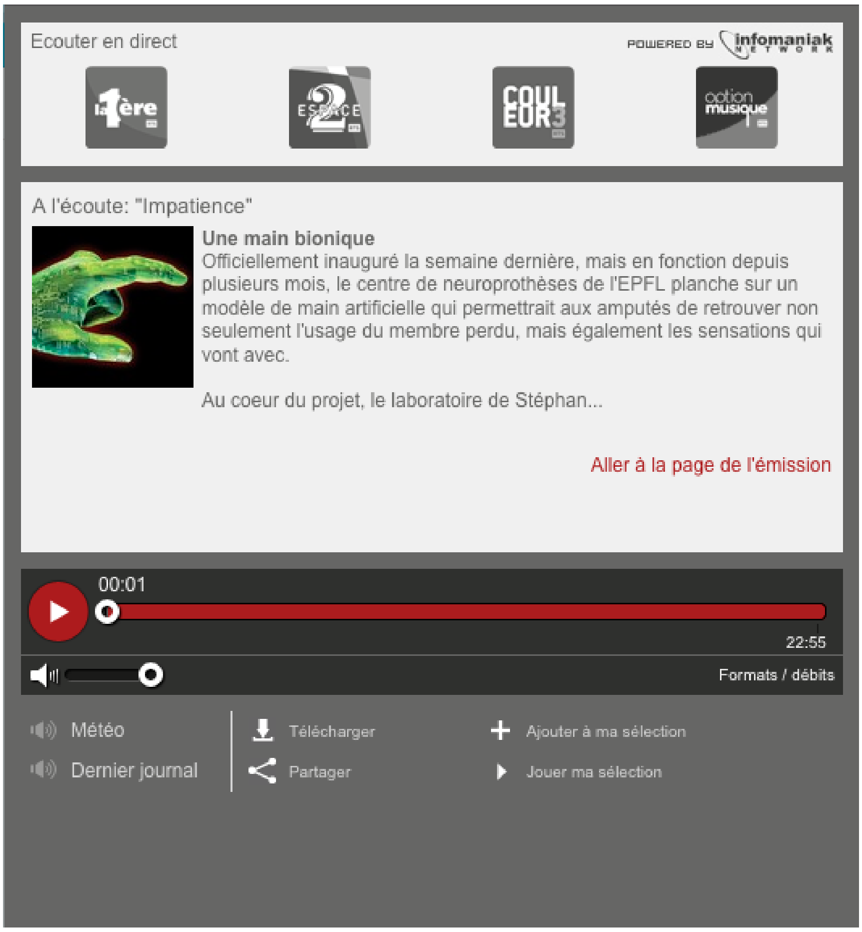


# PRINT & WEB ARTICLES - INTERNATIONAL

# Avatar becomes reality: Hi-tech head cap lets disabled man 'move' a robot slave 60 miles away using just his brain power

By ROB WAUGH

**PUBLISHED:** 16:55 GMT, 25 April 2012 | **UPDATED:** 11:33 GMT, 26 April 2012



Disabled people could one day be waited on hand and foot by a robot servant - or even send out the robot into society in their place.

It sounds like the plot of James Cameron's sci-fi hit Avatar, but Swiss scientists showed off today how a partially paralyzed person can control a robot by thought alone.

Simply by thinking about lifting his fingers, a patient was able to 'move' a robot 100 miles away.

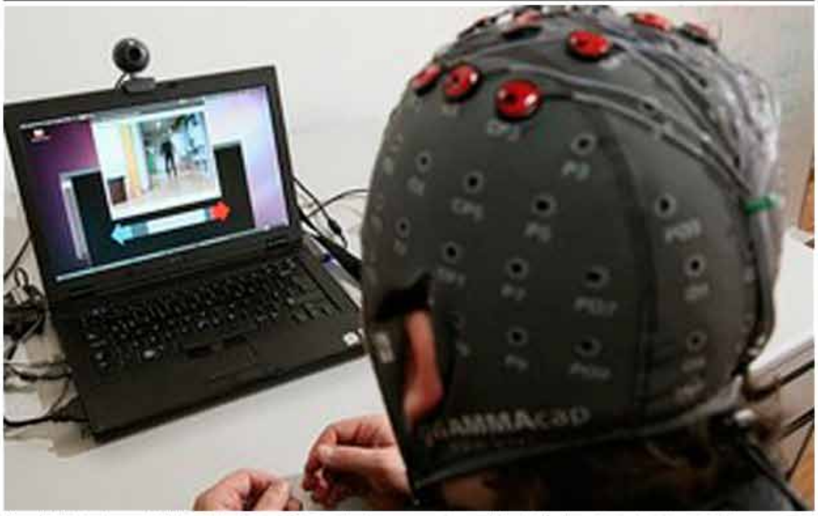
**Swiss billionaire philanthropist Ernesto Bertarelli, fourth from left, follows a robot controlled by Mark-Andre Duc, a partially tetraplegic patient at Switzerland's Federal Institute of Technology in Lausanne, Switzerland**

http://www.telegraph.co.uk/technology/news/9224652/Mind-controlled-robot-for-paraplegics-unveiled.html



## Mind-controlled robot for paraplegics unveiled

A robot that can be controlled by the brainwaves of a paraplegic person wearing an electrode-fitted cap has been unveiled.



The robot that can be controlled by the brainwaves of a paraplegic person wearing an electrode-fitted cap Photo: Alain Herzog / EPFL

6:06AM BST 25 Apr 2012



A paralysed man at a hospital in the **Swiss** town of Sion demonstrated the device, sending a mental command to a computer in his room, which transmitted it to another computer that moved a small robot 37 miles away in Lausanne.

The system was developed by Jose Millan, a professor at the Federal Polytechnic School of Lausanne who specialises in non-invasive interfaces between machines and the brain.

The same technology can be used to drive a wheelchair, Millan said.

"Once the movement has begun, the brain can relax, otherwise the person would soon be exhausted," he said.

But the technology has its limits, he added. The brain signals can be scrambled if too many people are gathered around a wheelchair, for example.

http://www.washingtonpost.com/world/europe/swiss-scientists-show-partially-paralyzed-person-can-control-robot-using-brain-signals/2012/04/24/gIQASEa4dT_story.html



# Partially paralyzed person can control robot using brain signals, Swiss scientists show

CAPTION FULLSCREEN

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By Associated Press, Published: April 24

LAUSANNE, Switzerland — Swiss scientists have demonstrated how a partially paralyzed person can control a robot by thought alone, a step they hope will one day allow immobile people to interact with their surroundings through so-called avatars.

Similar experiments have taken place in the United States and Germany, but they involved either able-bodied patients or invasive brain implants.

http://www.foxnews.com/world/2012/04/24/swiss-scientists-demonstrate-mind-controlled-robot/



# Swiss scientists demonstrate mind controlled robot

*Published April 24, 2012 / Associated Press*



LAUSANNE, SWITZERLAND – Swiss scientists have demonstrated how a partially paralyzed person can control a robot using brain signals alone.

The team at Switzerland's Federal Institute of Technology in Lausanne says the experiment takes them a step closer to enabling immobile patients to easily interact with their surroundings through a robot 'avatar.'

Tuesday's demonstration involved a partially tetraplegic patient at a hospital in the southern Swiss town of Sion who imagined lifting his fingers to direct a robot at the university 100 kilometers (62 miles) away.

Similar experiments have taken place in the United States and Germany but they either involved able-bodied patients or invasive brain implants, while the Swiss team used only a simple head cap to record the brain signals.

# Mind-controlled robot gives paralyzed man mobility

By Frank Jordans, Associated Press

Updated 4/24/2012 12:25 PM



LAUSANNE, Switzerland – Swiss scientists have demonstrated how a partially paralyzed person can control a robot by thought alone, a step they hope will one day allow immobile people to interact with their surroundings through so-called avatars.

Anja Niedringhaus, AP

A spectator moves out of the way as Mark-Andre Duc, seen on the computer screen, directs a robot at Switzerland's Federal Institute of Technology in Lausanne, Switzerland.



Similar experiments have taken place in the United States and Germany, but they involved either able-bodied patients or invasive brain implants.

On Tuesday, a team at Switzerland's Federal Institute of Technology in Lausanne used only a simple head cap to record the brain signals of Mark-Andre Duc, who was at a hospital in the southern Swiss town of Sion 100 kilometers (62 miles) away.

Duc's thoughts — or rather, the electrical signals emitted by his brain when he imagined lifting his paralyzed fingers — were decoded almost instantly by a laptop at the hospital. The resulting instructions — left or right — were then transmitted to a foot-tall robot scooting around the Lausanne lab.

Duc lost control of his legs and fingers in a fall and is now considered partially quadriplegic. He said controlling the robot wasn't hard on a good day.

"But when I'm in pain it becomes more difficult," he told The Associated Press through a video link screen on a second laptop attached to the robot.

Background noise caused by pain or even a wandering mind has emerged as a major challenge in the research of so-called brain-computer interfaces since they first began to be tested on humans more than a decade ago, said Jose Millan, who led the Swiss team.

While the human brain is perfectly capable of performing several tasks at once, a paralyzed person would have to focus the entire time they are directing the device.

"Sooner or later your attention will drop and this will degrade the signal," Millan said.

To get around this problem, his team decided to program the computer that decodes the signal so that it works in a similar way to the brain's subconscious. Once a command such as 'walk forward' has been sent, the computer will execute it until it receives a command to stop or the robot encounters an obstacle.

## Mark-Andre Duc, Partially Paralyzed Man, Moves Robot With His Brain, Say Swiss Scientists

AP | By FRANK JORDANS

Posted: 04/24/2012 6:41 am Updated: 04/24/2012 6:22 pm



AP

# Swiss scientists demonstrate mind-controlled robot

Published: Tuesday, 24 Apr 2012 | 8:26 PM ET



LAUSANNE, Switzerland - Swiss scientists have demonstrated how a partially paralyzed person can control a robot by thought alone, a step they hope will one day allow immobile people to interact with their surroundings through so-called avatars.

Similar experiments have taken place in the United States and Germany, but they involved either able-bodied patients or invasive brain implants.

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The robot itself is an advance on a previous project that let patients control an electric wheelchair. By using a robot complete with a camera and screen, users can extend their virtual presence to places that are arduous to reach with a wheelchair, such as an art gallery or a wedding abroad.

Rajesh Rao, an associate professor at the University of Washington, Seattle, who has tested similar systems with able-bodied subjects, said the Lausanne team's research appeared to mark an advance in the field.

# PARAPLEGIC REMOTELY CONTROLS ROBOT WITH THOUGHTS

The technology can help make paraplegics mobile and recover their lost senses.

Wed Apr 25, 2012 09:06 AM ET
Content provided by AFP



Controlling a computer using mental commands could help paraplegics drive a wheelchair. Click to enlarge this image.
*Jose Millan, Federal Polytechnic School of Lausanne*

**THE GIST**

- A paraplegic person wearing an electrode-fitted cap controlled a robot 37 miles away.
- The same technology can be used to drive a wheelchair.
- The brain-machine interface can help return mobility to paraplegics.

A professor at a Swiss university on Tuesday unveiled a robot that can be controlled by the brainwaves of a paraplegic person wearing an electrode-fitted cap, news agency ATS reported.

A paralyzed man at a hospital in the town of Sion demonstrated the device, sending a mental command to a computer in his room, which transmitted it to another computer that moved a small robot 60 kilometers (37 miles) away in Lausanne.

ANALYSIS: First Human Infected with a Computer Virus

The system was developed by Jose Millan, a professor at the Federal Polytechnic School of Lausanne who specializes in non-invasive interfaces between machines and the brain.

The same technology can be used to drive a wheelchair, Millan said.

"Once the movement has begun, the brain can relax, otherwise the person would soon be exhausted," he said.

But the technology has its limits, he added. The brain signals can be scrambled if too many people are gathered around a wheelchair, for example.

DNEWS VIDEO: Mind-Controlled Robot Uses Human Brainwaves

Besides making paraplegics mobile, neuroprosthetics could be used to help patients recover lost senses, researchers said.

Professor Stephanie Lacour and her team are working on an "electric skin" for amputees, a glove fitted with tiny sensors that would send information directly to the user's nervous system.

Eventually, researchers say they hope to create mechanized prosthetics that are as mobile and sensitive as a natural hand, Lacour said.

PHOTOS: Extraordinary Beauty of the Nano Art World

Other researchers at Lausanne are working on enabling paraplegics to walk again with electrodes implanted in their spinal cords.

# Mind-reading robot links with partial quadriplegic, takes orders



Mark-Andre Duc, a partially tetraplegic Swiss man, controls the movements of a mind-reading robot 62 miles away using his brain signals. (Associated Press / Anja Niedringhaus / April 24, 2012)

By Deborah Netburn
*April 24, 2012 | 2:15 p.m.*

Mind-reading robots? It's not as scary as it sounds.

Researchers in Switzerland are developing a robot that can respond to human thoughts, and may one

## Swiss scientists demonstrate mind-controlled robot

Posted at: 04/24/2012 2:08 PM
By FRANK JORDANS

(AP) LAUSANNE, Switzerland - Swiss scientists have demonstrated how a partially paralyzed person can control a robot by thought alone, a step they hope will one day allow immobile people to interact with their surroundings through so-called avatars.

Similar experiments have taken place in the United States and Germany, but they involved either able-bodied patients or invasive brain implants.

On Tuesday, a team at Switzerland's Federal Institute of Technology in Lausanne used only a simple head cap to record the brain signals of Mark-Andre Duc, who was at a hospital in the southern Swiss town of Sion 100 kilometers (62 miles) away.

Duc's thoughts _ or rather, the electrical signals emitted by his brain when he imagined lifting his paralyzed fingers _ were decoded almost instantly by a laptop at the hospital. The resulting instructions _ left or right _ were then transmitted to a foot-tall robot scooting around the Lausanne lab.

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Background noise caused by pain or even a wandering mind has emerged as a major challenge in the research of so-called brain-computer interfaces since they first began to be tested on humans more than a decade ago, said Jose Millan, who led the Swiss team.

While the human brain is perfectly capable of performing several tasks at once, a paralyzed person would have to focus the entire time they are directing the device.

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To get around this problem, his team decided to program the computer that decodes the signal so that it works in a similar way to the brain's subconscious. Once a command such as 'walk forward' has been sent, the computer will execute it until it receives a command to stop or the robot encounters an obstacle.

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Rajesh Rao, an associate professor at the University of Washington, Seattle, who has tested similar systems with able-bodied subjects, said the Lausanne team's research appeared to mark an advance in the field.

"Especially if the system can be used by the paraplegic person outside the laboratory," he said in an email.

Millan said that although the device has already been tested at patients' homes, it isn't as easy to use as some commercially available gadgets that employ brain signals to control simple toys, such Mattel's popular MindFlex headset.

http://dawn.com/2012/04/25/swiss-scientists-demonstrate-mind-controlled-robot/



# Swiss scientists demonstrate mind-controlled robot

AP | 25th April, 2012



A scientist waves to Mark-Andre Duc, a partially tetraplegic patient, at Switzerland's Federal Institute of Technology in Lausanne, Switzerland, Tuesday, April 24, 2012. — Photo by AP

**LAUSANNE: Swiss scientists have demonstrated how a partially paralysed person can control a robot by thought alone, a step they hope will one day allow immobile people to interact with their surroundings through so-called avatars.**

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Duc's thoughts or rather, the electrical signals emitted by his brain when he imagined lifting his paralysed fingers were decoded almost instantly by a laptop at the hospital. The resulting instructions left or right were then transmitted to a foot tall robot scooting around the Lausanne lab.

http://www.slate.com/blogs/trending/2012/04/25/mind_reading_robot_debuts_in_sqitzerland.html



«OLDER
Mad Cow Disease Hits U.S. With Fourth Confirmed Case

NEWER »
Obama and Jimmy Fallon Slow Jam the News on *Late Night*

# Mind-Controlled Robot Debuts in Switzerland

*By Ben Johnson and Slate V Staff* | Posted Wednesday, April 25, 2012, at 2:17 PM ET



A new robot with a laptop built in Switzerland can be controlled from 60 miles away by a person wearing nothing more than a special cap on their head.
Photo by YASUYOSHI CHIBA/AFP/Getty Images

Finally, we have proof that mind-reading robots can be used for good, not evil.

With the help of scientists from Switzerland's Federal Institute of Technology, a partially paralyzed man was able to control the movements of a mind-reading robot from more than 60 miles away simply by using brain signals.

April 24, 2012 8:30 PM

PRINT TEXT

# Swiss scientists demonstrate mind-controlled robot

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AP Associated Press

# Swiss scientists demonstrate mind-controlled robot

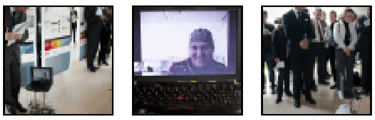
By FRANK JORDANS, Associated Press
Tuesday, April 24, 2012



Anja Niedringhaus / AP

A spectator moves out of the way as Mark-Andre Duc, seen on the computer screen, directs a robot at Switzerland's Federal Institute of Technology in Lausanne, Switzerland, Tuesday, April 24, 2012. From the hospital 100 kilometers (62 miles) away, Duc imagined lifting his fingers to direct a robot. Swiss scientists demonstrated with this test how a partially paralyzed person can control a robot using brain signals alone.

IMAGES



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(04-24) 08:18 PDT LAUSANNE, Switzerland (AP) --

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http://abcnews.go.com/Technology/wireStory/swiss-scientists-demonstrate-mind-controlled-robot-16200606#.T6D1ML_RdIt



# Swiss Scientists Demonstrate Mind-Controlled Robot

Associated Press

By FRANK JORDANS Associated Press
LAUSANNE, Switzerland April 24, 2012 (AP)



Swiss scientists have demonstrated how a partially paralyzed person can control a robot by thought alone, a step they hope will one day allow immobile people to interact with their surroundings through so-called avatars.

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Background noise caused by pain or even a wandering mind has emerged as a major challenge in the research of so-called brain-computer interfaces since they first began http://www.smh.com.au/it-pro/government-it/swiss-scientists-demonstrate-mindcontrolled-robot-20120425-1xkjr.html

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# Swiss scientists demonstrate mind-controlled robot

Frank Jordans
April 24, 2012

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Mark-Andre Duc, a partially tetraplegic patient, is seen on a laptop as he talks to scientists in Switzerland's Federal Institute of Technology in Lausanne, from a hospital 100 kilometers away. *Photo: AP*

Swiss scientists have demonstrated how a partially paralysed person can control a robot by thought alone, a step they hope will one day allow immobile people to interact with their surroundings through so-called avatars.

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Duc's thoughts - or rather, the electrical signals emitted by his brain when he imagined lifting his paralysed fingers - were decoded almost instantly by a laptop at the hospital. The resulting instructions - left or right - were then transmitted to a 30 centimetre-tall robot scooting around the Lausanne lab.

Duc lost control of his legs and fingers in a fall and is now considered

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# Swiss study using robot to help immobile people

Source: Agencies | 2012-4-26 | NEWSPAPER EDITION

SWISS scientists have demonstrated how a partially paralyzed person can control a robot by thought alone, a step they hope will one day allow immobile people to interact with their surroundings through so-called avatars.

Similar experiments have taken place in the US and Germany, but they involved either able-bodied patients or invasive brain implants.

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Duc lost control of his legs and fingers in a fall and is now considered partially quadriplegic. He said controlling the robot wasn't hard on a good day.

"But when I'm in pain it becomes more difficult," he said via a video link screen on a second laptop linked to the robot.

Background noise caused by pain or even a wandering mind has emerged as a major challenge in the research of so-called brain-computer interfaces since they first began to be tested on humans more than a decade ago, said Jose Millan, who led the Swiss team.

While the human brain is perfectly capable of performing several tasks at once, a paralyzed person would have to focus the entire time they are directing the device.

"Sooner or later your attention will drop and this will degrade the signal," Millan said.

To get around this problem, his team decided to program the computer that decodes the signal so that it works in a similar way to the brain's subconscious. Once a command such as "walk forward" has been sent, the computer will execute it until it receives a command to stop or the robot encounters an obstacle.

The robot itself is an advance on a previous project that let patients control an electric wheelchair. By using a robot complete with a camera and screen, users can extend their virtual presence to places that are arduous to reach with a wheelchair, such as an art gallery or a wedding abroad.

theTelegraph

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TECHNOLOGY SWITCHED ON

# Scientists show mind-controlled robot

From correspondents in Lausanne, Switzerland | AP | April 25, 2012 12:07am

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SWISS scientists have demonstrated how a partially-paralysed person can control a robot using brain signals alone.

Mark-Andre Duc, a partially tetraplegic patient, is seen on a laptop screen as he talks to scientists in Switzerland's Federal Institute of Technology in Lausanne, Switzerland. Picture: AP

The team at Switzerland's Federal Institute of Technology in Lausanne say the experiment takes them a step closer to enabling immobile patients to easily interact with their surroundings through a robot "avatar".

Today's demonstration involved a partially tetraplegic patient at a hospital in the southern Swiss town of Sion who imagined lifting his fingers to direct a robot at the university 100km away.

Similar experiments have taken place in the United States and Germany but they either involved able-bodied patients or invasive brain implants, while the Swiss team used only a simple head cap to record the brain signals.

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## SuperMoon 2012 - keep calm and carry on

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# PRINT & WEB ARTICLES - SWITZERLAND

Date: 25.04.2012
LE TEMPS

Le Temps
1211 Genève 2
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www.letemps.ch

Genre de média: Médias imprimés
Type de média: Presse journ./hebd.
Tirage: 42'433
Parution: 6x/semaine

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

N° de thème: 999.56
N° d'abonnement: 1086739
Page: 14
Surface: 45'376 mm²

# Fusion entre cerveau et électronique

Olivier Dessibourg

**> Neurosciences**

## Marier l'homme et la machine: le défi du Centre de neuroprothèses de l'EPF de Lausanne, inauguré mardi

Sur le tapis roulant vert, un rat blanc se tient debout sur ses pattes arrière, soutenu par une sangle ventrale reliée à un système robotisé collé au plafond. De sa peau, au niveau de la tête, sortent des électrodes. Si le rongeur parvient à se gratter le museau avec ses pattes de devant, celles de derrière, elles, sont inertes: l'animal a subi une section de sa moelle épinière, le rendant partiellement paralysé.

La chercheuse manipulant le rat enclenche un dispositif qui lance des impulsions électriques directement dans sa moelle épinière, à travers les implants: ses muscles bougent, le quadrupède se met à marcher! «Dans nos dernières expériences, il peut même courir. Et, petit à petit, il y arrive sans l'aide des impulsions», explique Grégoire Courtine. En précisant que le rongeur a reçu par injection un cocktail de molécules chimiques destinées à réveiller ce qu'il appelle le «cerveau spinal», un réseau de fibres électromotrices qui s'«endort» lors d'une paralysie. Et de conclure: «L'objectif de nos travaux est la récupération locomotive après une lésion de la moelle épinière.» Et chez l'homme? «Nous avons bon espoir que les effets soient les mêmes. Ce traitement a été testé sur un patient aux Etats-Unis. Et nous souhaitons bientôt lancer un essai clinique en Suisse.»

Ce chercheur est l'un des cinq professeurs du Centre de neuroprothèses de l'EPFL, lancé en 2009 mais inauguré officiellement mardi, auquel sera dédié, dans deux ans, un bâtiment actuellement en rénovation. Une initiative rendue possible notamment grâce au soutien de la Fondation Bertarelli, qui finance deux chaires, ainsi qu'à un partenariat dans le domaine avec la prestigieuse Harvard Medical School de Boston (LT du 30.10.2010).

«Le timing ne pouvait être

**Cobaye soumis à des expériences sensori-motrices déroutantes.** Les chercheurs souhaitent mieux comprendre comment, par les sens et les mouvements, le cerveau se représente le corps. ARCHIVES

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meilleur, se réjouit son directeur, Olaf Blanke. D'un côté, des avancées récentes ont été réalisées pour implanter de nouvelles technologies électroniques directement sur le système nerveux. De l'autre, les neurosciences ont aussi fait d'énormes progrès. L'objectif de ce centre est de fusionner ces deux domaines.»

De manière non invasive, d'abord. Depuis des années, le groupe de José Millan développe une chaise roulante que son passager peut guider par ses pensées uniquement, au travers d'un casque d'électrodes posées sur sa tête (LT du 15.05.2007); il peaufine aujourd'hui son prototype de manière à ce que le «pilote» n'ait pas besoin de se concentrer sans cesse sur le guidage, ce qui l'épuiserait vite mentalement. «En rendant la chaise plus «intelligente», nous parvenons à faire durer l'expérience plusieurs heures», explique le professeur.

D'autres recherches ont un caractère plus invasif. Ainsi, l'équipe de Silvestro Micera planche sur un nouveau type d'implants cochléaires. Quelque 200 000 exemplaires de ces dispositifs auditifs ont en effet déjà été implantés dans le monde pour palier au fonctionnement de la cochlée, mais ils sont inefficaces lorsque le nerf auditif est défectueux.

Le même groupe met au point un bras bionique visant à rétablir les fonctions complexes de la main, en créant une interface bidirectionnelle directe entre le système nerveux périphérique et une prothèse perfectionnée. Ce membre robotisé serait actionné par des commandes transmises via les nerfs moteurs. De même, des informations extérieures pourraient être transmises à ces mêmes nerfs, puis acheminées jusqu'au cerveau. Mais quel genre d'informations?

> «Le timing ne pouvait être meilleur pour l'ouverture de ce centre»

«Sensorielles, par exemple», répond Stéphanie Lacour. La chercheuse travaille sur une sorte de peau artificielle. «Nous développons des matériaux élastomères sur lesquels le défi est de pouvoir intégrer des circuits microélectroniques, le tout devant garder une grande souplesse dans les déformations possibles.» Objectif: «Obtenir une surface souple capable de ressentir la pression tactile, la température ou les mouvements de glissement, comme lorsque qu'un objet nous glisse des mains. Nous sommes assez avancés dans ce domaine.» Mais concernant l'utilisation des signaux générés par cette peau électronique et leur «injection» dans le système nerveux du patient, «nous n'en sommes qu'au début, admet-elle. Nous devrions avoir de premiers prototypes dans une décennie.»

Au fait, comment une personne s'approprie-t-elle mentalement une prothèse? C'est le genre de questions qu'évalue Olaf Blanke. «Lorsque je me touche le ventre, je le vois et je le sens physiquement, explique le professeur. Le cerveau fusionne ces deux informations de manière automatique et très rapide. Or, pour mieux comprendre la représentation que notre cerveau se fait de notre corps, et donc la contrôler pour ensuite la stimuler, nous souhaitons dissocier les différents stimuli (moteurs, tactiles, visuels) que le cortex reçoit, ceci en observant, à l'aide de l'imagerie IRM notamment, les diverses aires cérébrales impliquées.» Pour ce faire, le chercheur a mis au point tout une série d'expériences mettant en scène des avatars. Par exemple, des images du propre corps du cobaye sur lesquels ce dernier voit se faire des actions alors qu'il en ressent physiquement d'autres, à d'autres endroits de son enveloppe charnelle. Une sensation déroutante.

EN SEPTEMBRE, VINGT-CINQ VILLAGES FÊTERONT MONTREUX
Riviera-Chablais, page 24

L'AVION SOLAIRE *SOLAR IMPULSE* VA TESTER SES LIMITES AU MAROC
Nord vaudois-Broye, page 25




Neuroprothèses

# L'EPFL est à la recherche d'une peau artificielle électronique

**Dans le centre de neuroprothèses présenté hier, la professeure Lacour planche sur des circuits intégrés déformables à l'envi**

**Jérôme Ducret** Textes
**Florian Cella** Photos

Redonner le sens du toucher aux personnes qui portent une prothèse de la main, c'est l'une des applications possibles des travaux de l'équipe de la professeure Stéphanie Lacour, établie depuis quinze mois à l'EPFL. Elle dirige l'un des six groupes de recherche qui forment le centre de neuroprothèses, présenté hier à la presse suisse et internationale.

«Les circuits intégrés traditionnels sont structurés de manière plane et ils sont très peu déformables, explique Stéphanie Lacour. Ce qui les rend difficilement utilisables pour certains usages, notamment dans des interfaces entre des prothèses et le système nerveux. Il faut pouvoir adapter la forme des circuits ou des dispositifs électroniques aux parties organiques sur lesquelles ils sont censés venir se greffer.»

Elle cite l'exemple de la peau artificielle. Elle doit être déformable, de la même manière que la peau d'origine. Et pour permettre de sentir ce que l'on touche, il faut qu'elle dispose de capteurs et de circuits électroniques résistant à ces déformations. «Nous avons un matériau qui répond à ces exigences et qui peut contenir des pistes métalliques conductrices de courant, déclare la scientifique. Il faut encore arriver à y intégrer des composants électroniques, ce qui n'est pas si simple.»

Quant à savoir quand cette technologie se retrouvera vraiment au service des patients amputés, par exemple, Stéphanie Lacour reste prudente dans sa réponse. «Peut-être dans une dizaine d'années, les technologies sont là, mais il faut les intégrer.» Et trouver des partenaires industriels, bien sûr.

### Prothèses de l'ouïe

Les techniques employées pour créer des peaux électroniques ont encore bien d'autres applications, notamment dans le traitement de la surdité ou des malfonctions de l'ouïe. «Nous travaillons par exemple sur de nouveaux types de prothèses auditives, explique Stéphanie Lacour. Dans certains cas, le nerf auditif, qui se trouve entre la prothèse et le cerveau, ne fonctionne plus, et il ne sert donc à rien d'effectuer un implant classique.»

L'idée est de court-circuiter le nerf en question et de brancher le dispositif directement sur les cellules nerveuses du cerveau. «Mais, pour cela, il faut des électrodes qui s'adaptent précisément à la surface cérébrale», ajoute la chercheuse. Grâce à un matériau conducteur et déformable…

Le centre de neuroprothèses fourmille d'autres projets. Ils bénéficient du soutien de l'EPFL, mais aussi de fondations agissant comme des mécènes: Bertarelli (du nom de l'ex-PDG de Serono), Defitech (famille Borel, les fondateurs de Logitech), Fondation de famille Sandoz, et Fondation internationale pour la recherche en paraplégie. Ces bailleurs de fonds privés allouent 15 millions sur cinq ans.

Stéphanie Lacour travaille sur des circuits électroniques déformables, prélude à des prothèses de peau.


Un prototype, avec un sens du toucher rudimentaire.


Le matériau pressenti, souple et conducteur d'électricité.

## La pensée pilote un robot et le paralysé remarche

● Le groupe du professeur José Millan, qui fait lui aussi partie du centre de neuroprothèses, travaille sur un type non invasif d'interface entre le cerveau et la machine. Il a mis au point un bonnet à électrodes qui capte en direct les signaux électriques. Ils sont immédiatement analysés et réutilisés pour piloter à distance un fauteuil roulant, un petit robot avec caméra ou d'autres appareils. Tout ça, uniquement par la pensée. «Nous n'allons pas mettre à disposition cette technologie, autrement que de manière expérimentale, tant que nous ne sommes pas certains qu'elle est sûre et qu'elle fonctionne bien sur la durée», prévient cependant José Millan. Il ajoute qu'il faut encore trouver un ou des partenaires industriels. Dans un autre registre, le professeur Grégoire Courtine et son équipe travaillent sur des rats. Grâce à une combinaison de stimulations électrique et chimique, ils ont réussi à faire remarcher des rongeurs qui avaient subi des lésions sévères de la moelle épinière. «Au lieu de vouloir régénérer la partie endommagée du système nerveux, on stimule la partie qui est encore fonctionnelle mais qui ne reçoit plus les signaux du cerveau et qui est donc dormante, explique le scientifique. Nos rats marchent sur un tapis roulant. Il y a encore du travail pour qu'ils puissent le faire en conditions réelles. Et notre espoir est d'implanter un dispositif de ce genre chez l'être humain. Dans tous les cas, on devrait déjà réussir à améliorer la qualité de vie des personnes ayant subi des lésions de la moelle épinière.»

Rayonnement

## «L'ADN de la Suisse»


**Patrick Aebischer,** président de l'EPFL

**En quoi ce centre dédié aux neuroprothèses est-il «unique au monde»?**
En Suisse, nous sommes bons pour faire des choses petites, complexes et fiables. Les neuroprothèses correspondent bien à cet ADN. L'originalité du centre extrêmement interdisciplinaire est la rencontre entre les sciences de la vie et l'ingénierie. Ingénieurs et neurobiologistes seront bientôt regroupés dans le même bâtiment. Nous disposons d'une masse critique unique, avec six professeurs qui s'intéressent à des domaines médicaux pointus. L'autre spécificité du centre réside dans son financement par des philanthropes.

**Son ouverture date de 2008. Qu'est-ce qui a changé depuis?**
Les chaires et les professeurs n'étaient alors que des concepts. Ils sont devenus réalité.

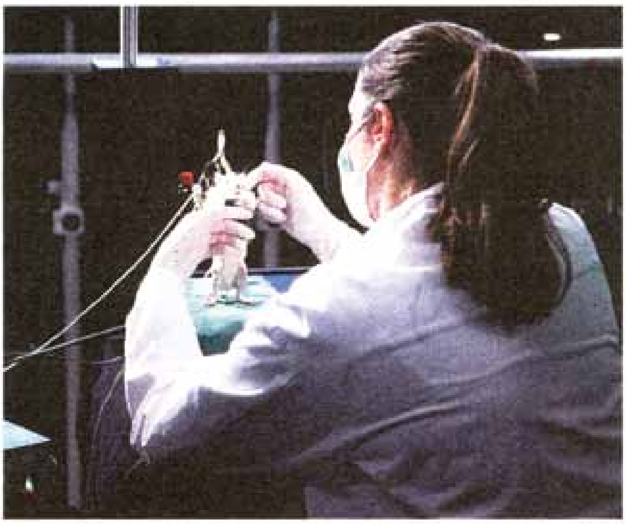
**La réalisation d'un rêve personnel…**
Je suis neurobiologiste de formation et j'ai aussi fait de l'ingénierie. Alors oui, faire interagir ces deux mondes et voir, déjà, une émulation, c'est extraordinaire.

**Les applications cliniques sont imminentes. A qui profiteront les brevets?**
Ils appartiennent à l'école. Nous allons aider les jeunes entrepreneurs à valoriser leur travail; une start-up s'est déjà créée. S'il y a un succès commercial, nous réinvestirons les royalties dans la formation et la recherche.

**Qu'en est-il de la collaboration avec Harvard?**
Des échanges sont en cours dans le domaine des prothèses auditives. Des étudiants de la Harvard Medical School viendront étudier chez nous cet été. **M.N.**

# Neuroprothèses de pointe à l'EPFL

**ÉCUBLENS (VD).** L'Ecole polytechnique fédérale (EPFL) a présenté hier les recherches de son nouveau centre pour les neuroprothèses. Celui-ci regroupe 80 chercheurs et chercheuses, et a notamment pour but de permettre à des paraplégiques de marcher de nouveau. Le centre planche aussi sur la fusion «homme-machine» et a présenté hier une expérience où un paraplégique pilotait un ordinateur «avec la pensée».



**Les essais sur des souris se sont montrés concluants.** -KEYSTONE

Date: 25.04.2012

20 minuten
Zürich

20 Minuten AG
8004 Zürich
044/ 248 68 20
www.20min.ch

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Page: 11
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# Paraplegiker steuert Roboter nur mit Gedanken

**LAUSANNE. Weltpremiere: Einem Paraplegiker im Wallis ist es gelungen, mit Gedanken einen Roboter in Lausanne zu steuern.**

Allein mit Gedankenkraft, einer Elektrodenkappe und zwei Computern steuerte ein Paraplegiker im Suva-Spital in Sitten im Wallis einen Roboter durch die Räume der ETH Lausanne. Mit der gestrigen Demonstration hat das Forscherteam um José Millán von der ETH Lausanne bewiesen, dass eine Mensch-Maschinen-Interaktion auch über grosse Distanzen hinweg möglich ist. Eine Elektrodenkappe übertrug die Hirnströme des Paraplegikers auf einen Computer direkt vor ihm. Dieser gab das Signal weiter an einen Computer im Konferenzsaal in Eclubens im Waadtland. Dieser war beweglich und mit einer Kamera ausgerüstet. Der Roboter liess sich somit aus grosser Distanz – mit dem Zug benötigt man rund eine Stunde von Sitten nach Lausanne – fernsteuern.

> «Auf diese Weise könnten Patienten virtuell am Leben ihrer Familie teilnehmen.»
> **José Millán**
> Forscher der ETH Lausanne

Auf diese Weise könnten bettlägrige Patienten im Spital zumindest virtuell am Leben ihrer Familie teilnehmen, erklärten die Forscher. Ähnlich funktioniert ein Rollstuhl, der ebenfalls über elektrische Impulse vom Gehirn gesteuert wird – auch von Millán entwickelt. Diese so genannten Neuro-Prothesen stecken alle noch in der Entwicklungsphase. «Wir wollen den Patienten keine falschen Hoffnungen machen», sagte Millán. Bis zur Marktreife könnte es noch über zehn Jahre dauern. SDA

NEUROPROTHÈSES

24 avril 2012 16:55; *Act: 24.04.2012 18:02*

# Un espoir pour les paraplégiques

*Permettre aux paraplégiques de remarcher, tel est l'un des objectifs des chercheurs du centre de neuroprothèses de l'Ecole polytechnique fédérale de Lausanne (EPFL).*



Plutôt que de chercher à régénérer les tissus nerveux, les neuroscientifiques implantent des électrodes dans la moëlle épinière. Le mouvement est ainsi généré par stimulation électrique. Cette approche a permis d'obtenir en 2011 le premier mouvement volontaire chez un patient paraplégique américain, explique le professeur Grégoire Courtine, directeur de la chaire en réparation de l'épine dorsale du centre de neuroprothèses, devant les médias invités mardi à l'EPFL.

### Système immunitaire

Les essais sur les souris ont montré que la stimulation électrique engendre aussi une amélioration des fonctions urinaires ainsi que du système immunitaire des paralysés, souligne le scientifique.

Le professeur Courtine est en train de mettre en place des essais cliniques en Suisse: «le but est qu'après un an d'entraînement avec une aide robotisée, le patient puisse marcher sans robot, les électrodes restant implantées à vie». Il espère pouvoir démarrer les essais à l'hôpital universitaire zurichois de Blagrist dans une année, puis en faire d'autres à Lavigny (VD), d'ici deux ans.

### Force de la pensée

Quatre autres professeurs et leurs équipes travaillent actuellement au centre lausannois de neuroprothèses pour faire avancer la médecine grâce à la fusion «homme-machine». Le professeur José Millan a montré en première mondiale comment «par la seule force de sa pensée» un paraplégique peut faire bouger à distance un ordinateur sur un support mobile.

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Der Bund

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# ETH-Premiere

Lausanne - In einer Demonstration der ETH Lausanne ist es einem Paraplegiker im Wallis gelungen, einen Roboter zu steuern - laut der ETH Lausanne eine Weltpremiere. Dies funktionierte allein durch Gedankenkraft über grosse Distanz: Eine Elektroden-Kappe übertrug die Hirnströme des Paraplegikers an einen Computer vor ihm, der ein Signal an einen weiteren Computer in einem Saal in Eclubens VD weitergab. Dieser war beweglich und mit einer Kamera versehen und liess sich somit auf Distanz fernsteuern. *(sda)*

# Bouger "par la seule force de la pensée", une première à l'EPFL

25.04.2012 09:20

Ce robot est piloté à distance par la seule force de la pensée par un patient paraplégique. [Jean-Christophe Bott - Keystone]

**L'Ecole polytechnique fédérale de Lausanne a présenté mardi une première mondiale: un paraplégique a fait bouger un robot par la "seule force de sa pensée".**

Le centre de neuroprothèses de l'Ecole polytechnique fédérale de Lausanne a présenté mardi une première mondiale: un paraplégique a fait bouger à distance un ordinateur sur un support mobile "par la seule force de sa pensée".

Coiffé d'un bonnet équipé d'électrodes, un patient hospitalisé à Sion, à quelque 60 km de Lausanne, a envoyé mentalement une commande à un ordinateur placé devant lui, faisant ainsi bouger un deuxième ordinateur équipé d'une caméra et placé dans la salle de conférence à Lausanne.

Avec la même technologie, une personne en chaise roulante peut faire avancer son engin uniquement grâce aux impulsions électriques transmises par son cerveau. "Une fois le mouvement lancé, le cerveau peut se relâcher, sinon la personne serait rapidement épuisée", a précisé le professeur José Millan , directeur de la chaire en interfaces cerveau-machine non invasives.

Cette méthode a toutefois ses limites, les signaux transmis pouvant être facilement brouillés. Si de nombreuses personnes entourent par exemple le fauteuil roulant, ce dernier ne pourra pas être guidé de manière optimale.

## VIDÉOS ET AUDIOS



**EPFL: un patient a pu commander un robot par la seule force de la pensée**
01:40 | 19:30 le journal | 24 avril 2012


**Grégoire Courtine, la paraplégie et l'espoir des neuroprothèses**
06:33 | L'invité du 12h30 | 12 mars 2012


**Contrôler une machine par l'esprit, c'est bientôt possible**
03:45 | Mutations | 8 décembre 2011

## ARCHIVES

Science
Des chercheurs ont fait remarcher des rats paraplégiques | 21 septembre 2009

*25.04.2012, 14:36 - Suisse*
*Actualisé le 25.04.12, 16:41*

# Une première mondiale de l'EPFL entre Sion et Lausanne

ROBOTIQUE

Le robot situé à Lausanne est piloté depuis Sion par le patient Jean-Marc Duc équipé de capteurs sur la tête (ici sur l'écran). Crédit: KEYSTONE



**Le Centre de neuroprothèses (CNP) de l'Ecole polytechnique fédérale de Lausanne a réussi une première mondiale, mardi 24 avril à Sion.**

Une première mondiale a été réalisée par le Centre de neuroprothèses (CNP) de l'Ecole polytechnique fédérale de Lausanne, mardi 24 avril entre Sion et Lausanne. Un patient hospitalisé à la SUVA à Sion a pu commander par son esprit un ordinateur situé devant lui et relié via Skype à un robot situé à Lausanne.

C'est coiffé d'un bonnet équipé d'électrodes, que Jean-Marc Duc, un patient hospitalisé à la SUVA Sion, a envoyé mentalement une commande à son ordinateur, faisant ainsi bouger un deuxième ordinateur équipé d'une caméra et placé dans la salle de conférence à Lausanne. Ce second ordinateur, placé sur un support mobile, fait partie d'un robot pilotable à distance et équipé d'une caméra.

**Impulsions électriques**

Avec la même technologie, indique l'ATS, une personne en chaise roulante pourrait faire avancer son engin uniquement grâce aux impulsions électriques transmises par son cerveau. "Une fois le mouvement lancé, le cerveau peut se relâcher, sinon la personne serait rapidement épuisée", a précisé le professeur José Millan, directeur de la chaire en interfaces cerveau-machine non invasives.

Cette méthode a toutefois ses limites, les signaux transmis pouvant être facilement brouillés. Si de





*April 26, 2012*

## Brain power robot

Researchers at the Federal Institute of Technology in Lausanne have accomplished the task of piloting a wheelchair using brainpower alone.

This brain machine was developed by the Institute's Neuroprosthetic Centre, and promises to vastly improve the lives of disabled people. (SF/swissinfo.ch)

Flying robots

Universities extend global reach

Date: 25.04.2012

Der Landbote

Der Landbote
8401 Winterthur
052/ 266 99 01
www.landbote.ch

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# Gelähmter steuert Roboter mit Gedankenkraft

**LAUSANNE.** In einer Demonstration der ETH Lausanne ist es einem Paraplegiker im Wallis gelungen, einen Roboter in Lausanne zu steuern – laut der ETH Lausanne eine Weltpremiere. Dies funktionierte allein durch Gedankenkraft mittels einer mit Elektroden bestückten Kappe – welcher die Hirnströme überträgt – und zwei Computern. Die Mensch-Maschinen-Interaktion ist auch über grosse Distanzen möglich, wie eine Demonstration gestern zeigte. Allein mit seinen Gedanken steuerte ein Paraplegiker im Suva-Spital in Sitten einen Roboter durch die Räume der ETH Lausanne. Dank dieser neuen Technologie könnten bettlägrige Patienten im Spital zumindest virtuell am Leben ihrer Familie teilnehmen, erklärten die Forscher. Die sogenannte Neuroprothese stecke aber noch in der Entwicklungsphase. *(sda)*

# CENTER FOR NEUROPROSTHETICS

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

School of Life Sciences / School of Engineering

## Engineering the nervous system to improve sensation, cognition and mobility

### Human Nervous System

The brain and spinal cord compose the Central Nervous System (CNS). Nerves in the body make up the Peripheral Nervous System (PNS) where information travels up to **360 km/h**, permitting movement and sensation.

#### Brain

Composed of over **100 billion neurons**. Despite major advances in neuroscience, a full understanding of the human brain and its functions is still lacking. It is the central organ for sensation, movement, and cognitive functions.

#### Sensation

**Sight - 100 million photoreceptive cells** transmit information to the brain via **1.2 million nerve fibers.**

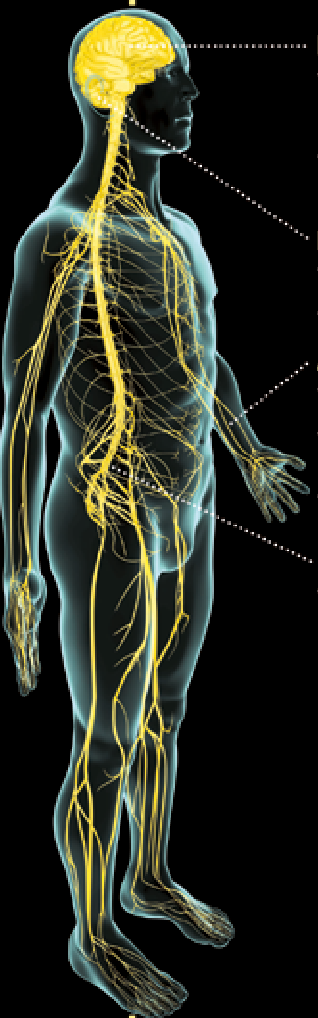
**Hearing - 15,000 hair cells** in each inner ear capture sound waves and transmit the signals via **30,000 auditory nerve fibers** to the brain.

**Balance -** Hair cells in each inner ear detect acceleration and orientation of the head in space and transmit **40 to 50 signals per second** via the vestibular nerve to the CNS.

**Touch -** In the hand alone, **17,000 receptors** send signals to the CNS via sensory nerves.

#### Movement

**600 skeletal muscles, 40%** of our body weight, contract or relax when activated by signals sent from neurons in the primary motor cortex throughthe spinal cord and the PNS to the muscles.



### EPFL Research

#### Brain

- **The Brain's Body Representation:** Activity in sensorimotor and temporoparietal cortex reflects key changes for the embodiment / incorporation of virtual limbs, avatars and "external" devices in the brain's body representation.
- **Brain Machine Interfaces:** Decoded brain activity can be exploited online to control computers and to move avatars and robots, and other devices such as wheelchairs.

#### Ear

- Hearing again with **cochlear and auditory brainstem flexible electronic implants**.
- Regaining the sense of balance with **vestibular implants**.

#### Arm

- **Prosthetic Arm:** Bi-directional prosthesis connected to the central and peripheral nervous system.
- **Stroke Rehabilitation:** Using virtual reality, robotics, lesion mapping, and brain-machine interfaces to regain limb movement.
- **Electronic Skin:** Flexible, electronic skin that fits over prosthetic arms or damaged skin.

#### Legs and mobility

- To make paraplegic patients walk again: **Spinal Cord Implants** with electrical and chemical stimulation of the spinal cord and **Robot-assisted rehabilitation.**

**Neuroprosthetics** is a domain at the frontier of engineering, neuroscience and medicine with the goal of developing neural prostheses; artificial extensions of the central and peripheral nervous-system that restore and augment functions lost due to accidents and disease ranging from sensation to cognition and mobility.

### The EPFL Center for Neuroprosthetics

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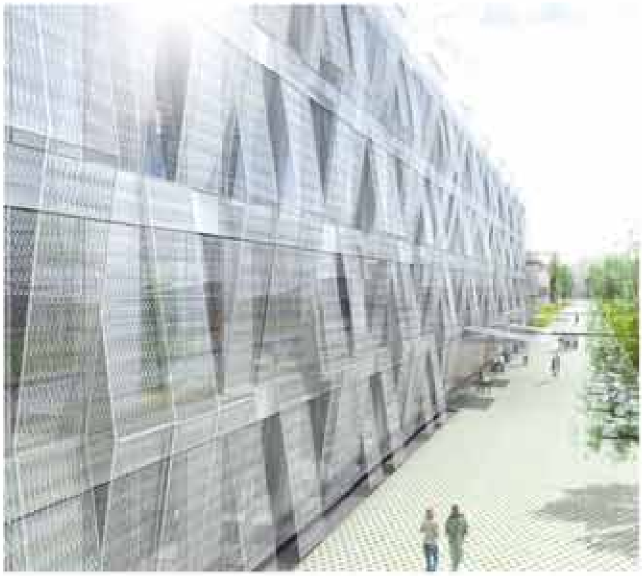
# The new building

EPFL's Center for Neuroprosthetics is a multi-disciplinary collaboration between the School of Life Sciences and the School of Engineering, but it will also be a cutting-edge, purpose-built facility. Due for completion in 2013, the new building will house laboratories for all five Chairs and will serve as a hub bringing together fundamental research with clinical collaboration and technology transfer.



The building has been designed by Dominique Perrault, whose work includes France's National Library in Paris, the European Court of Justice in Luxembourg and the Fukoko Tower in Osaka, amongst others. In Switzerland, Dominique Perrault is currently redesigning Locarno's main station.
Swiss engineering group Karl Steiner have been contracted to carry out the transformation of EPFL's old library and mechanical halls.

**Funding**
The budget for this project will be partly covered by the credit of 67 million Swiss francs accorded by the Federal Parliament at the end of 2009 as well as contribution from the Bertarelli, Defitech, IRP and Sandoz Foundations.

**The EPFL Center for Neuroprosthetics**

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# CENTER FOR NEUROPROSTHETICS

School of Life Sciences / School of Engineering

# Neuroprosthetic solutions to hearing loss

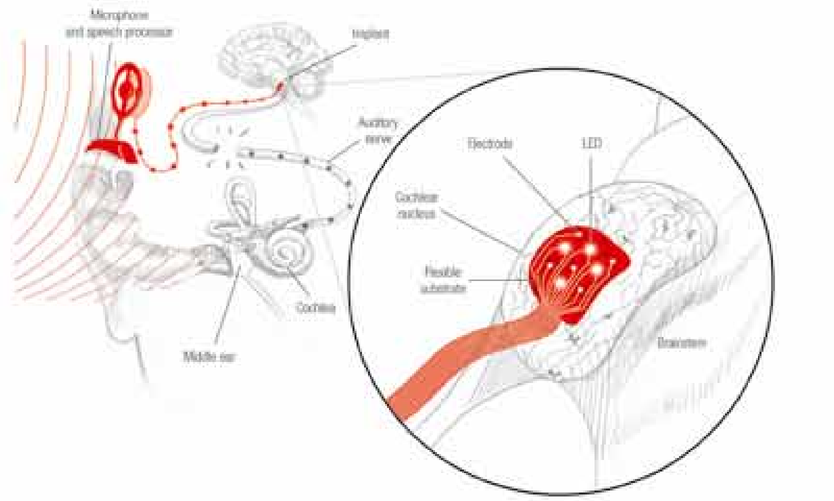
## The Bertarelli Program in Translational Neuroscience and Neuroengineering

Basic scientists and physicians at Harvard Medical School are working with EPFL bioengineers to create new methods to diagnose and treat a wide range of hearing loss afflictions, from those that are genetically based to those caused by damage from excessive noise.

### New generation of auditory brainstem implants

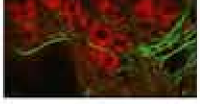
The auditory brainstem implant (ABI) in its current form bypasses the auditory nerve to directly stimulate the central auditory pathways found in the brain using a rigid electrode paddle. Unlike most cochlear implant users, the vast majority of ABI patients do not understand speech and many have side effects due to electrical current spread. An exciting new approach is the use of light, or optical stimulation, to provide more selective activation of auditory neurons.

An interdisciplinary team of EPFL engineers (Stéphanie P. Lacour, Philippe Renaud, Nicolas Grandjean) and HMS scientists and surgeons (Daniel J. Lee, Christian Brown) are developing and testing new, flexible electrical and optical arrays that will conform to the surface of the brainstem and more precisely stimulate the central auditory pathways. This work will enhance the performance of existing ABI technology and provide the basis for a new generation ABI device.



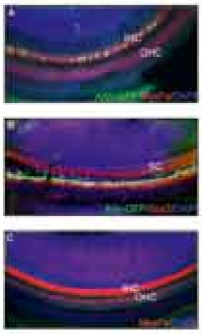

### Seeing how we hear

Demetri Psaltis at EPFL is collaborating with HMS otologic surgeon Konstantina Stankovich to develop new imaging methods for the human inner ear. The researchers will use mouse and human inner ear tissue to optimize these new detection methods, learning, for instance, how to look through bone with long-wavelength light. Through imaging inner ear cells in animal models, they will set the stage for eventual clinical trials.



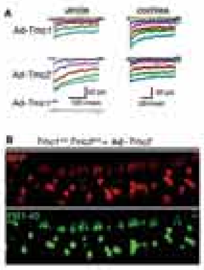
### Delivering drugs to treat hearing loss

HMS hair-cell regeneration specialist Zheng-Yi Chen and EPFL bioengineer Jeffrey Hubbell are exploring solutions in protein engineering and nanotechnology techniques to develop new ways of delivering regenerative factors to the inner ear. Bound to hydrogels or packaged in novel "polymersomes" the factors will be taken up by the remaining cells, and will reprogram them to proliferate and morph into sensory cells.



### Gene therapy to regenerate hair cells

Jeffrey R. Holt, a pioneer in use of viruses for hair-cell physiology from HMS and Children's Hospital Boston, and Patrick Aebischer, EPFL researcher in the field of gene therapy, are collaborating to explore new viruses to deliver genes into hair cells to restore functionality. The researchers will attempt to correct inherited deafness in living mice, clearing a path for developing similar genetic tools to restore hearing function in humans.



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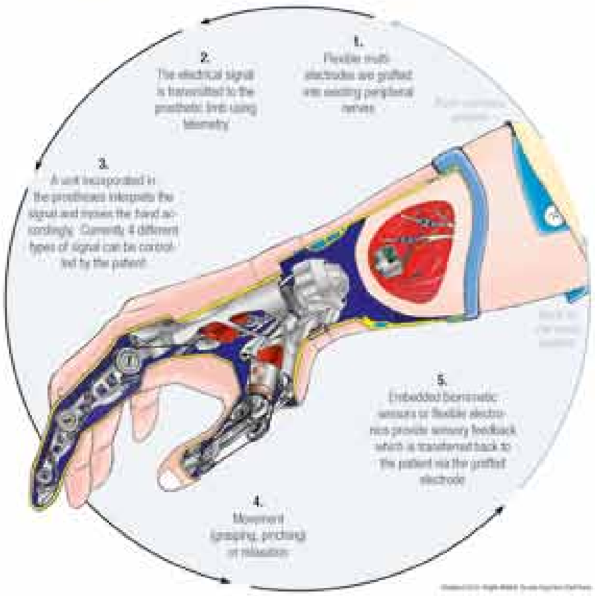
# CENTER FOR NEUROPROSTHETICS

School of Life Sciences / School of Engineering

# Bionic hand

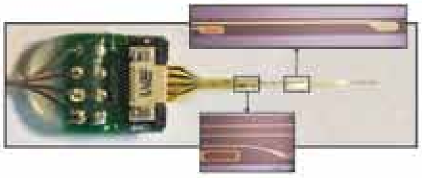
## Restoring sensory and motor functions after an arm or hand amputation

The EPFL Center for Neuroprosthetics is developing a bionic arm connected directly to the peripheral nervous system. By implanting flexible electrodes into the peripheral nerves in the arm of an amputee, then decoding the signals with algorithms and transmitting them to the prosthetic hand embedded with feedback sensors, scientists hope to give amputees a chance to regain both motor and sensory function.



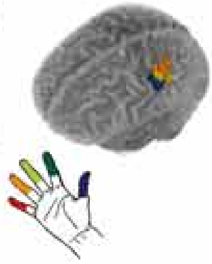

### Intraneural electrodes

Flexible, polymer based electrodes are well-adapted to neuroprosthetics devices because they adapt to the constant movement of the body and are easier to implant.

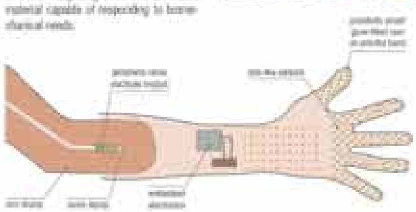
### Representation of real and prosthetic fingers in the brain

The finger representation in primary somatosensory cortex changes massively for the amputated arm and such changes lead to phantom limb pain. Future prosthetic devices will be designed that avoid and can alter such brain changes in finger regions avoiding phantom limb pain and better prosthetic hand feelings and movement.



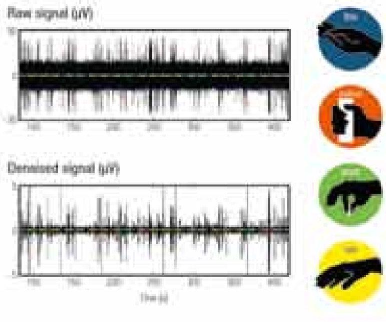
### An Electronic Skin

The future prosthetic arm will be covered by a sensitive polymer skin. But there are challenges, notably connecting the neurones to an electronic bio-extensible system and integrating them into an elastic material capable of responding to biomechanical needs.



### Decoding brain-signals for grasp types

A raw signal coming from the brain down to the peripheral nerve can be quite noisy. Advanced algorithms filter out the noise and detect the signals specific to different hand movements, or grasp types (little finger, palmar, pinch, and resting).




## The EPFL Center for Neuroprosthetics

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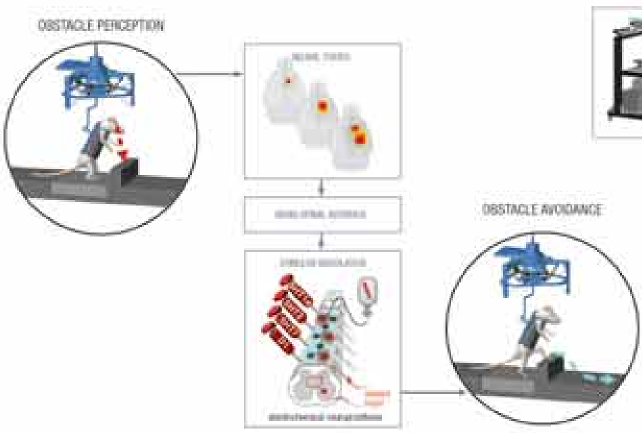
# CENTER FOR NEUROPROSTHETICS

School of Life Sciences / School of Engineering

## Walk again

### Restoring sensorimotor functions after spinal cord injury

Brain-Spinal interface to restore voluntary gait control after a complete spinal cord injury: the paralyzed rat's intention is decoded from real-time recording of brain activity. This information is directly fed into a Brain-Spinal Interface that computes optimal spinal cord stimulation patterns to execute the desired movement. As a result the animal is capable of negotiating the obstacle, even though the spinal motoneurons are physically separated from the brain.




#### Robotic postural neuroprosthesis

Novel robotic postural neuroprosthesis to evaluate, enable, and train locomotion under natural walking conditions. The amount of support can be fine tuned for each axis according to the animals' capacity.

#### Ultra-compliant microelectrode array

The 16 electrode array is 14mm wide. Such array can conform complex, curvilinear biological tissue, e.g. the brain or the spinal cord, and move along with the tissue. The array is manufactured using standard microfabrication technology using thin gold film and silicone rubber.

Schematic top-view of a microelectrode array being stretched along its length

#### The electrical neuroprosthesis restores movement in a paralyzed patient

Rob Summers suffered from paralysis after being hit by a car at the age of 20 years. The MRI scan showed a severe injury to the spinal cord.

4 years after the accident, Rob Summers was implanted with an electrode array over the lumbar spinal cord and a neurostimulator.


After 5 months of training, Rob Summers regained voluntary control over leg movements while the stimulation was applied.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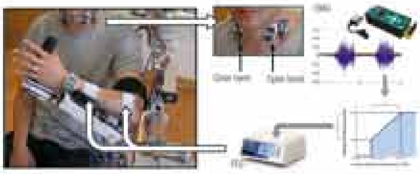
**CENTER FOR NEUROPROSTHETICS**

School of Life Sciences / School of Engineering

# Rehabilitation of upper limb sensorimotor loss

## Hybrid tools for reaching and grasping rehabilitation

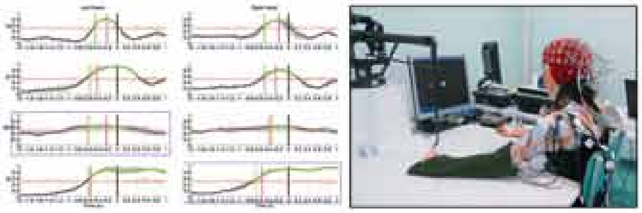
The system consists of a passive upper arm exoskeleton with gravity compensation, a 4-channel functional electrical stimulator (FES) and a wireless surface EMG system. The user controls the opening and closing of his/her own hand by selective activation of neck muscles (left and right sternocleidomastoid, SCM).




We couple a brain-computer interface (BCI) with FES to restore whole hand prehension and object manipulation.

## Movement intention detection

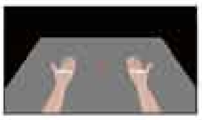
EEG can be used for detecting the intention to make self-paced reaching movements. Our experiments with 12 human volunteers, two of them stroke patients, yield high sensitivity and specificity —i.e., high recognition rates close to the movement onset and low recognition rates during the non movement intention period.

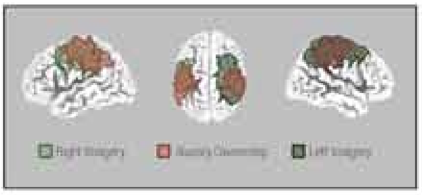


## Illusory ownership for artificial hands is reflected in frontal and parietal brain regions

Virtual reality and brain imaging

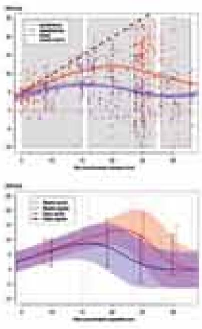
Electrical brain activity (EEG, mu rhythm, 8-14Hz) in fronto-parietal cortex during illusory hand ownership overlaps anatomically with left and right motor imagery. Decoding of this activity can be used to control virtual hand online.





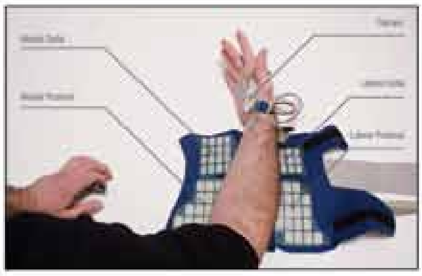

## Ownership and position of artificial hand can be predicted by computational neuroscience

A mathematical model of the illusion allows to predict the probability of ownership of the visual hand as a function of the visuo-proprioceptive separation for asynchronous and synchronous visuo-tactile stimulation. The model also predicts drift of hand localization error.



## Precise Neuro-Muscular Electrical Stimulation of hand and fingers

Our electrode arrays facilitate specific flexion and extension of the fingers and control of the wrist.



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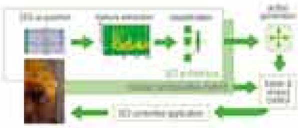
# CENTER FOR NEUROPROSTHETICS

School of Life Sciences / School of Engineering

# Human-Computer confluence

## Decoding brain activity for feeling and moving artificial bodies and robots

### Non-Invasive Brain-Machine Interaction

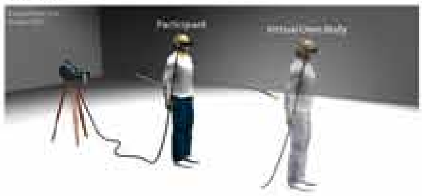


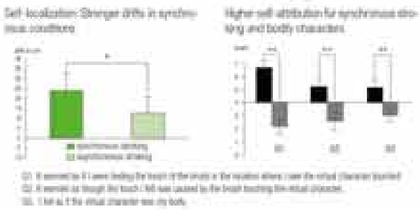

### Telepresence semi-autonomous robot

A BCI controlled mobile device for telepresence enables patients, constrained to remain in bed because of their severe degree of paralysis, to join relatives and friends to participate in their activities.

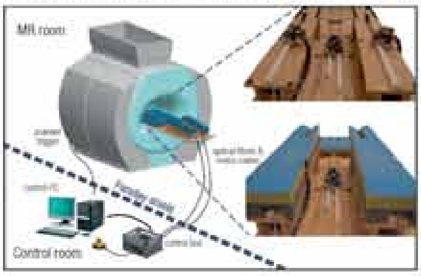
### Projecting body ownership to avatars and robots: the cognitive science and virtual reality approach

The brain's full body representation is the simplest brain representation that can induce states of self-consciousness and project them to computer-generated avatars and and robots, including prostheses.



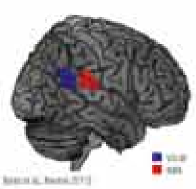



### Neuroscience, robotics and haptics: the brain mechanisms of body ownership

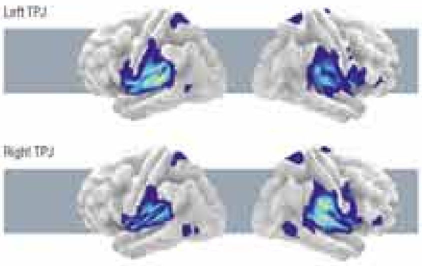



Custom made robotic devices allow to control visuo-tactile stimulations for the induction of illusory body ownership during fMRI acquisition (including ultra high scanners, 7T).

Temporo-parietal activity (fMRI) reflects the experience of the conscious "I" as embodied and localized in space (red). If the same area is damaged (blue), these neurological patients have impairments of body ownership and self location.

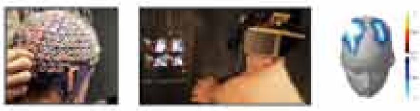


Functional connectivity analysis reveals that, in addition to the temporo-parietal activity, a distributed network is recruited during illusory ownership and self location.




### Body ownership in virtual reality with high density EEG

EEG recordings during an immersive head-mounted display based VR scenario reveals scalp regions whose activity reflects the strength of illusory body ownership.



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Press information – April 24th 2012

## EPFL Announces the Next Phase for its Center for Neuroprosthetics

***Lausanne, April 24th 2012*: Research in biotechnology, microelectronics and neural implants as well as unprecedented advances in our understanding of the brain are changing our approaches to treating disability. EPFL's Center for Neuroprosthetics (CNP) is defining and establishing a truly interdisciplinary area of study; merging neuroscience with engineering and medicine, and efficiently translating major breakthroughs from bioengineering and neuroscience to the clinic.**

Over the last decade, EPFL has moved steadily towards becoming a world center for bio-engineering technology and applications. In 2009, it affirmed this intention with the launch of its Center for Neuroprosthetics. Today, five professors make up the current research core of the Center for Neuroprosthetics (CNP). They represent world specialists in their varying domains - stretchable electronics, paraplegic treatment, translational neuroprosthetics, cognitive neuroscience and neurology, and brain-machine interfaces.

**The Future of Neuroprosthetic Technology:**

In order to better explain the activities of the CNP and highlight the Center's transdisciplinary nature, here are four scenarios that cover a large scope of its research and collaborations.

### HUMAN-COMPUTER CONFLUENCE

Virtual reality, sensory stimulation and robotics, combined with brain-computer interfaces, have allowed the merging of man and machine in an unprecedented fashion. Non-invasively recorded brain activity can control computers, move avatars and robots, and drive wheelchairs. Merging insights from cognitive neuroscience and real-time decoding of brain activity, research at the CNP exploits EEG, functional magnetic resonance imaging, and non-invasive brain stimulation to understand, control, and enhance brain mechanisms for feeling and moving artificial limbs, bodies, robots, and wheelchairs.

### HEARING RESEARCH

The cochlear implant, a device that bypasses a damaged inner ear and conveys electrical signals directly to the auditory nerve, has been the most successful neural prosthesis of that past few decades, with over 200,000 in use worldwide. However a substantial fraction of patients are not candidates for a cochlear implant, and there has been great interest in developing a similar prosthesis that bypasses the damaged auditory nerve by directly stimulating the brainstem.  Scientists at the CNP are developing a novel generation of auditory brainstem implants that conform to the contours of the brainstem and will be able to deliver electrical and optical stimulation more selectively than current clinical implants. The project is part of the Harvard Medical School and EPFL collaboration for the Bertarelli Program in Translational Neuroscience.

**TECHNOLOGY-ASSISTED REHABILITATION AFTER STROKE**

Rehabilitation using advanced technologies such as robotics and electrical stimulation have demonstrated improvements in motor function after intensive treatment in both chronic and sub-acute post-stroke populations.
The CNP is developing a novel generation of "hybrid" devices that are able to customize complex rehabilitation solutions tailored to the needs of specific patients. The approach is based on the combined use of human-machine interfaces and several technology-based neurorehabilitation approaches, with a particular attention to the characterization of the cognitive effects of the clinical protocols.

**WALKING AGAIN & PARAPLEGIA**

The CNP is pioneering an integrated cortico-spinal neuroprosthesis that will restore voluntary control of locomotion after a complete spinal cord injury. To achieve this goal, we are interfacing cortical modulations with a novel, stretchable spinal electrode array. Practically, real-time decoding of brain signals will be exploited to achieve selective electrical stimulations of spinal circuits through the electrode array. This cortico-spinal neuroprosthesis will re-establish supraspinal control of spinal circuits and locomotion after the physical interruption of connections between the brain and spinal cord. The project is also part of the Harvard Medical School and EPFL collaboration for the Bertarelli Program in Translational Neuroscience.

**BIONIC ARM & AMPUTATION**

CNP researchers are pursuing the restoration of complex hand functions by creating a novel bidirectional link between the peripheral nervous system and a dexterous hand prosthesis. Novel (intraneural and regenerative) implantable interfaces are under development to achieve a fast and intuitive connection to allow an effective bidirectional flow of information between the user's nervous system and the smart artificial device. The project implies a wide array of new technologies: novel bioinspired artificial skins, the use of the bionic prosthesis in terms of body ownership as well as brain-computer interfaces are also being explored.

**The Five Labs:**
**Bertarelli Foundation Chair in Cognitive Neuroprosthetics** - Olaf Blanke
**IRP Foundation Chair in Spinal Cord Repair** - Grégoire Courtine
**Bertarelli Foundation Chair in Neuroprosthetic Technology** - Stéphanie P. Lacour
**Translational Neural Engineering Laboratory** - Silvestro Micera
**Defitech Foundation Chair in Non-Invasive Brain-Machine Interface** - José del R. Millán

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## IMPRINT

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