

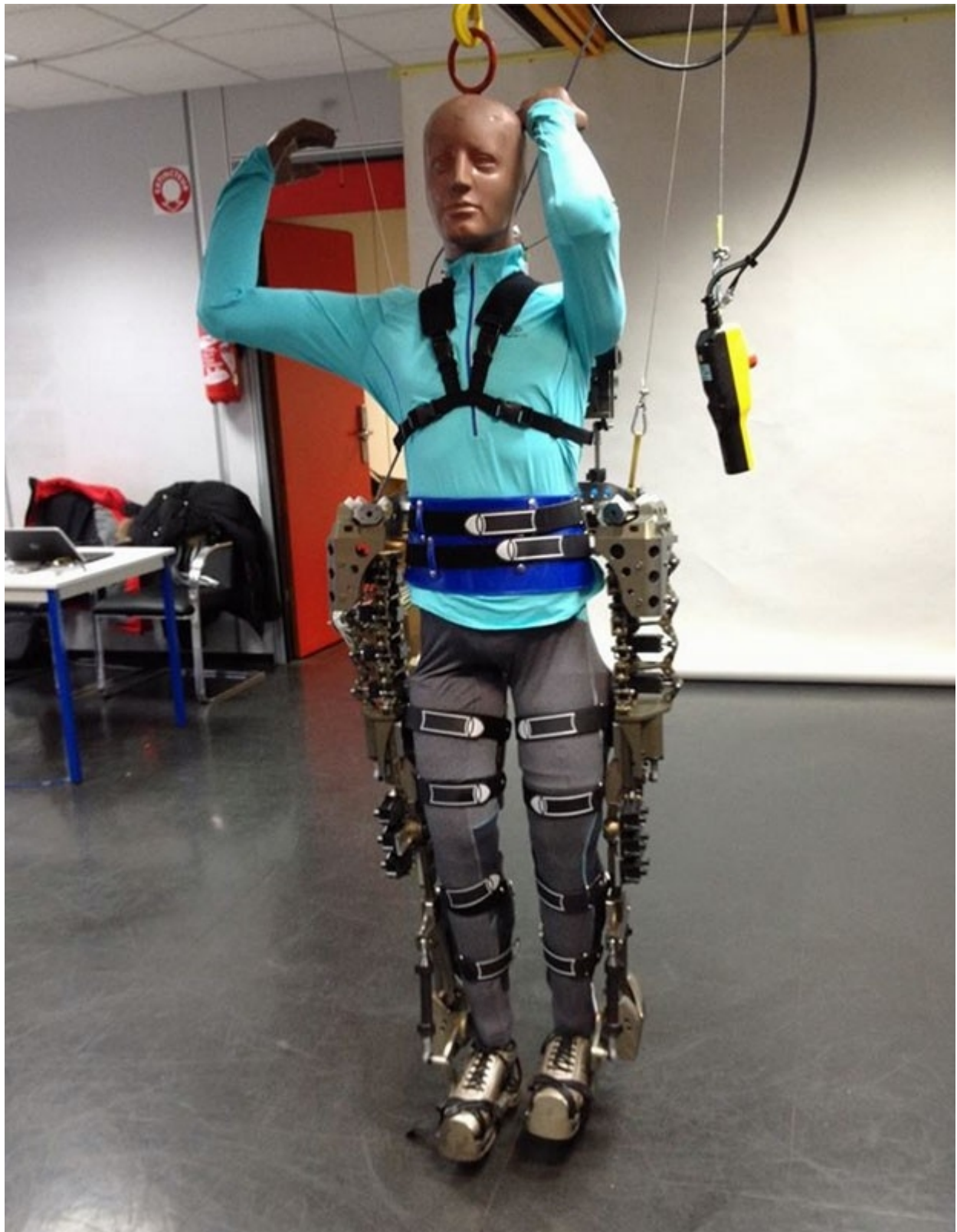
Puerto Rican ingenuity at the 2014 FIFA World Cup ^[1]

Submitted by [Mónica Ivelisse Feliú-Mójer](#) ^[2] on 9 June 2014 - 3:47pm



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Exoesqueleto que le permitira a un joven brasileño "andar de nuevo". Crédito: Miguel Nicolelis.

Puerto Rican neuroscientist and graduate student David Schwarz is part of Walk Again (Andar du Novo), a project that will allow a paraplegic Brazilian teen to control a robotic exoskeleton with their mind to execute the inaugural kick at the 2014 FIFA World Cup.

This event will be historical for many reasons. First, it is the culmination of years of research and the collective work of hundreds of scientists around the world, from engineers, to computer scientists, to neuroscientists.

Second, millions of people around the world will be able to appreciate the impact of science and technology in our lives. Third, the technology being used by the exoskeleton represents great hope for thousands of patients with motor problems, such as spinal cord injuries.

Finally, this historical moment will put Latin American and Brazilian science in the spotlight since the project's leader, Dr. Miguel Nicolelis is from Brazil and a strong advocate for the development of science in that country and in the region.

To celebrate this scientific milestone and David's participation in such a transformative project, Ciencia Puerto Rico asked him a few questions.

Q: David, what are you studying and where?

I am finishing up my doctorate in Neurobiology in Miguel Nicolelis' laboratory at Duke University in Durham, North Carolina.

Q: Where did you go to school in Puerto Rico?

I went to the American Military Academy in Bayamón, Puerto Rico. I started college at the University of Puerto Rico (UPR) in Mayagüez, studying computer engineering and then I transferred to the UPR in Río Piedras to complete a bachelor's degree in biology with training in computer sciences.

Q: How did you become interested in research?

I took a biology class with Dr. Carlos Muñoz in Mayagüez. He was the first person to suggest I do research. When I transferred to Río Piedras, I was lucky to talk to several people who steered me towards Dr. Carlos Jiménez-Rivera at the UPR Medical Sciences Campus.

During my time in Carlos' laboratory, where I learned neurophysiology (the study of the function of the nervous system) techniques, he would tell me about his friend Miguel Nicolelis, who he met as a post-doc. As I got closer to graduating, I started to participate in conferences and internships, exploring fields to pursue my graduate studies. I was between continuing in neuroscience or going into computational biology.

In 2008, I presented at the Society for Neuroscience conference and went to see a few presentations from the Nicolelis' lab. There I met a few members of Miguel's research group and I became enthusiastic about the opportunity of combining my two passions, biology and computer sciences, at Duke. I told Carlos (Jiménez-Rivera) that I would like to work with Nicolelis, and he

set out to help me make that dream come true.

Q: Tell us about Project Walk Again.

Project Walk Again is an idea that Miguel Nicolelis, my graduate advisor, has had for a long time. After many attempts to get funding, he finally convinced the Brazilian government to invest in his idea.

“Andar du Novo” has multiple goals. First is to establish a platform in Brazil for the treatment of patients with movement problems, such as spinal cord trauma, with the help of biomedical engineering. To accomplish this the project has brought together over 100 professionals in a variety of fields: physicians, engineers, neuroscientists, physical therapists and computer programmers, to design a kind of robotic armor—an exoskeleton—capable of supporting the weight of a human. This exoskeleton can execute movements controlled just by a patient’s brain and biological signals and can give the patient the sensation of walking again.

The project will be unveiled during the opening ceremony of the 2014 World Cup, in Sao Paulo, where millions of people will be watching Brazil’s first match.

Walk Again also wants to promote the development of science and technology in a Latin American country, Brazil, as a way to tell the world that the region is much more than football (soccer).

Something that has not received much media coverage is that as part of the efforts of this project Miguel has founded a school for low-income children and a maternity institute, in addition to a research institute that will open soon.

Q: What has been your role in Walk Again?

Initially when (in 2013) Miguel convinced me to take this on as a “side project” (in addition to my main dissertation research), I had a technical consultant role. Eventually I became more involved in the research and development aspects of the project.

At the beginning, because of my previous experience, I had the opportunity to help select the sensors and computing devices for the exoskeleton. Later on I designed the controls system that would translate the patient’s biological signals into commands for the exoskeleton.

Eventually I proposed a prototype of the control system and programmed it, and the team in Brazil kept developing it. Later I traveled to France to see the almost-completed exoskeleton for the first time and finished connecting it to the control system.

As in every research project we faced challenges. We had issues with my original program; it had compatibility issues and other problems that made the use of the exoskeleton hard. I had to rewrite the program.

I spent the month of January implementing the new system and the team in Brazil further developed it. I then traveled to Brazil and lived in Sao Paulo for a month, working on connecting different components developed by different groups in the team into one controls system to

manage everything. Of course I didn't do this alone, the system is a result of the efforts of a whole team, which includes Anthony Lin, Solaiman Shokur, Kenneth Lyons, Simone Gallo, and several others.

Q: What impact has your participation in the project had on you, personally and professionally?

This project has had a significant impact in my life as a neuroengineer and scientist. To fulfill my role I had to tap into my previous experiences with brain-machine interfaces, controls, and computer science. The system that controls the exoskeleton is really complex. It uses electroencephalography to read the patient's brain signals; electromyography to read their muscle signals; and tactile sensors. The system also provides sensory feedback to the patient. Through this work I have learned more about how complex systems work.

I have had to put my thesis research temporarily aside and postpone my graduation to fulfill my role in Walk Again. However, I do it for my co-workers and for the patients.

The impact this project has had on me became evident one day, when the exoskeleton's lead engineer—visibly tired after 24 hours without sleep—said to me: "This is why I do it. I do it for the patients." That's when I understood this project was much more important.

I think the demonstration of the exoskeleton during the World Cup goes beyond the coolness or the novelty of the technology. My participation in this project has helped me appreciate the importance of the sometimes slow and frustrating pace of science and it has helped me grow.

Q: You spent some time in Brazil as part of your role in Walk Again. Tell us about that experience.

Brazil is a country with great potential and wonderful people. It is interesting because there is a language barrier, but one that is easy to overcome if you speak Spanish. This leads to many entertaining moments when you try to use your "Puerto Rican portuñol (a combination of Portuguese and Spanish)."

When I went to Natal, in northeastern Brazil, I was surprised by how much it reminded me of towns in northwestern Puerto Rico, like Quebradillas. The people, the climate, even the flora. Maybe I see a projection of Puerto Rico in Brazil or vice versa; that's why I appreciate the country so much. It has its development, its potential as much as it has problems and many people working hard to make things better.

The city of Sao Paulo is a little different. It is huge, but I was only able to see a small part. Literally my life consisted of walking from my lodging to the laboratory and coming back 14 or 16 hours later. It wasn't easy!

Q: How does it feel to be part of this historic moment for science?

Just to be clear, my contribution has been small compared to the contribution of the patients and the rest of the team in Brazil. These people have worked night and day to make what started as an idea a reality. Nothing compares to being able to see the patients, standing for the first time,

their faces filled with an excitement I can't even begin to describe. Their sacrifice of coming in everyday, of training, of improving their physical condition not just for them but for those after them; that's the project's real achievement, beyond the engineering and the science.

I hope the public can see beyond the futurism of the exoskeleton, because it is worth to learn about the patient's sacrifices and what's ahead for those who dream of getting up from their wheelchairs.

I can't lie; this is all surreal. I look back and it's weird. I would have never imagined I would be here. This is not something I set myself to do, because who would have imagined this moment was possible 5 or 10 years ago? If I hadn't transferred from Mayagüez to Río Piedras, if I hadn't met Carlos, if I had pursued another field of study as I almost did... I wouldn't be here. A chain of coincidences (and hard work) has brought me to this moment.

I think that without the support of my parents, of my siblings and of my wife I would have ended up in a very different place. I don't mean it in a dark way; I just would not have been able to continue, because the road has not always been easy. I feel very, very fortunate.

Q: What is next step for the project after the World Cup?

The next logical step is to continue improving the technology. It would be amazing to have the patient "feel" their steps in a more natural way. Have them go up the stairs, or run. To achieve this we will need more efforts on the technology side, from the team that created the exoskeleton and on the neuroscience side as well.

As I have mentioned the system uses electroencephalography (EEG) technology to capture the patient's brain signals. This has brought on criticism because it's not the best way to control such a complex system (it can't control all of the exoskeleton's joints individually, for example), but because of time and safety constraints it was the best option for now. Moving forward it would be best to develop brain implants to capture the patient's brain signals.

Using EEG technology is like having only one microphone to record Bach's symphony, from outside of the auditorium. Using brain implants would be like having the best microphones to record each instrument. There's no doubt of which one would do a better job of capturing the "music".

The next step to accomplish this is to improve the safety and effectiveness of brain implants. Our research group recently published a manuscript in the journal Nature Methods describing methods and guidelines to achieve this (in primates). I hope that our paper is useful to those trying to develop better and safer brain implants for humans. With safer and more stable implants, a patient could dribble a soccer ball or run over obstacles. Right now the system allows the patient to make relatively simple movements. Better implants could make an incredible difference.

The next steps are more long term. We hope that with this demonstration, there will be increased popular interest in science in Brazil. There are several institutes waiting to be completed, in anticipation of this interest. I hope that this popular interest in science replicates through Latin America. If a percentage, however small, of the kids around the world watching the demonstration

at the World Cup are inspired to follow dreams similar to the dreams of Miguel, it is all worth it.

The author is a neuroscientist, manager of outreach programs at the Department of Biostatistics at the University of Washington and a member of Ciencia Puerto Rico (www.cienciapr.org [3]).

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