Fundación
Innovación
Bankinter

# Superhumans

# Introduction

Human beings want to be more than human. Cultural expressions, ranging from religion to romantic comedies or comics, have forged an interesting habit in us: to set for ourselves unreachable references to then become frustrated with our own inability to meet the standard. It doesn't matter whether we talk about Gilgamesh, Hercules, Achilles, Superman or Neo. **All societies have created their own superhumans** and then proceeded to establish a love-hate relationship with them.

When Bankinter decided to discuss 'Preparing for Superhumans' at the Future Trends Forum (FTF), they contributed to prove that we are not more interested in enhanced capabilities for human beings just because Hollywood suddenly decided so: an appetite for this type of products existed already and the entertainment industry is simply catering to it.

The sessions were organized by the Bankinter Foundation of Innovation. They brought together a wide range of experts who made very interesting and varied contributions to the discussion. The discussion touched on science, technology and challenges for investors, but also philosophy, ethics and the impact of superhuman in all types of relationships between human beings.

In order to structure the discussion, the Future Trends Forum (FTF) divided capabilities or superpowers into three groups: informational, anatomical and biological. An effort was made in each of these groups to define the frontiers and challenges that are barely in the horizon today and the viable commercial initiatives already underway. The truth is that progress in the latter often enters the realm of science fiction for the non-initiated, turning out to be as surprising as or more than we could have imagined.

**Miguel Ángel Uriondo**
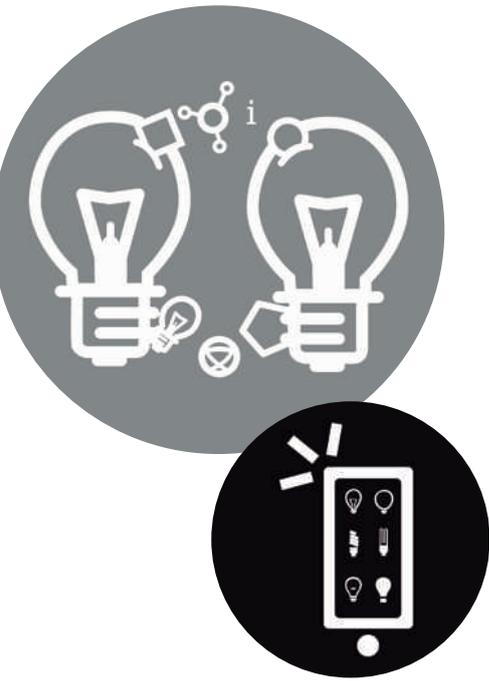
# Informational Capabilities

Capabilities to enhance our access to information and/or knowledge of the world. Smartphones currently connect us to the world. However, there are groundbreaking technologies under development to connect us to the world, such as wearable technologies, the cogs (systems capable of learning and interacting with human beings), augmented reality, sensors, etc.

Attendants were asked the following question during the Bankinter Foundation of Innovation sessions: What is your main superpower? It was a good question and one particular answer was noteworthy: "I carry a cell phone. I can tap into the world's knowledge in a matter of seconds with Google Scholar and Wikipedia".

We may acknowledge our lives have changed ever since smart phones and tablets are part of our lives, to the point of discussing the future survival of the PC as we know it. We are even creating new social habits around phones and their apps.

And if this is the case with the adoption of the truly smartphone —a 5-year-old trend that started with Apple's iPhone— what will bring the introduction of Google Glass and other wearable-computing products?

There are many companies working to transform information into knowledge in the real world. And there is increasingly more information: according to Cisco, there are over 10 billion things—and counting—connected to the Internet around the world. According to the Internet

Even though home automation hasn't penetrated our households at the rapid pace forecasted, Google just bought a ticket to make sure it will not miss the train

equipment manufacturer, we will probably hit 50 billion by 2020. "Big Data" actually refers to the difficulty in extracting meaningful information from the avalanche of ones and zeros.

Currently, the key is to know where to find knowledge as opposed to actually knowing. In the future, our human capabilities will depend on the type of cognitive agents available to us

IBM is working on how we will relate and associate with systems than can learn and interact and relate to people naturally. Agents designed to enhance our cognition. They are called cogs. What is a cog, exactly? It is a software agent, a cloud program created to help us solve issues, one with which we can relate through many interfaces, depending on the I/O (input/output) devices we are using. It will change depending on the sensors or connectivity or computing capacity available.

Didier Stricker is Professor in Computing Science at the University of Kaiserslautern

and Scientific Director at the German Artificial Intelligence Research Center. He made sure to mention augmented reality capacities in our daily lives.

Do you want to teach a foreigner how to fix the washing machine? The technology Stricker is working on enables capturing a video with all the actions of an individual, uploading it to the servers to then segment and structure it in different actions and download it to someone else's Google Glass. The system even checks correct actions with a green indicator and incorrect actions with a red indicator. How does the machine know what we are doing? Partly through the image itself, but it could know through other means, such as textile sensors.

Regarding apps already on the market, Mula Friedman's presentation was very interesting. Her company is working on the closest competitor of Google Glass: the Lumus DK-40. Its vision of augmented reality, running on Android's OS, is different from Google's product in several aspects. It aims to become a long-term alternative in consumer electronics.

Google Glass may guide you in all sorts of complex processes, from fixing a car's engine to carrying out complex actions in a factory

Anthony Lewis, from Qualcomm, mentioned an irrefutable fact: the US microconductor company sells 750 million chips per year, mainly for cellphones and tablets. "This means that every year we have access to 10% of mankind". They are now working on microprocessors inspired on the brain and biology. Lewis emphasized the importance of the "constant sensor": the possibility of having sensors constantly tuned to the environment and adapted to an individual's behavior to process data smartly.

# Anatomical Capabilities

Technological capabilities adapted to our bodies to enhance their performance, such as microelectronics applied to exoimplants and body-area networks and exoskeletons and advanced prosthesis.

## Body-area networks

At this point, the group discussed low-voltage, low-power microelectronic components that generate sensor networks around our bodies, the wireless body-area networks (WBAN). An intimate relationship with technology, a machine-human symbiosis of sorts.

Vincent Peiris has been working for the Swiss company CSEM for several years. This company has put 400 scientists to work on low voltage,
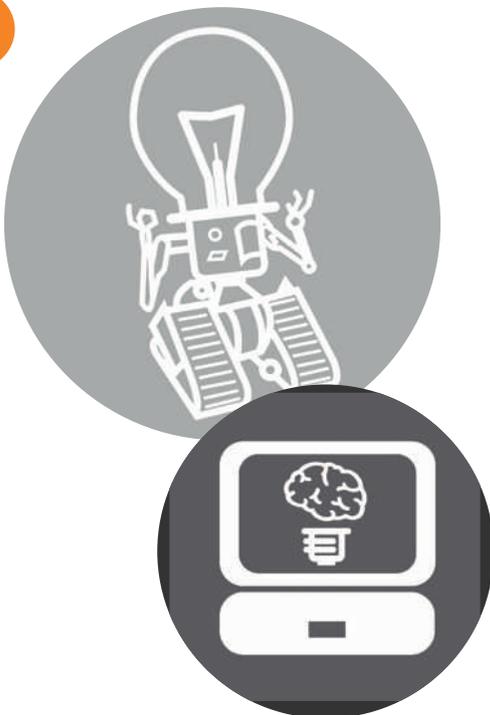
low power microelectronics. This scientist says that these body-area networks, made up of tiny sensor-nodes with different functions, are not only recording information, but also carrying out local proces-

It was even more impressive to listen to him talk about how microelectronics have enabled neurostimulating a rat with bone marrow problems: the rat regained control of its lower limbs

sing tasks, making their sensors increasingly smart. Up until now they have been used in telemedicine, for example.

Peiris coordinates WiserBAN, a European project pursuing ultra-miniatures and other objectives with industrial partners in different areas. This project requires sensors to be really tiny. The RF link must use an insignificant amount of energy and both the antenna and the radio must adapt to propagation losses around the body.
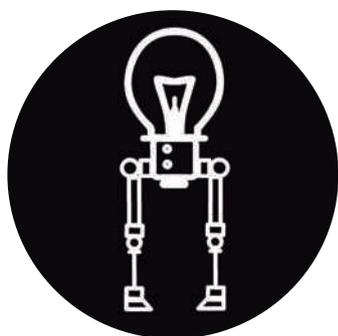
# Exoskeletons

The story of Russ Angold, co-founder and technical director of Ekso Bionics, has an echo of superheroes. With a background in agricultural engineering, his professional career focused on exoskeletons. Back in the day he used to joke around with his brother (member of the Navy SEALs, the special op body of the US Marine Corps) about

we are in the early stages of this technology's golden age, ultimately to be applied in many industries

how one day he would launch something to help him in his dangerous job.

The seed for HULC was planted then. It is currently being built by Lockheed Martin for the US Army. However, tragedy hit their household: a bone marrow lesion disabled his brother. Angold decided to support him in hospital, the same way he had intended to do in the battlefield, and focused his work on rehabilitation with machines.

The Ekso manufactured by this company enables patients to

# Informational Capabilities

**1** Access to information through smart devices: phones, chips and wearable computing products.

**2** Smart interfaces to interact with devices around us (virtual assistants).

**3** Smart systems that learn from and interact with human beings (cognitive computing).

**4** Combination of augmented reality and sensors to recreate reality in a virtual world.

# Anatomical Capabilities

**5** Body-area networks made of tiny sensors integrated into our bodies to enhance and strengthen our capabilities.
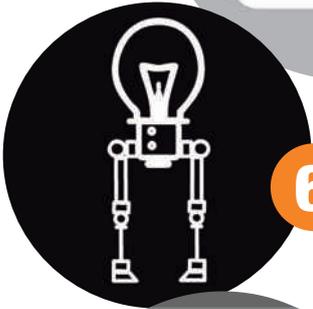
**6** Exoskeletons to enhance physical skills and help the disabled regain their mobility.

**7** Prosthesis, particularly, developing sockets as an interface between the patient and the prosthesis to increase the control and neuro-skeletal connection to the prosthesis.

# Biological Capabilities

**8** Neuroscientific developments to augment our brain capability, achieving the optimal state of brain capabilities.

**9** Genetic therapy to preserve health and avoid severe disease.

**10** The combined use of medicine and technology to augment quality and life expectancy.

What is the GPS but military technology? Drones were created for unmanned war missions. They are now used for inspections in industrial areas, recording pan views for movies, etc.

stand and walk assisted by a physiotherapist. As opposed to struggling at the gym and coping with the doubts ("Will I ever walk again?"), patients walk again, aided by this type of machines, pure and simple.

Panasonic's robotics division, Activelink, is based in Nara, Kyoto. They are working on their own exoskeleton too, the Power Loader; designed to maximize the efficacy of different types of professionals. They are priced fairly reasonably, even below the €10,000 mark. "During the 2011 earthquake and tsunami and after Fukushima, many Japanese people wished they were more powerful", said Motoki Nakano, whose videos on the Power Loader, to be marketed in early 2015, were a hit during the forum. The company believes these exoskeletons and its future fully automated versions will be useful in radioactive testing, or to free survivors from a collapsed building and building the skyscrapers of the future, or carrying out tasks underwater and in outer space.

# Prosthesis

Randall Alley participated in these sessions. He is one of the foremost experts in prosthetics worldwide. Most of his work has focused on developing a socket—the prosthetic components around the stump that interface between the patient and the prosthesis.

His High-Fidelity Interface Systems technology captures and controls residual bone, clearing heat and increasing stability, energy efficiency, control and the overall experience

Alley explained how his company, Biodesigns, is progressing towards developing this key component. His High-Fidelity Interface Systems technology captures and controls

residual bone, clearing heat and increasing stability, energy efficiency, control and the overall experience. "We preserve movement of the skeleton. We were focusing on the wrong place; the key was to replicate the neuroskeletal connection. But we want the prosthesis to be really part of you, not something you add", he explained. "

Another interesting project at DARPA is RE-NET, a reliable neural-interface technology created in 2010. It aims to create high-performing interfaces to control complex functions of advanced prosthetic limbs

Alley is also consulting for DEKA Research in the Revolutionizing Prosthetics Program of the Defense Advanced Research Project Agency (DARPA). This program seeks to develop a new generation of upper limb prosthetics for the US Army.
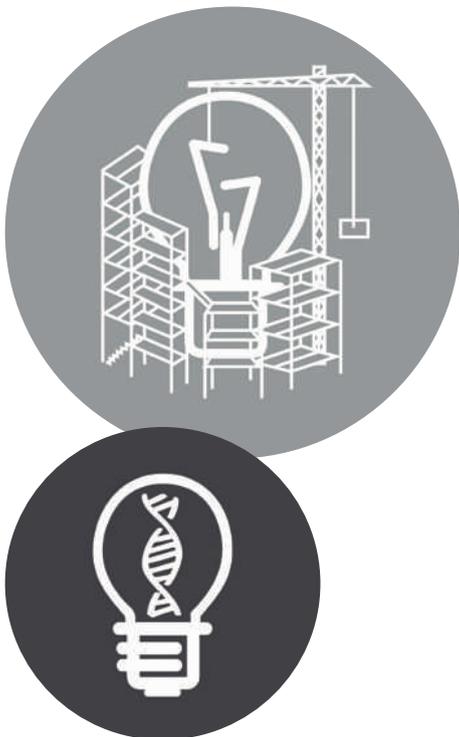
# Biological Capabilities

Capabilities based on analyzing new fields of biological enhancements, such as neuroscience, genetics and the intersection between big biology and big data.

A distinguished forum attendant, James L. Olds, directs the Krasnow Institute for Advanced Study, which is strategically focused on the intersection between neuroscience, cognitive psychology and computational science. Mr. Olds is an expert on the molecular base of learning and memory and son of the mythical scientist James Olds, who co-discovered with Peter Milner the reward system of the brain

The brain is the most complex machine discovered in the whole Universe. Besides, it is very slow, compared to computational circuits

and the role of dopamine in the chemistry of pleasure.

The scientist sits on the Board of the Flow Genome Project, which studies the neurobiology behind flow states. Steven Kotler and Jamie Wheal have co-founded the program. They are working to understand exactly what flow states are—many athletes or videogame players refer to it as "being in the zone", the optimal awareness state when humans simple work best.

The ability to concentrate of Adderall users improves significantly. It is not uncommon for some individuals to seek prescriptions to take advantage of short-term benefits, instead of to solve a previous defect

"Neurobiology is receiving massive investments from governments because it is easy to sell: everyone has an acquaintance with a brain disease", says Olds. In any case, this field is in its early stages. It hasn't had an Einstein and it hasn't developed a full theoretical framework like Physics has.

Javier de Felipe is a well known Spanish neuroscientist, leader of the Cajal Blue Brain project. The main axes of this project focus on the anatomical and functional microorganization of the neocortical column and the development of biomedical technology (basically computational). This project was the foundation of the European Human Brain Project, launched in October 2003. This scientist is involved in the European project as well.

His goal is to obtain detailed biological simulations of the human brain and develop supercomputational, modeling and IT technologies to carry out this simulation. It is a multidisciplinary approach engaging scientists from different fields. During the sessions, he remarked how important it is to know the brain—a forest made up of millions of trees (neurons) with branches (dendrites)—to find the cure to disorders like Alzheimer of schizophrenia.
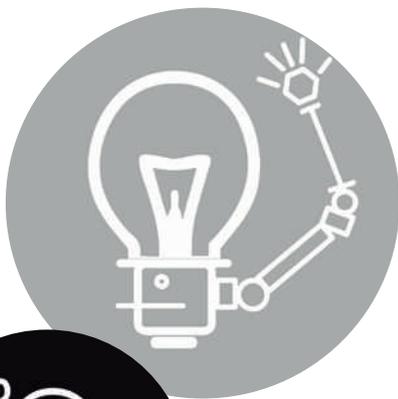
Juan Ruiz, Operations Director of the Spanish biological company Digna Biotech raised future challenges and fueled the discussion on ethics with suggestive and/or worrisome possibilities.

"We can accelerate evolution", he said, in reference to how

*During the sessions, he remarked how important it is to know the brain to find the cure to disorders like Alzheimer of schizophrenia*

better genetic information could enhance our abilities. "This is the Stone Age of genetic augmentation. For the time being, it is not accurate or well-defined, but it provides a broad view of future possibilities", he said.

Geoffrey Ling, Deputy Director of the Defense Sciences Office at DARPA, explained how this office regards governmental investment in projects such as those in the framework of the Brain Initiative, promoted by Barack Obama's executive team.

"We believe the best way to make the most of research is to start with the goal, imagine the use-cases and challenge scientists to comply with them. Selecting the best scientists in the world, giving them the resources they need

*He believes there is great potential to develop biological capabilities, provided that they are focused on maintaining quality of life*

and setting a deadline to obtain results. And knowing from the beginning how this research will be brought to the general public", highlighted Ling.

Success will in part depend on how the reward system is reevaluated. "I'd love to see a young doctor purchasing a BMW or a Porsche and motivating others to follow suit".

Christian Macedonia, Program Head at DARPA, made a call to respect the DNA complexity and highlighted the importance of understanding it as a whole. "For the last 50 years we have been looking for a bad gene, but DNA is a very complex system, we must treat it with respect and humility. It is an orchestra, a symphony of genes. Our focus right now is to look for patterns, rather than individual genes. We are trying to understand how the network of genes works". Additionally, he said that DARPA is not focused on short-term investments, but rather on long-term, great opportunities. "We'd rather invest on the foundation, on a combination of big biology and big data that we believe will be very profitable for companies".

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# Ethics

During the sessions, there was a lengthy discussion about the ethical risks implied by the technologies being analyzed. However, if we had to choose two discussion threads, they would be the struggle between what is possible versus what is right and the capabilities that level the playing field versus those that give some—and not others—an advantage.

Several speakers voiced serious ethical qualms in certain scenarios, mainly related to altering the DNA of fetuses in the pursuit of objectives other than normalizing them or curing a disease.

In general, the scientific community agrees that genetically improving a human being's abilities beyond its predetermined abilities when still a fetus would involve several actions hardly acceptable from an ethical perspective. Before it yields clear advantages, it would require experimenting with many fetuses, which en- tails problems of all kinds. What parent would allow this type of experiment? What government would sanction the regulation?

In-vivo modifications of a human being well aware of the risks are quite a different matter. A deaf person with cochlear implants regains normality, but his community considers him a dissident with superhuman capabilities.

We live in a society that punishes doping because there is an understanding that sportsmanship means competing in equal conditions against our peers. However, having been born free and equal before the law doesn't guarantee we will enjoy similar athletic skills. This difference is part of what makes us humans.

*A deaf person with cochlear implants regains normality, but his community considers him a dissident with superhuman capabilities*

Economic inequality is a noteworthy problem as well, both within developed economies and with emerging countries. Many technologies we have analyzed require sizeable investments. The type of advanced prosthesis or exoskeletons analyzed at the FTF are not available, in the least, for the general public, and very likely, it will be impossible to make them widely available in the short to medium term.

They are frequent in the literature and explicable in a world where some men were considered more human than others and men enjoyed more rights than women in some situations created by society

But let us not rule out the ability of technology to permeate through different social classes. There was talk at the Mobile World Congress in Barcelona of the launch of actual smart phones for $25 apiece in emerging countries. But even mobile phones running technologies now considered obsolete, such as SMS, on the ancient operating system Symbian, have had colossal impact in many communities.