

Building the Knowledge Archipelago

Globalization of a development model

By Miguel A. L. Nicolelis

Editors' note: An article in the February 2008 issue of *Scientific American*, "[Building a Future on Science](#)" by Christine Soares, describes a project led by neuroscientist Miguel Nicolelis to use science as an agent of social and economic transformation in his native Brazil. In this essay, Nicolelis explains the origins of his idea and how it could be extended to other nations.

Key Concepts

In the 21st century, innovative knowledge and technology creation, arguably the most unique by-products of the human brain, are likely to become the most valuable commodities fueling the global economy. As countries and multinational companies diversify their strategies in response to a new wave of globalization, a competitive edge will be held by those who are capable of more efficiently utilizing geographically distributed technological assets and skilled labor forces. It seems plausible, therefore, to envision that widely diverse communities worldwide will start linking their efforts to form virtual partnerships capable of competing more efficiently for the economic, social and political benefits generated by the growth of the knowledge-based industry. A project underway to build one such knowledge-based enclave of activity in northeastern Brazil is an example of this paradigm, and potentially the first of many such knowledge islands that will link to form a true knowledge archipelago worldwide.

Sitting on a comfortable chair at the leftmost corner of a stage set in the spacious west hall of the Presidential Palace, I could hardly believe that the ceremony unfolding in front of me was actually taking place. Flanked by the Brazilian minister of education, Dr. Fernando Haddad, and facing a crowd which had stoically endured a two-hour delay, I found myself next to President Luiz Inácio Lula da Silva while he calmly went about the business of signing a series of important presidential decrees.

It was an unusually breezy and politically charged early spring afternoon in Brasília. Despite his already busy day, the president seemed genuinely happy to be there—particularly since each of his signatures was saluted by a salvo of applause and exuberant celebration by different constituents, invited from all over the country to witness the event.

The ceremony had been delayed because President Lula had to participate in a series of last-minute meetings with congressional leaders involved in a highly disputed vote to extend a tax on financial transactions that would raise an estimated 40 billion reais a year (\$23 billion) to fund a variety of federal social programs.

It turns out that there was plenty of justification for the crowd's patient wait and for cheering each presidential signature. The decrees signed on December 12th created a series of complementary programs to support the backbone of a new Brazilian Plan for Education Development. Announced last April, this strategic educational project was spearheaded by Minister Haddad and his team as the ministry's flagship initiative to revamp Brazilian public education in the next few years.

Lost in my thoughts—most of which revolved around my amazement at how a five year roller coaster ride that started in front of a TV set in my home office in Chapel Hill, N.C., could have landed me in the Presidential Palace that afternoon—I almost missed the call to join President Lula, Minister Haddad and the provost of the Federal University of Rio Grande do Norte, Professor Ivonildo do Rego, at the front of the stage. The time had come for signing the decree that allocated 42 million reais (\$25 million) toward construction of the "Campus of the Brain" of the Edmond and Lily Safra International Institute of Neuroscience of Natal (ELS-IINN; www.natalneuro.org.br). The campus will be built in the bucolic little town of Macaíba, 25 kilometers from Natal, the capital of one of the smallest, neediest and most beautiful states of Brazil, Rio Grande do Norte.

Science as an agent of social transformation

After spending most of my life as a *Paulista* (a native of São Paulo State), I had been "reborn" five years earlier as a *Potiguar*, as citizens of Rio Grande do Norte are proudly known, in honor of one of the few Brazilian Indian tribes that never surrendered to the Portuguese colonists. I vividly recall the date and the precise moment of this rebirth, in which not one but two *Potiguars* were delivered at the same time. This twin delivery occurred late on the night of October 27, 2002. Standing in front of a 60-inch TV set that was specially purchased to follow Brazilian soccer matches, Sidarta Ribeiro, my longtime collaborator (and at that time a postdoctoral fellow in my laboratory at Duke University) and I spent most of the night following the news of the Brazilian presidential elections.

Around midnight in North Carolina, and just a couple of hours after all 86,129,335 million votes had been digitally cast and counted, Brazilians all over the world learned that Luiz Inácio Lula da Silva, the metalworker who gained national and international renown for his stand against the military dictatorship that ruled Brazil from 1964 to 1985, had been elected

president of Brazil with more than 61 percent of the ballots. Minutes later, Mr. Lula da Silva celebrated both his birthday and his unprecedented election by addressing a huge crowd that had gathered on the *Avenida Paulista*, in the financial heart of São Paulo, to greet their new president.

During that victory speech, President Lula said that it was time to start building a new and fairer country where all Brazilians would have the opportunity to fulfill their individual potential and become true participants in the decisions and challenges required to allow Brazil to awaken from its long slumber and reach out, at long last, toward a future of prosperity, justice and happiness. As most Brazilians would say, such a bright future had been heralded by many, for a long time, but it had never quite materialized.

Although the idea had been floating in our minds for some time, the decision to build the "Natal project," as it was originally named, came to life that unforgettable night when President Lula's call to arms hit us head-on in Chapel Hill.

There has been no looking back since then.

But how could a bunch of scientists living abroad do anything at all that would help in any meaningful way a country as huge and diverse as Brazil to move ahead? The answer to this question, which became the motto of our entire effort, surprised many in Brazil: We would use science as an agent of social transformation.

A few months after that night, we landed in Brasília to meet with President Lula and announce our intent to create a private project whose main goal would be to use science to transform the Brazilian northeast. Covering 71 million hectares of land (roughly twice the area of California), most of which is occupied by a semiarid ecosystem unique to Brazil known as *caatinga*, the northeast is home to 51 million people and some of the worst human development indexes found in the country.

As Brazilian scientists, we felt that high-quality science could do something to start reversing this sad reality. Instead of working solely within the limits of the traditional public university system, our plan called for the creation of a network of stand-alone private research institutes, loosely inspired by the Max Planck Institutes in Germany, that would spread across different northeast states and promote world class basic and applied scientific inquiry in 12 key strategic areas of research considered vital for Brazil's future development. Different from the Max Planck network, however, the key mission of each of these new institutes would not be limited to the production of academic research, but would also include the establishment of new paradigms through which scientific enterprise could become the main driving force behind a series of educational, social and economic initiatives aimed at empowering impoverished communities throughout the region.

Given our professional backgrounds, the scientific focus chosen for the first of these institutes was brain research. That is how, in 2003, the project to build the International Institute of Neurosciences of Natal (IINN) was launched simultaneously in Brazil and abroad. To handle all aspects of the IINN project and the future network of institutes, a private, nonprofit organization, Associação Alberto Santos Dumont para Apoio à Pesquisa (AASDAP), was created on April 17, 2004. Its name honors the greatest of all Brazilian scientists, the inventor and aviator Alberto Santos Dumont.

Seeding a knowledge island

The IINN project was conceived as a three-layer structure. A modern brain research facility defined the core layer. A series of social programs, built around the research institute, formed the middle layer. It included a science education program for children, a women's and children's clinic, an ecological park and a sports complex. The final layer would be formed by a series of private spin-offs, start-ups and established biotech companies located in an International Neurotechnology Industrial Park to be built in a special free enterprise zone created by the federal government. Altogether, this structure became known as the "Campus of the Brain."

Almost at once, the IINN initiative introduced a series of key innovations to the scenery of Brazilian science. First, the project was built essentially as a private enterprise, supported primarily by private funds and philanthropic donations raised within Brazil and abroad. Although strategic joint ventures were signed with the federal government, AASDAP has remained in charge of the management of the entire project since its conception, which includes fund-raising, recruiting and operating multiple research facilities and social initiatives, such as two schools and the women's health clinic.

A couple of years were enough to demonstrate that the proposal of using science as an agent for social transformation could attract private investment of real significance. In July of 2005 the São Paulo-based Sírio-Lebanese Hospital, one of the most prestigious private hospitals in Brazil, became the first Brazilian private institution to sign a broad scientific-social partnership with AASDAP. Later on, in February of 2007, history was made when Ms. Lily Safra kindly granted AASDAP one of the largest private donations ever made to a Brazilian scientific project. In recognition of her generosity, AASDAP renamed its first institute as the Edmond and Lily Safra International Institute of Neurosciences of Natal (ELS-IINN).

In addition to recruiting talent throughout Brazil, AASDAP invested considerable effort to repatriate young Brazilian neuroscientists who had been working abroad without any concrete hope of returning home, due to a lack of available positions, infrastructure and funding at the public university system.

By taking a major research project to the northeast of Brazil, AASDAP also gave support to the notion that it is possible to decentralize the production of science throughout Brazil and still maintain high standards of academic performance outside the main public university-based model. Despite its private orientation, since its first days the ELS-IINN has worked in close

collaboration with the Federal University of Rio Grande do Norte (U.F.R.N.), which in 2004 donated to AASDAP 100 hectares of land for the construction of the Campus of the Brain.

The ELS-IINN project was also innovative in establishing, since its conception, long-term links with leading brain research institutes in the U.S., Europe, Latin America and Asia. Built through multisite research collaboration projects, and supported by a new U.S.-based nonprofit entity, the International Neuroscience Network Foundation (INNF), this global network currently fosters research and educational initiatives worldwide.

Currently, the ELS-IINN is implementing the next phase of its paradigm to produce and disseminate innovative knowledge. By linking the activities of its state-of-the-art brain research institute to the creation of the first International Neurotechnology Industrial Park and a biofuel plant for producing biodiesel—a renewable fuel derived from a variety of tropical oilseeds cultivated in the Brazilian semiarid highlands by family farming cooperatives—AASDAP is aiming to create a self-sustainable business model to support the growth of the ELS-IINN Campus of the Brain and the community around it. The long-term goal of this massive scientific-social experiment is to create a model that can be replicated not only within many other locations in Brazil, but also in other developing nations in Latin America, Africa and Asia.

Having started to build a "knowledge island," we now intend to link it to a distributed knowledge archipelago. But how far can one take an idea, born in a little town in the Brazilian northeast? As the discussion below shows the answer is: far, very far indeed!

Driving forces for building a Knowledge Archipelago

The most recent wave of economic globalization—triggered by the mutually reinforcing cascade of events resulting from the opening of sizeable emergent markets along with the strategic decision made by multinational companies to outsource, primarily for cost-reducing purposes, not only their production facilities, but some of their operational and service-based activities to developing countries—has acquired revolutionary status, thanks to the unprecedented breakthroughs achieved by the information technology industry during the same period.

As a result of the widespread, seamless and virtually instantaneous means for information to be disseminated today, many developing nations have enhanced and diversified their economies by incorporating a range of innovative production technologies and good practice processes, while accumulating substantial revenues originating from service-based businesses at a pace that was simply unimaginable just a few years ago. Thus, by taking advantage of the coupling between massive business outsourcing and rapid information technology deployment, developing countries, such as India, China and Brazil have started to realize that this new economic model could, at long last, generate some of the significant wealth required to finance their massive social development needs.

Yet, according to prominent economists, such as Joseph Stiglitz, this last wave of globalization has failed to produce significant economic and social benefits for the vast majority of people living in the developing world. The world happens not to be flat after all. At least, not for the vast majority of those who live in its poorest and underdeveloped regions.

If exploited to its fullest capacity, however, it is conceivable that a radical and empowering combination of widespread knowledge dissemination—through massive education programs and strategic investments in scientific initiatives, and aimed at transforming the economies and social realities of developing nations—could lead to astounding outcomes. Indeed, this process could establish the basic initial conditions required for emergent nations to become, for the first time in history, key players in the assembly of a new global economic and political order; one in which significant worldwide economic growth would be attained without the classical colonial paradigm of domination, exploitation and environmental devastation that characterized previous incarnations of globalization pushes.

In its newest version, therefore, economic globalization could cease to be a simple, but very efficient, one-way highway for multinational corporations to reduce production costs and achieve higher profits. Instead, it could become a powerful global political tool for achieving a significant improvement in the life conditions of hundreds of millions of people through the massive distribution of the means to generate and consume knowledge. It could also lead the way for the emergence of a consensual model of cooperative global democratic governance; a system in which the pursuit of happiness becomes the undeniable right of all members of our species.

As this new globalization paradigm takes off, its limiting rate will likely be determined by the speed and efficiency with which developing nations embrace the profound structural transformations and policies needed to move their societies from pure consumers and beneficiaries of innovation produced by others to a stage in which they too can become true contributors in the process of generating cutting-edge knowledge and technologies.

Membership in such a radical new knowledge-based global society, however, will require profound changes in cultural and social traditions. This process will entail a deep rethinking of public policies and priorities, ranging from a massive investment in high-quality education and public health, efficient new technologies to produce renewable and clean energy to fuel rapidly expanding economies without further compromising the planet's health, and unorthodox urban development planning to accommodate the new lifestyle of knowledge-driven societies. Thus, if current societies accept the proposition that the mining, sculpting, validation and dissemination of innovative knowledge are likely to become the major economic driving forces in future leading economies, governments have to start enacting these new policies now. For once, developing countries will have to start increasing their current investments in science education, basic research and technological infrastructure, because the deployment of centers of R&D excellence and a large qualified workforce will be pivotal in the establishment of geographically

distributed, domestic or international networks of collaboration that can help local communities become active players in the global knowledge economy.

As these policies take effect, some of the revenue generated by the translation of innovative research, produced in local centers of R&D excellence, into new products and services will have to be reinvested into further education initiatives and the development of strategic R&D infrastructure. This latter step will be vital for enhancing the ability of developing nations to generate abundant supplies of food, clean water, renewable sources of energy and to build general information technology resources to further promote the digital inclusion of their people and institutions in the global market. In this context, it should be stressed that new income from knowledge-based activities will also help developing nations provide for widespread basic educational programs, universal health care coverage, job retraining and overall improvement in the life and labor conditions of their societies.

In summary, what we envision is the replacement of the current "sweatshop" model of globalization with a paradigm in which developing nations become full protagonists in the process of international knowledge trade and economic growth and use the proceeds of this new source of revenue to finance the largest period of concurrent global education and social development ever seen in world history.

Building virtual bridges

Once this process starts unfolding, individual communities that opt to morph into true knowledge islands, like the one currently being built in the northeast of Brazil, will naturally seek the comfort and uplifting synergy of becoming associated with similar communities worldwide. Likely, the unleashing of such a self-organizing, distributed scientific-social transformation process will quickly grow far beyond current country borders and lead to the emergence of true global communities; virtual knowledge archipelagoes, in which multilateral, multidisciplinary collaborations among citizens without boundaries determine the creation of a distributed, knowledge-based economic system built, regulated and nurtured by the archipelagoes' own democratically chosen systems of governance.

If such a model of large-scale virtual scientific interaction and economic production succeeds in the long run, it could provide the structure upon which communities interacting through worldwide interdependent social and economic partnerships begin to shape a complete new political order, one that diminishes the role of traditional political boundaries and differences, while encouraging and strengthening synergistic relationships across diverse cultures around the globe.

Because such concepts are currently only theoretical exercises, the key question at this juncture is: What is the roadmap for promoting knowledge archipelagoes capable of generating significant wealth and prosperity to the global society? Although this is a difficult question to answer at this moment, the first step should focus on the definition of comprehensive frameworks to design and build knowledge islands in developing nations.

One attractive idea is to build such islands around centers of research excellence, which are themselves surrounded by comprehensive educational and social projects, such as the Campus of the Brain project in Brazil. By building multiple outlets with which to communicate with society at large, the innovative nature of such knowledge islands can spill over its borders to reach out to impoverished neighboring communities. Self-sustainability of these research and social projects could be attained, at least in part, by the establishment of industrial research parks, tailored to suit the scientific vocation and aspirations of each of these communities, as the outermost layer of the knowledge island.

Such parks could house a broad spectrum of knowledge-driven business units, ranging from large, well established companies to small spin-offs and start-ups. This mixture would nurture a highly collaborative research and technology transfer environment in which companies share the infrastructure offered by the park to conduct large-scale industrial research services, promote technology development and the creation of new knowledge-based products. The central goal of this approach would be to create a highly diversified portfolio of economic activities that generate the wealth required to maintain the research and social-inclusion missions of the knowledge island. Once a few such enclaves become established, one could move to the next phase of the process: the integration of geographically distributed knowledge islands into global knowledge archipelagoes.

The investment required for such projects is considerable, though. Certainly, such efforts require the involvement of large multidisciplinary consortiums, lengthy negotiations with countries and significant fundraising. There is, however, a much faster, cheaper and potentially disruptive way to introduce the concept of knowledge archipelagoes worldwide and to prove its worthiness. That is, to create internet-based tools that allow communities worldwide to establish their own "domain-based knowledge archipelagoes." The emergence of thousands of such virtual knowledge archipelagoes, built around a particular theme or interest (for example, brain research, biofuels, environmental science) could provide the empirical social support, not to mention considerable revenue, for the development of true "four-dimensional knowledge archipelagoes"—those that involve networking real physical cities (with their 3-D spatial dimensions) through cyberspace (the new fourth-dimension frontier of urban development).

Whether knowledge archipelagoes will ever be established in the future as an economically feasible new scientific-social paradigm remains to be seen. Right now, the hope is that starting the discussion of such a concept can, at the very least, remind us that never before in the history of our species have the future prospects of individual and collective happiness, widespread human prosperity and the health of our environment been so obviously intertwined. Moreover, never before have we had the necessary accumulated knowledge and technological tools to support the design and implementation of a global model of self-sustainable economic growth that promotes widespread social inclusion worldwide.

Thus, by freeing science and knowledge from the isolated walls of our universities and taking it to the most remote corners of the world, we have the chance of triggering the greatest wave of social transformation ever witnessed.

By uniting the many Macaíbas that exist out there, a new breed of mighty *Potiguars* shall rise.

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