

# CHALLENGES FOR A NEW MILLENNIUM

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## The Current Crisis

A dilemma, according to the dictionary, is a difficult choice between two conflicting alternatives. Brazil, however, being a complex system in the modern sense given by the Complexity Theory<sup>1</sup>, actually faces a “multilemma”, that is, many alternatives. In fact, our greatest problem is precisely the simultaneity of problems in time and space. Yet, in a complex system not all variables are equally significant: a hierarchy exists that allows us to seek what are known as “control variables”. This type of analysis might pull us away from inaction by raising our hopes of eventually developing strategic plans for complex systems such as the social systems. Historically, in countries from the so-called Third World, particularly in Latin America, one of the very first strategic plans was formulated by the ECLAC (Economic Commission for Latin America and the Caribbean), founded by two political geniuses, Raul Prebisch and Celso Furtado. With regard to science and technology policies, Nobel prize winner Abdus Salam, with whom I had the privilege of working for more than a decade<sup>2</sup>, proposed a set of actions

1. Nunzeisweig, H. M. (org.) *Sistemas Complexos*, Rio de Janeiro, Ed. UFRJ.
2. Salam, Abdus. *Ideals and Realities*, Trieste, Italy, ICTP, 1990.

for the Third World in his book *Ideals and realities*. Today, at United Nations Conference on Trade and Development (UNCTAD), proposed and created by Prebisch, by the way, another Brazilian, Rubens Ricupero, strives to devise a viable planning model for the global control of economic/financial structures. From his privileged international observation post, Ricupero has produced shrewd analyses of the current world scene<sup>3</sup>.

In these times of disbelief in the State and in every sort of planning agency, it might seem naïve, or even a waste of time, to deal with such issues. Nonetheless, I am convinced that other alternatives exist, that we have not reached the end of history, that we may bring them about. The absence of a social cooperative disposition is the great pathology at the turn of the millennium, and conceals a new and simple paradigm, namely, that we can begin to cooperate in order to establish a new world disposition. That is why I am heartened to express some ideas deriving from my national and international experience in over fifty years of work in the fields of education, scientific research and technological development. I am aware I have limited experience in public policies, except in the aforementioned areas. But as education, science and technological development have become control variables for analyzing and planning social development, I have the intuition that my observations might be of some value.

Let us begin by acknowledging that strategic planning – which might lead to public policies for proposed scenarios (a sense of the absolute does not subsist in strategic planning) – starts out with analyses and studies of the systems themselves. To break this vicious circle, I believe the recent (1999) data compiled by the UNDP (United Nations Development Program) on Latin America may be taken as a reasonable starting point. I mention and fully endorse the framework put forth by Celso Furtado in his recent book<sup>4</sup>. Thus, I follow Furtado in proposing initiatives on three fronts:

3. See, for instance, Ricupero, Rubens. *Ponto Ótimo da Crise*, Ed. Revan, 1998.
4. Furtado, Celso. *O Longo Amanhecer*, Rio de Janeiro, Paz e Terra, 1999.

*Reverting the process of wealth and income concentration*

According to the author, this process “is at the root of Brazil’s social malformations”. He also stresses that the solution to these problems resides much more in the political than in the economic realm, recalling recent Nobel laureate Amartya Sen’s “focus on empowerment”, that is, the large excluded masses are not empowered by the power elites to attain land, education (and, therefore, work) and housing. This leads to situations of ruinous violence and crime, and possibly renders our problems worse or unsolvable – a situation that resembles the destruction of the environment, which has led at times to the disappearance of our fauna, flora, soil and waters. In the absence of political will and of more concrete goals to withstand this condition (not to mention the corresponding lack of vision for the serious problems that afflict us), we now seem bent on destroying the social ecosystem.

What paralyzes our political will? The inexistence of solid political and social leaderships, soon consumed or degraded by the problems themselves? The ongoing international recolonization through financial and technological globalization? A systemic and systematic corruption, embedded in our social disarray and in the vertiginous flux of trillions of dollars that rove electronically through every nation, nurturing the concentration of resources on the financial system, the dissemination of drugs and the subservience of the media? The fact is that the destruction of the socialist utopia engendered a kind of cataclysm, a thunderous breaching that led to the free-for-all of speculation and financial savagery associated with violence and unemployment.

*Abysmal ranking in the human and social development index used by the United Nations to assess different societies*

Brazil’s ranking in this index is abysmally low (74<sup>th</sup> place), in terms of per capita income. Furtado goes as far as saying that “the misery of a large part of the Brazilian people is the countervailing facet of the hyperconsumption practiced by a relatively small minority”.

*Inadequate insertion into the process of globalization*

This derives from the dismissal of every major expedient to control or outmaneuver the crises of speculative onslaught brought about by international capital or by multinational or transnational companies – including the loss of important domestic markets through the overhasty and sometimes inconsequential privatization of domestic companies to service our debts, to obtain resources, or sometimes for purely electoral purposes. At present, the great danger is the wholesale dollarization of the economy, which would (or will) lead to our complete loss of autonomy as State, nation and people. Pressures in this sense are enormous and are already producing results in weaker economies. Future times will surely make reference to this huge threat, perhaps the largest and most devastating of all, to which so far only China and a few other countries have not yet succumbed to.

**A Potentially Glorious Dawning? Education, Science and Technology: Challenges, Possibilities and Opportunities**

Building on Furtado's general demarcation, I now attempt to broach some more direct considerations, including alternative proposals derived from my experience as scientific researcher, consultant in the field of technological development, and university professor.

Our civilization is living at a time of exceptional opportunities. The globalization of communications, epitomized by the Web, the tremendous impetus of basic and technological research, the new educational technologies that are tearing down barriers between peoples and cultures, the space age that now pervades our social and cultural structures, specially through telecommunications, may eventually lead us to a "new dawning", to counterpoise Furtado's chosen title, "long dawning" – if we manage to understand and exploit all these new possibilities. To be sure, competition is fierce and we face the very difficult set of conditions bequeathed by our "long dawning". On the other hand, certain arguments and facts allow us to believe in more favorable performances. International examples do exist, veritable laboratories<sup>5</sup>

5. See Paul Singer's essay in this book.

wherein we may obtain valuable information. The crucial factor will be to find the strength and the political, corporate, scientific and cultural will and leadership needed for us to undertake these efforts against natural obstacles and hindrances – which, in a nutshell, are the conflicting interests of today’s dominant forces. This is the great dilemma of our current historical phase, which Helio Jaguaribe calls *Pax Americana*<sup>6</sup>.

*A proposal: pro-development “guerilla” tactics*

Let us go straight to the heart of the matter: in the “war for development” going on smack in the middle of the financial and technological recolonization of the *Pax Americana*, one of the few remaining feasible strategies is not global warfare or radical standoffs, but veritable “guerilla countermoves”. These guerilla tactics would be implemented by regional university-industry cooperation policies in islands and nuclei of excellence. Once fully structured, these islands and nuclei would gradually expand and join together for more ambitious alternatives and options. The Mercosul/FTAA standoff illustrates the kind of strategic policing the *Pax Americana* submits us to – and, indirectly, confirms the validity and legitimacy of “regionalist guerilla policies”.

This is an essential difference vis-à-vis the massive central planning that has led to gigantic difficulties, as in the former Soviet Union. Although not a radical defense of “small is beautiful”, I propose the optimization and adjustment of scales to avoid social and economic dysfunction. I do believe that the current wave of corporate mergers may lead to a serious and even lethal dysfunction of many conglomerates – and, as a result, to increased unemployment and possibly to a more virulent crisis, such as the one in 1928.

In the realm of scientific and technological R&D, we have witnessed precisely this process of regressive evolution in major American and European laboratories – e.g., RCA’s, the Westinghouse Research Labs and the Bell Labs, among others. And although we must acknowledge some success stories among the large laboratories – the Centre Européen de Recherches Nucleaires (CERN), for in-

6. See Hélio Jaguaribe’s essay in this book.

stance, and also the National Aeronautics and Space Administration (NASA), the National Institute of Health (NIH) and others – the fact is that these are involved only with rather specific objectives. After all, networks are more efficient and functional than conglomerates, more conducive to innovation and competitiveness, and more amiable to cooperative endeavors. Today the concept of networking is a victorious concept in many areas of science, technology, social sciences and the humanities. Embrapa (Brazilian Agricultural Research Company), for instance, one of the most successful institutions in Brazil and Latin America, operates as a network of centers and laboratories. Nevertheless, I believe we should combine the concept of networking with that of “emerging” centers or nuclei of excellence. These emerging centers would become catalysts of a broader development and give rise to a capillary texture, so to speak, providing sustenance to the system. Moreover, the network would evolve, bringing forth a new political will on a national, and even international level.

If these centers were organized by regional, university-industry strategic plans derived from a framework of networked cooperation, we might obtain positive results in the basic bottlenecks of our development: education, scientific and technological R&D, public policies in the areas of health, housing, employment and land, economic development, environment, culture, citizenship, demographics and many others.

Therefore, it is my belief that what we require is a gradual structural shift from central planning to a new, more decentralized, more regionalized strategic planning system – one that strongly emphasizes the emergence of regional centers and programs to foster, or even induce, new, more dynamic, more pluralist leaderships and visions for our society. In this manner we would incorporate that all-important ingredient for our development: new leaderships stemming from the younger population, expanding the scope of democratic governance to the various sectors and regions of Brazil.

There is nothing better than real-life examples and actual cases for us to assess these suggestions. I have had the opportunity of following-up on, and in certain cases even participating in some initiatives that, pursuant to this view, were successful. Among them I might mention:

- The implementation and nucleation of a regional physics center in Recife (northeastern Brazil), under the leadership of Sérgio Machado Rezende and his

team. This center brought new qualitative and quantitative scientific and technological perspectives to the region, including new public agencies, such as the Science and Technology Support Foundation and even the state of Pernambuco's Department of Science, Technology, and Environment. This winning model shows the extraordinary opportunities for similar actions in scientific and technological development, even in the northeast and in other less prosperous regions.

- The implementation, nucleation and development of Materials Engineering in Brazil at the Federal University of São Carlos, following the lead of the University of São Paulo in São Carlos. This changed the profile of Brazilian engineering with important economic and scientific reflections – including the industry's new, high-level human resources. More than one thousand engineers and hundreds of Masters and Doctors have graduated from the department since its inception in 1970<sup>7</sup>.

- The implementation and nucleation of Embrapa's National Center for Research and Development of Agricultural and Animal Husbandry Instrumentation, which introduced a new way of doing technological research in agriculture and animal husbandry, now applied all over Latin America. This effort also emerged at the University of São Paulo's São Carlos campus, with the bold support and vision of Eliseu Roberto de Andrade Alves, one of Embrapa's founding pioneers, and the efforts of extraordinary researchers such as Sílvio Crestana and Paulo Cruvinel, its successive directors.

- The implementation and nucleation of the University of São Paulo's Physics and Chemistry Institutes in São Carlos, which together with other institutes from the University of São Paulo and the Federal University of São Carlos have catalyzed the creation of São Carlos' technological and scientific nucleus and the establishment of many other high technology centers, companies and industries in the region and throughout Brazil.

- An important example is FAPESP, whose decentralized programs have created efficient networks for research and development in science and technology.

7. See Gonçalves, José Roberto. *Trinta anos de engenharia de materiais no Brasil*. Professor Gonçalves is a PhD in Science of Materials and associate professor at DEMA-UFSCar. Jan. 24, 1999.

FAPESP's bold initiatives, including its genome projects, illustrate how establishing networks for research or cooperative thematic projects may enhance the socioeconomic influence of science and technology. These initiatives owe much to the exceptional scientific leadership of Flávio Fava de Moraes and José Fernando Perez.

I would now like to make an observation which I deem relevant for our dilemmas and challenges: the need for a figure I call "science/technology and education entrepreneur". Please note that I carefully avoided referring to a scientist/businessperson or to a businessperson/scientist, or even to a plain entrepreneur. What I have in mind are *science and education entrepreneurs*. In other words, public or private proactive leaders with organizational skills to enable swift and differentiated advances in society through innovation, audacious goals and, above all, the creation of new leaderships. Many come to mind, including, among the deceased, the profiles of Anísio Teixeira, Paulo Freire and Darcy Ribeiro in education, and of Oswaldo Cruz, Carlos Chagas, Álvaro Alberto, Joaquim da Costa Ribeiro and Carlos Chagas Filho in science. I personally had the good fortune of working with Anísio Teixeira and Costa Ribeiro, closely sharing their struggles. In the international Third World scene, I must mention Pakistani-born Abdus Salam, a Nobel laureate in physics with whom I had the honor of working at what is now the Abdus Salam International Center for Theoretical Physics, in Trieste. Salam was a true statesman of global science and a great science and education entrepreneur in the sense I referred to above<sup>8</sup>. Finally, I must not fail to mention once again Argentina's Raul Prebisch, an extraordinary economist and visionary, and founder of the ECLAC and other international agencies. I mention these names to make clear that, in spite of enormous difficulties, we have produced exemplary leaders whom we can take as our paradigms.

This view of, and emphasis on the areas of education, science and technology, leaderships and persons, may seem less practical than more globalized and more sophisticated discussions and analyses. But they were successful in every central country and in those countries that have recently undergone accelerated development – particularly in terms of enhancing the wealth and culture that drove their

8. See Mascarenhas, Sérgio. "Ideals and Realities: Working with Abdus Salam" in Hamende, A. M. (org.) *Tribute to Abdus Salam* (1997).



progress. Brazil's situation is more precarious, however, because we require more profound cultural changes – so that, for instance, the younger generations may envision the fundamental significance of science and technology, and strive to become public and private entrepreneurs. Unfortunately, with rare exceptions, even our modern managers have only a superficial knowledge of science, technology and education. Not to mention that this is all happening in the presence and company of yet another generation, which remains frozen in the culture of the Ford era, at the most. This intermediate generation controls, often arrogantly, the country's major public and private policy decisions pertaining to the development of science, technology and education.

The lack of understanding and vocabulary between these generations prevents the existence of a true “language” with which to express our national will and educate future generations. This ominous gap is one of our gravest pathologies, and the reason for the crippling discontinuities in the support and aid given to Brazil's development in the Age of Knowledge. Recently, José Galizia Tundisi, one of the foremost environmental scientists in Brazil, was thwarted in his efforts as head of the National Council for Scientific and Technological Development – and the country is so much poorer for it.

The crisis which Amartya Sen refers to also encompasses a lack of political “empowerment” in the areas of science and technology, and an absence of up-to-date knowledge that engenders a cruel and insidious scientific illiteracy. An educational revolution is essential to change this picture, which is cultural and was inherited from centuries of dependence and from the age-old lack of science and technology<sup>9</sup>. The foundations of this educational revolution would have to be more in keeping with the Age of Knowledge, without forgoing the good that exists in our classical multiracial cultural base as literature, music, arts and sports. I remember Anísio Teixeira, with a visionary gleam in his eyes, saying to me, “We must fill the Maracanã stadium for scientific education!” Once, at his request, I travelled with him to Bahia to give a course on science teaching for elementary school teach-

9. See in Mascarenhas, Sérgio, Celso Furtado, Hélio Jaguaribe, Miguel Reale and José Reis. *Raízes e Perspectivas do Brasil*, Campinas, Editora Unicamp, 1985, an analysis by José Reis and Sérgio Mascarenhas.

ers. Today, we are still struggling to bring these changes about. However, as Alfredo Bosi<sup>10</sup> has unmistakably pointed out, even the most basic changes have yet to be made: in an article describing the overall financial situation of elementary school teachers in Brazil, we learn that a teacher's hourly wage varies from R\$ 1.50 to 3.00 in every Brazilian state, including São Paulo!

## Conclusions and Proposals

As may be inferred from what I have proposed, the fundamental variables that need to be fulfilled are:

- The development of science, technology and education by means of regional programs to establish emerging centers in these fields, including university-industry goals and vocations, and interdisciplinary integration. In the field of science and technology, a more resolute implementation of development nuclei, with strong cooperation between universities, companies, secondary schools and technical schools. The creation, within these nuclei, of centers for science instruction and technological education, with their own multimedia production and distance learning facilities. It must be noted that I have associated the sciences of education with educational technologies, because otherwise it would be impossible to attain the requisite quality levels in the teaching/learning process, but only with soft-hard-ware without “human-brain-ware”. It must be acknowledged, however, that the Ministry of Education is currently striving to initiate efforts along these lines by implementing numerous special programs.

- A complementary effort in the area of culture and education that includes science and technology as the new, necessary elements for our youth to develop a new political disposition and acquire a new worldview. In this sense, it is imperative to create a “network of science centers and museums” throughout Brazil, financed by permanent public and private funds from a National Foundation of Science Centers and Museums. A new culture and a new concept of citizenship would thus emerge, more in keeping with the onset of the new Age of Knowledge.

10. Bosi, Alfredo. “O Ponto Cego da Educação”, *Folha de S.Paulo*, 1997.

These problems were dealt with in a recently published book<sup>11</sup> and have long been studied by Crodowaldo Pavan, José Reis, Isaías Raw, Ernesto and Amélia Hamburger, Shiguelo Watanabe, Yvonne P. Mascarenhas, Dietrich Schiel, Antônio Teixeira Jr., Julieta Ormastroni, myself and many others, from differing angles and perspectives.

– Science and technology, if not complemented by the rich humanistic traits of our multiracial culture and our artistic, literary, musical and sports traditions, are not enough for Brazil to attain the goal of establishing a new platform of values and citizenship to launch our “New Dawning”.

Nothing epitomizes these ideas and proposals better than the figure of Janus – the dual-faced Roman god – looking at the past and its traditions, and into the future and its potentials.

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11. Crestana, Silvério, Míriam Goldman de Castro and Gilson R. M. Pereira (orgs.) *Centros de Museus de Ciências: Visões e Experiências*, São Paulo, Saraiva, 1998.