Research & development for the 21st century

Part 28
Ibero-American integration

The capacity for sustained and autonomous development of Ibero-America depends on its being able to reach world stature in the domain of scientific and technological research. Nuclear energy is one crucial area in this regard, both for its immediate productive potential, and for the opportunities for training of personnel that it presents.

This installment begins Chapter 10 of *EIR*'s exclusive translation of the Schiller Institute book, *Ibero-American Integration: 100 Million New Jobs by the Year 2000!* published in Spanish in September 1986. It was commissioned from an international team of experts by the Schiller Institute's Ibero-American Trade Union Commission, to elaborate the 1982 proposal by Lyndon LaRouche for an "Operation Juárez" that will transform the huge foreign debt problem into the springboard for a regional economic boom—and an unheralded world recovery.

Numbering of the tables and figures follows that of the book.

What Ibero-America must do in the area of research and development over the next 15-30 years is defined by our overall parameters for total population, labor force, and economic growth. Specifically, it would be a mistake to try to extrapolate from present levels of either manpower in, or funding for, R&D: This will be totally inadequate for the tasks posed to the region in the 21st century. Rather, we must return to the parameters developed in Chapter 5, in terms of where the continent must be by 2015, if it is to productively employ its labor force.

To recapitulate the conclusions from that chapter: The economically active population (EAP) will increase from about 400 million today to about 786 million in 2015, at a 2.3% annual rate of growth. The economically active population will grow from about 134 million to 323 million, at a 3.0% annual rate. The GNP will grow at an average annual rate of 10%, and manufacturing at 11.3%. To achieve these goals, productivity per manufacturing worker must grow by 5.2% annually, a target exceeded for many years in a row by such countries as Japan. But to do that will demand the same commitment to advanced and large-scale research and development programs that characterizes Japan today. In fact, Japan has surpassed the United States in total number of scientists and engineers engaged in productive research.

These targets for Ibero-America mean that the continent in 2015 will have a population greater than that of the entire OECD today, with an average level of worker productivity as high as the OECD countries today, and average living standards also on the level of these advanced countries. This will be achieved simply by applying today's most advanced technologies across the board in Ibero-America. But an economic entity of this magnitude requires a research and development establishment also on the level of the OECD today. It would be a profound error for Ibero-America to limit itself to so-called "appropriate technologies," as the World Bank and the Brandt Commission always insist. Nor can our research and development effort be geared toward passively acquiring techologies developed elsewhere, while remaining 20-30 years behind the more advanced countries in the adoption of the most modern technologies. Ibero-America must in the early 21st century become self-sufficient in this most profound of ways: It must be capable of generating its own scientific and technological breakthroughs on a continuing basis.

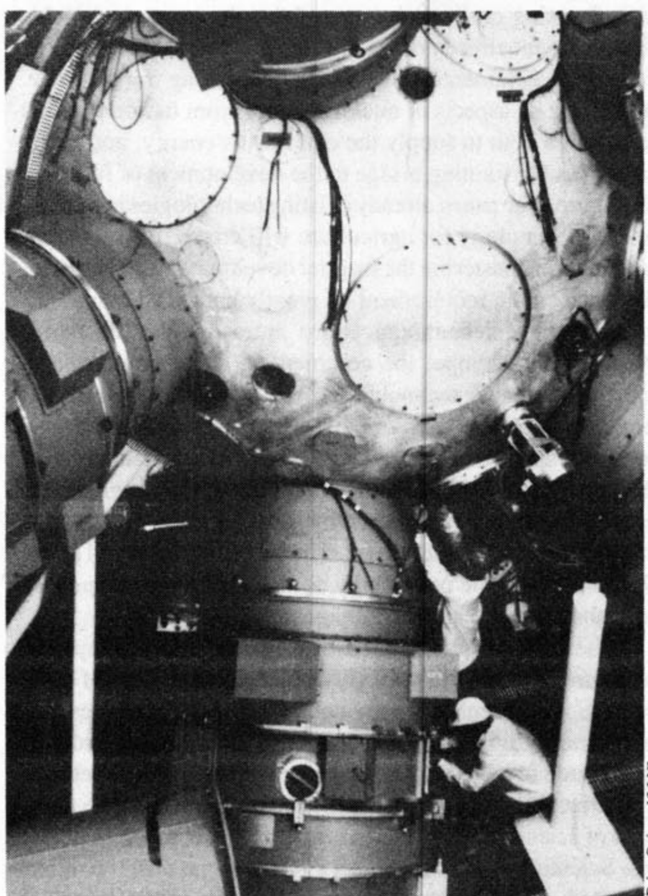
The application of such frontier technologies on a par with the advanced sector over the first decades of the 21st century, will produce nonlinear leaps in productivity, which will bring average Ibero-American productivity up to the then-existing advanced sector level by the second quarter of the 21st century. In other words, any economic distinction between "advanced sector" or "developed" nations, and "underdeveloped" or "developing" nations will be erased in about two generations' time.

We recapitulate here the four main areas which will be the scientific frontiers of the 21st century, as identified in the Introduction, as these must orient Ibero-America's program for science and technology development.

1) Fusion power and high-energy-density plasmas. These technologies will transform electric power generation; non-electric energy consumption patterns (through the use of hydrogen instead of fossil fuels); all metal-refining processes and many other industrial processes; and, in the form of the so-called "fusion torch," will permit the low-cost "mining" of every mineral needed by man, directly from ordinary rock or seawater. Fusion energy will harness isotopes of hydrogen which can be extracted from seawater for fuel. Moreover, with heats achieved in the millions of degrees centigrade, thermonuclear fusion reactors can co-generate process heat sufficient to ionize mineral ores, seawater, and garbage wastes, permitting easy separation into elemental form.

2) Laser technology. These technologies consist of concentrating very coherent electrohydrodynamic radiation, thus generating very high energy-densities at the point of targeting. They will have many applications, including anti-missile systems and precision machine tooling; there will be lasers extended to all ranges of the electromagnetic spectrum.

3) Optical biophysics. This field will use lasers and other forms of coherent electromagnetic radiation to effect a revolution both in medicine and in the application of biological processes to agricultural and industrial purposes. Optical biophysics is an advanced application of spectroscopy to diagnosis and analysis of living processes, permitting everything from observation of living processes at work at the microscopic level (without killing the specimen), to scientific molecule identification. The latter will greatly enhance the range of possibilities and efficiency of so-called bioengineering.


Brian Quintard/LLNL

Laser technicians install diagnostic instruments on the Nova target chamber at Lawrence Livermore National Laboratory. Nova is the world's most powerful laser.

4) Computer technology. This field will undergo orders-of-magnitude advances in speed, complexity, and kinds of operations possible, which will be required by the three areas mentioned above, and by other fields.

To be capable of contributing to these areas, and to the subsidiary areas elaborated below, Ibero-America must take steps immediately to expand the quantity and quality of education at all levels, from the primary up to the advanced university level. As indicated in Chapter 5, by 2015, one hundred and forty-five million additional students at the primary, secondary, and higher educational levels will need to be provided for. Simultaneously, the quality of education must be improved dramatically, and the percentage of students entering fields related to science and technology must increase very greatly.

The first phase of the R&D program

Today, however, Ibero-America is further behind in the area of research and development than it is in overall economic development. The first phase of the required program entails focusing on those aspects of the above research fields that represent already developed technologies that are essential for the continent's development beginning immediately. Mastering all aspects of nuclear energy from fission reactors is required both to supply the continent's energy, and as the only possible training bridge to the development of fusion in the future. The use of already existing technologies in biology and biotechnology for agriculture will create the infrastructure for later mastering the frontier developments in this field. The immediate requirement of greatly enhanced communications and telecommunications infrastructure in Ibero-America will compel the continent to focus on mastering existing computer technologies. The perspective must be to organize present efforts to build up the research and development capabilities of the continent from the standpoint of the identifiable long-term technological breakthroughs, rather than any attempt to proceed by some series of "pragmatic" steps up from the present level. The latter approach will doom the continent to be perpetually decades behind the vanguard in global research and development.

The kind of organization of research and development structure adopted will strongly influence the success of these efforts. At present, not only does Ibero-America invest extraordinarily little in R&D, and has, per capita, an order of magnitude fewer scientists and engineers than the developed countries, but this lack translates into too few absolute numbers of scientists in most areas to do any effective research at all. Scientific research requires a "critical mass" of top minds engaged on the same and related projects in the same, or coordinating, institutions, to make significant advances. In this sense, the
engaged in R&D is intrinsically less important than total numbers of scientists. India, whose per capita number of researchers is necessarily quite small, nonetheless has built up one of the largest total pools of scientists and engineers in the world, and is in fourth place behind the United States, Japan, and the Soviet Union. India does have this "critical mass" for major innovations, in a growing number of areas of advanced technology.

In fact, the Indian example for organizing research offers a useful model for Ibero-America to follow. India, in accord with the guiding concept of Pandit Nehru during the 1950s, has set up a growing network of central research institutes throughout the country. Usually one or two such institutes become the centers for the most advanced research, which in turn organize subsidiary centers in universities and elsewhere in the same fields. The results in little over 30 years are impressive, in which India has its own entirely self-sufficient nuclear energy program, a space program, and many other advanced programs.

In Ibero-America, the diversity of nations dictates that at least a dozen or more advanced institutes in as many fields be set up in various countries, the locations to be determined by existing concentrations of expertise, or by physical requirements, where top researchers from around the continent will work together to create the required "critical mass" to galvanize the research effort. Satellite polytechnic institutes and university centers in each country will be tied into these central research units. Below, we will detail several of the fields most urgently required, although this list is not intended to be exhaustive.

It should be emphasized that the armed forces of the various nations of Ibero-America have a proper and especially important role to play in these high-technology endeavors. The military's principal peace-time function must be to actively participate in the nation-building projects that this book has sketched out, since most breakthroughs will have military and national security—as well as economic—applications.

Nuclear energy

Immediately, long before the continent becomes competent to contribute to the frontier areas of research enumerated above, several strategic areas of the Ibero-American economy demand major R&D investments in order to achieve the projected economic growth.

The first area is that of energy. As shown in Chapter 6, even conservative estimates of total electrical energy requirements in 2015 indicate that Ibero-America will be courting energy disaster if we have not created the infrastructure to switch almost totally to nuclear energy generation by that time.

The effort required will of necessity be a continent-wide one. The Euratom (European Atomic Energy Community) cooperation program begun in the 1950s as part of the European Common Market, is an example of the kind of international cooperation that will be required in Ibero-America. Euratom, created in 1958, established a common market in nuclear fuels and began joint research in areas such as nuclear reactor design. As nuclear energy became increasingly commercialized in the 1970s, Euratom shifted its emphasis more and more to research into fusion energy, with an annual budget of $170 million, and presently maintains the JET (Joint European Torus) project in Britain, which is the largest fusion test facility on the continent, staffed by scientists from all EC member countries.

Ibero-America must assimilate the experience of Euratom, and create a joint nuclear energy commission that is both larger and more encompassing than Euratom. Because the scientific and engineering infrastructure in this field is so primitive in most Ibero-American countries, the joint nuclear commission of Ibero-America will have to be concentrated not only in research as such, but in helping each country to establish nuclear power plants and train the manpower to operate them. In this regard, Ibero-America has a significant, if still small, nuclear establishment to build on. During the 1950s and 1960s, under the Atoms for Peace program, many countries acquired small research and training reactors and developed cores of 50-100 or more nuclear scientists and engineers. While the promise of this program was not fully realized, this infrastructure still exists. In addition, Argentina has developed its own nuclear industry much further, becoming the first Ibero-American country to operate commercial nuclear power plants, beginning in 1974, and now plans to manufacture a small reactor of their own design for domestic use and export. Brazil has more recently constructed its first reactors, and Mexico has extensive plans for nuclear power as well, although their first plant, Laguna Verde, is still awaiting completion. All of these programs provide a good basis for the expansion of trained manpower in this field.

To meet the energy goals of the year 2015, Ibero-America must be able by that time to bring on-line each year as much new installed capacity of nuclear energy as the entirety of the nuclear installed capacity in the United States today. Meeting this goal will transform the entirety of the industrial economy of the continent. The NASA program in the United States in the 1960s similarly demanded major contributions from industry and science, and returned to industry benefits in the form of new technologies which remain today the basis of advances in productivity in almost every field. So too the installation of the required nuclear energy capacity in Ibero-America will have ramifications in dozens of major industrial areas, and will in turn generate spinoffs of technology that will greatly enhance the productivity of these and other countries. The relative impact of this program will be even greater than that of NASA on the United States' economy.

This is so because almost every field of heavy industry and capital goods is involved in manufacturing nuclear plants. Argentina currently is about 60-65% self-sufficient in manufacturing the components for its nuclear plants, and aims for 80% or more by the year 2000. The direction of this effort is correct, but it is entirely inadequate for the goals set out in this report. One hundred percent Ibero-American self-sufficiency in all areas that go into manufacturing nuclear plants must be achieved by 2000, and preferably before. This requires starting up the industries required immediately, including high quality alloy steels, large pressure vessels and reactors, advanced instrumentation, heavy water plants, etc.

In addition to producing nuclear electric generating units according to already known models, at least three technologies now under research and development must also be developed.

- Magnetohydrodynamics, or MHD, in use in the Soviet Union and experimentally in the West, promises to harness the heat energy from fossil fuel or nuclear energy and convert it directly to electric current, without the mediation of boilers, turbines, or generators, thus realizing a 100% increase in electrical output per unit of fuel imput.
- Cryogenics, the supercooling of magnets and electric transmission lines to eliminate friction losses, will revolutionize electric generation and transmission processes, reducing total electricity consumption needs.
- Thermonuclear fusion requires an ever-increasing investment of money and manpower to make this technology a reality by early in the 21st century.

To meet the targets for the nuclear program demands, in particular, major breakthroughs in the area of materials science. Research in the three processes mentioned above is more advanced today than research into materials that are capable of containing the very high, or very low, temperatures involved. Therefore, research efforts must focus on both new metallic alloys to meet the demanding criteria, and on the possibilities of ceramics.

Another area requiring development by Ibero-America is that of designing and manufacturing instrumentation. Increasingly sophisticated computers, measuring intruments, and control equipment will be needed for this program.

Finally, the question of qualified manpower will prove to be the biggest bottleneck of all. By the year 2000, Ibero-America will need at least as many scientists and engineers in the nuclear field as the United States now has. That will mean at least 10,000 nuclear engineers, and 50,000 engineers from other disciplines dedicated to the nuclear field. And it will entail 15,000-20,000 scientists, including 4,000-5,000 physicists, 3,000 chemists, 2,000 mathematicians, and a good number of others in the fields of geology and earth science, metallurgy, biology, and medicine. While the continent has sufficient engineers, it is desperately short of the required number of qualified scientists. Argentina currently has about 1,200 nuclear-related scientists and technicians, and turns out about 30 trained scientists a year from its institute at Bariloche. Thus, programs such as this one in Argentina and other countries must be scaled up dramatically to meet this need.

By the year 2015, Ibero-America will require another order of magnitude increase in the numbers of scientists and engineers. By 2000, Ibero-America must have installed nuclear reactors in the major countries of the continent and laid the basis for later mass production of reactors. By 2015, the region must be producing reactors with upwards of 100,000 MW of installed capacity per year. This will entail thousands of scientists in research and development to pioneer the design and mass production of the requisite reactors. Using parameters computed in 1980, the construction alone of nuclear plants requires about one nuclear engineer per megawatt of installed capacity. This means at least 10,000 nuclear engineers by 2000, and 100,000 by 2015, for this function alone. In reality, the new reactor designs will lower this figure significantly, but the calculation indicates the range of manpower required.

To train the number and quality of scientists and engineers needed by 2015 will necessitate expanding centers for training and research and development, on the Bariloche model, in all major countries of Ibero-America. All in all, the future of the continent's nuclear capability will depend principally on a proper marriage of Argentina's nuclear expertise with Brazil's capital goods capabilities. It were therefore proper that an *Ibero-American Institute for Nuclear and Laser Research* be established between those two countries.