ISSUES
IN SCIENCE AND TECHNOLOGY

Global Innovation

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Mexico's Innovation Cha-cha

The country has taken some encouraging steps toward strengthening its science and technology capacity, but it retreats when it comes to providing adequate resources and following through on implementation.

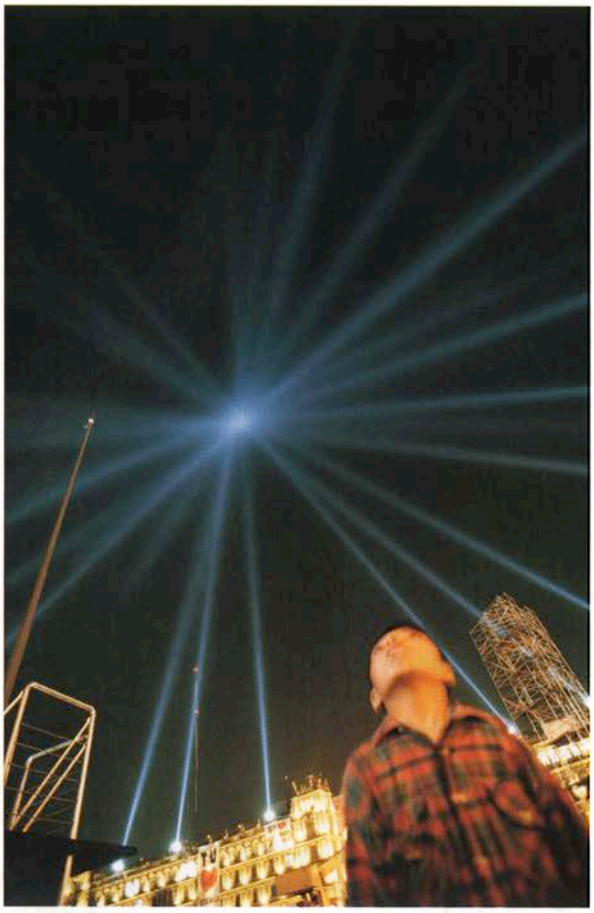
Like many nations, Mexico has been making an effort to increase its investment in R&D and in scientific manpower. But although Mexico's investment in science has grown significantly in absolute terms during the past few decades, the country still lags far behind others. In 2004, nations that are part of the Organization for Economic Cooperation and Development (OECD) on average invested 2.3% of their gross domestic product (GDP) in R&D. Mexico's R&D investment in 2004 was less than 0.4% of GDP, a ratio that has remained essentially constant during the past decade. Why has Mexico been so slow to invest in R&D? What are the implications of this? And what can be done about it?

Historically, economic activity in Mexico was largely based on exploiting its abundant natural resources, with oil production accounting for an important share of GDP. In addition, its economy was closed and heavily regulated. As a result, until recently, Mexican companies have had little incentive to innovate and did not perceive the need to invest in R&D. Similarly, science and technology (S&T) was largely absent from the government agenda.

Mexico's S&T system began around 1930 with the creation of the National Institutes of Health, with government support dedicated almost exclusively to improving the nation's health. In 1960, the country took a first step toward broadening its S&T effort through creation of the National Institute for Scientific Research (Instituto de Investigación Científica), which provided scholarships to fund undergraduate college theses and graduate education.

Mexican S&T began to evolve during the 1970s. First, the Mexican higher education system expanded as a number of large public universities were established. Mexico's economic development strategy was based on import substitution, and increasing education levels was seen as critical to making this approach work. Second, in 1970, the National Institute for Scientific Research became the National Council for Science and Technology (Conacyt) and began to award research grants. Although these early grants were minor and worked mostly as complements to the higher education expansion effort, S&T investment had finally entered the policy arena. As a result of these policies, a small, active scientific community in Mexico was established.

Then the severe financial crisis of the 1980s hit. Mexican inflation levels reached more than 150%, and purchasing power dropped dramatically. Inflation's impact fell heavily on the middle class, which included university professors. As a result, the few scientists that the country had been able to foster started leaving, mainly for the United States.



Rafael Lozano-Hemmer

The interactive art project portrayed here was designed by Mexican artist Rafael Lozano-Hemmer to celebrate the arrival of the year 2000 in Mexico City's Zócalo Square. The event website allowed anyone to design immense light sculptures over the historic city center. The light designs, rendered by 18 robotic searchlights placed around the square, could be seen for a 10-mile radius. A personalized web page was made for every participant, with virtual and real images of their design from three perspectives. In Mexico 800,000 people from 89 countries participated. The project was later installed for the opening of the Basque Museum of Contemporary Art in Vitoria (300,000 participants), at the fête des Lumières in Lyon (600,000 participants), and for the European Union expansion celebration in Dublin (520,000 participants).

Images courtesy of Bitforms Gallery, New York.

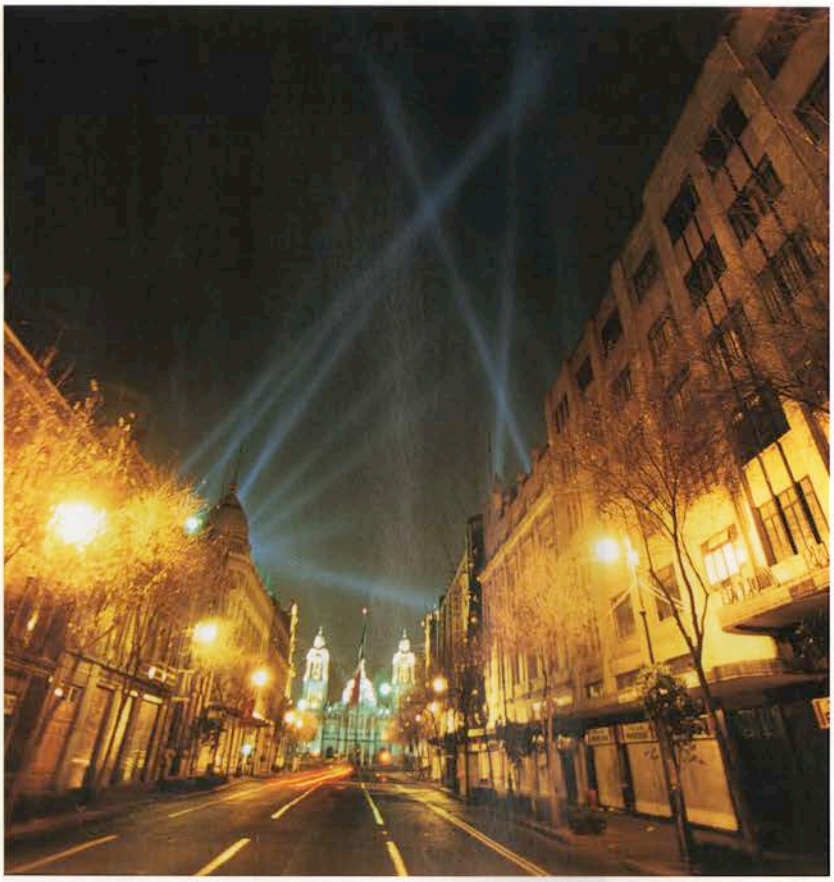
In an attempt to avoid a total collapse of the budding scientific community, Mexico created the National System of Researchers (SNI - Sistema Nacional de Investigadores) in 1984. SNI supplemented the salaries of the most productive researchers. This program has remained active, becoming a distinguishing feature of the Mexican S&T system. The number of SNI researchers grew from fewer than 7,000 in 1992 to more than 12,000 in 2005. In 2003, about 30% of the researchers in Mexico were members of the SNI. They published about 85% of the Mexican international peer-reviewed publications in the ISI Thompson Web of Science Database. Currently, researchers receive recognition—and a significant part of their incomes—by being part of SNI.

Mexican S&T begins to stir

By the end of the 1980s, Mexican economic policy had changed. Import substitution was abandoned, and the country moved toward a deregulated and open economy. Mexico became a member of the General Agreement on Tariffs and Trade (GATT) and signed the North America Free Trade Agreement (NAFTA). These changes had an impact on science as well as trade. In 1991, the first World Bank loan for S&T in Mexico led to the creation of PACIME (Programa de Apoyo a la Ciencia Mexico). This program provided $150 million to support scientific activities, with a matching amount provided by the Mexican government. The funds enabled the creation of a number of new initiatives: programs for research but also for equipment, infrastructure, retention of scientists, and endowed chairs.

These initiatives had a significant impact on S&T investment in Mexico. Federal S&T expenditure as a percentage of GDP increased from 0.28% in 1990 to 0.33% in 1991. By 1994, it had reached 0.41%, roughly the level of today. Moreover, Conacyt, which became the primary agency responsible for defining and implementing S&T policy, saw its budget increase more than 230% in real terms from 1989 to 1994.

During the 1990s, the main objectives of S&T policy



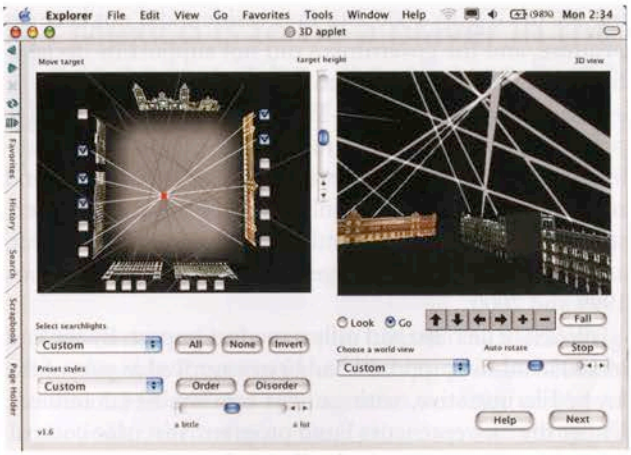
were increasing the country's capacity in scientific research, supporting advanced training, and to a lesser extent, supporting technological development. Almost all the programs created by PACIME remained and their administration improved. Conacyt's budget reflected these priorities, with only a small proportion dedicated to promoting innovation. In the 1993 budget, 26% went to science, 2% to technology, 29% to scholarships, 20% to SNI, and the remaining 23% for other programs. This distribution remained similar during the rest of the decade. These programs have had an impact in Mexican science, with national researchers publishing more papers. According to ISI, the participation of Mexican scientists and engineers in the global scientific production increased from 0.2% in 1993 to 0.5% in 2003.

By the turn of this century, Mexico's S&T system had grown in size, output, and international impact, but its S&T investment had not keep pace with the country's economy. According to OECD figures, gross R&D expenditures as a percentage of GDP was 2.65% in the United States, 1.58% in Canada, but remained at 0.40% in Mexico— the last place among OECD countries in terms of resources devoted to S&T. Similarly, Mexico also has a limited pool of science manpower. As recently as 2002, it had only 0.33 full-time researchers per 1,000 inhabitants. Brazil and Poland had 0.45 and 1.53 per 1,000 inhabitants respectively, and developed nations are typically much above these figures.

Still, Mexican S&T, although small, is quite efficient and effective on an individual researcher basis. The average researcher publishes more papers and is cited by other researchers more often than in most comparable nations. In 2003, Mexico was publishing 1.14 ISI papers per full-time equivalent researcher, compared to 0.74 in Brazil and 0.83 in Poland.

New policies and innovation

Because the emphasis in the 1990s was on increasing the amount and quality of Mexican scientific research, only 2% of Cona-



RAFAEL LOZANO-HEMMER, *Vectorial Elevation, 1999-2000, Relational Architecture 4,* Interactive public installation: Mexico City, Mexico. Robotic searchlights, custom software, computer, Internet access, dimensions variable.

View Quicktime video:
http://www.bitforms.com/movies/moviehemmer4.html

cyt's budget was spent on technology development. In the early 1990s, Conacyt designed its first programs to foster industry innovation. The R&D Technological Modernization Trust Fund (Fondo de Investigación y Desarrollo para la Modernización Tecnológica, FIDETEC) was established to provide warranties and long-term financing for precommercial R&D. Complementary initiatives were also created, including one program to promote university-industry linkages (PREAEM), another to encourage the creation of technology-base incubators (PIEBT), a third supporting private research centers (FORCCyTEC), and, finally, a program to improve technology information (RCCT). However, scarcity of resources, together with high interest rates, lack of capacity for risk evaluation, and poor program design led to very low demand for these programs. Consequently, their impact was modest at best.

A second set of initiatives for promoting innovation happened only late in the 1990s. First, resources from the second World Bank loan for S&T were assigned to new programs devoted to the enhancement of technological innovation (PCI - Programa de Conocimiento e Innovación). Second, a system of fiscal incentives for S&T was established. But despite this new set of resources from the World Bank, very few companies submitted projects to the program, and even fewer ended up receiving support.

The slow pace of these programs was due partly to the extremely low investment of the business sector in innovation activities, in particular R&D. The long history of economic protectionism in Mexico had created a social environment with very little appreciation for innovation. In 1999, only a little more than 20% of gross expenditures in Mexican R&D was financed by companies, whereas in Brazil companies contributed 40% and in Korea more than 70%. Moreover, since few Mexican scientists worked in industry, university-industry research collaborations were almost nonexistent.

As the millennium began, the Mexican innovation system displayed some progress, but also enormous gaps. This became even clearer when the new administration that began in 2000 put together its S&T plan. The administration prepared a diagnosis of the state of national S&T, which included contributions from the S&T community as well as the consulting body for the federal government, Foro Consultivo Científico y Tecnológico. It concluded that:

- S&T expenditures were very low
- The business sector contribution to R&D was particularly small
- The proportion of R&D money applied to experimental development was below the amounts that other advanced developing countries were spending
- The S&T community had a very small size
- Mexican industry had little international competitiveness
- The number of patents filed by Mexicans was extremely small

The response was the Special Program on Science and Technology 2001-2006, which had three objectives: a federal law encouraging S&T, increased national S&T capacity, and