the projections. For a fuller discussion see Frejka (1).
8. That is, total fertility rate (T) = 2.08. (The sex ratio at birth is set at 1050 males per 1000 females.)
9. U.S. Public Health Service, *Vital Statistics of the United States, 1968*, vol. 1, *Natality* (Government Printing Office, Washington, D.C., 1970), table 1-4, p. 1-6; U.S. Public Health Service, *Monthly Vital Statistics Report* (Government Printing Office, Washington, D.C., 1973), vol. 21, No. 12, p. 1.
10. Periods of below-replacement fertility in the 1930's were followed by various alarms about "race suicide," and governments instituted pronatalist programs to stimulate a resurgence of fertility rates. Partly in response to such programs, and also in response to more general social and economic conditions, fertility rates did in fact subsequently rise. In the ensuing years, fertility rates rose to the point of a "baby boom" in the post-World War II era, and then began to fall again in the 1960's. Concerning probable future conditions, the available evidence (20) suggests, with respect to a lower limit, that desires and plans for families are still widespread enough that, even if temporary postponements lower fertility rates in certain periods, in the long run there will probably continue to be enough childbearing to guarantee at least replacement fertility in the total population. With respect to an upper limit, the finite environment will simply make it necessary for population growth to balance out at zero levels in the long run. Fluctuations may of course occur in the interim, possibly following swings in general economic and social conditions [see R. Easterlin, *Nat. Bur. Econ. Res. Occ. Pap. No. 79*, (1962)].
11. Coale-Demeny (6, part 2, p. 72) West model stationary population, mortality level 24.
12. $\Delta = \frac{1}{2} \Sigma |p_{i1} - p_{i2}|$ where p_{i1} and p_{i2} are the entries in the two percentage distributions (i ranges over the same number of categories for both distributions; Δ may also be obtained by adding only the positive differences between the distributions, or by adding only the negative differences and then disregarding the sign).
13. The data actually show a negligible negative growth rate as the final rate because of a technical problem in model specification: the oldest age group used for the population projections was 80 and over, yet the error that results from truncating the age scale, even at this point, accumulates enough in the long run to produce the observed effect.
14. For example, see *Muhammad Speaks* (1 September 1967, p. 5; 5 January 1968, p. 24; 24 January 1969, p. 7; 31 July 1970, p. 3); *Ebony* (March 1968), p. 29; W. A. Darity, C. B. Turner, H. J. Thiebaux, *Population Reference Bureau Selection No. 37* (Population Reference Bureau, Washington, D.C., 1971).
15. Rev. J. Jackson in a discussion of the report of the Commission on Population Growth and the American Future (NET-TV, 27 November 1972).
16. Since the computation process adopted the net reproduction rate as the starting point, internal assignment of the initial life expectancy to the first projection period resulted in gross reproduction rates of 1.94 in the early period. The final, fixed rate was the initial 1.92, with a corresponding net reproduction rate of 1.89. The effect on results is negligible.
17. W. Barclay, J. Enright, R. T. Reynolds, *NACLA* [*North American Congress on Latin America*] *Newsletter* **4** (No. 8), 1 (1970); J. Jackson (15); see also the population commission report for alternative developments of various aspects of the "smoke-screen" argument (2, pp. 61, 71–74).
18. B. L. Crowe, *Science* **166**, 1103 (1969); G. Hardin, *ibid.* **162**, 1243 (1968).
19. See D. Callahan, *Science* **175**, 487 (1972); population commission (2); and articles by A. J. Coale (pp. 168–181), F. Notestein (pp. 31–43), and A. J. Dyck (pp. 351–377), in *The American Population Debate*, D. Callahan, Ed. (Doubleday, Garden City, N.Y., 1971).
20. U.S. Bureau of the Census, *Current Population Reports*, series P-20, No. 240 (Government Printing Office, Washington, D.C., 1972).
21. See articles by G. Hardin (pp. 259–266), K. Davis (pp. 227–258), A. J. Coale (pp. 168–181), J. Blake (pp. 298–324), M. M. Ketchel (pp. 279–297), and O. Harkavy *et al.* (pp. 325–350), in *The American Population Debate*, D. Callahan, Ed. (Doubleday, Garden City, N.Y., 1971).
22. K. E. Bauman, *Demography* **9**, 507 (1972).
23. The research reported here was supported by the Population Council. I particularly wish to thank T. Frejka for granting me free use for my own purposes of the population projection computer program that he developed. I also thank him and W. Seltzer and R. G. Potter for their comments on an earlier draft of this article.

NEWS AND COMMENT

Science in Mexico (I): The Revolution Seeks a New Ally

Mexico City. Not far from this city's great central square is a brooding hulk of a colonial building that at one time or another has been home to as wide an array of scientific endeavor as any structure in the Western Hemisphere. The first tenants of the Palacio de Minería, as the building is called, included Imperial Spain's school of mines in the 1790's. More recently, in fact up until the early 1950's, one large and rather gloomy room of the Palacio was occupied by a tiny band of half a dozen scientists, two or three technicians, and one secretary who together made up the national university's Institute of Physics. The institute, which busied itself mainly with cosmic rays, in turn constituted most of Mexican physics research.

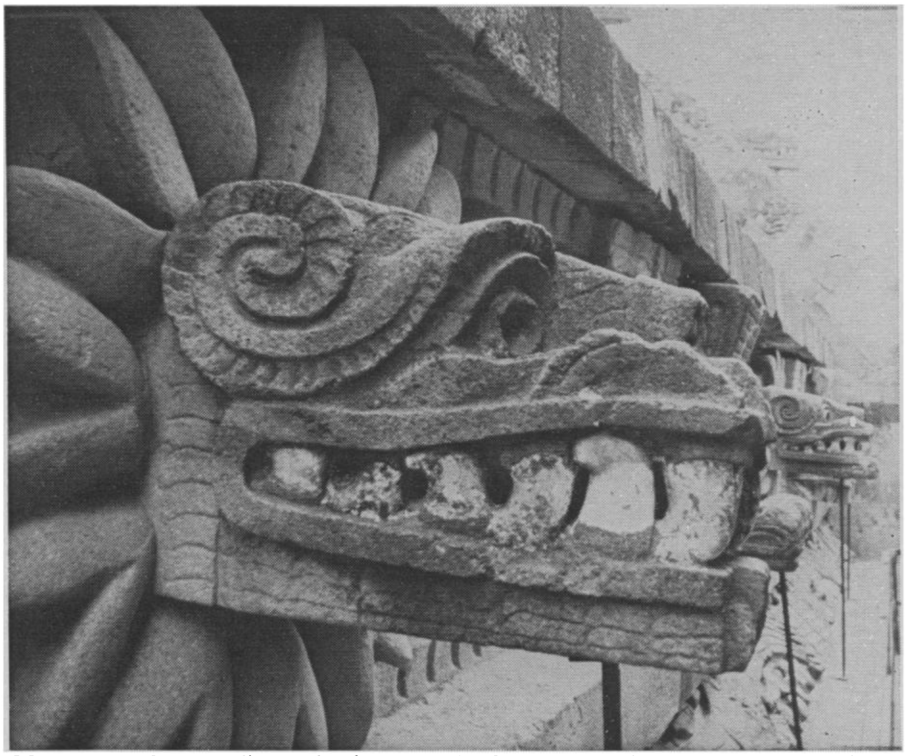
Marcos Moshinsky, who was then a young physicist freshly graduated from Eugene Wigner's tutelage at Princeton, and has since become one of Mexico's best-known scientists, recalls that physics then was strictly a shoestring affair. Equipment tended toward the primitive, even in its time, and some of it exhibited strange idiosyncrasies. "I once made a discovery that I never published," Moshinsky says with a wry smile. "Every time a trolley car went by outside, our Geiger counters showed the cosmic ray intensity going up."

But that was 20 years ago, and physics, like most of the rest of science in Mexico, has come a long way up from the depths of poverty. If the gloom of the mining palace can be taken as a symbol of where science stood in those days, its counterpart today might be the government's new, $15 million nuclear research center at Salazar, 30 miles outside the Federal District, where university researchers have access to a reactor and a tandem Van de Graaff accelerator—both small but sophisticated—and a well-equipped collection of allied laboratories. "Salazar is certainly comparable to what we have at M.I.T. right now," notes William Buechner, a physicist at M.I.T., and a long-time acquaintance of Moshinsky's.

The institute itself has long since moved to more spacious quarters on the university's sprawling, leafy campus in the southern part of the city. And across town, physics research in the government's National Polytechnic Institute (Instituto Politécnico Nacional or IPN), the nation's second largest school, is showing signs of healthy competition.

In some ways physics has enjoyed a favored position, but its upward progress nevertheless indicates in a general way how Mexican science has fared over the past two decades. In a word, progress has been a long, slow climb punctuated in the past 2 or 3 years with a breathless gallop.

To be sure, Mexico is still a long way from plunging headfirst into big science. Pockets of poverty and serious manpower deficiencies remain; in 1972, for example, the total expenditure from all sources for R & D was only $110 million. This amount and the overall size of its science community are still small in comparison with such Latin American nations as Brazil, Argentina, and Venezuela. But even so, Mexican science is currently in the midst of a relative boom that in many ways reflects a new and positive view toward science—a view in-



Monument of an earlier technology, head of Quetzalcoatl decorates a pyramid at Teotihuacan, near Mexico City.

creasingly evident among developing nations in the Western Hemisphere. Mexico's expenditures for R & D, for example, have gone up by a factor of 8 since the mid-1960's and have doubled just since 1970. The official goal is to reach about $200 million by 1976, the end of President Luis Echeverría's 6-year term.

One reason for the surge in support for R & D is simply that Mexico can afford a lot more research than it could two decades ago. For nearly 30 years now the country has been riding the crest of an economic boom that has begun to shift the base of the economy away from agriculture and increasingly toward industry. With a gross national product of more than $33 billion, Mexico now ranks just behind Brazil with the world's 15th largest economy. Although Mexico's rate of population growth is among the highest in the hemisphere at 3.4 percent a year, the real gross national product has consistently outrun the birthrate over the past 20 years, with an average annual increase of 5 percent, and in some years hitting 7 to 8 percent. This growth, offset by only moderate inflation and encouraged by more than 40 years of political stability since the chaotic aftermath of the Mexican Revolution (1910–1970), has allowed a steady rise in the federal budget, the main source of money for science.

A more direct and significant reason for the improving position of science, however, appears to be a recent and clear-cut shift in the attitude of Mexico's political leaders toward science and technology. Interviews with a number of researchers and government officials during a 3-week visit to Mexico in May produced a recurring refrain that the federal government has begun to abandon its traditional view of R & D as an expensive and somewhat onerous luxury, and instead has begun to treat science and technology as real, if expensive, necessities to continued development.

The official view, reflected repeatedly in speeches by cabinet members and President Echeverría himself, is that Mexico now faces a crucial choice if it is going to sustain its current pace of growth and achieve the position of Third World leadership that seems to be a major objective of the President's. Either Mexico must resign itself to depending more heavily than ever on foreign capital and imported foreign technology; or it must support a vigorous science and engineering community that will, in time, confer on Mexico a new measure of technological—and therefore economic—self-sufficiency.

In a mood that North American analysts often characterize, and perhaps too glibly, as one of "economic nationalism," the Echeverría Administration has opted for the latter course with an almost tangible sense of urgency. Besides pumping up the science budget, the government has, in the past 30 months, created virtually from scratch a large new federal agency to orchestrate and strengthen R & D. The new agency is called the National Council of Science and Technology (Consejo Nacional de Ciencia y Tecnología or CONACYT), and its mission is nothing less than to orchestrate and strengthen Mexican R & D, to shore up its weaknesses, and to put it to the service of economic development. On top of this, the government put into force two laws this year granting it broad new authority to regulate foreign investment and the importation of foreign technology.

Mexico's heightened interest in science and technology is part of a general pattern that emerged across Latin America during the 1960's. In part, this new attention to science policy stems from a persistent drumming by the United Nations and the Organization of American States on the theme that massive and unrestricted importation of technology by nations in the throes of industrialization is economically foolhardy—that a nation needs at least a minimum measure of technological "autonomy" if for no other reason than to be able to shop wisely in the world market. An important turning point in the OAS campaign came in 1967, when OAS officials persuaded a meeting of Western Hemisphere presidents at Punta del Este, Uruguay, to adopt a resolution essentially endorsing this point of view. From there on the science policy bandwagon picked up momentum. By the end of 1970, with an eye to national economic needs, Mexico and nine Latin American nations had set up new agencies or revamped old ones to fund and coordinate research.

Within Mexico itself, at about the same time, a number of prominent scientists and economists who were deeply and vocally concerned that Mexican science was slipping behind that of its neighbors both north and south, convinced the administration of former President Gustavo Díaz Ordaz to begin a detailed diagnosis of the state of the country's R&D. This stocktaking process lasted from 1967 to 1970, and in characteristically Mexican fashion ultimately canvassed nearly everyone qualified to give an opinion on the subject, roughly 800 researchers in all. As a direct outgrowth of these studies the Mexican legislature approved the new science agency, CONACYT, shortly after President Echeverría took office at the end of 1970.

The government's most compelling incentive to galvanize the nation's research system, however, appears to have come not so much from any infirmities in science itself as from Echeverría's conviction that science and technology offered at least partial solutions to a host of disturbing social and economic problems that confronted Mexico at the end of the 1960's. While it was true that Mexico possessed one of the world's most successful developing economies, gross measures of achievement masked a markedly uneven quality to this development. "Looking only at the overall figures," Echeverría noted in his inaugural address 2 years ago, "one might think that we have surmounted underdevelopment. But when we regard the reality that surrounds us, we have reason to be deeply concerned."

One major problem is that, while manufacturing and commerce have been expanding rapidly, the primary sector of the economy—including forestry, fishing, and agriculture—have been showing signs of serious stagnation.

In large areas of the arid central plateau and the humid flatlands of the south, areas where a fifth or more of Mexico's 50 million people eke out a subsistence living, the agricultural economy is in a touch-and-go race with the birthrate. Agricultural output grew by less than 2 percent a year in these

Computer for Watergate Probe

Congressional investigators are resorting to a computer to keep track of the complexities of the Watergate affair. The committee chaired by Senator Sam J. Ervin, Jr., (D–N.C.) decided on the use of the computer because "there was just too much to handle with the old ways of record keeping."

The full title of the Ervin committee is the Senate Select Committee to Investigate the 1972 Presidential Campaign Activities, and the committee's intention is to perform a broad information gathering function. In addition to testimony in the current Senate hearings, the panel plans to take into account "inputs" from the Watergate bugging trial, other criminal and civil suits, and the confirmation hearings for L. Patrick Gray, former nominee for the FBI directorship.

For its automatic data processing, the committee plans an essentially in-house operation utilizing a Library of Congress computer. The computer link is still undergoing tests but is expected to reach the functional stage fairly soon.

The computer operation is under the general charge of a committee assistant counsel, C. Eugene Boyce, a Raleigh, North Carolina, attorney with considerable trial experience on both the prosecution and defense sides in criminal cases. Boyce had worked in the congressional campaign of Congressman Ike F. Andrews (D–N.C.) and was serving as the first-term congressman's administrative assistant when he was recruited to the staff of the select committee.

The Senate resolution creating the investigative committee provided that other congressional committees and agencies should cooperate to the extent that resources were available; in the case of data processing this meant drawing mainly on the Library of Congress and its Congressional Research Service for technical advice and on the Senate Rules Committee's subcommittee on computer services.

According to Boyce, discussions began 6 to 8 weeks ago, and less than a month ago a decision was made that using the computer was the only way to handle the mass of information with which the committee had to deal.

The computer being used is an IBM 370-155, which the Library of Congress employs for cataloging and administrative chores and also to serve congressional committees with data processing demands.

Committee staff members believe there is no precedent for the full-scale use of a computer in investigative hearings but are satisfied that it will be possible to retrieve information "alphabetically, chronologically and by name and topic."

Outsiders knowledgeable about computers say the computer in question is a very fast machine capable of dealing with a massive data base, and there should be no state-of-the-art problems in developing software to meet the committee's need to keep tabs on who said what, to whom, when, and where.

Boyce says that, ordinarily, in extensive hearings or court cases when a number of attorneys are involved, there are information retrieval problems. Usually an alphabetical filing system is set up, but it is "a horse and buggy system" he says, and mainly it's "a case of relying on attorneys' memories."

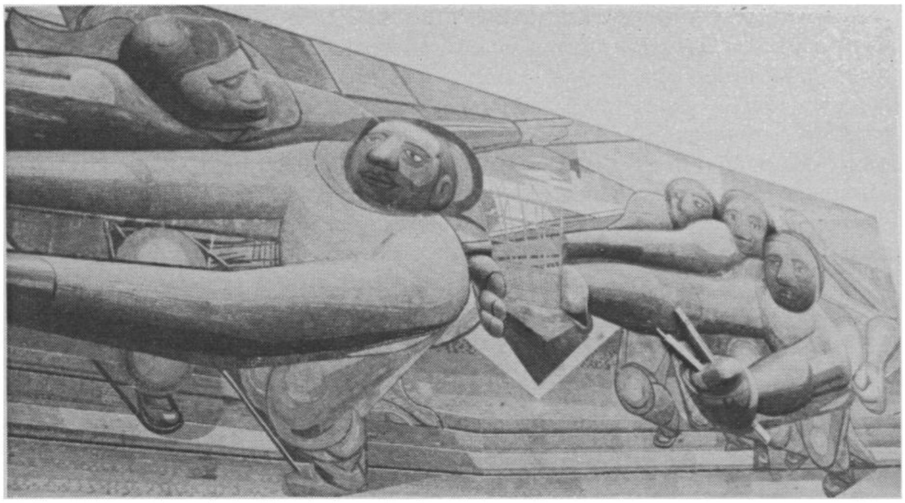
The Ervin committee has no computer people as such on the staff, but there has been good collaboration with the computer specialists, "with each group telling the other what they need to know." Provision had been made for a group of research assistants whose job is to go through material, analyze it, index it, and put it in the filing system. A card index system has been started and information from it will be transferred to computer input sheets.

During the test period, most of the work in the Watergate computer project has been done at night to avoid interfering with the regular library computer tasks. The plan, however, is to use the computer in "real time" during committee hearings, so that it will even be possible to have telephone queries answered in a short period.

The committee, however, is looking beyond the hearings to the ultimate use of the computer record to fulfill its mandate of writing a report to Congress within a year of the findings of its investigation.

The Ervin committee is acutely security conscious, and this extends to its data processing activities. Provisions are being made for the committee to maintain physical control of the computer record. Committee staff members decline to be specific, but presumably precautionary measures will include standard procedures such as duplicating the data base and using codes to control access.

As for the more conventional record of the hearings, Ervin is pressing for rapid action and expects the first volume of the printed hearings to be available by the beginning of July.—JOHN WALSH



Engineers and architects reach across a mural at the national university campus, Mexico City.

areas during the 1960's, while the population it supports grew by 2 percent or more a year, even discounting outward migration. For a variety of reasons—among them lack of education, credit, machinery, roads, and water—the green revolution that was spawned by research in Mexico has yet to leave its mark on a large part of the country's agriculture; the government knows this and seems determined now to remedy the situation.

Until it is remedied, though, rapid growth of industry around Mexico City and migrations from impoverished rural lands will continue to swell the city. The Federal District and its environs already comprise the world's sixth largest city, a megalopolis of 10 million people swimming in a pall of smog as noxious as the one over Los Angeles. While the central part of the city retains much of its old charm, the periphery is ringed with encampments of rural poor who seem to descend on the city so suddenly that the Mexicans call them *paracaidistas*, or parachutists.

The plight of the urban and rural poor, and the uneven quality of development, is reflected in the distribution of wealth. Although Mexico's income is spread more equally than Brazil's, the distribution is less equal than in the United States, Europe, and several Latin American nations including Costa Rica, Panama, and Argentina. A study published by the United Nations in 1970 and updated this year shows that the most affluent fifth of the population (including an expanding upper middle class of professionals) earns 56 percent of the income, while the poorest fifth of the population earns less than 4 percent. Moreover, there is solid evidence that the bottom fifth has actually lost ground and is poorer now than it was 10 years ago.

There are other problems. At the current birthrate there will be twice as many Mexicans at the end of the century as there are now. The Echeverría Administration has abandoned its initial opposition to government family planning programs, but even so it will be a long time before the birthrate is significantly curbed, if ever. In the meantime, by one estimate, Mexico will need a million new jobs a year by the end of the 1970's just to maintain the current level of employment.

The government seems well aware of these problems, and its public statements discuss them with notable candor. In a pendulum-like movement characteristic of modern Mexican politics, Echeverría has swung his government slightly to the left of the more conservative Díaz Ordaz Administration, thus counterbalancing his predecessor's emphasis on economic growth with a new emphasis on themes of "social justice" and more equal distribution of wealth. The official view is that Mexican scientists and engineers can do their part by helping to find and develop new resources, by overcoming technical hurdles to opening new industries in rural areas, and by giving industry the innovative capacity it now sorely lacks—in turn to create the new jobs and exports Mexico urgently needs. "The advancement of science will be one of the primary goals of the Mexican government," Echeverría has observed. "Technological progress is today the best ally of the Mexican Revolution."

But how good is Mexican science? Can it meet the government's new expectations? There are few if any objective measures of quality. By the usual yardsticks of international prestige—prizes and memberships in foreign academies—Mexico does not rank high. But these are unreliable measures at best, and for countries outside the social circles of big science they may be altogether meaningless. Mexican scientists and and engineers themselves point out that they publish some 250 papers a year in foreign journals (and at least twice as many in Mexican journals and books), thus suggesting, as one scientist put it, that "our work is at least comparable with others'."

In addition, U.S. government science officials and researchers who are familiar with Latin American science seem to agree that in a number of specialized fields Mexican research is on a par in quality, though not in scale, with the most advanced work in the United States, Japan, and Europe. Among the areas of strength most often mentioned are theoretical physics, civil engineering, agriculture, and such biomedical sciences as pediatrics, nutrition, cardiology, neurology, and tropical diseases.

It must be said, though, that distinction has been achieved in the face of a severe and chronic case of fiscal malnutrition only now beginning to ease. Mexican analysts acknowledge that in years past, money from Ford, Rockefeller, Kellogg, and other U.S. foundations made crucial differences in the quality and quantity of medical and agricultural research. More often than not, however, it appears that the strengths in Mexican science have centered on brilliant individuals with a certain mastery of grantsmanship, rather than on institutions as a whole. "There is no question that Mexico has some first-class people," said one American foundation official with considerable experience in Mexican higher education. "But at the same time," he adds, "I've seen a lot of bright young men wasted for lack of support."

Penury is a common enough feature of science in developing countries, but Mexican science has suffered some special handicaps that has left it in some respects weaker and smaller than might be expected, given the relatively robust economic environment. These handicaps, and the government's ambitious efforts to overcome them, will be the subjects of a second article.

—ROBERT GILLETTE