Research on Research in Venezuela

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In Venezuela, over the past 2 years, a study of the scientific resources of the nation has been made, and now a report has been issued on the strengths and weaknesses of science in that country. The report, *The Basis for the Creation of a National Council for Scientific and Technological Research in Venezuela* (*1*), explores in breadth and depth the most significant factors influencing the development of science in Venezuela.

At least three Latin American countries—Argentina, Brazil, and Mexico —have national research councils, and these countries are therefore leaders so far as the formal organization of science in Latin American countries is concerned (*2*). Others, including Chile, are considering the establishment of councils. The Venezuelan approach was somewhat different from that followed by other countries in that a comprehensive study was made in the course of considering whether a national research body should be created. Other countries have tended to study these matters after the creation of official bodies.

A brief sketch of the background and contents of the report is presented here because most of the nations of Latin America which are undertaking to raise the quality and extend the breadth of their scientific activities lack organized data on their national scientific efforts. This deficiency is not unique to Latin America, and it is surely one of the important impediments to the development of science. Collection and analysis of salient facts, and their presentation in a form readily understandable by the public and by political leaders, can contribute to the advancement of science. The usefulness of such studies, and of national organizations for science, has been pointed out forcibly in important reports (*3*), but progress is slow.

Research on research is being recognized throughout the world as a productive area of investigation. These investigations range from studies of the psychological and sociological aspects of scientific creativity to analysis of national resources for science and technology. The Venezuelan study falls in the latter category. Well-presented data on national resources for science can contribute (to varying degrees, depending upon local circumstances) to various desirable ends:

1) Such data enable a nation to set a steady course for the development of science. When a country has a very large and diversified scientific effort, the interplay of numerous powerful forces tends to exert a stabilizing influence which can prevent major errors in national policy without stifling diversity and initiative. When a country's scientific effort is smaller, the avoidance of mistakes may be more difficult and the consequence of a single error (such as overinvestment in physical facilities) can be more serious.

2) The data indicate the resources available for research, in terms of professional talent, facilities, and funds, and thereby provide a guide to rational priorities in investment, in terms of facilities, training of manpower, and equipment.

3) They provide a rational base for considering the current distribution of national scientific effort, by field of inquiry and by types of institutions.

4) By showing the total national investment in science as a percentage of the national budget or of the gross national product, they permit comparison of the intensity of scientific effort with that of other countries.

5) They contribute to the education of scientists, the general public, and political leaders, and indicate to potential foreign sources of aid to science the total dimensions and distribution of the scientific effort.

Prerequisites to a Study

The Venezuelan experience illumines a number of practical problems relating to studies of national resources for science and to proposals for strengthening national structures for science.

1) The first efforts in either direction—the study of resources or the strengthening of mechanisms—are not likely to be entirely successful. Persistence seems to be a necessary virtue. There have been earlier studies of this kind in Venezuela; the first was one by T. Caspersson of Sweden in 1947.

2) The willingness of a group of leaders to devote considerable time to the effort seems indispensable.

3) A good study is costly, more in terms of contributed effort than in terms of actual expenditure of money. The cost in money of the Venezuelan study was 100,000 bolivares, or $22,000 (the bolivar is valued at 22 U.S. cents). Most of the expenditure was for the salary of a full-time executive secretary.

4) A competent full-time staff is needed. At least one person, preferably a scientist or engineer with an interest in science policy, is indispensable.

5) The cooperation of all major organizations concerned with science—governmental and quasigovernmental—is desirable. It is generally difficult to establish a study group which will be regarded as providing balanced representation of all interested groups, but the group must, at the very least, be so composed that its findings are broadly acceptable. The Venezuelan Preparatory Commission, as well as the groups sponsoring the study, were widely representative.

6) The study should be under the direct auspices of the head of state or prime minister.

7) A solid statistical base is desirable but not essential. It is a great advantage to have available the numbers of people with academic training in various disciplines, measures of national economic output, and reasonably accurate measures of national expenditures for research.

8) A country must have a substantial and reasonably diverse national science structure, including at

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Table 1. Distribution of scientists in Venezuela and in the United States by broad field (7).

Field	Venezuela		United States	
	No.	Percentage	No.	Percentage
Physical sciences and mathematics	83	21	202,000	18
Engineering	89	23	822,000	72
Biology (including medicine, veterinary science, and agronomy)	223	56	112,000	10
Totals	395	100	1,136,000	100

least one well-developed university, before a survey is worth while.

9) Technical assistance from other countries may be helpful in assessing national scientific resources. For example, UNESCO was of great assistance in the Venezuelan study, although the impetus, general scheme of investigation, and final report were the work of the Venezuelan group (*4*).

10) Planning of science is most effective if it is undertaken in the context of a general plan for economic development. Venezuela has been fortunate in having a realistic and productive general plan for economic development which has stimulated developmental and technological efforts.

Major Contents and Findings

It would be presumptious to summarize the report, which must be read in full if one is to understand it fully (*5*). However, some of the facts, judgments, and relationships seem to an outside observer to be relevant to any country which wishes to take stock of its scientific potentalities. Among them are the following.

1) Venezuela is spending 44.3 million bolivares per year on science and technology (about 9.8 million U.S. dollars per year at the current rate of exchange). This is about ½ of 1 percent of the national income. As the report points out, countries with higher per capita incomes spend from 2.0 to 2.5 percent of their national income on science. The report used a rough means of estimating research expenditures, based upon the data available: (i) Total monthly wages of all scientists who answered questionnaire, 1.1 million Bs. (ii) Percentage of all scientists who answered questionnaire, 62 percent. (iii) Total *monthly* wages of all scientists, 1.77 million Bs. [(1.1 million Bs.)/0.62]. (iv) Total *annual* wages of all scientists, 21.2 million Bs. (1.77 million Bs. × 12). (v) Percentage of total costs of research represented by wages (based upon data from 26 institutes), 54 percent. (vi) Total *annual* Venezuelan investment in research, ~ 40 million Bs. (22.14/0.54). (This rough computation is presented here to indicate how countries can use available information, incomplete though it may be, to compute the order of magnitude of their investment in science.)

2) About 750 professional people in Venezuela are engaged full time or part time in research—fewer than 125 per 1 million persons. UNESCO has estimated that between 500 and 2000 scientists and engineers per 1 million population are required in order for a country to become industrialized. It is more and more clear that extreme shortages of highly trained people are the major factor inhibiting the growth of science and technology. This is a policy guide of first importance, derived from figures which are not precise but which are accurate enough to provide firm guides to action.

3) Of all Venezuelan scientists, about 150, or 20 percent, are foreign citizens and almost another 26 percent are naturalized citizens. Of the 150, about 75 are from Europe, 65 are from Latin America, and 10 are from other parts of the world. Forty percent of all Venezuelan scientists have degrees from foreign universities —the greatest number of them from universities in Spain; U.S. universities rank next as a source of foreign degrees.

4) The distribution of scientists by broad field is shown in Table 1. The concentration in biology is high in Venezuela, as is common in Latin America. The United States has a much higher proportion of engineers.

5) The distribution of investigators by age in Venezuela, as compared with the United States (Table 2), is interesting. Venezuela has a higher proportion of investigators under 35; the United States has a higher proportion over 45. Similarly, the distribution of years of experience of scientists in the two countries (Table 3) is interesting. Both distributions indicate that the professional scientific and investigative career is relatively new in Venezuela. Modern science is relatively new in Venezuela, and many adjustments remain to be made.

Table 2. Percentage distribution of investigators by age in Venezuela and in the United States (7).

Age (in years)	Venezuela	United States
Under 35	48	38
35–44	34	34
45 and over	18	28

Table 3. Percentage distribution of years of professional experience of scientists in Venezuela and in the United States (7).

No. of years of professional experience	Venezuela	United States
Less than 10	76	51
10–19	20	34
20 or more	7	25

6) Almost three-quarters of all investigators are engaged in "free" or in "oriented" fundamental research. As the report says: "It is paradoxical that no more than a quarter of our scientific personnel are dedicated to applied research and to development and technological innovation. This phenomenon is frequently encountered in countries which, like Venezuela, are just beginning to develop industrially and in which, until recently, social stimulus to research with immediate applicability has been lacking."

7) About 40 percent of all investigators are engaged full time in research. This is a remarkably high percentage for Latin America, and may well reflect the relative wealth of Venezuela. On the other hand, the inherent inefficiency of the multiple-job pattern remains widespread (*6*).

8) The monthly salaries of those

Table 4. Distribution of monthly salaries of scientists engaged full time in research in Venezuela.

Monthly salary (in approximate U.S.-dollar equivalents)	Percentage of scientists
170–400	6
400–440	7
440–550	14
550–660	33
660–770	17
770–880	13
880–990	6
Over 990	4

engaged full time in research are shown in Table 4. This scale of salaries is almost certainly higher than that of any other Latin American country, and probably accounts in large part for the fact that Venezuela is able to attract scientists from other countries.

9) There are 76 research institutes in Venezuela—6 ministerial, 3 autonomous governmental, 58 university, 8 private, and 1 mixed. The report does not contain data on their staffing and financing, primarily because a great number of the institutes did not respond to questions on these matters. Most of the institutes are small. However, the Venezuelan Institutes for Scientific Investigation (IVIC) is very large. This outstanding organization spent, in fact, about 10 million bolivares annually, as compared with a total expenditure of 44.3 million in the whole country for scientific research in 1963. The report does not emphasize this most significant fact, but it does stress the importance of establishing multiple points of scientific strength, particularly in the universities.

10) Until the past decade, individual scientists in Venezuela worked as a rule in isolation without creating schools or training disciples to follow them. During the past 10 years that situation has changed.

Recommendation of the Study

The general conclusion of the report is as follows. "Science and technology have not been sufficiently exploited in Venezuela. Not because of lack of material resources, but because objectives have not been set with sufficient clarity, resources have not been coordinated, and programs have not been planned. In a word, science has not been organized."

In a concluding section which is realistic, sophisticated, and persuasive, the report recommends the establishment of a National Council for Scientific and Technological Research. It states the functions of a council and the protections for individuals and institutions that must be built into such an organization.

To an outsider, some fundamental assumptions of the report seem particularly significant. The role of science and technology in the intellectual and economic development of the nation is stressed. The vital role of the universities and the need to link the development of science to the development of universities are recognized. The importance to the nation of increasing the numbers and the competence of Venezuelan scientists is pointed out. The significance of these assumptions becomes clearer when one notes that other basic assumptions could be made. That is, Venezuela might invest heavily in grandiose scientific undertakings not related to the development of the country or to its actual scientific potential. Adoption of such a course, instead of the course recommended in the report, would constitute a mistake of major proportions.

However, the principal aim of this review is not to assess the merits of the report's recommendations, but to point out the value of such a study to nations which are undertaking to strengthen their national capacity for research and technology.

References and Notes

1. The report was prepared by a distinguished Preparatory Commission having the following members: Drs. Luis R. Ocando O. (executive secretary), Gustave J. Martin B. (assistant executive secretary), Miguel Layrisse, Luis Medina, Frederick Rivero, Marcel Roche, Carlos Pi Sunyer, and Armando Vegas.
2. The organization in Argentina is the National Council for Scientific and Technical Investigation; the Brazilian organization is the National Research Council; the Mexican organization is the National Institutes of Scientific Research. The actual influence of these bodies in their respective countries varies widely. The Argentine Council is most influential and the Mexican Council, which has a rather restricted charter and budget, is least influential.
3. *The Organization of American States and the Development of Science* (National Academy of Sciences and Pan American Union, Washington, D.C., 1958), pp. 20 and 38; *Science and Government Policy* (Organization for Economic Cooperation and Development, Paris, 1963), pp. 37–45.
4. UNESCO (Place de Fontenoy, Paris 7e) and the Department of Scientific Affairs of the Pan American Union, Washington, D.C., are prepared to consult with countries which wish to review the status of their scientific efforts. A professionally prepared manual of instruction for the use of countries which wish to measure their scientific and technical activities is available. It is a monograph entitled *Proposed Standard Practice for Surveys of Research and Development*, prepared by the Directorate for Scientific Affairs of the Organization for Economic Cooperation and Development (Chateau de la Muette, Rue André Pascal, Paris).
5. The report contains historical accounts of the development of ten fields of science in Venezuela, and an interesting and useful analysis of the structure and functions of the central research organizations of 32 countries.
6. University salaries in Latin America are often very low, and many faculty members must hold more than one job to make ends meet. In earlier days, this part-time system was essential to secure the services as teachers of people whose primary occupation was business, government, or the practice of a profession. Now a major object of university reform in Latin America is to establish full-time teaching. Low university budgets are the primary obstacle.
7. The data for the United States are taken from "American Science Manpower," *Natl. Sci. Found. Publ. NSF 62-43* (1960), and from "Scientific and Technical Manpower Resources," *Natl. Sci. Found. Publ. NSF 64-28* (1960). Both the Venezuelan and U.S. figures exclude "social scientists," "other," and "mixed specialties." The data from the two countries are not precisely comparable, but, as is often the case with information on such matters as research expenditures or research personnel, gross comparisons which shed light on fundamentals can be made accurately.