S&T Development in Mexico: Obstacles and Opportunities

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Since the world engaged in the current globalization process, the lack of technological independence has created deeper philosophical and ethical confrontations as well as abysmal differences among countries and even among groups within countries. Those nations who have been able to develop and protect their own resources are integrating the present *élite* where serious efforts have been made to articulate scientific knowledge, technology, and social needs.

The role universities and R&D centers play in every country within this group has been of the greatest importance, and should be emulated by those who have not joined them. First, because the former have never rejected nor ignored their needs and priorities, in accordance to their own national and regional agendas; second, because they never stopped allocating financial resources for S&T activities as well as for the education of individuals who showed professional skills and potential; and third, because they have proven to be able of transforming themselves to deal with the increasing turbulence in today's environment.

Around the world it is widely recognized that every effort directed towards scientific and technological research and development will eventually pay back in the grounds of future economic sustainability and social well being. Besides their strategic nature in the economic, political and social arenas, the techno-scientific dimension of every State understood as a system is closely intertwined with national sovereignty and international prestige.

Mexican society is not an exception to the critical asymmetry most underdeveloped countries are facing: the coexistence of very different and even opposed economic production systems as well as the predominance of social and cultural abysms. If public investment in S&T activities does not provide significant yields in terms of socio-economic progress, other efforts will prove futile and the survival of certain population

groups will become extremely difficult; among them, the already small Mexican scientific community.

Indeed, the main concern of most research institutions in Mexico has focused on both, the improvement of human resources –through training of graduate students– and the sponsorship of R&D projects –basic and applied S&T– along with the achievement of results. Unfortunately, a measure for the efficiency of the latter has been mostly based on the number of papers published in refereed journals.

Prominent R&D centers in the country are usually assessed in terms of their share in annual federal S&T expenditures, faculty profile, and the number of papers published in indexed and mainstream international journals. Other *scientific products* are hard to account for when documenting an application for a grant or any request for budget increases.

In 1984, the federal government established a National System of Researchers (NSR), in charge of assessing their academic work. From the outset, this effort has unquestionably contributed to alleviate the critical economic situation of most Mexican scientists that prevailed for many years, particularly during the 1980s.

Nonetheless, and despite the fact that these incentives have made academic life more appealing, the National System of Researchers has been unable to significantly increase its membership, which could be interpreted as failure to accomplish one of its main implicit goals: to foster national scientific activity by increasing the number of persons engaged in scientific research and technological development.

Notwithstanding the relative progress and success of NSR and other programs of this kind, it cannot be said that Mexico has overcome the scientific and technological backwardness of prior decades, especially as pertains to research in industrial technologies. On the one hand, results from scientific research are not manifested in productivity of the various sectors of the Mexican economy neither in public planning programs or policies. On the other, support from the private sector, and even that springing from the public sector, continues to be inadequate, unduly, and extremely small.

This precarious situation is further aggravated by the current trends toward economic globalization and their impacts on some unstable national economies. In the case of Mexico, the North American Free Trade Agreement (NAFTA) and an economic crisis from which the country seemed to be emerging during the early 1990s but which has reappeared during the last few years, worsened by diminishing world oil prices, have posed new questions and challenges which should be dealt with urgently.

In an effort to conceive the opportunities embedded in the present situation, some quantitative indicators will be reviewed in the following paragraphs, stressing certain policy making issues which are required if Mexico is to strengthen its R&D apparatus in order to compete under more equitable circumstances in the highly competitive race towards world globalization.

The Mexican Scientific Community

Even though the economy has shown to be rather unfavorable in the past few

decades, Mexico has been able to establish several new R&D centers in the periphery, somehow alleviating the strong institutional concentration of the S&T system.

These centers are being rapidly acknowledged at both, national and international levels. Their core faculty is integrated by well known scientists who were already engaged in R&D activities and whose results eventually get published and cited in refereed journals. For institutions who adopted and enforced this policy in the past, academic prestige was settled on how often they were present in high impact indexed journals. Even though they did enter the race with foreign universities and labs with a long standing R&D tradition, global trends of S&T prevailed over Mexican scientists' concerns on their projects suitability to national needs and priorities.[1]

Whether or not the kind of science under way determines federal budgetary allowances, Mexico's scientific community has been faced with a two-fold dilemma: to observe the ruling "publish or perish" policy and therefore increase their academic productivity and salary, or to ignore it by setting the focus on their own personal drives while missing the chance to improve a long time low income level.

Although briefly outlined, these issues raise specific questions and concerns, while offering at the same time new opportunities and challenges for education and science.

Center vs. Periphery:
The Unsolved Problem of Concentration

Shifting the focus of our analysis to the labor market perspective, 1995 data for

National Researchers –actual members of the NSR in any of the three existing levels– working at public higher education institutions (IEPS) show that –with the exception of UAM and UNAM– only 14 percent is employed by state universities, which represents a scant geographical distribution of scientific activity, particularly since this percentage was only up to 11.8 percent the year before. The figures listed are as follows: 37% of *National Researchers* work at UNAM[2] (National Autonomous University of Mexico); 6.3% at UAM[3] (Metropolitan Autonomous University); CINESTAV (Center for Research and Advanced Studies) has 6%; and the SEP-CONACYT Centers[4] (coordinated by the National Science and Technology Council, CONACYT), 11.2%. The remaining 39.5% is to be found in other state universities and national institutions belonging to the public health sector, the National Polytechnic Institute (IPN), the Mexican Institute of Petroleum (IMP), the National Institute for Forest, Agriculture and Animal Husbandry Research (INIFAP), as well as in some other academic centers geographically scattered throughout the country. Thus, the institutional analysis of this subgroup, which only includes *National Researchers*, is much revealing.[5] In this case, for 1995 figures, slightly over 60% were concentrated in the four academic organizations mentioned above, and only 40% in all other institutions.

In an attempt to encompass overall NRS membership while assessing the role this System has played for the advancement of Mexican S&T, available data show that approximately 56% of both "candidates" and *National Researchers* are indeed concentrated in

four major institutions: CINESTAV, SEP-CONACYT Centers, UAM, and UNAM. The remaining 44% is distributed among state universities, which means that young scientists working outside large metropolitan areas are starting to counterbalance both geographical and institutional concentrations.

The geographical concentration problem refers to the existing imbalance between the "center" (the Federal District, f.d., seat of the capital city) and the periphery (all other cities and states). There are vast evidences which prove that resource allocation (Jiménez *et al*, 1986a), academic production in terms of quantity and quality (Jiménez *et al*, 1986b), as well as other sound indicators (Domínguez *et al*, 1987) have long favored the large metropolitan center. As mentioned above, institutional concentration is clearly related to this geographical location since it also originates from largely populated areas where educational organizations grew in size to respond to their never-to-be-met demand, and diversified according to the fields of specialization of their faculty members. Hence, institutions where R&D activities have been traditionally concentrated due to their own faculty spatial concentration have not been granted the resources they need to carry out serious decentralization projects; only a few show authentic *campus* in regions away from the Mexico City area.

In addition to the obvious implications of an inadequate institutional allocation of resources, the problem of a severe geographical concentration in a single federal entity is also implicit. In fact, 56.4% of NRS total membership, that is 3,309 researchers work at institutions located in Mexico City. The Mexi-

can state with the second largest number of researchers following the f.d. is Morelos, with only 6% of NRS members. Other states following a descending order of importance are Mexico, Puebla and Baja California, with 5.5%, 4.0%, and 3.3%, respectively. It is important to bear in mind that both Morelos and the State of Mexico are adjacent to the Federal District, which once again underlines the problem of both unequally and unbalanced scientific development within the national territory.

Challenges from Small Numbers

Undoubtedly, any increase in the number of people dedicated to R&D activities is always a good sign with respect to future S&T development. In spite of the apparent growing number of Mexican institutions offering graduate programs, the number of scientists has not followed this trend. As mentioned earlier, and due to difficulties in estimating how many people are involved in R&D, we have used NSR data as an approach. The annual rate of increase has fluctuated from negative to small positive figures but has never reached 5% in the years since its creation.

The proportion between the scientific community and the total population of a country is another indicator of the scientific and technological activity in Mexico. Indeed, in 1993 there were only four persons engaged in research and experimental development *per* 10,000-labor force while in more advanced countries the average exceeds forty, rising up to seventy eight in Japan´s 1992 figures.

Despite its growth and incipient consolidation as rigorous academic entities

Table 1. Mexico: Breakdown of NSR membership, 1984-1996.

	1984	1985	1986	1987	1988	1989	1990
Candidates	212	651	1,121	1,499	1,588	1,859	2,282
Nat'l Res. I	797	1,127	1,353	1,338	1,523	2,010	2,453
Nat'l Res. II	263	339	374	413	480	550	691
Nat'l Res. III	124	159	171	208	183	247	278
Total	1,396	2,276	3,019	3,458	3,774	4,666	5,704

	1991	1992	1993	1994	1995	1996
Candidates	2,502	2,655	2,274	1,683	1,559	1,349
Nat'l Res. I	2,636	2,860	2,810	3,012	3,077	3,318
Nat'l Res. II	718	779	191	807	839	862
Nat'l Res. III	309	308	352	377	393	440
Total	6,165	6,602	6,233	5,879	5,868	5,969

Source: CONACYT, Indicadores de Actividades Científicas y Tecnológicas, 1995.

mostly in the last three decades, one of the crucial issues regarding the future development of S&T lies in the way Mexican academic institutions operate. These institutes, universities and research centers have failed to formally integrate as a *system* with competing parts. A strong reason for not doing so lies in the normative framework. Federal norms and regulations have missed the ultimate goal of R&D, imposing bureaucratic procedures and policies which seriously challenge institutional performance as much as they diminish scientists' natural drive and joy for creative work.

Mexican R&D centers could easily capitalize their already existing potentials in terms not only of their human and material resources but also in interdisciplinary projects and graduate programs, along with more emphatic interinstitutional efforts to connect and co-operate among themselves, and with other entities in the academic, public and private spheres. Needless to mention that a clear scientific leadership by this group would have quickly emerged and alternatives for national development would have been identified, in the event the S&T community had been allowed to operate as a system at earlier stages.

There is obviously a large room for improvement in two directions. On the one hand, and as far as communication concerns, channels between government officials and scientists should be paved, getting the former to realize no S&T development and independence will ever be achieved if science is to be judged from an input-output utilitarian perspective, and ruled by norms and regulations designed to watch independent private firms and their financial behavior closely. On the other, new av-

enues to broaden their financial status should be identified and attempted as soon as R&D institutions envision themselves as interacting parts of a dynamic and more integrated whole.

Financing S&T: The Economic Arena

It should be clear by now the importance of funds available to any scientific community for carrying out its R&D activities and projects. Unfortunately, they mainly include federal budgets and expenditures incurred by the federal government for science and technology (FSTE), leaving aside private contributions for they occasionally occur and their figures are rather small.

In 1996, 67% of Federal S&T Expenditures in Mexico actually went to the Education Sector, which includes all public universities and institutes, graduate schools, colleges and other R&D institutions (HEI) somehow related to higher education endeavors. The allocation of these funds goes primarily to a large group of public higher education institutions (42.6%) including UNAM. They are then followed by CONACYT, the Mexican government agency devoted to the generation, promotion, diffusion of scientific and technological knowledge (30.8%); the SEP-CONACYT System comes next (18.8%) and, finally the group of all other public institutions receiving 7.8% of government funds.

The analysis of FSTE figures has generated a wide range of studies and publications which seem to point to the advisability of conducting this type of efforts through an elementary indicator such as the percentage it accounts for in the Gross Domestic Product (GDP).

Indeed, as previously indicated, the obstacles observed in the development and growth of a strong Mexican S&T system is reflected in indicators as critical as the proportion government spending and total GDP keep over time, which for the years at hand has decreased rather than expanded. Instead of showing a positive slope, the graph of this percentage has remained stable and low, going from 0.46 percent in 1994 to 0.45 percent in 1995.

Total amount of Federal Expenditures on Research and Experimental Development (FERD) is also extremely low, particularly if we bear in mind that specific spending ranges between 2 and 3 per-

Table 2. Share of Federal Spending on Science and Technology in Mexico, 1980-1995, in GDP (%).

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
FSTE/GDP	0.43	0.46	0.42	0.32	0.37	0.35	0.35	0.28	0.27	0.27

Year	1990	1991	1992	1993	1994	1995
FSTE/GDP	0.30	0.36	0.35	0.41	0.46	0.45

Source: CONACYT, Indicadores de Actividades Científicas y Tecnológicas, 1995.

cent of the GDP in developed nations. Further, it is also important to illustrate a point which was mentioned earlier: 80.1 percent of total funding for this branch originates from the public sector, while only 10 percent is provided by the industry; government funding in industrialized nations does not exceed 50 percent.

Available dataalso illustrates an additional discouraging situation: the most optimistic estimate calculates that in 1995 the Mexican government allocated less than 0.5 percent of its GDP to scientific and technological development activities. If we followed, in an effort to find more benevolent patterns, the formulas prescribed by 1993 OECD's Frascati Manual to estimate FSTE of the member states of that organization were applied, this percentage would be reduced even further, reaching scarcely 0.1 prcent.

Regardless of the figures at hand, even the most optimistic estimate is well below that reported by other countries, including those which are currently our trade partners as a result of the North American Free Trade Agreement (NAFTA). In fact, according to CONACYT's *Indicators*, in 1993 Canada allocated 1.5% of its GDP to laboratory research and development activities; that is, between four and five times the amount spent in Mexico. In the case of the United States of America, the country which devotes the largest amount to S&T in the world –along with Germany and Japan–, the percentage totaled nearly 2.7% that same year, the equivalent of six times the Mexican figure.

In addition to the proportion FSTE represents of total GDP, another important factor to take into account in any evaluation of the economic resources available for R&D purposes is precisely their distribution. Given the features mentioned above, there is a close relationship between funds allocated, institutions where these activities are concentrated, and the geographical location or region where the largest number of scientists carry them out.

Distribution of FSTE in Mexico on a percentage basis is significantly beneficial to the Public Education Sector (62.3% of total spending in 1995), bearing in mind that other major sectors participating in R&D are Health, Energy, and Natural Resources. Considering only this Sector (100%), FSTE was distributed in 1995 in the following way: UNAM, 23.5%; SEP-CONACYT, 17.7%; CINESTAV, 6.6%; UAM, 6.1%; Instituto Politécnico Nacional, 1.0%; and the remaining 45.1% among all the other public education institutions.

If we focus exclusively on expenditures allocated to Research and Experimental Development (FERD), proportions remain approximately at the same level, where total amount allocated to the public education sector rose to 72.4% in 1996. Even within this sector, we observe again the same distribution pattern with the following highlights: UNAM (35.5%), SEP-CONACYT (16.3%), CINESTAV (8.1%) and UAM (6.5%).

Allocation of FERD measured as annual expenditures *per* member of NRS was on the order of US$110,000 in 1996. Nonetheless, if this particular expenditure is analyzed per *National Researcher* for certain other institutions –UNAM, UAM and CINESTAV, in particular– the average amount *per capita* turns out to be lower. In fact, in the case of UNAM, the sole university with the largest num-

ber of NSR members, the annual expenditure *per capita* was US$ 84 400, the lowest of all *per capita* allocations that year. Data for UAM are slightly more generous, totaling US$ 84,600; as for CINESTAV, the figure goes up to US$ 96,400, approximately.[6]

These differences in the allocation of funds for the same type of R&D activities should lead to further official evaluations and the implementation of criteria pertaining to the institutional competitiveness and efficiency spheres, allowing for a more rational distribution of resources, particularly insofar as research and experimental development concerns.

By no means are we implying no such funds should be destined to academic institutions nor do we consider S&T budgets adequate to their needs. On the contrary, subsidizing R&D in public universities and institutes is clearly one of the better bets in investment of public budgets. However, we do emphasize the urge to design policies and alternatives which will hopefully aid them to accomplish some financial autonomy while making an impact in the regions where they are located. Attempting it by themselves, in a separate and atomized fashion, might prove futile; integrating as a system could very well be their best option since they ought to improve not only their economic viability but also their operating conditions and strengths, supporting each other in their research efforts, and sharing material and human resources to fulfill new and broader objectives.

Some public academic institutions have already engaged in planning-type self-reflective exercises whose results generally converge in the following basic goals:

a. Teaching, since only with highly qualified individuals will the country successfully overcome challenges more advanced societies are already posing upon us;

b. Research on issues that will eventually generate more universal knowledge as much as feasible alternatives to national problems;

c. Consulting and assisting social groups such as communities and organizations seeking for expertise and skillful guidance; and,

d. Enlarging and propagating the results of the previous three to benefit society as a whole.

Another issue that merits assessment within the framework of the funds available to Mexican institutions for S&T is the result of comparing average expenditures by source: i.e. the breakdown between public and private funding, and the percentage the latter represents of total spending. Due to conceptual and operational difficulties, we were not able to get data at a national level to estimate private sector funding for R&D. Nonetheless, it is only fair to mention that several Mexican research centers and institutions mentioned herein have already started to design new actions and strategies directed towards the promotion of outside financial participation in budget programming activities.

Basic Agents to Foster S&T: Education and Industry

Higher Education public institutions have traditionally been the ones in charge of carrying out R&D activities, therefore they are generally held responsible for the advancement of Mexican

S&T. However, the ties between teaching and research though essential have not been sufficiently stressed.

Most private universities and some public institutions, especially those offering doctoral degrees, have not progressed much to have their graduates keep pace with S&T research endeavors. Worse than that, and even more serious, there are many academic institutions for whom scientific activity is a secondary concern, designed and realized exclusively for prestige purposes and not as an essential element for academic development.

A quick look at various highly developed countries, both economically and scientifically, clearly shows that much of their success lies in the fact that their most prestigious universities carry out their major research projects and programs to train scientists. In fact, there is a close relationship –indeed almost a cause and effect relation– in which it is confirmed that the top universities are those where the best scientific research is carried out.

Thus, an important task for our education system resides precisely in the design and implementation of mechanisms, currently nonexistent at many colleges, to include research at the core of their academic work and as an essential element of their mission as universities.

The number of existing doctoral programs and their graduates should be an unquestionable indicator of the presence of R&D activities at institutions of higher education. Although there has been a relatively sustained growth in the number of graduates over the past few years, it is also important to point out that 70% have earned their doctorate degrees at universities located in the Federal District which, as mentioned above, is also where most scientific activity is carried out. Mexico cannot expect to achieve top-quality student learning unless higher education institutions embrace the idea that, in order to accomplish it, they must have their own prestigious research groups, linked closely to teaching activities.

Table 3. Doctoral Program Graduates i Mexico, by location of granting institution.

	1990	1991	1992	1993	1994
F.D. (Mexico City)	258	228	254	250	342
Guanajuato	0	1	4	56	33
Edo de Méx	2	2	4	5	23
Coahuila	0	0	0	1	10
Nvo León	2	1	13	5	8
Otros	7	6	38	35	72

Source: CONACYT, Indicadores de Actividades Científicas y Tecnológicas, 1995.

The lack of a strong relation between universities and industry has discouraged applied research and a strong development of Mexican technologies, which has in turn curbed the appeal of academic activity for younger generations. Highly qualified graduates of current doctoral programs will not likely join research institutions, as demonstrated by the very small growth of the Mexican scientific community, measured by the annual increase in the National System of Researchers, NSR.

A fundamental step to proceed with and enrich initial efforts to get together scientists, industry persons, and businessmen is to build up a growing awareness of the kind of applied scientific projects that universities and research institutes are able to carry out, stressing their potentialities as much as their present capabilities. By doing so, they might help in the solution of real problems through rigorous and effective methods. Unquestionably, this alternative implies a commitment that will have to be assumed gradually by both parties.[7]

Another step is the establishment of an ongoing, far-reaching government policy to design mechanisms to promote and strengthen scientific and technological development. That is not to say that there is no policy whatsoever at present; indeed, approximately 14% of the total funds given to the Mexican S&T system under CONACYT's coordination and supervision is devoted precisely towards R&D projects.[8]

Although this last paragraphs might be understood as encouraging, the situation will not be fully satisfactory until funds allocated to R&D endeavors are increased, exceeding those traditionally spent by government agencies for managerial and support purposes.

If Mexico is to build a strong S&T system it should be done through increased federal support; the design of legal instruments to foster relations between academia and industry; the implementation of tax incentives and any other complementary policies to strengthen relations between higher education institutions; the S&T system itself, and the

Table 4. Federal S&T Expenditures for Selected Administrative Programs in Mexico, 1990-1995 (Thousands of pesos; 1980 purchasing power)

	Support Activities	Technology Development	Applied Research
1990	930	461	4,189
1991	640	540	4,751
1992	1,975	1,159	2,678
1993	2,562	1,468	3,537
1994	2,984	2,086	2,861
1995	2,432	2,276	2,207

Source: CONACYT, Indicadores de Actividades Científicas y Tecnológicas, 1995.

economically productive apparatus. To this end, private funding needed to consolidate achievement of these goals should undoubtedly be increased.

Finally, it must also be borne in mind that the weakness in university-industry relations is also a reflection of the very small Mexican scientific community and the distance which separates it from production processes. To the extent that Mexican scientific community grows and diversifies its options, the relationship between the academic and private sector will irreversibly and expeditiously become closer and stronger.

Conclusions

In full recognition that any effort towards a healthy and highly competitive economy becomes practically unfeasible if it is not supported by a strong S&T system, this paper presents some points of concern that must be heeded in order to improve its current status in Mexico. It also draws some guidelines to deal more effectively with existing problems which might hold true for other developing countries.

The Mexican scientific community is small by any standard, particularly if we take into consideration our population size, the economic structure, and the pressing need for academic and industrial education throughout the national territory, for it is also highly concentrated both institutionally and geographically. It is obvious that major higher education institutions must contribute to decentralize scientific activities; furthermore, as a specific measure, the government must seek new alternatives to strengthen ties between universities and between teaching and research at state university levels.

In analyzing alternatives to expand this community, it is necessary to take into account the funds available for both research and education endeavors. Unfortunately, it goes without saying that the resources to strengthen them are scant and prevailing policies do not favor them either. Even worse, as mentioned earlier, relations between teaching and research are weak, as are those between academia and industry.

On the one hand, it seems imperative to increase federal science and technology expenditures (FSTE); and although this could be done gradually, its growth must be sustained. Unfortunately, Mexico's previous scientific policies have not been consistent. Nonetheless, it is believed that with the experience of the past few years, a specific policy congruent with the national development model being adopted could be outlined in greater detail. On the other hand, R&D activities fulfill a double role: as a source of new knowledge and as an active promoter of its diffusion and application. The prestige and recognition of every S&T institution should then be based on their ability to combine teaching and training with research.

Last but not least, it has been underscored the urgent need for mechanisms both in universities and governments – at federal and state levels– to further the relation between research and industry, and between the former and teaching, not only in graduate programs but at undergraduate levels as well.

Given its present scientific status, Mexican R&D institutions are about to face an opportunity of becoming the forefront of a national S&T project. The emergence of a systemic vision to be

shared among all stakeholders will definitely reinforce their position in negotiating any budgetary increase and in lobbying changes in personal and institutional evaluation criteria. Moreover, it will certainly involve the development of new concepts and models beyond the simple emulation of structures, which have proven to be appropriate to some other R&D national or foreign organizations.

The understanding and application of systems, concepts for the fulfillment of its own purposes along with those of its individual parts will eventually render fruits in the larger system of which they are a part. A fundamental part of it lies on education, not only in terms of the system's ability to reach all Mexican population but also with regard to issues such as quality and pertinence, without which it becomes futile.

Notes

1   It is difficult it for third-world researchers to have their work included in mainstream journals. Much has been written and discussed with regard to the drawbacks frequently faced by scientists in developing or underdeveloped countries in having their articles published if they are not linked to research groups in more developed nations. Despite this new and surprising sight to the problem of discrimination, Mexican scientists have been forced to follow this fashion regardless how far away they might end up from their initial concerns and interests.

2   UNAM is the largest and eldest public university in Mexico. Aside from its numerous schools and campus, it separately includes R&D centers and institutes devoted to S&T as their main activity, grouped as follows: 24 for scientific research (natural and exact sciences), 9 for the social sciences and humanities, and 3 for technology research and development.

3   Not surprisingly located in the metropolitan area of Mexico City.

4   The SEP-CONACYT Centers include a total of 27 institutions, sponsored by the National Science and Technology Council (CONACYT), grouped in the three main areas: scientific research, research in social sciences, and technology research and development. Some of these institutions were founded and consolidated as renowned centers long before CONACYT was established in 1972.

5   It is particularly important to exclude the category "candidates" from the group of *National Researchers* from the analysis since this group consists of people involved in research projects whose training process has not been completed. They are usually graduate students working on their dissertations whose academic careers are not yet consolidated but whose initial experience in R&D has been successful.

6   Based on an average 1996 exchange rate of MxPs$7.56 per US dollar.

7   In 1991, CONACYT established a special fund seeking to promote a more dynamic relationship between R&D institutions and Mexican industry. The *Academia-Industry Liaison Program*, as it was called, has not been all that successful due to fluctuating economic resources: in its second year of operation, its budget more than doubled, rising expectations; unfortunately, it has decreased ever since, going below that initial allowance.

8   In terms of the budget which exclusively fuels the *Technological Development Program*, it is important to mention that it accounted for 9.3% of total FSTE in 1995, a percentage well above that of prior years.

*R*eferences

Ackoff, R.L.
1972 "On Purposeful Systems". Chicago, Aldine-Atherton.

Campos, M.A.
1992 "El desarrollo científico-tecnológico", [en] M.A. Campos y S.R. Medina (eds.), Política científica e innovación tecnológica en México, IIMAS-UNAM, México.

Chapela, G. et al.
1997 "Un camino trillado en la tierra ignota: la política científica y tecnológica" Ciencia 48, 1, pp. 21-30. México: Academia Mexicana de Ciencias.

Consejo Nacional de Ciencia y Tecnología
1996 Indicadores de Actividades Científicas y Tecnológicas, 1995. México.
1997 Indicadores de Actividades Científicas y Tecnológicas, 1996. México.
1997 Programas de Posgrado en el Sistema SEP-CONACYT. Primer Encuentro Nacional de Investigadores del Sistema SEP-CONACYT. México.

Domínguez J. et al.
1987 "S&T performance assessment of Mexican research units", Comunicaciones Técnicas, 1-43. México: IIMAS, UNAM, Serie naranja: investigaciones, no. 491.

Jiménez, J. et al.
1991 "Distribution of scientific tasks between center and periphery in Mexico", Social Science Information, SAGE, 30,3: 471-482
1986a "Scientific Research Areas in Mexico: Growth Patterns in the Late Seventies", Scientometrics 9 (5-6): 209-23.
1986b "Center Periphery Analysis of Research and Development Resource Allocation: Preliminary Results of ICSOPRU in Mexico", Comunicaciones Técnicas, 1-62. México: IIMAS, UNAM, Serie naranja: investigaciones, no. 436.

Russell, Jane
1995 "The increasing role of international co-operation in science and technology research in Mexico", Scientometrics 34, 1: 45-61.

Suárez, G., J. Zubieta.
1996 El desarrollo regional de la ciencia. Perspectivas de desarrollo científico para México (en(Rodríguez y R. S. et al (Coordinadores): "El Desarrollo Regional en México. Antecedentes y Perspectivas. "Asociación Mexicana de Ciencias para el Desarrollo Regional (AMECIDER), Universidad Autónoma de Querétaro e Instituto de Investigaciones Económicas, UNAM.

Tapia, R.
1997 "La evaluación de los investigadores y de la producción científica", Ciencia 48, 1, pp.3-11. México: Academia Mexicana de Ciencias.

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