Nanotech Cluster in Nuevo León, Mexico: Reflections on its Social Significance

Edgar Zayago Lau*

Abstract

Nanotechnology development in Mexico is occurring in a regulatory vacuum, one in which many claims are made for this sector's broader benefits to Mexican society and business. This article takes a case-study approach to one of the most significant nanotechnology initiatives in Mexico. It examines the scientific policy context surrounding its creation, the regulatory environment, charts its implementation, and discusses the social implications that few are researching and even fewer appear to view as requiring investigation. The article concludes that the interests of private business continue take priority over scientific goals or relevance to social needs; that the pursuit of the nanotechnology-business nexus exhibits wasted resources; that Mexico's education system is ill-prepared to provide the necessary human resource base; and that repercussions for Mexico's internal labor market are profound, with unanticipated consequences.

I. Introduction

Both developed and developing countries alike are pushing forward with the development of nanotechnology as a tool to increase business competitiveness. The Mexican case is no different. Since 2008, it has been developing a specialized nanotechnology cluster in the state of Nuevo León as part of a high-technology business park that brings together research centers, universities, government agencies and private business. The cluster is intended to spark economic growth in the area. The objective of this article is to track the growth of this cluster and to reflect on a few social questions relating to its development. In the first section, we follow the evolution of the country's

* Researcher with the Department of Development Studies, Autonomous University of Zacatecas. Member of the Latin American Nanotechnology and Society Network (ReLANS). E-mail: zayagolau@gmail.com The author of this article would like to thank the PROMEP program (UAZ-PTC-122) for the funding provided.

scientific-technological platform. Later, we illustrate how the regulatory framework has changed to allow for the privatization of scientific endeavors, in the hope of increasing business competitiveness. This is reflected in the vision that guides the nanotechnology cluster, which we examine in the third section. In the fourth section, we consider some of the key questions regarding the social relevance of the Nanotechnology Cluster in Nuevo León to Mexico.

1. Summary of the Scientific-Technological Platform in Mexico

Mexican science and technology (S&T) policy is intended to go hand-in-hand with the business sector, although the schemes have varied with every change in federal government (a six-year cycle). From the beginning, the State intended to tie-in S&T with production and consumption, though in recent years there has been movement to place the responsibility for that linkage to businesses, universities and research centers. The market has been prioritized as the means of transferring any possible technological benefits to society. For the adherents to the economic theories of technology known as evolutionists or neo-Schumpeterians, knowledge arises from the triple helix or virtuous circle of innovation, that is, of the interaction between government, industry and university.[1]

In 1934, the first steps were taken toward implementing a S&T program in Mexico. President Lázaro Cárdenas (1934-1940) initiated policies with a nationalist vision that gave preference to the socioeconomic needs of the country. The scientific-technological program included such matters as health, employment and the well-being of the population, and fomented the development of national technologies through an import-substitution industrialization strategy.[2] This strategy consolidated the basic manufacturing sector in Mexico,[3] and strengthened the appliance, auto and chemical industries that drove the internal market.[4]

President Manuel Ávila Camacho (1940-1946) institutionalized S&T policy planning with the creation of the Commission to Stimulate and Coordinate Scientific Research (CICIC). This body continued the *cardenista* policy of linking research with the challenges facing health, agriculture and industry.[5] In 1950, the National Institute of Scientific Research (INIC), which became the

[1] L. Leydesdorff & H. Etzkowitz, *The Transformation of University-Industry-Government Relations*, 5(4) ELECTRONIC J. SOC. 101 (2001), http://www.sociology.org/content/vol005.004/th.html. There are, however, other relevant actors who also shape the development of new technologies, such as non-governmental organizations, unions and consumer groups. *See* Guillermo Foladori & Noela Invernizzi, *The Workers' Push to Democratize Nanotechnology, in* 1 THE YEARBOOK OF NANOTECHNOLOGY IN SOCIETY 23 (Erik Fisher et al. eds., 2008); G. Foladori &. E. Zayago Lau, *Las nanotecnologías y los sistemas nacionales de innovación* [*Nanotechnologies and Systems of Innovation*], *in* VISIONES DEL DESARROLLO [VISIONS OF DEVELOPMENT] (Humberto Márquez et al. eds., 2011).

[2] R. Casas, *El Estado y la política de la ciencia en México* [*The State and Science Policy in Mexico*], CUADERNOS DE INVESTIGACIÓN SOCIAL [NOTEBOOKS OF SOCIAL INVESTIGATION] (1985) (Mex.).

[3] JAIME ABOITES & MANUEL SORIA, INNOVACIÓN, PROPIEDAD INTELECTUAL Y ESTRATEGIAS TECNOLÓGICAS: LA EXPERIENCIA DE LA ECONOMÍA MEXICANA [INNOVATION, INTELLECTUAL PROPERTY AND TECHNOLOGY STRATEGIES: THE EXPERIENCE OF THE MEXICAN ECONOMY] (1999); Jorge Katz, *Technology, Economics and Late Industrialization*, *in* THE UNCERTAIN QUEST: SCIENCE, TECHNOLOGY & DEVELOPMENT ch. 7 (Jean-Jacques Salomón et al. eds., 1994); E. Martínez, *Ciencia, Tecnología y Estado en América Latina: el fin del siglo XXI* [*Science, Technology and State in Latin America: The End of the 21st Century*], *in* DEMOCRACIA ARA UNA NUEVA SOCIEDAD [DEMOCRACY FOR A NEW SOCIETY] (H. González & H. Schmidt eds., 1997).

[4] A. Rocha & R. López, *Política en ciencia y tecnología en México: un análisis retrospectivo* [*Science and Technology Policy in Mexico: A Retrospective Analysis*], *in* INNOVACIÓN, APRENDIZAJE Y CREACIÓN DE CAPACIDADES TECNOLÓGICAS [INNOVATION, LEARNING AND TECHNOLOGICAL CAPACITY BUILDING] 113 (Jaime Aboites & Gabriela Dutrénit eds., 2003).

[5] Richardo Hernández Ramirez, *La Política de la Ciencia y de la Tecnología en México, la educación científico-técnica y la formación de recursos humanos* [*The Politics of Science and Technology in Mexico, Scientific and*

principal advisory body to the President in this area, was created. Later, to link scientific development with institutions of higher learning, the INIC created the National Association of Universities and Higher Education Institutes. However, the INIC as well as the CICIC were dismantled at the end of the 1960s, without achieving the hoped-for results.[6]

This attempt spurred an analysis of the state of S&T and its connections with the productive sector. The outcome of the study was the recommendation that an institution be created to systematize scientific-technological activities in Mexico, channeling them toward industry. On December 29, 1970, a legal framework was established to create the National Science and Technology Council (CONACyT). The objectives: to promote, coordinate and evaluate S&T policy in Mexico.[7]

The 1982 economic crisis demanded a change of State-directed development policies. The government of Miguel de la Madrid (1982-1988) blamed the import-substitution industrialization model for the lack of growth and productivity, and decided that market forces should regulate S&T. A fiscally-viable platform was created, with the direction of S&T no longer left exclusively in the hands of the State.[8] In preparation for the withdrawal of the State from S&T policy management, three strategies were established: i) create a fund to promote the development of scientific research; ii) facilitate relationships between universities, research centers and business; and iii) decentralize post-graduate study and scientific-technological research.[9]

Under the government of Carlos Salinas de Gortari (1988-1994) economic liberalization, financial deregulation, massive privatization of para-state businesses, and the signing of the North American Free Trade Agreement put an end to the import-substitution industrialization model and the exclusive role of the State in the creation of S&T policies.

Regulatory changes accompanied this new vision. In 1991, for example, the Law of the Promotion and Protection of Industrial Property was passed in order to protect processes, products and inventions of business (both national and foreign) operating in the country.[10] This changed the legal framework for intellectual property to guarantee monopolistic profit-making by extending industrial property protection for twenty years, in line with international business practices. A Science and Technological Modernization Program was implemented to assist in the development of technological activities and to promote business competitiveness. This program gave credit to businesses or research centers that innovated or developed new technologies. Likewise, the government launched a privatization process to sell businesses that were still funded by federal S&T sources. In a scholarly article, Taeko Hoshino noted that in 1982 there were 1,155 state enterprises; today there exist only 150, although in reality there are only two with a market presence: Mexican Petroleum (PEMEX) and the Federal Electricity Commission (CFE).[11]

Technical Education and Training of Human Resources], 7(20) APORTES [JOURNAL OF THE FACULTY OF ECONOMICS BENEMERITA UNIVERSIDAD AUTONOMA DE PEUBLA] 87 (2002).

[6] Retana Guiascón & Oscar Gustavo, *La institucionalización de la investigación en México, breve cronología* [*The Institutionalization of Research in Mexico, a Brief Chronology*], 94 CIENCIAS 46 (2009).

[7] Ley del Consejo Nacional de Ciencia y Tecnología [LCNCyT] [Law of the National Council of Science and Technology], Diario Oficial de la Federación [D.O.], 29 de Diciembre de 1970 (Mex.).

[8] Rocha & López, *supra* note 4, at 114.

[9] Guiascón & Gustavo, *supra* note 6, at 51.

[10] Rocha & López, *supra* note 4, at 114; Ley de Fomento y Protección a la Propiedad Industrial [Law for the Promotion and Protection of Industrial Property], *as amended*, Diario Oficial de la Federación [D.O.], 27 de Junio de 1991 (Mex.).

[11] Taeko Hoshino, *Privatization of Mexico's Public Enterprises and the Restructuring of the Private Sector*, 34(1) DEV. ECON. 34 (1996); Directorio del Gobierno Federal México [Directory of the Federal Government],

Under the regime of Ernesto Zedillo (1994-2000) these programs changed, but the tendency to link development of S&T with the private sector persisted. In 1994, Mexico joined the Organization for Economic Cooperation and Development (OECD) and requested an evaluation of its scientific-technological system by that body. The OECD recommended various measures for the creation of technologically-competitive industry, among them: the formation of one institution to guide all S&T activity, the creation of a S&T policy linked to the demands of the business sector, the restructuring of the National Science and Technology Counsel (CONACyT), and becoming open to external financing.[12]

Over the course of two presidential terms, the OECD's recommendations were followed to the letter. In 1997, Mexico sought a $700-million loan from the World Bank to finance scientific and technological research, link universities with businesses, restructure public research centers, and to improve technology in the private sector.[13] During the administration of Vicente Fox (2000-2006) the remaining OECD recommendations were implemented. In 2002, the Law of Science and Technology was passed, which created the General Council of Scientific Research and Technological Development.[14] This law situated CONACyT at the forefront of S&T in the country and funded the Scientific and Technological Consultative Forum (FCCyT). The Charter of CONACyT, also published in 2002, gave greater autonomy to that body, freeing it from the control of the Secretary of Public Education. Moreover, in 2003, the Mexican government created a program of fiscal incentives for companies to invest in S&T.[15] All of this legal and regulatory framework modification intensified the move toward the privatization of scientific knowledge and technology.

II. Contemporary Regulatory Framework: Toward the Privatization of Public S&T

Current S&T policy in Mexico is intended to complement a series of policies that promote business competitiveness. There exist, however, some formal guidelines that place national problems as priorities for S&T policy. One of these is the Special Program of Science, Technology and Innovation (PECiTI) 2008-2012, which on page 18 establishes:

> The ultimate aim of the programs that supports science, technology and innovation is to contribute to a higher quality of life, raise employment and reduce poverty through higher productivity and competitiveness. To that end, the evaluation of the results produced through the investment of public resources in science, technology and innovation must be performed with the economic and social impact in mind.[16]

Entidades paraestatales y organismos descentralizados [Government Controlled Entities and Decentralized Agencies], http://directorio.gob.mx/comunicacionsocial.php?categoria=3 (last visited Mar. 4, 2011).

[12] ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT, REVIEW OF NATIONAL SCIENCE AND TECHNOLOGY POLICY: MEXICO, EXAMINERS REPORT DSTI/STP (94)11 (1994).

[13] FINANCE, INFRASTRUCTURE AND PRIVATE SECTOR MANAGEMENT UNIT, WORLD BANK, PROJECT APPRAISAL DOCUMENT ON A PROPOSED LOAN IN THE AMOUNT OF US$300 MILLION TO MEXICO FOR A KNOWLEDGE AND INNOVATION PROJECT (1998).

[14] Ley de Ciencia y Tecnología [LCyT] [Law on Science and Technology], Diario Oficial de la Federación [D.O.], 6 de Diciembre de 2009 (Mex.).

[15] Jaime Parada, *Monterrey: Internacional City of Knowledge Program*, *in* UNDERSTANDING RESEARCH, SCIENCE AND TECHNOLOGY PARKS: GLOBAL BEST PRACTICE: REPORT OF A SYMPOSIUM 74 (Charles W. Wessner ed., 2009).

[16] Programa Especial de Ciencia y Tecnología e Innovación 2008-2012 [PECiTI] [Special Program for Science and Technology 2008-2012], Diario Oficial de la Federación [D.O.], 16 de Diciembre de 2008 (Mex.), *available at* http://www.conacyt.gob.mx/Acerca/Documentos%20Normatividad/Programa-Especial-de-Ciencia-y-Tecnologia_2008-2012.pdf.

Although the declaration in favor of using S&T to improve the quality of life of the population and to reduce poverty is worthy, the methods of doing so through an increase in competitiveness and productivity could prove to be in error. Mexico is a classic case of the disconnect between competitiveness, inequality and poverty reduction, in that since the mid-1980s to the mid-1990s, as competitiveness increased significantly so did inequality and poverty, with the Gini coefficient jumping from 0.49 to 0.55, respectively.[17] Despite the fact that Mexico is the country with the fastest growth in the number of multi-millionaires, it is also the country with the fastest growth in the number of people living in poverty.[18] Other studies suggest that the increase in competitiveness and productivity through the use of new technologies and machinery does not necessarily improve the condition of life of the workers, nor raise their salaries.[19] In spite of this, Mexican S&T policy remains overshadowed by the search for incremental increases in business competitiveness as the recipe for economic growth and development.

The National Development Plan 2007-2012 identified five principal axes for the promotion of economic growth in Mexico; one of those is the development of a *competitive economy and the creation of jobs*, and S&T is, presumably, one important tool with which to achieve that goal.[20] The Law of Science & Technology, passed in 2009, laid bare the orientation of S&T toward the promotion of business competitiveness, as the following excerpt from that law indicates its intention is:

> To foster the technological development and innovation of national businesses that are active within national territory, in particular within those sectors in which the conditions exist to generate new technologies and achieve greater competitiveness. [Moreover, it is the policy of the State] that the incorporation of technological development and innovation in the productive processes and services be undertaken to increase productivity and competitiveness that require the national production apparatus.[21]

PECiTI, the Special Program for Science and Technology 2008-2012, represents the core axis of medium-term S&T policy and was designed via a public consultation.[22] Participating in the process were the Secretaries of State, the OECD, individual State S&T Councils, the scientific-technological community, the National Association of Universities and Higher Education Institutes, the Mexican

---

[17] Raúl Delgado Wise & Noela Invernizzi, *México y Corea del Sur: Claroscuros del crecimiento exportador en el contexto del globalismo neoliberal* [*Mexico and South Korea: Monochrome Export Growth in the Context of Neoliberal Globalism*], 2(4) APORTES: REVISTA MEXICANA DE ESTUDIOS SOBRE LA CUENCA DEL PACÍFICO [JOURNAL OF STUDIES ON THE PACIFIC RIM] 63 (2002).

[18] PABLO GONZÁLEZ CASANOVA, LA UNIVERSIDAD NECESARIA EN EL SIGLO XXI [THE UNIVERSITY NECESSARY FOR THE 21ST CENTURY] 127 (2001).

[19] Adrian Sotelo Valencia, *La precarización del trabajo: ¿premisa de la globalización?* [*Job Insecurity: Introduction of Globalization?*], 18 PAPELES DE POBLACIÓN [POPULATION ROLES] 82 (1998); Press Release, International Labour Organization, Global Employment Trends, (Jan. 23, 2008), http://www.ilo.org/asia/info/public/pr/lang--en/WCMS_BK_PR_221_EN/index.htm; C. FIGARI & G. ALVES, LA PRECARIZACIÓN DEL TRABAJO EN AMÉRICA LATINA: PERSPECTIVAS DEL CAPITALISMO GLOBAL [THE UNCERTAINTY OF WORK IN LATIN AMERICA: PERSPECTIVE OF GLOBAL CAPITALISM] (2009).

[20] Plan Nacional de Desarrollo (2007-2012) (PND), Mensaje del Presidente Felipe Calderón Hinojosa, http://pnd.presidencia.gob.mx (last visited Mar. 6, 2011).

[21] LCyT, *supra* note 14.

[22] PECiTI, *supra* note 16.

Academy of Sciences, businesses and related bodies, and the Scientific and Technological Consultative Forum (FCCyT). Left outside of the discussions were other actors such as unions, non-governmental organizations, farmers associations and indigenous groups, who could have brought in social priorities.[23]

Program creation must be accompanied by funding to have any impact. S&T in Mexico has never had sufficient investment. The funds applied to Experimental Research & Development, as a percentage of gross domestic product (based on the OECD's GIDE indicators), has been less than 0.50% over several decades, although the OECD recommends that the level be at least 1%.[24] Nevertheless, private-sector contributions affecting the GIDE measurements increased after the OECD recommendations were implemented, rising from 14% in 1993 to 41% in 2005.[25]

The FCCyT published a program catalog to facilitate linkages between research and development (R&D) with the private sector.[26] Some forty programs are included in the catalog; twenty-one are involved in S&T, and of those sixteen are administered by CONACyT and five by the Secretary of the Economy. Although the FCCyT claims that any social or civil sector can participate in the programming, the reality is that thirty-three of the programs listed are directed toward the private sector, while only eight involve the social sector.[27]

The Law of Science and Technology (LCyT) is meant to assist the privatization of scientific knowledge. For example, Public Research Centers (CPIs), which are state enterprises with public administrations, must promote:

> …conformity among strategic associations, technological alliances, consortiums, linkage and knowledge-transfer bodies, new technology businesses, and regional innovation networks in which attempts will be made to incorporate technological developments and innovations in said centers, as well as the researchers included therein….

[23] The FCCyT envisioned the organization of fora in each Mexican state. In some states, such as in Zacatecas, the unions were included.

[24] The GIDE is an indicator created by the OECD to measure activities related to development and innovation. Essentially, three factors are considered: basic research, that generates new knowledge at the theoretical level; applied research, that consists of research directed toward practical application; and experimental development that uses knowledge in the production of new materials, products, devices and improves existing systems. ORGANIZATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD), FRASCATI MANUEL 2002: PROPOSED STANDARD PRACTICE FOR SURVEYS ON RESEARCH AND EXPERIMENTAL DEVELOPMENT 30 (2002). The GIDE considers five sources of financing: the productive sector, government bodies, higher education institutions, private non-profit institutions and foreign investment.

[25] G. Dutrenit & A. Vera-Cruz, *Innovation Policy and Incentives Structure: Learning from the Mexican Case*, *in* TECHNO ECONOMIC PARADIGMS: ESSAYS IN THE HONOUR OF CARLOTA PEREZ 104 (W. Dreschler et al. eds., 2009).

[26] FORO CONSULTIVO CIENTÍFICO Y TECNOLÓGICO (FCCyT) [SCIENTIFIC AND TECHNOLOGICAL CONSULTATIVE FORUM], PROGRAMAS PARA EL FOMENTO EMPRESARIAL Y LA VINCULACIÓN 2010 [CATALOG OF PROGRAMS FOR ENTERPRISE DEVELOPMENT AND LINKING 2010] (2010) (Mex.) (its purpose was to compile and spread information on the different public programs that promote enterprise development in Mexico).

[27] The FCCyT has a total of 40 programs, but some of those offer support to more than one sector. This explains the discrepancy in the count. *Id*. at 17.

The CIPs, moreover, approve and establish:

> I. The guidelines and basic requirements of the associations, alliances, consortia, units, networks or new businesses that require the participation of the center, with a share of the social capital of the area in which they operate, and
>
> II. The terms and requirements for the incorporation and participation of staff of the center in the associations, alliances, consortia, units, networks or new businesses in the area in which they operate.[28]

The CPIs must also facilitate the transference of scientific and technological knowledge to businesses. Under the LCyT up to 70% of the intellectual property right royalties could be awarded to the researchers who develop commercial applications.[29]

The increase in the financial participation of the private sector, the programs of the FCCyT connected to the private sector, and the incentives for commercialization of scientific knowledge under the CPIs come together making a framework that favors S&T development according to business interests.

III. The Nanotechnology Cluster in Nuevo León

After Brazil, based on the number of institutions undertaking research in the area, infrastructure, scientific publications, international agreements and human resources, Mexico is one of the Latin American leaders in nanotechnology.[30] Mexico has no national nanotechnology policy or initiative, although there are declarations in official documents that place this technology in a position of strategic importance regarding the increase in competitiveness and, consequently, an improved quality of life for society.[31]

Government, universities, and business have been brought together in various industrial parks throughout Mexico to drive nanotechnology development. One of these is the *Silicon Border Development Park*, built on the border between Mexicali and San Diego – it bills itself as the first high technology park in America specialized in nanocomponents.[32] Another important park is located in Puebla, where the National Nanoelectronics Laboratory (LNN) is located. Multinational firm Motorola donated a production line for electronic devices and integrated circuits to the NNL,

---

[28] LCyT, *supra* note 14.

[29] *Id.* at 28.

[30] Guillermo Foladori, *Nanotechnology in Latin America at the Crossroads*, 3(2) NANOTECH. L. & BUS. J. 205 (2006); ORGANIZACIÓN DE ESTADOS IBEROAMERICANOS (OEI) [ORGANIZATION OF LATIN AMERICAN STATES], LA NANOTECNOLOGÍA EN IBEROAMÉRICA: SITUACIÓN ACTUAL Y TENDENCIAS [THE NANOTECHNOLOGY IN LATIN AMERICA: SITUATIONS AND TRENDS] (2007), *available at*, http://www.oei.es/observatoriocts/index.php?option=com_content&view=article&id=12&Itemid=3.

[31] CONSEJO NACIONAL DE CIENCIA Y TECNOLOGÍA (CONACYT) [NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY], PROGRAMA ESPECIAL DE CIENCIA Y TECNOLOGÍA Y INNOVACIÓN 2008-2012 (PECITI) [SPECIAL PROGRAM OF SCIENCE, TECHNOLOGY AND INNOVATION 2008-2012] 36 (2008), *available at* www.conacyt.mx/Acerca/Normatividad/Programa-Especial-de-Ciencia-y-Tecnologia_2008-2012.pdf .

[32] Silicon Border, Silicon Border Development Science Park, http://www.siliconborder.com/company.html (last visited Mar. 7, 2011).

where it is hoped that the manufacture of semiconductors, sensors and nano/micro appliance systems (MEMS/NEMS) for businesses in the area will be produced.[33]

Located in the city of Monterrey, in the state of Nuevo León, there is one park that stands out – the Research and Technological Innovation Park (PIIT). This park is part of the *Monterrey: International City of Knowledge* project, which seeks to convert the city into a world-class competitor among business, academia and government.[34] PIIT's objectives include: i) promoting applied research and innovation; ii) linking S&T to the needs of the market and businesses; iii) making use of and further developing Nuevo León's intellectual capital; and iv) promoting the incubation of businesses with a foundation of innovation. The PIIT is built across some 175 acres, and represents an investment of $100-million USD for infrastructure and $150-million USD for equipment.

The park seeks to capitalize on the "triple helix" convergence of industry, government, and academia already existing in and around Nuevo León. The industrial sector in the area produces 11% of the total manufacturing output of the country, equivalent to $12-million USD; there are also 93 higher education institutions, among them technical colleges and universities; and government agencies have commitment to support S&T in the region, including PIIT.[35] The PIIT hosts clusters specializing in technologies ranging from aerospace, to automotive and software development. Additionally, it has two incubators specializing in emerging technologies: one for biotechnology and another for nanotechnology. Our interest lies with the Nanotechnology Cluster in Nuevo León (CNNL).

Objectives of the Nanotechnology Cluster in Nuevo León include the development of specialized human resources, the creation of businesses with nanotechnology applications, the attraction of financing, and to drive regional productivity and competitiveness.[36] When it opened its doors in June 2008 CNNL had sixteen members. Since then it has experienced a significant and rapid gain in membership, which now stands at twenty-eight. Members include governmental and educational entities, as well as businesses.

The CNNL includes representatives of the Federal and State governments: CONACyT, with a national scope, is present with various funding programs; the government of Nuevo León, with its Institute of Innovation and Technology Transfer (a governmental entity of Nuevo Léon); and the Secretary of Economic Development.

---

[33] INSTITUTO NACIONAL DE ASTROFÍSICA, ÓPTICA, Y ELECTRÓNICA (INAOE) [NATIONAL INSTITUTE OF ASTROPHYSICS, OPTICS AND ELECTRONICS], LABORATORIO NACIONAL DE NANOELECTRÓNICA (LNN) [NATIONAL LABORATORY FOR NANOELECTRONICS] (2010) (Mex.), *available at* http://www-elec.inaoep.mx/lnn.

[34] Monterrey Ciudad Internacional del Conocimiento (MTYCIC), http://www.mtycic.com.mx/?p=vision (last visited Mar. 7, 2011).

[35] PITT's vision for 2025 includes: i) raising the GDP per capita from $15,975 to $35,000 by 2020; ii) remake Nuevo León as one of the 25 most competitive places in the world to do business; iii) be home to a world-class system of education, innovation and research, and iv) demonstrate to the public the importance of education, knowledge, research and development in their lives. PARADA, *supra* note 15.

[36] Jesús González Hernández, PowerPoint Presentation at the Symposium on Nanoscience and Nanotechnology at la Universidad Autónoma Metropolitana, Desarrollo de un cluster: La experiencia del cluster de nanotecnología de Nuevo León [Development of a Cluster: The Experience of the Nanotechnology Cluster Nuevo León] (Nov. 16, 2010) (Mex.).

The academic sector's presence is provided by the Center of Advanced Materials Research (CIMAV),[37] which coordinates the cluster, and:

- Monterrey Technological Institute of Higher Studies;
- Autonomous University of Nuevo León;
- University of Monterrey;
- Center for Research and Advanced Studies of the National Polytechnic Institute;
- Various sub-centers of CONACyT's CPIs, such as the Center for Applied Chemical Research, and the Center of Engineering and Industrial Development;
- Foreign universities, such as Arizona State University, University of Texas-Austin, and University of Texas (A&M).

There are also seventeen businesses located in the cluster: Proleg (a joint venture of Xignux and General Electric), Nanomateriales, Whirlpool, CopaMex, Vitro, Cydsa, Sigma, Cemex, Iza VentureCapital, Lamosa, Viakable, Univex, Grupo Simplex, Industrias Vago, Verzatec, and Owens Corning.[38] The CNNL hopes to have, by 2015, some 100 nanotechnology businesses that compete at the global level.[39]

Today, there are forty-eight linkage projects (publicly funded projects that bring scientists and research centers together with private business for the purpose of commercializing new technologies) in different stages of development, thirty-five of which are categorized as "signature projects," that is, of high priority. These projects are focused into three areas: (i) nanostructures to reinforce metal; (ii) nanostructures to reinforce polymer materials; and (iii) functional coatings. Some developments have gone through the complete linkage cycle and are now being introduced into production processes. CIMAV, for example, has eight linkage projects with different national and international business partners, although not all of these involve nanotechnology.[40]

As an incubator of nanotechnology-related commerce, the objective of the CNNL is to bring products to market on an industrial scale. In 2009, it received 61-million pesos in funding to purchase equipment and build infrastructure. The intention is to take advantage of the potential regional market, estimated to be more than $40-million dollars per year, and presumably, create highly paid jobs.[41] There are also other business technology incubators within the PITT that financially support nanotechnology projects, for example: the IC2 *Austin Incubator Center* at UT-Austin, the EGADE Business Accelerator, and the Mexico-United States Foundation for Science's TechBA incubator. The Nuevo León Fund for Innovation intends to connect S&T initiatives with

[37] CIMAV, located in Chihuahua state, has been the headquarters of the National Nanotechnology Laboratory (NaNoTeCH) since 2008 and, since 2009, the National Point of Contact in Nanotechnology. The Potosino Institute of Scientific Research and Technology (IPICYT) is the headquarters of the other National Laboratory in Nanotechnology and Nanoscience Research (LINAN).

[38] Cluster Nano, Cluster de Nanotecnologia de Nuevo León, http://www.clusternano.org (last visited Mar. 8, 2011).

[39] González, *supra* note 36.

[40] *Id.*

[41] Cluster Nano, Cluster de Nanotecnologia de Nuevo León, www.clusternano.org. According to the Director General of the Institute of Innovation and Technology Transfer, Dr. Jaime Parada, the PITT created approximately 3,500 jobs for engineers and researchers. PARADA, *supra* note 15 .

commercial applications to generate new businesses, not only in the nanotechnology field, but also seed funding to related initiatives in other technology sectors. This fund was founded with 100-million pesos in startup financing, with support coming from the state government of Nuevo León, CONACyT, and the Mexican Foundation for Innovation and the Transfer of Technology to Small and Medium Businesses. It is hoped that the Interamerican Development Bank and other institutions will support the initiatives, with each project budgeted to cost up to two million pesos.[42]

Additionally, as part of the collaboration package under the CNNL, a master's program in Science and Technology Commercialization was created under an agreement established between UT-Austin, CONACyT and CIMAV. The one-year program is delivered through the Instituto IC2 at UT-Austin as part of the CNNL. The master's program trains experts in the commercialization of technology and innovation, and it is hoped that some of the graduates will remain to work in the businesses and research centers that make up the cluster.

The CNNL is one example of collaboration for innovation that can occur within the "triple helix" of academia, industry, and governmental institutions coming together. It remains to be seen if this initiative can bring benefits to the broader social sectors in the region.

IV. Social Implications Facing the CNNL

The role of S&T in Mexican development has changed along with corresponding governments over the decades. The current scientific policy, which is tied to the private sector and the market, shapes the development of S&T in Mexico. The CNNL is also caught up in this vision, which invites us to consider some of the social implications of its development.

- *Relevance for the most vulnerable.* The objective of the scientific-technological platform in Mexico has changed according to each administration; necessities in the areas of health, agriculture and industry have been left aside in order to respond to market requirements and private sector competitiveness. The programs, laws and fiscal incentives that exist are oriented toward bringing S&T to the service of business and the privatization of scientific knowledge. The CNNL structure, it appears, likewise follows this path. The market mediates relationships between business and society, and transfers the products and services to the consumer to satisfy demand. The market determines the productive agenda of business. This does not necessarily correspond to the needs of the more than 54.8 million people living in poverty in Mexico.[43]

- *Duplication of effort.* Mexico hosts various high technology parks and a number of institutions skilled in the nanotechnology industry. However, there is no national initiative in nanotechnology that specifies in which areas of research effort should be directed, nor objectives, common goals, or strategic sectors that should be encouraged. This context appears to create the potential problem of duplication of effort. The lack of public policy leaves us wondering; could this create an environment of competition for scarce resources between nanotechnology clusters, leading to winners and losers, and economic and social waste?

[42] Cluster Nano, Cluster de Nanotecnologia de Nuevo León, www.clusternano.org.

[43] According to the World Bank, the number of poor people in Mexico exceeded 50.6 million in 2007, and 54.8 million in 2009. *En México 43% de jóvenes padecen algún tipo de pobreza* [*In Mexico 43% of Children Suffer from Various Types of Poverty*], CNN MÉXICO, Aug. 11, 2010, http://mexico.cnn.com/nacional/2010/08/11/en-mexico-43-de-los-jovenes-padecen-varios-tipos-de-pobreza.

- *Supply of human capital.* Mexico's education system is lacking in many respects: primarily at the basic-secondary and pre-graduate studies levels. According to the National Assessment of Academic Achievement in Education 2010, at the primary level, more than 60% of students were rated "insufficient" and "basic" in their mathematics and Spanish abilities; students at the secondary level ranked worse: some 80% were listed as not having achieved sufficient ability in the material.[44] At the high school level, the situation is similar: five of every ten students are unable to read and eight in ten cannot multiply nor divide.[45] A research area such as nanotechnology requires personnel with training in the sciences and engineering. Where will these qualified human resources come from to support the development of the CNNL? How will Mexico satisfy these requirements if many of its youth are unable to handle basic math?

- *Workforce impact.* The CNNL is intended, in part, to create high-value jobs. However, there are studies that show the application of technology to production may result in labor instability and an increase in unemployment.[46] Also, with an official unemployment rate at 6% and with 7-million youth who neither study nor work ("ninis"),[47] what social relevance do these nanotechnology clusters represent when they will seek only a highly specialized workforce? What impact will nanotechnology products, which are more efficient and with new, multifunctional characteristics, have on the creation of new job openings in Mexico?

- *Thematic vacuum in debates.* In Mexico there is practically no debate on the social, legal, labor, and above all, environmental and health impacts of nanotechnology. The formulation of S&T programs falls to the business sector, government, and academia. There are other social actors who also should be permitted to participate in the design of technology policies and on a national nanotechnology plan. Social actors such as: unions, indigenous groups, environmental organizations—essentially any organized social group that could be adversely affected by the introduction of this new technology. These are actors who at the world-level have had an influence on the trajectory of nanotechnology development.[48]

These considerations seek to stimulate a dialog on aspects that have not been considered by the actors currently participating in the CNNL and in the development of nanotechnology in Mexico. This is not about the imposition of an agenda for debate, there are many other themes that we have not touched upon; we do hope to bridge the communication gap that exists between the natural sciences and engineering with the social sciences.

---

[44] Raymundo Carmona & Maira Fernanda Pavón, *Enlace 2010: sin mejoría educative* [*Connection 2010: Without Educational Improvement*], EL UNIVERSAL, Sept. 4, 2010, http://www.eluniversal.com.mx/editoriales/49736.html.

[45] *Ocho de cada diez egresados de bachillerato no saben leer ni escribir* [*Eight out of Ten High School Graduates Cannot Read or Write*], E-CONSULTA, Sept. 10, 2009, http://www.e-consulta.com/index.php?option=com_content&task=view&id=35464&Itemid=181.

[46] Sotelo, *supra* note 19; Press Release, International Labor Organization, International Organization of Labor Global Employment Trends Press Report (Jan. 2008), *available at* http://www.ilo.org/global/About_the_ILO/Media_and_public_information/Press_releases/lang--en/WCMS_090085/index.htm; FIGARI & ALVES, *supra* note 19.

[47] *Existen 7 millones de ninis en México, insiste Narro Robles* [*There are Seven Million Young People in Mexico who Neither Study or Work, Insists Narro Robles*], MILENIO.COM, Sept. 8, 2010, http://www.milenio.com/node/513760.

[48] Foladori & Zayago, *supra* note 1.