

PUERTO RICO SCIENCE AND TECHNOLOGY ALLIANCE

FINAL VERSION

PUERTO RICO'S POLICY ON SCIENCE AND TECHNOLOGY

Prepared by:

PR's Science and Technology Alliance

September, 2001

<http://www.hpcf.upr.edu/prstp>

PREAMBLE

This document has been prepared by Puerto Rico’s Science and Technology Alliance, with broad participation of representatives from the Puerto Rico Manufacturers Association, the Puerto Rico Chamber of Commerce, Venture Capital groups, Technology Entrepreneurs, the public and private institutions of higher education, entrepreneurs, and the Puerto Rico Techno Economic Corridor, among others.

The conceptualization and design of the original draft was prepared by Dr. Joaquín Villamil, CEO of Estudios Técnicos, Inc., and Dr. Manuel Gómez, Vice President for Research and Academic Affairs of the University of Puerto Rico System.

Table of Contents

Introduction.....	1
I. Policy Statement	4
II. Why a Science & Technology Policy?.....	8
III.Lessons Learned from Other Experiences.....	11
IV.Objectives and Strategies.....	15
V. Managing the Implementation of the Policy	36
Footnotes and Glossary.....	43

Introduction

- **The adoption of a policy¹ on the development of Science and Technology (S&T) and its role in Puerto Rico’s economic future** should be a major component of any **economic development strategy**. Technology is increasingly seen as the driver of economic change in the global economy.
- Puerto Rico's **rate of economic growth had fallen to around 2.5% annually in the period of 1976 through 1993**, in contrast to a **growth rate above 6.0% in the sixties**. In the second half of the nineties, growth was not much better being surpassed by many of our peers and by the United States itself.
- **Puerto Rico's traditional competitive advantages had eroded over time**, for example our preferential access to the U.S. market, and new foundations for our competitiveness have to be established.
- Our **biggest strength is the high quality and educational level of our workforce**; this strength should form the **key for future economic growth** and the **promotion of new industries**.
- The importance of **science and technology in the new knowledge based economy** is widely recognized. This translates into the need to **stimulate the attraction to Puerto Rico of R & D and Science and Technology based industries** and the **promotion of home grown technology driven start-ups**.

FINAL VERSION – PUERTO RICO’S POLICY ON SCIENCE AND TECHNOLOGY

- The Government of Puerto Rico has established an Office of Science and Technology in the Department of Economic Development and Commerce and has committed to supporting various S&T initiatives.
- The government’s **policy in the area of Science and Technology** must adopt a **systemic² view** and establish a **general framework for the various components of the Science and Technology system (institutions of higher education, private firms, non-government organizations, and government)** to develop action plans in support of stated objectives.
- The Policy should **provide for the coordination with pertinent government agencies** which, although not directly related to Science and Technology, are key in Puerto Rico’s development efforts. Among these, the **Department of Economic Development and Commerce, the Puerto Rico Planning Board, the Puerto Rico Legislature, PRIDCO, the Education Department, the Economic Development Bank for Puerto Rico (EDB), and the Government Development Bank (GDB).**
- The Policy must recognize that the linkages **between basic scientific research and technological innovation are complex and are not necessarily sequential or linear.** In some instances, the process is science driven, while in others it may be market or technology driven.
- The **industrial and academic sectors understand** that they must act as full partners and that their **fundamental task is to create and implement a policy to increase the economic growth rate of Puerto Rico** and, at the same time, facilitate its

insertion into the global knowledge and technology driven economy, with **the government playing a supporting and nurturing role.**

- **This Policy, which has been developed by a task force on industry, commerce, venture capital, and the academic sectors, has based its recommendations on a thorough analysis of the experiences in a number of countries and the U.S. states which have been successful in this area.**

I. Policy Statement

- The Government of Puerto Rico is fully committed to developing Puerto Rico's capacity to innovate and to understand, produce and harness developments in Science and Technology for its economic development and social welfare. Substantial activity already exists in the science and technology field; the Policy on Science and Technology is aimed at focusing these efforts to achieve economic development.
- The Policy aims to accelerate growth in investment in R & D³ and other Science and Technology activities so that the proportion of GNP devoted to them will at least equal that of our competitors while recognizing the efforts in that direction made by Puerto Rico’s system of higher education. The target number should be to raise R&D activity in Puerto Rico within five years to 1% of the GNP⁴. Another objective is to double R&D funding from the federal and Puerto Rico governments within the next five years. Simultaneously, substantial private industry support for R & D has to be generated.
- The Policy aims to harness the S&T Enterprise⁵ so that the net contribution of S&T-related corporations to PR’s GNP increases over time.
- In order to achieve this, the Policy aims to promote alliances between Government, the private sector, and academia to deploy strategies and actions that will result in enhanced economic growth and better quality of life, better jobs, health, and environment. The Alliance will also promote and implement

measures that will enhance the understanding in the population at large of the role that science and technology play in economic development enhancing the quality of life and job creation.

- **The Policy seeks to nurture and facilitate the self-organization of clusters, start-ups, and multisectorial alliances and technology corridors. The success of these self-organized entities will be determined by market forces.**
- **Through the implementation of the policy, a substantial strengthening of Puerto Rico's Science and Technology Community's⁶ and its capabilities will be achieved by: enhancing individual firm's capacities; strengthening contribution to R&D, technology transfer (T²)⁷, and innovation⁸ that will result in economic development, improving the educational system, and promoting collaborative actions among the industrial and academic sectors.**
- **The policy recognizes that Science and Technology permeates modern life in its many manifestations and that it is not a separate set of activities limited to the academic sphere or R & D alone, but a systemic effort to create a strong S&T infrastructure that will promote and achieve innovation. In Puerto Rico's case, it is particularly important that strong links are developed between the innovation process and economic development.**
- **The policy builds upon Puerto Rico's strengths in the areas of education and research, its strong system of higher education, a strong managerial class, highly skilled human resources, strong financial institutions, and the existence**

of a broad industrial base that includes the following key sectors: pharmaceutical, electronics, medical devices, and emerging biotech industries.

- The Policy sees the retention and attraction of S&T talent and the strengthening of the innovation process as key strategies for its success. A major thrust will be the development of a system of incubators and the promotion and nurturing of high tech⁹ start-up companies¹⁰.
- The initiative to implement the policy will be led by the industrial, business, and academic sectors while the Government of Puerto Rico’s role will be to serve as a facilitator and provide the necessary policies and support needed to develop the science and technology infrastructure¹¹, the Science and Technology Community, and the innovation process.
- Puerto Rico can benefit and should build on the existing S&T, technology transfer (T²), and R&D federal programs to support the S&T Policy.
- Nothing less than a change in the prevailing culture’s vision and understanding of the role of the S&T Enterprise in enhancing economic competitiveness will be necessary for the Policy to succeed.
- This change in culture will require that the value of the S&T Enterprise for economic development and the need for harnessing new resources for its development be actively marketed¹².

- Because of the **complex, systemic and multisectorial nature** of the **S&T Policy**, its successful implementation requires a **well-defined entity** to **steer, incentivize, catalyze, and manage its implementation.**

II. Why a Science & Technology Policy?

- **Competitive conditions have changed over the years from an emphasis on low labor costs and other attractions--such as tax incentives--to a renewed interest in endogenous technological capabilities,** needed to meet the requirements of the global economy. A strong **capacity to manage the complexities of new technologies;** the **capability to understand, create, adapt, and apply new knowledge, promote effective technology transfer,** and provide the **educational and research infrastructure required** to sustain these capabilities are the new foundations of global competitiveness.
- It has become **commonplace to indicate that competition is now based on the capacity of an economy to produce goods that are technology and knowledge intensive.** Countries have become to a large extent **creators of their own competitive advantages** rather than passive beneficiaries of their given natural advantages. In becoming "creators" rather than "takers", countries must then assume a **more proactive role in developing these capabilities.**
- Business enterprises are faced with new conditions which require that the **technology dimension receives explicit attention.** These include the following: the **global nature of technological advance, shorter product life cycles,** promoting the **innovation cycle** and the development of new products and services, the accelerated rate at which new technologies are being introduced, fragmented markets, the need to shorten the time it takes to bring a product to

market, increasing integration between process and product technologies, and the increasing costs of developing new manufacturing technologies.

- The Policy on Science and Technology is an instrument to harness the capabilities of Government, **private enterprise, and the academic establishment** towards **more effective actions in the direction of improving Puerto Rico's capabilities in Science and Technology** and, thus, contribute to its competitiveness.
- The Policy recognizes **the complex and systemic nature of generating the conditions** for the improvement of S&T capabilities. It is a process which requires not only a profound knowledge of the **emerging technologies and their implications**, but also developing the **capacity to bring together the many institutions, both private and public**, the private business sector and the academic establishment. It requires not only the academic knowledge implicit in understanding technology and its implications, but also **innovation know-how and strong skills in strategy formulation, organization, and marketing**.
- It serves as an **indication of the importance attributed by Puerto Rico's government, academia, and private sector to Science and Technology** in the emerging global economic context, and as a **powerful instrument to generate a wide consensus on the matter**. This will, in turn, **promote the support for increasing resources** to activities that have received scant attention over the past thirty years in Puerto Rico and assure the continuity of these efforts.

- Finally, the Policy on Science and Technology is **essential to ensure that the required resources are allocated to enhance scientific and technological capabilities**. It also provides for assigning of **responsibilities and resources to an entity charged with the implementation of the Policy**, its **monitoring**, and the taking of the appropriate actions to assure that its **objectives are fulfilled**.

III. Lessons Learned from Other Experiences

- As part of the process of developing this policy statement, the industry/academia alliance reviewed the experiences of a number of countries. This section describes the lessons learned from this review.
- The major lesson to be learned from the successful experiences in the field of Science and Technology is that the Policy must adopt a systemic view; that is, it must consider that efforts related to Science and Technology must be dealt with in close integration with other economic development efforts. It must also incorporate an institutional dimension, issues related to management of the Science and Technology infrastructure, and the formation of networks and alliances, among sectors within the country or state and in a broader context.
- Policies in the area of science and technology must also provide a framework for system wide actions in the short, medium, and long term; and provide the tools for assuring that the various entities and components of the system— institutions of higher education, research organizations, private firms, for example--develop their own policies and actions within this framework.
- Another lesson is that there are no quick fixes. Developing scientific and technological capabilities requires time, the investment of resources by both government and the private sector, and the coordination of efforts in many areas. Singapore, for example, started its efforts in this area over two decades

ago when its competitive advantages still rested on low labor costs and labor intensive manufacturing.

- The identification of **key areas in which an opportunity exists to be globally competitive were identified**; and the **formation of industrial clusters**¹³ and the **creation of world class research facilities** in these areas were incentivized and promoted at universities and research institutions.
- **Puerto Rico has a unique inherent advantage in the fact that universities and start-up companies have access to a vast federal source of competitive R&D funds that can be harnessed by providing local matched or leveraging funds** to encourage faculty, students, and start-ups to do R&D in economically relevant areas.
- **Advanced graduate education** in these areas was found to be **an important component for progress in many of the countries examined**; thus, the importance of **nurturing and promoting the development of PhD’s and other advanced degrees in strategic fields** of relevance to Puerto Rico’s **economic development**.
- The cursory description of these experiences **suggests that Puerto Rico lags behind many countries and states** in terms not only of the **amounts invested**, but also with respect to **organizational arrangements**. Not only do we lag behind Singapore--which now, largely as a result of its policy, has a per capita income three times that of Puerto Rico--but we also lag behind Chile, an

economy with a much lower income per capita than ours. This suggests the need for strategies based on those areas in which results can be obtained in a relatively short time.

- Nevertheless, it is also true that **Puerto Rico benefits from the existence of federal programs in this area which have the potential of becoming a major component of Science and Technology initiatives.** In this sense, it is similar to **Arkansas and Montana, both of whom, like Puerto Rico, benefited from the NSF-EPSCOR¹⁴ program.**
- The experiences evaluated also point to the **importance of joint efforts by all components of the Science and Technology system.** Successful programs have **integrated government, private enterprise, and the universities in joint efforts.**
- For example: **Kansas (an EPSCoR State) has created a non-profit corporation called Kansas Technology Corporation (KTEC) that receives government funding and is run by a board constituted by representatives from industry and academia.** The mission of KTEC is to create, grow, and **expand Kansas enterprises through technological innovation and commercialization.** The **Corporation is the implementation arm of their S&T policy.**
- Policy must also identify the Science and Technology and economic development nexus and provide the **means to intervene in the appropriate manner at the indicated point in the continuum.** Thus, it has been generally accepted in the United States that intervention by the **Government** must be

centered on basic research, while in other countries, Singapore, for example, **intervention has focused on the application of technologies** and, still in others, on the **transfer of technology**. The decision has to be framed in the context of each economy's capabilities and needs.

- Finally, the adoption of a public policy on **Science and Technology must take**, as its **point of departure, society's priorities and needs**. In the case of Puerto Rico, this has been expressed as the **need to become more competitive in a global economic context** in which **knowledge-based activities** directly dependent on **Science and Technology** are increasingly important.

IV. Objectives and Strategies

From the policy statement at the beginning of this document, a number of objectives and strategies can be developed which are an integral part of the Policy on Science and Technology. The objectives and strategies incorporated in this section recognize the fact that short-term needs are known and that many necessary steps for meeting these needs are at hand. Puerto Rico must telescope advances in this area in order to make up for lost time.

The following five major objectives have been identified:

- A. Develop and Strengthen the Science and Technology Infrastructure**
- B. Improve the economy’s capabilities to develop, adopt, and adapt new technologies**
- C. Strengthen society's technological capabilities and its understanding of the role that science and technology plays in economic development**
- D. Strengthen the Scientific and Technology Community**
- E. Integrate activities in Science and Technology with economic development and competitiveness concerns**

- **Objective A-Develop and Strengthen the Science and Technology**

Infrastructure

Strategies:

- **Provide additional support for research facilities for all sectors involved in the innovation process.**
- **Develop the research facilities that are deemed necessary for Puerto Rico's economic development**, establishing new ones when necessary and strengthening the existing ones that are or could become competitive.
- **Leveraging federal R&D funds through co-funding and matching funds mechanisms, and promoting partnerships between industry and academia to harness R&D funds from federal agencies to stimulate economic development** and energize the innovation process, should be a **cornerstone of the S&T infrastructure building effort.**
- **Science parks, independent technology and R&D centers, industry related R&D centers, research institutions, and research institutes affiliated with higher education institutions should be considered as**

mechanisms to strengthen the Science and Technology infrastructure.

- **Promote effective integrated planning for the higher educational institutions, including both private and public institutions, in the area of Science and Technology.**
- **Promote the creation of consortia, the formation of industrial clusters, and adoption of regional consortia in order to achieve critical mass.**
- **The institutions of higher education are urged to promote collaborative programs among themselves and with private industry, as well as with universities and research institutions abroad. Joint ventures with off-Island universities could prove to be a powerful instrument for the transfer of technology; strengthening of research staff; and, generally, improving links with the global science and technology community.**
- **Puerto Rico should seek to become a regional hub for Science and Technology related activities in the wider Caribbean and Latin American region, including a greater role in the transfer of technology to the region.**

FINAL VERSION – PUERTO RICO’S POLICY ON SCIENCE AND TECHNOLOGY

- Develop a plan to **attract, retain, and repatriate science and technology talent to Puerto Rico** and provide them with a **nurturing environment to develop science and technology R&D institutes** and stimulate these human resources to develop entrepreneurial outlook and **participation in the formation of start-up companies.**
- Evaluate the **regulatory and legal framework to ascertain that it is compatible with the objective of strengthening Science and Technology.**
- This entails a review of **the legislation and fiscal policies which govern the higher education system** and making the necessary amendments to provide an environment conducive to making it a more effective actor in the area of Science and Technology and its contribution to economic development.
- Provide the **required legal framework for effective copyright and intellectual property regulations which stimulate R & D**, assuring the proper management of the regulations, providing incentives so that faculty and students engage in the generation and transfer of technologies, and that royalty funds flow both to the inventor and the institution enabling it to continue to fund research.
- Universities must adopt measures to attract and **retain academicians with entrepreneurial aptitudes within the academic community.**

Universities should act in an **entrepreneurial manner by establishing mechanisms and promoting the necessary legislative and regulatory changes that will permit faculty to become industrial entrepreneurs** within the university. This includes the creation of **university spin-off companies for the purpose of commercializing technologies and incubators for university entrepreneurs to move from the laboratory to the production stages in commercializing technologies.**

- Establish the means that will facilitate the **commercialization of R & D results through closer links between government, private firms, and the universities.** These efforts must be market driven; they must be assured of an existing or prospective market for the product at prices which assure profitability.
- New **financial instruments and institutions must be created** in the areas of seed and venture capital to generate new investment in Science and Technology related economic activities.
- Create a **regulatory environment and provide incentives** for the creation of **venture capital and start-up funds for start-up companies, particularly** for those in the **early stages of development.**
- **Federal program’s funds for S&T activity, R&D, and Technology Transfer (T²) must be harnessed** to support the **S&T Infrastructure.**

- **Objective B-Improve the Economy’s Capabilities to Develop, Adopt, and Adapt New Technologies**

Strategies:

- Generate an **appropriate incentive and regulatory structure** that will **stimulate increased R&D activity**, with potential impacts on the manufacturing, advanced services, and agricultural sectors.
- The current **R&D tax credit**, as designed, tends to **only benefit established firms** that can report net profits. **Tax legislation** will be proposed to **stimulate R&D activity** of local start-up firms by allowing them to sell **their R&D tax credit to firms or enterprises that report net profits**.
- **Firms will be encouraged** to establish links with **local universities in order to carry out R&D, through**, among others, the creation of programs aimed at **creating internships for university** and industry personnel in private firms and the universities, respectively, and **through industrial extension and incubator facilities**.

- Industries, businesses, and higher education institutions will be encouraged and incentivized to **develop intrapreneurship¹⁵** programs for **in-house product and process development** or the **creation of innovation pathways**.
- The formation of strategic **alliances between industries or clusters of industries**, and between **industries and academic institutions**, will be incentivized and facilitated for the **formation of virtual organizations¹⁶** to carry on **R&D, T², and other forms of innovation** that will result in **enhanced competitiveness and economic development**.
- Initiatives, such as those related to **providing venture capital**, will be **strengthened in order to promote the establishment** of emerging high **technology intensive start-up firms** that will **commercialize innovations**.
- A program--which will incorporate, **among other incentives, government leveraged grants and interest-free loans**--will be created to promote the **adoption and adaptation of new technologies by local firms**.
- A program to help **high tech start-up companies obtain federal SBIR¹⁷ and STTR¹⁸** funds will be developed to **finance the R&D that this type of company need to develop, adopt, or adapt technologies**

needed to develop new products or make the start-ups more competitive.

- The higher education institutions and industries will be encouraged to develop facilities, and the government **will provide PRIDCO facilities to serve as the site of a system of incubators**. Universities will be **incentivized to provide technical, scientific, marketing, and other business assistance to start-ups in incubators**. These incubators will have **access to R&D laboratories and prototyping facilities** that will be provided by academia and the **private sector**.
- Promote the adoption of state-of-the-art technologies **through industrial extension services**¹⁹.
- Government will **strengthen its existing programs** and make **available funds** designed to provide a **more effective means of promoting technology transfer**.
- PRIDCO’s promotional staff will be trained in the required skills needed to be effective in **promoting and marketing** technology transfer, in promoting the establishment of R&D activities in Puerto Rico, and the **development of start-up Science and Technology industries, recognizing that this entails different skills from those required of traditional promoters**.

FINAL VERSION – PUERTO RICO’S POLICY ON SCIENCE AND TECHNOLOGY

- To promote innovation and technology transfer, the industrial and academic sectors will identify areas of **competency in order to form S&T clusters**. The Government will create **incentives to promote the formation of these clusters** around the major existing and emerging industrial strengths of Puerto Rico.
- **The Department of Agriculture’s activities in R&D** and the pertinent **agricultural research and extension services** will be enhanced and steps taken to ensure that these activities respond to the objectives included in the **policy on Science and Technology**.
- Generate **conditions for firms to become learning organizations in the area of technology and technology commercialization**.
- As part of this policy, collaborative **efforts between private sector organizations, the universities, and the government** will be stimulated to provide support for firms in the various sectors in adapting to new conditions and to attract new core business.
- Promote the development of the **necessary competencies** needed to make **Puerto Rico competitive in the development of new products**, considered essential to obtain greater control of its competitive edge.
- The policy will create a favorable **environment for private sector organizations** to play a major role as **catalysts in promoting**

technology transfer and taking a proactive stance in meeting the challenges of emerging market conditions.

- Recognizing that technology transfer requires the **creation of networks which include "creating" and "adopting" firms**. Puerto Rico should **join existing regional and global networks with these objectives in mind**.
- **Concentrate efforts in those areas in which Puerto Rico has core competencies and, can develop these core competencies efficiently in a reasonable period of time**. Whenever possible, **the formation of clusters** of industries will be promoted to exploit the development potential of these core competencies.
- Puerto Rico's efforts in Science and Technology will focus on its need to be competitive in the **emerging global and regional context**.
- The **higher education system** must **build upon its capabilities, including its capacity to provide state of the art quality education, increase access to federal programs and funds** in the area of Science and Technology, and areas related to Puerto Rico’s **advanced and diversified industrial base**.
- Puerto Rico has produced a considerable **number of highly talented and well prepared scientists, engineers, MD’s, and business persons**

who have emigrated from Puerto Rico to the mainland and other countries seeking better opportunities to express their talent; and many of them have become successful entrepreneurs beyond the Island. Thus, Puerto Rico has a unique opportunity for bootstrapping its innovation process and the development of start-up companies by designing strategies that will encourage this large number of émigrés to relocate in Puerto Rico, and contribute to its economic development.

- **The best way to achieve technology transfer is through highly developed persons who already master the appropriate technology. Thus, Puerto Rico needs incentives and the development of a nurturing environment that will promote scientists, engineers, and entrepreneurs with the desired talent to relocate in Puerto Rico.**
- **An interactive website should be developed to serve as an electronic net to identify and engage the scientific, engineering, and entrepreneurial talent that Puerto Rico will need to enhance innovation, technology transfer, and the development of high tech start-ups in order to accelerate its economic development.**
- **Universities in Puerto Rico need to develop educational programs and curricula that will promote entrepreneurial skills and attitudes in the student population.**

- **Objective C-Strengthen Society's Technological Capabilities and Its Understanding of the Role that Science and Technology Plays in Economic Development**

Strategies:

- Improvements in the **educational system are required to ensure that the disciplines on which scientific and technological advancement depend**, including entrepreneurial skills, are given due weight in elementary, secondary and higher education.
- A thorough review of **curricula will be carried out** by the appropriate authorities in order to stimulate the study of S&T and to provide the basis for **enhancing Science and Technology content in the curriculum**. Although much progress has been achieved in educational programs (**for example, at the K-12 level, through the SSI²⁰ program**), efforts in this direction **need to be intensified with the objective of making** our population as literate and competent in science and mathematics as those of competing peer-group countries.

FINAL VERSION – PUERTO RICO’S POLICY ON SCIENCE AND TECHNOLOGY

- Information campaigns will be **started by the responsible entities** to communicate to the society at large the importance of **Science and Technology** in determining **Puerto Rico's future**.
- The educational system, from elementary school to the university level, should incorporate into the curriculum more **knowledge and awareness of the interdependence of science and technology** and **their relationship to social and economic progress**.
- The educational system must include, from elementary school to the university level, the **development of skills and know-how on the proficient use of informatics and telecommunications**. So that all students become **fluent in the use of information technologies**, Puerto Rico cannot permit the formation of a **digital divide among its citizens**.
- The **system of technological and vocational education must be recognized** as a separate component of the educational system with its own needs, its own links to the **economic sectors**, and its **separate clientele**. A **review of the existing vocational and technological education** will be commenced in order to **create the conditions necessary for making the system more effective in achieving Puerto Rico's economic development objectives**.

FINAL VERSION – PUERTO RICO’S POLICY ON SCIENCE AND TECHNOLOGY

- A broad consensus must be achieved among the leading **sectors of society that Science and Technology are important to Puerto Rico's future.**
- **Business, the Communication Industry, and Civic Organizations will be encouraged to participate** in the promotional efforts aimed at creating a **broad social consensus on the importance of Science and Technology.**
- A large **scale information and marketing campaign** should be started in order to create public **awareness of Science and Technology and its importance to enhance the quality of life and economic well being.** This includes: broadcasting in Spanish of programs in science and technology by local TV and radio stations, encouragement of science and technology journalism, and the public recognition through awards to those who have distinguished themselves in the area of science and technology and the dissemination of information about S&T.
- The ultimate goal of the S&T policy is to **achieve a fundamental cultural change in the way that society understands, values, and uses science and technology to promote innovation to enhance the quality of life and the economic well being.**

- **Objective D-Strengthen the Scientific and Technology Community**

Strategies:

- **A strong S&T Community is essential for the implementation of the S&T Policy.** Therefore, one of the key elements of this policy will be to implement strategies that will **significantly enhance the strength and capacities of its S&T community.**
- **Puerto Rico must establish a program to retain and attract scientific and technological talent.**
- **This will require that the appropriate conditions exist in the universities in order to provide an attractive and supportive environment for R&D. The absence of these conditions is what stimulates the brain drain of local scientists and engineers in the first place.**
- **It will also mean securing the resources to provide world class compensations that will make Puerto Rico attractive to scientists and engineers.** The labor market for these professions is truly global and Puerto Rico must compete, not only for investment, but also for human resources.
- **Universities are encouraged to establish collaborative efforts aimed at attracting such talent by the pooling of resources and the establishment of joint teaching and research activities, and shared research institutes that**

provide the underpinning for the establishment of science and technology industries.

- Promote the creation of **endowed professorial chairs, improvement of research facilities, and the establishment of research institutes** are three instruments to attract scientific talent to Puerto Rico.
- Create a **nurturing environment with the appropriate incentives to stimulate** the relocation of science and engineering talent to Puerto Rico as **entrepreneurs in the industrial high technology sector.**
- **Promote new tax laws that will stimulate donations and endowments to promote S&T infrastructure.**
- Develop a system of **incubators to attract and nurture budding entrepreneurs in the initial stages of the development of start-up companies.**
- Define allocation criteria for resources devoted to education that will assure that they are directed to those **areas in which it is felt that there is a need, for example:** graduate and undergraduate programs in the areas related to Science and Technology.

- The **Department of Education will be required to prepare a budget which specifically identifies resources devoted to Science and Technology educational areas.**
- The **higher educations institutions will be encouraged to prepare a budget in which funds assigned to S&T and R&D are clearly identified.** Such a budget will help them obtain funds from government sources, both local as well as federal, for this area.
- **Government, industry, and academia will join efforts to create Research Centers of Excellence** through the formation of **academic and industrial partnerships** that will serve to attract and retain world-class scientists and engineers.
- Graduate **level manufacturing engineering** programs should be initiated, and should be well funded. Likewise, there is a need for more technically oriented **graduate programs.**
- **Strategically create PhD’s and other advanced degrees and connect them synergistically with targeted research institutes in areas where Puerto Rico needs to develop key competencies that will allow it to compete in the global economy.** Examples of this are: Computational Sciences and Engineering degrees, CIT technologies, Medical Biotechnology, Plastic Mold Design, Manufacturing Technology, Materials Science, Medical

Centers, High Performance Computing, and Environmental Remediation, among others.

- PRIDCO will increase its **graduate scholarships program to educate PhD’s** in fields that are needed for Puerto Rico’s industrial development for which universities **do not have the infrastructure, resources, or critical mass needed to create the necessary graduate programs.**
- A **marketing campaign** should be developed with the assistance of the media to **create awareness of the existence of a strong and vibrant S&T Community** and its **contribution to Puerto Rico’s economic development** and the improvement of the **quality of life.**

- **Objective E-Integrate Activities in Science and Technology with Economic Development and Competitiveness Concerns**

Strategies:

- The Policy on Science and Technology is aimed at **achieving economic competitiveness and will be centered** on those activities directly related to **promoting economic development.**
- In view of the fact that economic competitiveness of nations and regions is increasingly a function of **their Science and Technology capabilities** and the importance of **Science and Technology industries in their economies, PRIDCO has to reconceptualize its promotional activities to account for this new reality.**
- **Criteria used in evaluating allocation of funds will take into account the direct relationship between Science and Technology activities and economic development.**
- **The technological capabilities, S&T human resources, and R&D capabilities will be actively marketed abroad by PRIDCO to attract and retain high tech companies.**

FINAL VERSION – PUERTO RICO’S POLICY ON SCIENCE AND TECHNOLOGY

- Puerto Rico's efforts will be centered on those areas in which the Island has **specific core competencies** or emerging needs.
- The development of **joint academia, industry, and government strategic planning** should be promoted to provide for diverse approaches that **include short term technology transfer** and longer term innovation and **product development**, as well as **new process technologies**.
- Assistance must be provided to **high tech start-up companies** and other **S&T related industries** to **develop the marketing know-how** that they need to become **net profit making operations**.
- Efforts will be centered on **the commercial applications of R & D results, development of new technologies, technology transfer, and applied research in strategic areas**. The policy will promote conditions for **attracting R&D based economic activity to Puerto Rico** and creating an **environment in which local technology related start-ups can thrive**.
- **Science and Technology** will receive the required priority in the budget allocation process.
- In recognition of the importance of Science and Technology for Puerto Rico’s economic development, a **well defined Science and Technology budget for the Commonwealth** should be developed.

- **Specific parameters must be devised that will permit the monitoring and evaluation of the implementation of the policy**, so as to enable corrective actions to be taken, such as:
 - benchmarking with other countries with respect to macrovariables:
 - net contribution of S&T related corporations to the GNP
 - percent of GNP attributed to high tech corporations
 - percentage of GNP devoted to R & D
 - number of S&T and high tech jobs created
 - number of incubated high tech start-ups
 - number of high tech start-ups that scale-up and generate net profits
 - number of patents to local inventors
 - measuring R & D investments from different sources and sectors
 - size and strength of the S&T Community
 - create an inventory of the available S&T infrastructure and measure its development

V. Managing the Implementation of the Policy

A. Rationale

Because of the complex systemic and multisectorial nature of the Science and Technology Policy, its successful implementation requires a well defined entity to steer, incentivize, catalyze, and manage its implementation. Furthermore, since the Policy needs short, medium, and long term strategies to harness S&T as a cornerstone of innovation and economic development, such an entity must have the staying power and stability to see the Policy through and, in an evolutionary manner, revise and update the Policy as the external challenges and opportunities for economic development change.

The proposed organizational entity must meet the following minimum criteria:

- The organizational **structure must be agile and able** to respond **quickly and flexibly** to **changing conditions** and **external opportunities** and **challenges**.
- The entity must **bring together the key players**--to wit: the industrial, business, professional and other non-governmental associations, and the academic sectors—into its fold and **work in a collegiate manner to promote and catalyze** the required **multisectorial alliances** that will be needed to implement the Policy.

- It should have the **capability and authority to assess the progress** of the Policy’s implementation, including **setting appropriate macro metrics and establishing benchmarks** that will be recognized and accepted by all sectors.
- It must have **sufficient high stature and command respect from the academic, service, manufacturing, and government sectors**. The government, in particular, will recognize its authority and prestige that will permit it to steer and **harness resources from the four sectors** to achieve the Policy goals and influence economic development policies and strategies.
- In view of the **complexity of its tasks** and the many economic, academic, and government entities with which it must interact, it should be structured in such a way that it can **work effectively and flexibly across sectorial boundaries** and **interact** with the **different government agencies**.
- It should serve as the **champion and advocate of S&T as a cornerstone of economic development in Puerto Rico** and be able to **effectively propose and influence legislation and policies needed** to facilitate the implementation of the Policy. As champion of the S&T Policy, it should be able to **function as the marketing agent to sell the importance of S&T for economic development** and to **enhance the quality of life**.

- The proposed entity should be **outside the normal government structures**, while **having access to government resources to catalyze the Policy** and **broker multisectorial alliances** to achieve the S&T goals.
- It should be capable of **providing continuity and sustainability** of strategies and efforts so that the Policy’s **medium and long-term goals can be achieved**.
- **As a non-profit corporation**, it must have the legal **authority to raise and receive funds, submit proposals to the federal and local government, contract and sell services, own property**, and have **financial interest in for-profit corporations**, as long as it is not the **majority owner of such corporations**.
- The **non-profit corporation will catalyze and promote resources** in such a way that the implementation of the S&T Policy **will never develop a significant dependence on Commonwealth funds** for its **implementation**.

B. Proposed Organizational Structure

Proposed organizational structure for the management and implementing the S&T Policy:

- **A non-profit Puerto Rico Science and Technology Corporation** should be created under the leadership of the incorporating partners from the industrial, business, and academic sectors to carry on strategic planning, coordinating different sources of funding—both local and federal—that will develop the S&T infrastructure, promote the formation of start-ups, and enhance technology transfer and the innovation process.
- The Corporation will have the name of **Corporation for Science and Technology Based Economic Development**.
- The mission of the Corporation will be to **implement the S&T Policy** and to forge the necessary alliances needed to harness S&T to the service of innovation, technology transfer, and economic development. It will also broker resources from the different sectors to achieve common policy goals.
- Major initiatives and strategies will be designed by the **Board and its consultants in a collegiate manner**. Once the Corporation defines key projects and initiatives, it will forge **multisectorial alliances** and incentivize the formation of clusters. The members participating in the alliances will agree to contribute or relocate resources to achieve common goals.

- The Government will contribute a fixed percentage of the Commonwealth budget that it will designate for developing and strengthening the S&T and R&D infrastructure, and promote technology transfer and innovation that will result in economic development. This budget will be managed by the Corporation for S&T Based Economic Development, under the direction of its Board. The funds derived from this source will be distributed or assigned by the Corporation solely on a competitive basis, following the principles of peer-reviewed grants. All government funds will be used only to achieve the full implementation of the policy.
- The Corporation will have the capacity and responsibility to raise funds and seek both private and federal funds, as well as local government funds, to achieve its mission. The Corporation will develop resource obtention strategies that will ensure that it will never have a significant dependence of Commonwealth funds for the achievement of its mission.
- The Corporation will have an external Advisory Board made up of world-class technologists, industrialists, business leaders, and academicians. The Advisory Board will assess the performance of the Corporation in its role as the implementer of the S&T Policy and advise the Board of the Corporation on management and organization issues.

FINAL VERSION – PUERTO RICO’S POLICY ON SCIENCE AND TECHNOLOGY

- **The Corporation will have a Board** of Directors named by the incorporating partners. The Board shall have members representing the R&D community, industrial and business sectors, and universities. These sectors shall constitute no less than two thirds of the Board’s members. The remaining third will be made up by ex-officio members from the following government entities: Department of Education, Department of Economic Development and Commerce, and Government Development Bank. The non ex-officio members from among its members will elect the Chairman of the Board. The Board will also appoint an executive director to manage the Corporation; this director will serve at the will of the Board. The director will appoint the necessary staff and hire the consultants that the Corporation may need with the approval of the Board.
- **The Corporation will be responsible for implementing, marketing, and revising the Policy, develop the metrics, and establish benchmarks for measuring progress in the implementation of the Policy.**
- **The Corporation will develop a coherent strategic plan** that makes optimal use of all available S&T and innovation resources both local and federal.
- **The Corporation will have the authority to obtain facilities, emit contracts, hire staff and consultants** for its operation, using no more than **10% of the Commonwealth budget** that it will receive in any given year

for this purpose. The remaining part of that budget **will be used to catalyze or incentivize strategies and projects** that will help achieve the Policy’s goals.

- **The Corporation will have the capacity to have minority shares or ownership of S&T corporations if, in doing so, it can materially advance the implementation of the S&T Policy.**
- **The Corporation will be a catalytic and nurturing agent for the formation of clusters, R&D lab, regional and multisectorial alliances, incubators, and other S&T corporations, but will not have the authority to exert any control on their development. Free market forces will be the sole arbiter of the success or failure of these corporations or any other S&T initiatives, alliances, or corporations that are developed in Puerto Rico.**

FOOTNOTES AND GLOSSARY

1. Policy: A plan or course of action, guiding principles and concepts intended to guide and influence decisions and actions needed to achieve an overarching goal. As used in this document, it is a broad blueprint to guide the harnessing of S&T with the purpose of promoting economic development and the improvement of the quality of life. The policy, as used here, is intended to delineate the scope and boundaries of specific strategic plans and decisions that will achieve the intended goals of the policy. For the implementation of specific actions, initiatives, or projects related to S&T and economic development, the policy will serve to provide the principles and concepts that will guide the specific implementation of the possible action plans that will make the policy’s multiple goals a reality. The policy proposed here is inherently systemic, thus every action plan has to be evaluated under the whole policy and not as unarticulated initiatives.
2. Systemic: Systemic is derived from “**system**”, which is a group of functionally interacting and interrelated elements forming a **complex whole**. Systems cannot be understood by breaking them into their elements and analyzing them as independent parts, since the interdependences and complexity of the whole is lost in this process (systems are much more than the simple sum of their elements). The Policy proposed here is truly systemic because the S&T

Enterprise is a truly complex system. For this reason, the Policy was conceptualized following the principles of “system’s thinking”, with emphasis being put on the functional interdependence, interactions, and feedbacks that exist between the system’s elements that are absolutely necessary to make the S&T • In order to achieve this, the Policy aims **to promote alliances between Government, the private sector, and academia to deploy strategies and actions** Enterprise functional. Using parts of the policy out of the context of the broad conceptualization of the policy will make this Policy dysfunctional.

3. R&D: Research and Development is defined in this policy to include the **full spectrum of innovation**, from basic/applied research, product development, and technology transfer to the point at which new products, processes, or services are ready for commercialization.
4. All developed nations measure longitudinally the level of R&D activity in all sectors of the economy and the academic sectors in terms of money directly invested in R&D as a percentage of the Gross National Product (GNP). The policy proposes that Puerto Rico does likewise and makes this number public and compares it with the investment in R&D of other nations.
5. Science and Technology Enterprise: Is the totality of all science and technology activities, infrastructure, facilities, and human resources that are responsible for generating S&T-related knowledge, technology transfer (T²), developing

competent human resources, and creating new products and processes that will result in economic activity.

6. Science and Technology Community: The Science and Technology Community is defined in this policy as the totality of university-trained scientists, engineers, and technologists in industry, academia, and the public sector, and the S&T culture that they engender. This community forms a subculture that is responsible for the generation of R&D, new technologies, technology transfer, and the development of new products, processes, and services that depend on an S&T knowledge base. The Community is also responsible for developing the S&T human resources that are needed to create technologically and scientifically literate citizens and to carry on all the other S&T roles defined in the Policy.
7. Technology Transfer (T²): T² is a key step of innovation. It is the totality of processes and knowledge transfer that are needed to adapt, adopt, and apply technology know-how and artifacts to create new products, processes, and services that will result in the improvement of the quality of life and economic development. Technology transfer can be achieved by purchasing intellectual property, converting R&D results into new technologies, or by recruiting scientists, engineers, or technologists with the appropriate technological knowledge or know-how.

FINAL VERSION – PUERTO RICO’S POLICY ON SCIENCE AND TECHNOLOGY

8. Innovation: Is defined in this policy as the process by which new knowledge or technologies are harnessed into new products, processes, or services that will result in enhanced quality of life or economic development. As such, it includes all the steps of the innovation processes, including basic and applied research, technology transfer, product and processes development, and commercialization.
9. High-tech Company: A high-tech company is in one of the following types of industries: biotech, computers, engineering, information technology, semiconductors, or telecommunications, either manufacturing or service; that has products with short life cycles, is based on innovation, invests heavily in research, and is knowledge-driven rather than manufacturing-driven.
10. Start-up Companies: Are businesses or companies that have recently started operations. Most start-ups commence operations as small business and, if they are technology driven, they have need for assistance in conducting R&D, innovation, technology transfer, product development, and commercialization. For this reason, their success depends on access to incubation facilities, links to universities, and access to early stage venture capital and government interest free loans.
11. Science and Technology Infrastructure: Is defined in this policy as Puerto Rico’s portfolio of human resources, laboratories, research institutes, informatics

resources, and equipment needed to conduct state of the art R&D, T², product processes and services development in order to carry on S&T innovation.

12. Marketing: Marketing is the societal process by which individuals and groups obtain what they need and want by creating, offering, and freely exchanging products and services of value with others.
13. Clusters: Cluster, as used in this Policy, is a group of similar or complementary industries, corporations, academic institutions, or laboratories that come together to achieve the common goal of enhancing their competitiveness and productivity. Clusters can form virtual organizations or other organizational arrangements to achieve common goals or to optimize their resources. Clusters can also serve as magnets to attract other complementary or similar organizations to develop specific competencies.
14. EPSCoR: Are federally sponsored programs at the following agencies: NSF, NIH, DOE, DOD, NASA, USDA, and EPA. The goal of these programs is to make States and U.S. jurisdictions that are less competitive in obtaining R&D funding from the federal government to develop their S&T and R&D infrastructure and human resources so that they become competitive with respect to other States. Puerto Rico has been considered an EPSCoR “State” since 1985 and, in 2000-2001, obtained more than \$18M for that year to build its R&D infrastructure in its universities.

15. Intrapreneurs: are defined as employees of industrial firms, business, and universities that act as entrepreneurs to develop innovation pathways and initiate the development of start-up companies within the firm or university, and later spin-off their products or companies as enterprises outside of their corporate structure.
16. Virtual Organizations: a virtual organization is an organization that is created through a strategic alliance of a group of firms and/or universities to create, adapt, and develop new technologies that cannot be done or are too expensive or time consuming to do individually by each member of the strategic alliance. Virtual organizations are usually delocalized in space and time.
17. SBIR: Federally sponsored programs, entitled: “Small Business Innovative Research”, with more than \$1.5 billions annually available to promote R&D, innovation, and technology adaption by small business, usually with the assistance of universities.
18. STTR: Federal programs that, like SBIR, stimulates R&D and innovation for start-ups and S&T related small business which requires the active participation of University-based scientists and engineers, and their research laboratories.

FINAL VERSION – PUERTO RICO’S POLICY ON SCIENCE AND TECHNOLOGY

19. Industrial Extension Services: Is a federally sponsored program run by the Department of Commerce (DC), through the “National Institute for Science and Technology” (NIST), that works in an analogous form to the Agricultural Experimental Stations, with the explicit goal of promoting technology transfer (T²) to promote economic development. The program puts special emphasis in promoting T² to small business and start-up firms.
20. PR-SSI: The Statewide Systemic Initiative (SSI) is a federal (NSF) program designed to reform schools in a systemic manner. Puerto Rico has reformed the science and mathematics curriculum and the teaching/learning culture of schools in order to enhance the learning of science and mathematics in more than 750 schools.