The Puerto Rico Life Sciences Road Map

Prepared by:
New Economy Strategies
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Goals of the Road Map

Over the years, the ebb and flow of the Puerto Rican economy has been influenced by conditions outside of its control as well as its own challenges and internal mindset. During the past several years, the emergence of a collective focus on science and technology as drivers of the Commonwealth’s economic, entrepreneurial, and societal future has sent a signal – both on and off the island - that these challenges and mindset require a new perspective and a new set of public policies. In addition, industry – especially the global pharmaceutical sector – has continued to ‘bet’ on Puerto Rico for its own future. With nearly $8 billion in new facilities under construction or in the planning phase with the equipment, information tools, and management necessary to maintain these manufacturing operations, it appears that Puerto Rico is in a second renaissance of technology-based economic development.

While greater emphasis has been given to science and technology, the role of academic institutions, industry investment beyond their own interests, and the development of a skilled workforce have increased awareness for public-private partnerships. These partnerships are typically market-oriented with a bent towards economic development and public policy in support of industry goals. In 2002, PRIDCO based an initial cluster activity on the communications and information technology industry throughout the island. This first attempt at organizing economic data and strategies around a cluster has appealed to a variety of stakeholders – the cluster approach recognizes a broader set of interests, includes a variety of institutions both public and private, and seeks to engage those that serve either internal markets or global export arenas.
Currently there is an opportunity present to develop a similar cluster approach for the health care cluster – a super-cluster of biotechnology, pharmaceutical manufacturing, medical devices, and health care operations and management. This objective of creating an inclusive cluster relationship among four different existing strengths is quite unique. For Puerto Rico to compete in the 21st century, it must not look for the ‘next big thing.’ The Commonwealth must be purposeful in its approach, strategic in its outlook, and innovative in drafting its competitive global market model.

While other states in the U.S., and nations throughout the world, are focusing on the life sciences, New Economy Strategies (NES) believes the timing is right for Puerto Rico to do likewise. As one of the oldest and respected locations for global manufacturing of pharmaceuticals, Puerto Rico is already positioned to take advantage of the emerging trends in the health care arena. If our approach, as outlined on the following pages, is to be successful and sustainable, we must remember one simple fact – it is not about the technology, it is about the benefits to society and mankind – creating positive economic and societal outcomes.

A major transformation is underway in the life science communities of science, technology, and health care delivery. Compelled by the rapidly increasing, overwhelming costs of health care in the U.S., several entities are forcing a discussion and debate as well as drawing investments towards connecting research and discovery with the delivery and distribution of medical and practitioner know-how. From shifts in the regulatory environment to insurer cost-cutting to venture capital tightening horizons, the U.S. is going through a chaotic transition that ends stovepipes of activity through integrated, multidisciplinary work and results-oriented collaboration. As noted in the following charts and graphs, the required reductions in health care delivery costs leading to a realignment of resources and knowledge is simply no longer an option – it is fast becoming an economic and societal necessity for continuing U.S. competitiveness and positive quality of life.
Executive Summary

As they stand today, Puerto Rico’s healthcare and Life Sciences clusters will soon hit a wall, in the form of competitive forces from U.S. and global industry and public policy. Unless the Commonwealth responds positively, aggressively, and intelligently to these global competitive forces in the public and private sectors, over the next five to seven years Puerto Rico will experience increased industry-specific problems, as well as the beginning of a long-term overall decline in Puerto Rico’s economic competitiveness. In order to resist sliding into economic irrelevance, Puerto Rico will need to concentrate on two goals:

1. **Achieving World-Class Status:** Stepping up to the Global Competition by Concentrating on Fundamental Actions

2. **Achieving Global Differentiation:** Taking Advantage of New Trends in Science, Technology, and Business to Strategically Position Puerto Rico in a World of Hubs and Nodes

The Road Map is designed to help Puerto Rico reach these goals, and in doing so, begin the next chapter in the Puerto Rico Innovation Story.

Strategic Commitments

Before forming the Hot Teams (small intensive working groups of Puerto Ricans with expertise in academia, industry, entrepreneurship, and the public sector), NES came together with key members of the community for a series of brain-storming sessions in order to develop Puerto Rico’s Targets of Opportunity. Recognizing the urgency of the situation, the participants worked quickly to set a time frame and to identify key actions to take within the six target areas. These actions then formed the core of the Hot Teams’ strategic commitments.

The Road Map process has led to agreement upon four strategic commitments:

1. A framework for a new business and economic development model
2. Taking action is not an option, it’s a necessity
3. Puerto Rico must focus its resources and efforts on a few key Next Steps
4. A collaborative, consensus-based, integrated strategy is necessary for sustainable implementation

Common to all four strategic commitments is the recognition that Puerto Rico needs to change direction in order to take advantage of the opportunities available in the 21st century innovation economy. The strategic commitments make it clear that Puerto Rico needs to agree upon and implement a bold new strategy, and that it needs to do so expeditiously.
As stated in the fourth strategic commitment, it is essential that the key players in Puerto Rico come to a consensus on the Road Map. They should view it as a guide and a starting point for agreeing upon and embarking upon Puerto Rico’s new strategic direction.

The below table lists the recommended actions in each of the six target areas for the short, medium, and long terms, as well as suggested performance metrics for measuring the implementation and efficacy of those actions.

<table>
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<th>Hot Team Subject Area</th>
<th>What actions do we envision ourselves taking in the…</th>
<th>…Short Term (6 - 18 months)</th>
<th>…Medium Term (19 - 36 months)</th>
<th>…Long Term (&gt; 3 years)</th>
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<tr>
<td>Clusters</td>
<td>• Building our Clusters</td>
<td>• Leveraging Relationships</td>
<td>• Exploiting Cluster</td>
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<td>• Finalizing Cluster Mapping</td>
<td>• Expanding our research</td>
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<td>Fully operational</td>
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<td>Innovation Lifecycle®</td>
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<td>Possible Metric</td>
<td>% Completion</td>
<td># of biotech projects</td>
<td># of patents</td>
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<td>Resident Expertise</td>
<td>• Consolidating our Resident Expertise</td>
<td>Promoting and Selling our</td>
<td>Establishing a World Class</td>
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<td>• Completing the Database of Knowledge</td>
<td>Resident Expertise and</td>
<td>position in two or three</td>
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<td>package offerings globally</td>
<td>areas of science and talent</td>
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<td>Possible Metric</td>
<td># of records</td>
<td># of contracts</td>
<td># of papers published</td>
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<td>Expatriate Network</td>
<td>• Building our Expatriate Network</td>
<td>• Nurturing our Expatriate</td>
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<td>• Assembling the network for action</td>
<td>Network Development</td>
<td>• Return on Investment</td>
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<td>activities in S&amp;T</td>
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<td>Possible Metric</td>
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<td># of participants</td>
<td># of participants</td>
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<td>Human Capital</td>
<td>• Strengthening our Human Capital</td>
<td>• Positioning our Skills</td>
<td>• Mastering the future of</td>
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<td>• Running platform programs in key skills</td>
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<td>• Integrating with定位</td>
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<td>positioning effort</td>
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<td>Strength of programs</td>
<td>Degree of integration</td>
<td>Average skill level</td>
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<td>• Building Brand Recognition</td>
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<td>• Integrating our message</td>
<td>• Creating a one-stop shop</td>
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<td>for promotion and access to</td>
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<td># of leads</td>
<td># of start-ups</td>
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In order for the Road Map to be successful, Puerto Rico must concentrate its efforts in two areas: Fundamental Actions, and Big Ideas.

**Fundamental Actions:**

There are fundamental issues which absolutely must be addressed if Puerto Rico is going to maintain its competitiveness in the global marketplace. These Fundamental Actions will form the foundation which is a prerequisite to building a sound and prosperous innovation-based economy. Five of the most critical Fundamental Actions are:

1. Create Strategies and Offices for Grant Management and Innovative Funding  
2. Make Significant Investments in Basic Research Teams and Facilities  
3. Create a Future Workforce Learning Resource Center  
5. Improve and Increase Marketing and Branding Efforts

**Big Ideas:**

In addition to shoring up the foundation of its innovation economy by concentrating on the fundamentals, Puerto Rico needs to have the confidence and the vision to think big. In order to carve out a place for itself in the global economy, and to meet the challenge posed by increasing competition from abroad, Puerto Rico will need to develop a few Big Ideas – three or four forward-looking thrusts in which Puerto Rico can concentrate its resources, which will help it differentiate itself from its global competitors. Three Big Ideas on which Puerto Rico should focus its attention are:

1. Creating a physical and virtual innovation zone  
2. Expanding upon clinical trials and clinical research  
3. Leveraging Puerto Rican Expertise in High-Tech Manufacturing

**Next Steps:**

The following Next Steps are recommended in order to effectively implement the recommendations of the Road Map and start Puerto Rico moving in a new strategic direction:

1. Design a digital portal for research, technology & skills to link expertise on and off the island  
2. Create a Puerto Rico science & technology global network  
3. Design a future workforce learning resource center  
4. Build a physical and virtual innovation zone around Puerto Rican hubs and nodes  
5. Build a research & commercialization center (technology transfer for Puerto Rico) and incubator  
6. Target the marketing and branding of Puerto Rican technology capabilities
Framework for Implementation – Our Approach and Process

The Road Map and corresponding implementation plan that we have defined is not one from a consultant’s folly – it is based on extensive and exhaustive data collection – both quantitative and qualitative. It has been a very inclusive process of engaging competing organizations, institutions, and interests around common scenarios and highest common denominators. Through interviews, surveys, and hard-data collection, the New Economy Strategies and QBS team was challenged to formulate a strategy and the corresponding tactics for implementation – a Road Map – on which the regional interests could immediately take action. Some of the relevant organizations and initiatives are listed below.

Figure 1 - Road Map Stakeholders

- Commonwealth Government
- Secretary of Commerce
- PRIDCO (NES fiscal client)
- INDUNIV (NES engagement partner)
- Puerto Rico Mfg Assoc
- Vision 2025 (A.T. Kearney)
- Initiative to Drive S&T Policy ($40M Centennial Fund from Commerce Dept to UPR)
- UNIVERSITIES
  - UPR System
  - SUAGM
  - Pontifical Catholic University
  - Polytechnic University
  - Ponce Medical School
  - Inter American University
- CLUSTER ASSOCIATIONS
  - Biotech
  - Pharmaceuticals
  - Health Care
  - Medical Devices
  - C&IT
- CHANGE AGENTS
  - New Coalition
  - Declaration of Economic Development Principles (S&T Innovation Public Policy)

KEY:
- Organizations / entities
- Initiatives
Roles and Responsibilities for Implementation

The third and most crucial step of the Hot Team process is the transition of actions agreed upon during the strategic process and proposed in the business plans. Each of the six Hot Teams must create Implementation Teams with champions, timelines, and resources to execute the strategic commitments. The Implementation Teams should be charged with executing respective elements of the Fundamental Actions, the Big Ideas, and the Next Steps.

The six selected targets of opportunity were:

- Continuously Updated Cluster Mapping so as to Engage Broader Stakeholders
- Resident Expertise in Pharma and Biotech Manufacturing and Facilities Management
- Expatriate Networks for Science and Technology
- Leveraging Existing Initiatives for Puerto Rican Healthcare
- Workforce, Skills, & Competencies
- Branding, Marketing, and Positioning as a Global Hub/Node

Based on interviews, surveys, and the Hot Team process, Puerto Ricans expressed reservations about the capacity for implementation; simply, a majority of individuals listed the historical pattern of starting but never completing initiatives. This concern raised a caution for New Economy Strategies to contemplate the next steps of implementation and execution as proof that the Road Map process could be proven successful only if very specific roles and responsibilities were agreed upon. Habits and patterns are often hard to change and thus there needs to be either an incentive or a penalty for the required next-step action items.

Incentivization of behavior includes both financial as well as societal reward – that individuals increasingly have access to the outcomes from their work and motivations; while those institutions and individuals who lack the confidence or the willingness to fulfill their agreed-upon task for launching and sustaining efforts around these action items are penalized. Financial reward incentives could include increased funding levels for certain milestones, the use of public or private resources to offset budgets and expenditures required for success but not counting those against existing budgets, and individual compensation bonuses and/or resources for programmatic objectives.

What is necessary more than any incentive is the reality of linking execution to outcomes and impact for the self-interest of individuals as well as their civic contributions to the Puerto Rican civic community. Celebrating success and highlighting on a regular basis activities is critical. Just as important is the reality or penalty for lack of action. Exclusion from future benefit, demonstrable score-keeping of participation and results, and other forms of public knowledge is sometimes considered to be harsh but frankly such behavior cannot be tolerated in the future of Puerto Rico’s strengthening of assets.
Fundamental Actions:

1. **Create Strategies and Offices for Improved Grant Management and Leveraging Innovative Funding:**

   Grant managers, offices of development or equivalent, representatives of the Federal Affairs Administration, and identified Puerto Ricans holding positions in the US federal government. Retain a highly regarded funding advisor to analyze not just federal dollar sources but global philanthropic, private sector and corporate investment opportunities.

2. **Make Significant Investments in Basic Research Teams and Facilities:**

   Presidents of all academic institutions conducting research, legislative members, and senior representative in the Governor’s office using the higher education alliance to advise on the establishment of a very specific inventory listing the key 10-12 research teams and the lead principal investigators critical for expanding resources if the team is already resident in Puerto Rico or determining what is necessary to attract the team to the Commonwealth. Note that the objectives of this implementation team is to produce the ‘ask’ or ‘order’ that then is provided to the Grant Management and Future Funding team for partnering on resource development. The key partner will be the Trust Fund.

3. **Create a Future Workforce Learning Resource Center:**

   Led by a special representative of the Governor’s office, establish a Workforce Continuum Team of high school, community college and technical school, four year institution, industry and the public workforce system. The Workforce Continuum will be responsible in reporting out within 90 days a newly constructed skills-competency delivery system in the top 5 areas of industry skill needs by key occupation codes and curricula.

4. **Create a Puerto Rico Science & Technology Global Network and Data Portal:**

   Leveraging the early launch of the PREST Network, complete the global inventory of the top 100 Puerto Ricans as a formalized Committee of 100 to participate in a January 2006 Summit on the Future of Puerto Rico’s Science, Technology, Commercialization. Establish in partnership with the Governor, Legislature, and a leading private sector/civic leader the first-ever Discovery Hall of Fame with five inductees every year. In turn, task the Committee of 100 with the design and execution of the Discovery Sabbatical Program that brings a minimum of ten researchers, principal investigators to Puerto Rico for a year-long research-teach-learn scenario. The Sabbatical Program should include a modest stipend as well as full coverage of expenses. The key partner will be the board of the Trust Fund.

5. **Improve and Increase Marketing and Branding Efforts:**
Formation of the Puerto Rico Science and Technology Branding Organization is necessary for the creation of a year-long global campaign that leverages the PREST Network, Committee of 100 and the Sabbatical Program as the underpinning for communicating the repositioning of the Commonwealth’s pursuit of an additional global theme in tandem of tourism. The Branding Organization should seek 10% of the annual budget from tourism and other inbound resources to coordinate and cooperate in the message for linking quality of life (arts, culture, golf, and the island-pace) with the opportunities for discovery in specific areas of science and technology. The Secretary of Commerce will be the key partner.

**Big Ideas:**

1. **Create a physical and virtual innovation zone:**

   It is now necessary to create a master, ten-year strategic infrastructure program that signals to the global science and technology community that Puerto Rico wishes to become not just a destination of choice for the expansion and attraction of industry and academic infrastructure investments, but also the Caribbean hub for commercialization and innovation. Utilizing the resources of PRIDCO as the key partner, a global RFP should be issued to identify the best resource for the design, formation, and initial execution of an-all commonwealth infrastructure scenario both in physical and digital form. Central to the initial results is the creation of a new Innovation Campus that expands upon the presence of the U.S. Food and Drug Administration by the recruitment of additional elements of critical life science infrastructure of the U.S. National Institutes of Health, the United Nations and World Health Organization, the OAS, the Inter-American Development Bank, and other resources for the first-ever regional Innovation Campus.

2. **Expand upon clinical trials and clinical research:**

   In turn, leveraging the creation of a Puerto Rico Comprehensive Cancer Center, research underway in chronic diseases, and the global distribution of Puerto Ricans in several key research-oriented communities in the US and beyond, creation of a Global Clinical Trial Research Organization is now necessary and viable. The Trust Fund, the universities, and the Governor’s Secretary of Health should form an interagency working group to identify, qualify and retain the services of a global industry partner for the design and management of a contract Clinical Trial Organization with a revenue plan that makes the CTO self-sustainable after 36 months. The Secretary of Health and INDUNIV should create a new non-profit holding company for the partnering arrangement. In turn, a commonwealth-wide Clinical Trials Liaison should be hired to serve as the Puerto Rico representative to co-manage and work with the entire health care delivery system on the island.

3. **Leverage Puerto Rican Expertise in High-Tech Manufacturing:**

   While initially concerned that Puerto Rico would export its world-class knowledge in High Technology Manufacturing, the reality is becoming clearer that the Asian-Pacific arena and
the European Community are fast organizing their own manufacturing programs that in less than five years could overshadow Puerto Rico’s past and current strong-hold. Simply, Puerto Rico has no choice but to create a global presence or risk losing forever its unique forty-year investment. Realizing too that Puerto Rico has not operated in a vacuum, many countries have begun to emulate the Puerto Rico financial and tax model. Therefore if Puerto Rico wishes to retain its strength, brand, and most importantly the opportunity to compete in manufacturing, it is critical to form the Governor’s Office of Global Manufacturing Innovation in partnership with INDUNIV and the Secretary of Commerce.

The Office of Global Manufacturing Innovation will be tasked with the creation of a ten-year plan to assist in the upgrade of local manufacturing facilities, equipment, and skill sets, the creation of a globally-recognized Center based on the current Process program, and launch of a Global Certification Program that signals “to succeed in global manufacturing, you must first pass through Puerto Rico.” This Global Certification Program will be headed by a corresponding globally recognized former plant manager from one of the large pharmaceutical, biotech firms as well as former FDA senior representative. The Program Director will be tasked with establishing 5 new programmatic nodes in key U.S. cities first so as to build the Puerto Rico model into a U.S. collaborative service. The Certification Program should include modules on design-construct-manage facilities, GMP and regulatory operations, logistics-distribution-fulfillment. The Certification Program Center should be based on the new Innovation Campus.

The Concentric Circles of Road Map Actions, Ideas, and Initiatives
The Approach to the Puerto Rico Road Map:

New Economy Strategies’ approach to accomplishing its objectives consists of three phases: in the first phase, a unique game plan is designed, tailor-made for the situation at hand. Collecting data, through interviews with important stakeholders, targeted surveys, and other methods allows NES to quickly identify the key issues and the key players who are eager to be onboard, provides invaluable access to the opinions of local experts, and helps with the assembly of the Project Advisory Group and Hot Teams, to get the dialogue flowing as soon as possible. In phase two the Hot Teams get underway, business plans are decided upon and the mechanisms for implementation are launched. Phase three involves wrapping up the planning of the projects, updating the data, and evaluating and monitoring progress for sustainable performance (see figure 2).

Figure 2 - Road Map Implementation

A process was designed to accelerate the data collection and analysis of Puerto Rico’s health care and life science competencies along a disciplined path (figure 3). Three phases were encouraged for mapping assets, identification of opportunities on which to target time and energies, and ultimately a means to launch sustainable implementation driven by academic and industry partnerships with government.
The work of the Hot Teams, INDUNIV and the consultants over the past year has substantiated what Puerto Ricans already knew – our asset base is strong and competitive but, given the current lack of an integrated strategic direction, it is not sustainable against long-term global trends. Bearing this in mind, the principal participants in the Road Map process have identified critical strategic commitments involving a handful of solutions and opportunities that will ensure the future of the Commonwealth economically and socially. The Road Map presents a Call to Action by several organizations and institutions to ensure success by focusing on results and immediate implementation.

**Data Collection:**

The data collected varies to a certain degree depending on the specific needs of the project in question, but there are some tools and research methods which are useful across the board. For example, NES conducts both qualitative (interviews with stakeholders and members of the community, and targeted surveys) and quantitative research. The research conducted on behalf of this engagement had several facets, as shown in the table below:
The intent for such a wide range of new data collection was to assist in distinguishing scientific, technological, and economic trends that would identify Puerto Rico’s target areas of opportunity. While NES could easily identify a range of targets through a simple interview process, narrowing the field into a handful that have the potential to compete in fierce global scientific and economic conditions required this comprehensive process. Further, NES gathered additional data only when current or previous sourced knowledge would not suffice for the examination and assessment. In turn, through the feedback from sixty stakeholders over informal gatherings, NES was able to refine the suggested targets and tactics required for creating globally competitive innovation ‘churn’ for the region.
An integral part of implementing the Road Map is the role of the Hot Teams. Comprised of 8-12 individuals representing key institutions, industry interests, entrepreneurs, venture capitalists, and resources for advancing priorities, the Hot Teams have created a business plan for implementation. In their meetings, the Hot Teams’ focused on results and on developing next steps through the prioritization of targets and must do actions. Target areas were identified through scientific and economic data collected, while ‘must do’ actions were determined using the qualitative data obtained during the interview and survey facets of this study. During Phase Two of this effort, the Hot Teams spent 90 days refining the targets and putting them to a ‘market test’ and determined the region’s ability to exploit these opportunities to compete in the global marketplace.

Completion of hard data collection and analysis – that is, (1) tracking federal and private sector dollar flow, (2) studying industry patterns and trends, (3) analyzing patent and licensing activity, and (4) reviewing regional venture investments – coupled with the interviews and surveys, allowed New Economy Strategies to determine specific target areas of opportunity that offer unique advantages for the Puerto Rico.

Each of the seven opportunities can be categorized in different ways - from cutting edge product developments, to value-added services and activities, to mechanisms for medical breakthroughs – however, all require the engagement and connectivity of people and institutions across the region. Similarly, each target area will have a myriad of regional impacts and outcomes, including increased employment in the region. New vendors, suppliers, service providers, and related companies will emerge as will a variety of measurable economic consequences and intangibles such as enhanced relationship building and leveraging of existing knowledge.

In previous engagements, NES has found that individuals are willing to commit their time and energies when the pace is focused, fast, and efficient. Therefore, we encourage the formation of a Puerto Rican Innovation Network to utilize the Hot Teams’ results for each of the seven targets to coordinate disparate activities, resources, and knowledge into a coherent set of strategies for implementation. Hot Teams were comprised of 8-12 individuals representing the key institutions, industry interests, entrepreneurs, and resources for advancing priorities and a ‘business plan’ on which to complete implementation. One challenge identified in the interview and survey process was Puerto Rico’s inability to complete tasks and bring closure to the planning process. Figure 4 below details the precise flow of the work for each Hot Team, the desired results of each work session, and the expectations for action and implementation.
Strategic Commitments:

- Create: What Puerto Rico must do to be viewed globally as an innovative location
- Define: Strategic commitments as bold statements of action and completion
- Identify and engage: All existing organizations, institutions, and individuals working towards a similar strategic commitment

Business Plan:

- Develop: Succinct two page business plan – identify requirements, determine expectations for resources and name champions to lead implementation
- Identify and characterize: Resources – time, money and reputation – necessary for success
- Attach: Milestones and timelines to actions
- Articulate: What the impact and outcomes mean for the region by 2010

Review and Implementation Plan:

- Review: Mapping of existing entities to determine key players for success and plan for launch, as well as to identify critical gaps that need to be filled
- Design: Implementation plan that is actionable, sustainable and measurable
- Identify: Five to ten vital performance metrics that will hold the region’s “feet to the fire”
- SMART Process: Simple, Measurable, Actionable, Responsible parties, Timeline
The Hot Teams have sought to prioritize all the possible actions into 3-5 areas that will accelerate results for Puerto Rico’s competitiveness and innovation within the technology sector. These 3-5 areas include further refinement of the targets into actionable strategies including increasing federal funding, attracting the best minds in research and commercialization within the targets, and the gathering of all infrastructure and know-how into a more efficient and effective process of engagement. The Hot Teams also considered the performance metrics by which progress can be measured. In doing so, the Hot Teams strove to come up with metrics which are tailored to the specific goals, not just metrics such as such as employment or wage levels that are easily identified but which lack specificity.

The Hot Teams considered several other elements that leverage the targets:

- **Overarching Opportunities Linked to Day-to-Day Operations and Roles:** It was important for the Hot Teams to take each of the situations through an examination of day-to-day operations and roles, in order to translate actions into real-time events and impacts on institutional activities, not just theoretical ideas and plans.

- **Bringing Opportunities and ‘Regional Technology Business Plans’ together to connect the dots, raise visibility and credibility, and encourage partnering to complete:** The Hot Teams used their entrepreneurial knowledge to design business plans that employ three principles:
  1. inventory assets and their interrelationships
  2. raise the visibility and credibility of existing initiatives and efforts that require greater attention for success, and
  3. encourage partnering with often-competing institutions and individuals that see highest common purpose through collaboration.

- **Using the Cluster Analysis, link company development to end-users and value chains:** It was necessary to make an inventory of the requirements for potential employees and skill-talent characteristics and found commonalities as well as unique threads of competencies in both academic and private industry and to develop programs and forums on emerging opportunities and products with a focus on the role of product development in the cluster opportunities. The Hot Teams had to consider potential products that could be developed within the clusters and targets of opportunities as the focal point for bringing together end-users and value chains. This approach has an additional impact on regional economic development strategies – if done with purpose, identification of value chains serves to focus the resources for recruitment, relocation, expansion and other marketing tactics to build the next generation of companies and enterprises.
Performance Metrics: How will we know what success is?

Puerto Rico has had successful performance metrics in the past, including the number of jobs created, the amount of wealth created, rises in the quality of life, and the expansion and attraction of global corporate facilities.

The Life Sciences community, the citizenry, and the government all have a stake in coming up with specific metrics that drive sustainable action and realistic outcomes. Successful performance metrics for the 21st century will be those that foster accountability. Metrics identified during the process of creating the Road Map include:

**Goal:** Creating an innovation environment from fundamental actions that ensure Puerto Rico produces a baseline of competitive strengths which will compare favorably to other life science regions around the world.

**Metrics:**

- The increase in relevant workforce skills and competencies
- The number and quality of translational research and discovery facilities
- The number of world-class principal investigators performing cutting-edge research in Puerto Rico
- The number and quality of new linkages between academia and industry for sharing and capitalizing on know-how.
- The return on investment.
- The number of patents
- The amount of spending on research and development.
About New Economy Strategies and QBS

New Economy Strategies (NES) is a national consulting firm based in Washington, D.C. with a strong focus and proven track record on implementing technology-based economic development strategies. Collectively our team has more than 60 years of experience working on the national, state and regional level. Some of these engagements include: Austin, Greater Philadelphia, Kansas City, San Antonio, Arizona, Tennessee, Texas, and Puerto Rico. The NES team has also advised a diverse group of stakeholders such as governors, CEOs, university chancellors and presidents, entrepreneurs, researchers, scientists, economic and workforce developers, and civic leaders.

Through this wealth of experience, we have identified two key elements of a successful project. First, the NES team takes the time to carry out in-depth case studies and craft tailor-made strategies – avoiding the “one size fits all” trap that is unfortunately common in the economic development consulting field. Second, NES has established a process for engaging leadership that ensures the recommendations are implemented – avoiding the dusty, shelf-sitting report epidemic.

In addressing these key elements, NES has established specific and clear objectives:

- Generate New Understanding: collect data, create new information tools, and conduct analysis with a single goal of spurring action, not paralysis;
- Accelerate the Results: facilitate an implementation process through our “hot team” process that quickly moves the client from reports to results; and
- Focus on the Future: make the complex simple by focusing leadership and resources (time, reputation, money) on 3-5 critical steps that will transform the state/region’s economic future.

NES augments its capabilities by leveraging a network of over twenty experts in the fields of research and development, infrastructure, capital formation, workforce and skill development, university-industry partnerships, entrepreneurial management, and economic analysis of cluster growth. Additionally, NES tracks 40 U.S. regions and 17 global regions where technology and innovation are drivers of the economy. This quarterly tracking follows a number of key metrics and identifies emerging trends influencing regional tactics for industry clustering, and overall regional competitiveness. Please visit www.new-econ.com for more information.

Quality for Business Services Inc. (QBS)

QBS is a quality multi-service team committed to an inter-disciplinary and professional approach for dealing with Quality, Human Resources, Organizational Culture and Change Management Problems. Please visit www.qbsteam.com for more information.
Flowchart Outlining Report Structure

Goals of the Road Map

Executive Summary

Framework for Implementation – Our Approach and Process

The Puerto Rican Innovation Story

Building on Strengths – An historical Perspective of the Puerto Rican Economy

An Island in Transition – The Current State of the Puerto Rican Economy

Global Trends in Science & Technology – Looking to the Future

Regional Competition in the United States

Global Competition

Findings

Quantitative Findings

Qualitative Findings

Patent Activity

Federal Funding

Interviews

Surveys

SWOT Analysis

Example of Strengths

Example of Weaknesses

Examples of Opportunities

Examples of Threats

Aging Population

Workforce/Talent Base

Venture Capital

Hubs & Nodes

Industry Clusters

Innovation Networks

Socioeconomic Problems

Declining Population/Brain Drain

Inadequate Commitment to R&D
Building on Strengths – An Historical Perspective of the Puerto Rican Economy

Puerto Rico has one of the most dynamic economies in the Caribbean region. A diverse industrial sector has far surpassed agriculture (which represents only 1% of GDP) as the primary locus of economic activity and income. Encouraged by duty-free access to the US and by tax incentives, US firms have invested heavily in Puerto Rico since the 1950s, when they were attracted to invest in the island by tax exemptions offered under “Operation Bootstrap.” Tourism has traditionally been an important source of income, although the tourism industry was negatively affected by the slowdown in the US economy from 2001 – 2003. Today tourism accounts for roughly 7% of Puerto Rico’s GNP, and 60,000 jobs.

The United States is by far Puerto Rico's chief trading partner. The leading exports include pharmaceuticals (some 50% of all U.S. prescription drugs), electronic and other machinery, chemicals, raw and refined sugar, and sugar products (rum, candy, molasses). Imports consist mainly of food products and consumer items. Although Puerto Rico is no longer dependent on one crop (sugar) and has the most diversified and powerful industrial economy in the Caribbean, heavy population and insufficient jobs have contributed to social and economic problems and to continued emigration.

Figure 5 - Puerto Rican GDP Composition by Sector, 2002

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1 CIA World Factbook
2 www.welcome.topuertorico.org/economy.shtml
“Industrialization by Invitation” – the economic development strategy of the last half century

Overall, Puerto Rico’s economic development strategy of the last fifty years, including Operation Bootstrap, was highly successful in certain areas, especially in industrialization and modernization. However, the benefits of economic development were uneven, and Puerto Rico remains plagued by poverty and high unemployment rates. Many Puerto Ricans were unable to successfully adapt to the violent changes that the economy underwent.

“In the 1950s, as the economy was engaged in the first phase of the transition from a monocrop agricultural system to an industrialized system, total employment contracted. The absorption of labor into the newly developed manufacturing sector fell behind the rate at which agricultural workers were being laid off. It was only after 1963 that a persistent employment expansion got underway. Under the momentum, spurred primarily by capital investment induced to enter the economy under the revisions in the Industrial Incentives Act, employment improved for a decade. Between 1963 and 1973, employment increased by an average of nearly 3% a year. During that time, the average rate of unemployment dropped to just over 12.5%—as an average, it was still unsatisfactory,”

--1979 report by the U.S. Department of Commerce
Primarily agricultural, rural, and poor, Puerto Rico’s main exports in the first half of the twentieth century were sugar cane, tobacco, and coffee. Intensive industrialization, however, transformed the Puerto Rican economy within a generation – GNP grew by 6% annually from 1948 to 1974, and GDP per capita tripled between 1950 and 1970.3 As shown in figure 6 (summarized below in English), Puerto Rico’s strategy for growth during the period of industrialization – to export manufactured goods to the mainland U.S. – was based on four elements:

1. Openness – as a part of the United States, Puerto Rico enjoys most of the economic benefits of a US state, including the free movement of people, and an exemption on tariffs and duties on goods and services.

2. Cheap labor – Puerto Rican wages were one quarter of mainland U.S. wages in the 50s, allowing manufacturers who set up operations there to substantially reduce their production costs.

3. Federal incentives and fiscal exemptions – federal tax exemptions for manufacturers such as the 931 and 936 codes, combined with federal grants for research and other activities was the heart of this strategy. Puerto Rico has also benefited significantly from federal transfer payments such as welfare assistance, which helps relieve part of the burden of Puerto Rico’s chronic poverty.

4. The uniqueness of Puerto Rico’s relationship with the mainland U.S. – although often indirect, the economic benefits of this relationship have been significant. For instance, the stability of the U.S. legal system, including protection of contracts, has made Puerto Rico a low-risk investment for U.S. companies. Puerto Rico also has benefited enormously from being immune to the severe currency fluctuations that periodically roil the economies of its Latin American neighbors.

3 United Nations CEPAL
Puerto Rico’s economy is much more flexible, diverse, and rapidly changing than it was in the 50s. Manufacturing, which at 42% of GDP is still the backbone of the economy, is being overtaken by the service sector (48% of GDP, plus another 9% of GDP in government), which is inherently more flexible and fluid. Because much of Puerto Rico’s manufacturing sector is high-tech, it will remain vibrant and a strong driver of growth for many years. But although it will be a long time before Puerto Rico truly becomes a post-industrial economy like the mainland U.S. (where services account for 80% of its GDP), it still needs to be aware of this evolution today so that it can prepare for the future. As its service sector grows, Puerto Rico should do more to encourage the export of its services, just as it has promoted the export of its manufactures.

Successful as it may have been, however, this economic strategy is no longer viable. Both the global economy and the Puerto Rican economy are very different in the 21st century, and as a consequence the first three of these four elements are losing their relevance:

1. As the U.S. continues to liberalize its trade policy, Puerto Rico’s free access to U.S. markets is becoming less exclusive.

2. Along with rising living standards have come rising wages. While still lower than in the U.S., the cost of labor in Puerto Rico is higher than in many of its Latin American and Asian competitors. The solution is for Puerto Rico to equip its workers with the best education, training, and technology possible, and concentrate on producing more sophisticated goods and services, so that they continue to be competitive. As Sergio
Marxuach, Director of Policy Development at the Center for the New Economy, a San Juan think tank, put it, “cheapest isn’t the only name of the game.”

3. The federal government has cut back on incentives to Puerto Rico, including removing the 936 tax break. And if Puerto Rico ever gains complete independence, benefits such as federal transfer payments would no longer be available either. Hiram Ramirez Rangel, the executive director of PRIDCO, has said that the phasing out of the tax breaks “[is] making us work harder on our business fundamentals. We have to do a better job of targeting companies in Europe and elsewhere.”

At any rate, these incentives have already served their purpose of creating a powerful industrial base which can serve as a springboard for the high-tech and knowledge-based economy of the future. Now Puerto Rico must learn to face global competition on a level playing field. “Having had 936 and the huge success of the manufacturing sector, we’ve grown too complacent. Having those structural connections allows you to slack off more than if you are in a sink-or-swim situation.” - Miguel Soto, Executive Director of the Center for the New Economy.

Puerto Rican leaders must also realize that it will not be possible to reproduce the incredible rate of growth that Puerto Rico experienced during the second half of the twentieth century – now that Puerto Rico is a mature economy (with a GDP per capita on par with many European countries) and has less catching-up to do, it will no longer be able to produce sustained growth rates as high as a developing country could. The opportunities for easy gains, such as the leap in productivity associated with urbanization and industrialization, are gone, and have been for some time. In fact, GNP has grown at a rate of only 2% annually since 1975. A realistic goal for future growth rates is to meet and exceed the growth rate in the mainland U.S. In this way Puerto Rico strive to narrow the gap in living standards between it and the mainland U.S.

Government and business leaders have recognized, belatedly, that the old model no longer applies, but although a loose consensus is emerging that changes in direction must be made, a coherent strategy has not been agreed upon. Partially, the problem is that a grand strategy like Operation Bootstrap that encompasses the entire economy and stretches over many years would not be as effective today, due both to the changing nature and increased speed of the global economy, and to transformations that Puerto Rico’s economy is undergoing.

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4 Griffiths, Frank. Canadian Press.
Global Trends in Science & Technology - Looking to the Future
Biotechnology – the International Scenario

While the “average” biotechnology company in almost any locale could be described as small, private, and unprofitable, several entities (namely in the U.S. and a few in Europe) are large corporate structures with products in the market generating billions in revenues and wielding the financial clout (for R&D, mergers and acquisitions) traditionally reserved for pharmaceutical players. For U.S.-based firms, this means more financial flexibility, more investment opportunities, and a more global outlook. For international biotech concerns, this means more chances for cross-border collaboration, a wider array of product development and financing options, and greater market entry opportunities via partnerships.

At the same time, the pharmaceutical industry is evolving to one dominated by an ever-smaller group of giant, global corporations that continue to merge with and/or acquire one another in an ongoing consolidation effort to create critical mass, reach key markets, enhance product pipelines, and deepen/broaden their in-house research capabilities. The significant growth in the size of participants in the closely-tied biotech and pharmaceutical segments is opening up new opportunities as outsourcing activities create demand for specialized laboratory and testing facilities, information technology providers, and other customized services.

In several countries, biotechnology has been anointed as one of the key priority areas on which a nation’s future overall economic success depends. In order to develop and/or enhance the critical mass of infrastructure required, countries have announced initiatives specifically focused on their domestic biotech sectors in amounts denominated in billions of dollars. Specifically, these amounts are directed at research programs, construction of facilities and related equipment, seed capital funds, promotion of technology transfer and commercialization operations, regional clustering programs, and related science and technology investments. Significant attention is being paid to ensure that invested funds are allocated in such a way as to promote R&D efforts related to specific products as well as enabling platform technologies and processes.
Regional Breakdown of Global Biotechnology Revenues, 2003
Total Revenues = $46.3 billion

- US: 77%
- Europe: 16%
- Canada: 4%
- Asia Pacific: 3%

Figure 9 - US, European, and Canadian Biotech

US, European & Canadian Biotech

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<th>US</th>
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<th>Canada</th>
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All numbers 2002 year-end unless otherwise noted

Source: Burrrill & Company; E&Y; Peter Winter, Canadian Biotech News
Structural changes

Many of the countries studied are undergoing significant reforms in regulatory and structural areas that, heretofore, have acted as barriers to advanced development in their domestic biotech sectors. Recent legislative and policy changes in this area include the ability for researchers and innovators to retain some level of ownership in the intellectual property they create as well as allowing these same researchers to form and retain equity stakes in commercial endeavors deriving from their discoveries/innovations. Additional reforms facilitate university-industry collaborations and for-profit joint ventures.

Figure 10 - The Evolving 21st Century Biotech Industry
Hot topics & Issues

Almost every activity going on today with respect to biotechnology is in some way related to genomics and related fields (e.g. proteomics, gene therapy). Hundreds of genomes have now been successfully mapped including those of the human being, a mouse, several types of bacteria, and the mosquito responsible for spreading malaria in sub-Saharan Africa, the puffer fish, and several plants. With this newfound information, novel therapeutic and diagnostic breakthroughs are emerging and almost every country involved with biotech has some level of research and infrastructure dedicated to the genomics field. The study of genomics is probably the premier example of the convergence between the biotech and infotech worlds as massive computing and processing power is required in the DNA sequencing process.

Not surprisingly, much of the efforts in the global biotechnology community are focused on treating, detecting and/or preventing human disease. Top research areas include cancer, AIDS, neurological disorders, heart disease and diabetes.

While the human disease and genomics areas of biotechnology get considerable headlines, it is surprising to many how advanced, and how common, the field of agricultural biotech has become. Transgenic crops, resistant to environmental stresses such as weather and insects, have now existed for more than a decade. In fact, significant cropland in the U.S. is farmed utilizing genetically engineered/modified plants, fertilizers and seeds. The widespread production and subsequent exporting of these crops has caused concern, particularly in Europe, regarding the safety of the food supply and long term ramifications of consuming genetically altered food products.

Another area of controversy and public debate surrounds the use of embryonic stem cells. Currently, political, religious, and bioethics groups are trying to control what they see as harmful exploitation of stem cells which hold significant promise with respect to regenerative therapies and tissue engineering. U.S. President Bush recently announced limitations on stem cell research programs with only 78 stem cell lines worldwide meeting eligibility criteria for U.S. federal funding. Of those 78 lines, 51 were either developed by foreign institutions and/or foreign institutions retain the intellectual property rights associated with the lines. For example, China, Hong Kong, and the United Kingdom have all committed millions in funding to create cell banks with thousands of stem cell lines, assuring lines for every human histocompatibility group.

Another area receiving significant attention from the international biotech community is the utilization and development of nanotechnology. Several applications are the focus of substantial research including drug delivery and diagnostic technologies.
Regional Competition in the United States

The enormous potential of the life science sector has not been lost on those interested in economic returns within communities and regions. After 25 years of watching the infant biotechnology industry mature, and having witnessed the success of vital clusters developed in other industries, regions worldwide are coming up with their own strategies to acquire — and maintain — a major piece of the healthcare industry pie.

Figure 11 - The Life Sciences Economic Cluster

Russ DeVol of the Milken Institute notes:

“Although discoveries in biotechnology/bioscience will benefit the entire human race, there is a different kind of race underway - one to determine where the new industries will cluster. The economic consequences will likely be immense. The pool of high paying, equity-owning knowledge workers that those industries will attract, and the supplier infrastructure that develops around them, promise significant wealth creation for the winning regions.”

According to the Biotechnology Industry Association (BIO), all fifty states now have technology-based economic development initiatives, while forty states are specifically targeting the biosciences for economic development. This growing interest in cluster development comes at a time when many major universities are stepping up efforts to profit from campus-spawned initiatives. University-linked venture capital funds, business parks or incubators and other business development aid are commonplace in this competitive arena. Sometimes these efforts pay off; often they don’t.

Figure 13 - North American Biotechnology Companies by State and Province

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6 Biotechnology Industry Organization: State Bioscience Initiatives 2004

INDUNIV and PRIDCO
Just as it is possible for states or regions to jump ahead in the race to become leaders in the New Economy, so it is also possible for states or regions already in leadership positions to fall behind. Complacency is the enemy of innovation and growth - the moment that leading regions begin to get too comfortable, they risk losing their edge over the competition. The troubles experienced by the state of New York are a case in point.

New York State has lost many of its university-based spin-off firms: of the 14 companies formed around technologies developed at the Cold Spring Harbor Laboratory since 1983, only four are located in that state. In 1999 alone, New York lost the $376 million that the other ten companies spent on operations and capital improvements, plus an estimated $458 million that would have been generated by their presence and that of their employees. Additionally, 9300 jobs would have been required locally to service and supply those companies and their workers.7

In its 1998 report titled “How New York Lost the Life Sciences,” the New York Academy of Sciences explained that a lack of a purposeful strategy to support research and development among several world-class patient and health care institutions. But New York in a few short years has invested heavily in centers of excellence and regions – and through its NYSTAR program has put the state back on track for holding on to its people and intellectual property for greater economic and health benefit.

### Key Life Sciences Trends and Cluster Implications

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<th>Key Life Sciences Trends:</th>
<th>Cluster Implications:</th>
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<tbody>
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<td>• Maturing Biotechnology Business Models</td>
<td>• Increasing demand for manufacturing and commercial capabilities</td>
</tr>
<tr>
<td>• Developing technologies in Life Sciences</td>
<td>• Creation of new opportunity with convergence of IT and biotechnology</td>
</tr>
<tr>
<td>• Emerging personalized healthcare model</td>
<td>• Need to address global markets to find profitable scale of patient population</td>
</tr>
<tr>
<td>• Rising cost of healthcare</td>
<td>• Pressure to improve the cost and efficiency of drug development</td>
</tr>
<tr>
<td>• Change in funding model</td>
<td>• Need for creative capital solutions and understanding of biotechnology model</td>
</tr>
<tr>
<td>• Changing regulatory environment</td>
<td>• Converging global regulatory standards and emphasis on IP protection</td>
</tr>
<tr>
<td>• Growing public interest in the ethics of Life Sciences</td>
<td>• Risk of public unwillingness to accept certain technologies and applications</td>
</tr>
<tr>
<td>• Increasing competition from other regions</td>
<td>• Competition for capital, resources, IP</td>
</tr>
<tr>
<td>• Expanding international scope of Puerto Rican companies</td>
<td>• Opportunity in new global markets</td>
</tr>
</tbody>
</table>

New Economy Strategies has scanned and tracked 40 regions in the U.S. where the life sciences are a driver of the economy. The data suggests that a concentration is occurring in a handful of regions – primarily Boston, Seattle, San Francisco, San Diego and Research Triangle Park, North Carolina. These regions have developed a pipeline of strengths for the creation of targeted chemical compounds and materials leading to new drug discoveries and products. While each of these regions has their own unique characteristics and culture, common among the five are the mechanisms by which ideas move from bench to market in a rather constant and smooth progression.

But as noted in earlier observations, the BioEconomy is not just focused on drug development. Some regions in the U.S. are becoming known for medical devices, nanotechnology, bioinformatics and other emerging areas of competitiveness. Other regions are becoming known for their role in hosting and supporting outsourced aspects of research, testing and evaluation, and manufacturing. Particularly noteworthy because of their successful and concerted efforts to use the biosciences to drive growth are the activities of three US regions: Research Triangle Park, NC, San Diego, CA, and Kansas City, KS/MO. Each of these regions has confronted a similar challenge, but their approaches have varied according to their respective strengths and weaknesses. From Puerto Rico’s point of view, these regions serve as both as positive examples and as competitive threats.
Research Triangle Park, North Carolina

Research Triangle Park (RTP) is a highly successful R&D cluster based in the communities of Raleigh, Durham, and Chapel Hill, North Carolina, which was created in 1959 by leaders from business, academia and industry. RTP continues to be a leader in the biotech market by shifting from anchor life science tenants to entrepreneurial formation. For too many years the region attracted a solid base of corporate holdings but little “begetting” or spin-outs. Something clicked in the mid 1980s – the realization that the quality of life was quite good, the round of next opportunities based on mergers of a few corporations, the introduction of new venture capital, and a handful of start-ups beginning to produce results. Simply put, RTP and now Winston—Salem together have formed a critical mass for the future. Today, RTP has about 38,500 full-time employees, earning an average annual salary of $56,000\(^8\). 40% of RTP companies employ less than ten workers. Half of all employees in RTP work for multinational firms, and 99.4% of them work for R&D-related organizations. The unemployment rate for RTP in June, 2004 was 3.9%.

<table>
<thead>
<tr>
<th>Employment</th>
<th>Patents</th>
<th>Patent Growth</th>
<th>Medical Devices</th>
<th>Pharmaceuticals</th>
</tr>
</thead>
<tbody>
<tr>
<td>An estimated 38,500 full-time employees work in RTP (About 45,000 including contract employees)</td>
<td>There were 15.13 patents per 10,000 employees in Raleigh-Durham-Chapel Hill, NC -vs. - 6.3 for the US.</td>
<td>Patenting growth per year from 1990-98 in Raleigh-Durham-Chapel Hill, NC was 12.40% -vs. - 3.19% for the US.</td>
<td>5993 employment by trade cluster 1999</td>
<td>2356 employment by trade cluster 1999</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Infrastructure</th>
<th>Investment Source</th>
<th>University Role</th>
<th>Regional Collaboration</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piedmont Triad Research Park building new 100,000 sq. ft. includes both web laboratories and office space. Total Development surpasses 19 million square feet.</td>
<td>Wake Forest University School of Medicine, Winston-Salem State University $12 million in total Wake Forest and Virginia Tech Federal funds $15 million Total capital investment exceeds $2 billion</td>
<td>Wake Forest University School of Medicine and Winston-Salem State University significantly engaged Wake Forest providing Medical and Virginia Tech the Engineering UNC Charlotte and Western Carolina University</td>
<td>Wake Forest and Idealliance (a regional incubator and collaborative of public-private interests) Joint effort to create a School of Biomedical Engineering and Sciences. Two school teaming together in cutting-edge research on biomedical engineering</td>
<td>7,000 acre Research Triangle Park, home to 140 employers and about 42,000 full-time employees, is the largest research park in the U.S. North Carolina is among the nation's top five biotechnology states with more than 125 biotechnology companies and 65-contract research and testing companies employing more 30,000 people and generating annual revenues of more than $2 billion.</td>
</tr>
</tbody>
</table>

\(^8\) http://www.rtp.org
San Diego, California

San Diego has become one of the top benchmarks for how to develop a biotech cluster in a region. The 1980s drop in defense spending coupled with a statewide effort to increase scientific and technological commercialization seemed to spur regional leaders towards a plan that has proven more than successful. In turn, the engagement by the President of UCSD in making economic development a critical mission and the formation of CONNECT – a regional collaborative mechanism for linking research with commercialization – have become legend in the story of San Diego.

<table>
<thead>
<tr>
<th>Baselines</th>
<th>Employment</th>
<th>Patents</th>
<th>Patent Growth</th>
<th>Medical Devices</th>
<th>Pharmaceuticals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total 1999 employment in San Diego, CA was 1,015,773, which was 0.92% of national employment.</td>
<td>There were 17.37 patents per 10,000 employees in San Diego, CA -vs- 6.3 for the US.</td>
<td>Patenting growth per year from 1990-98 in San Diego, CA was 9.38% -vs- 3.19% for the US.</td>
<td>10548 employment by trade cluster 1999</td>
<td>1373 employment by trade cluster 1999</td>
<td></td>
</tr>
</tbody>
</table>

| Infrastructure | Transformed 105,000 sq. ft. of former Mission Bay Hospital into San Diego Science Center for biotech |
| Investment Source | Private funds Phase 3 Properties $16 million in total. Department of Defense, Office of Naval Research $5.2 million over two years |
| University Role | San Diego State University and University of California San Diego is apart of collaboration to help make it cost-effective to commercialize technology |
| Regional Collaboration | Center of Commercialization of Advanced Technology (CCAT). Designed to provide a cost-effective and comprehensive approach to commercialization of technological advances from academia, private industry, and the government to meet problems of national importance. Joint effort between UCSD CONNECT, UCSD Jacobs School of Engineering, SDSU's College of Business Administration and Entrepreneur Management Center, San Diego's SPAWAR Systems Center, and ORINCON Industries. |
| Metric | Since 1985 Connect has helped launch 650 companies, which have raised $4 billion in venture capital and corporate sponsorships. Last year alone, 180 high tech companies came into being with Connect's help assistance, and raised $150 million in capital. In 1997, the last year the federal economic census was taken; San Diego had 27,299 people employed in life-science research and development, or 3% of its work force. And employment in the cluster is estimated to have grown by 17% since then, according to trade group Biocom/San Diego. San Diego |
| -- 26,491 employees |
| -- 499 companies |
| -- 18 universities/nonprofit research centers |
Kansas City, Kansas/Missouri

With a significant existing level of entrepreneurial interests, Kansas City has turned its attention to life science firm formation. After purposeful review of its science and academic institutional capacity, regional leaders engaged in a strategic process that leveraged prior activities of KTECH and other similar entrepreneurial management and capital formation initiatives.

<table>
<thead>
<tr>
<th>Baselines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment</td>
</tr>
<tr>
<td>Total 1999 employment in Kansas City, MO-KS was 865,967, which was 0.78% of national employment.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stowers Institute is built on 10 acres, 600,000 square feet of research, administrative and support space -- was completed in November 2000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Investment Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Stowers Institute building $200 million, Stowers gift of $1.1 billion in total, The Life Science Institute was started with $100 million and will be financed by more than $20 million per year from tobacco money. Kansas City Area Development Council, a business-led economic-development group, is trying to raise $300 million through state funds and foundation grants to build new facilities, hire researchers and develop a program to find commercial applications for research</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>University Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stowers Institute has many ties to University of Health Sciences, University of Kansas Medical Center, University of Missouri-Kansas City</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Regional Collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stowers Institute is stakeholder in the Life Sciences Institute, Inc. Other stakeholders include Midwest Research Institute, The University of Kansas, The University of Missouri-Kansas City, The University of Health Sciences, The University of Kansas Medical Center, Children's Mercy Hospitals and Clinics, and Saint Luke's Hospital of Kansas City. The Life Sciences Institute, Inc. is a collaborative effort to build Kansas City into one of the nation's top ten areas in life sciences research and development.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,250 life science firms in the state, accounting for 170,000 direct jobs, and indirectly supporting another 266,000 jobs. Income derived directly or indirectly from life sciences industry total more than $16 billion. The average salary of an employee in this industry is $38,000 per year, much higher than state's average per-capita income of slightly more than $27,000. Overall, the life sciences have contributed a staggering $23 billion to Missouri's economy, or 13.5 percent of the GSP.</td>
</tr>
</tbody>
</table>
### Targets of Opportunity:

- **Priority Assigned to Target of Opportunity by Government**
- **Progress Attained in Achieving Target of Opportunity by Government**

<table>
<thead>
<tr>
<th>Targets of Opportunity</th>
<th>Cluster Mapping &amp; Engaging Broader Stakeholders</th>
<th>Resident Expertise in Pharmaceuticals &amp; Biotechnology</th>
<th>PR Global Science &amp; Technology Networks</th>
<th>Leveraging Existing Initiatives</th>
<th>Workforce, Skills, &amp; Competencies</th>
<th>Branding &amp; Marketing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Government</strong></td>
<td>Priority Assigned</td>
<td>Progress Attained</td>
<td>Priority Assigned</td>
<td>Progress Attained</td>
<td>Priority Assigned</td>
<td>Progress Attained</td>
</tr>
<tr>
<td>Puerto Rico</td>
<td>••</td>
<td>✓✓</td>
<td>•••</td>
<td>✓✓✓</td>
<td>••</td>
<td>✓✓</td>
</tr>
<tr>
<td>Research Triangle Park</td>
<td>•••••</td>
<td>✓✓✓✓</td>
<td>••</td>
<td>✓✓✓</td>
<td>•</td>
<td>✓✓</td>
</tr>
<tr>
<td>San Diego</td>
<td>•••••</td>
<td>✓✓✓✓</td>
<td>••••</td>
<td>✓✓✓</td>
<td>•</td>
<td>✓✓</td>
</tr>
<tr>
<td>Kansas City</td>
<td>•••••</td>
<td>✓✓✓✓</td>
<td>••••</td>
<td>✓✓✓</td>
<td>•</td>
<td>✓✓</td>
</tr>
</tbody>
</table>

**Priority Assigned:**
- • = not a priority,
- •• = low priority,
- ••• = medium priority,
- •••• = high priority,
- ••••• = top priority

**Progress Attained:**
- ✓ = not started,
- ✓✓ = little progress,
- ✓✓✓ = moderate progress,
- ✓✓✓✓ = significant progress,
- ✓✓✓✓✓ = goal accomplished

This metric shows how much of a priority Puerto Rico’s competitors have placed on the areas which we have identified as Puerto Rico’s Targets of Opportunity, and how much progress they have made in these areas to date. It is clear from this crosscut of the competitive environment that Puerto Rico has significant progress to make in many areas.
Global Competition*

The possibilities for growth in the new economy are virtually unlimited. Biotechnology is such a vast, complex, and still largely uncharted frontier, that it is not possible for any one country or region to be the authoritative leader in all of its aspects. Any country or region in the world is free to develop its own niche expertise, based on the unique assets that it brings to the table. If a country has the vision, and it able to muster the resources, both internal and external, it can create the necessary critical mass of innovation and become a serious global contender. The other side of this coin, however, is that the potential competition in the new economy is virtually unlimited.

Figure 15 - World Leaders in Biotechnology are already Realizing Economic Gains xv

Because Puerto Rico’s economy is so dependent upon the mainland US (which buys over 90% of Puerto Rican exports), Puerto Rico is in direct competition with US states and regions, many of which are better-organized, better-funded, and more tightly focused on achieving breakthroughs in the new economy. In addition, Puerto Rico faces tough international competition from countries as diverse as Singapore and Ireland, both of which have well-funded, forward-looking strategies designed to re-fashion their economies as global leaders in the new innovation and knowledge-based industries.

* For a complete survey of the global competitive environment, see Appendix C
Of all the potential competitors in the world, however, a few countries stand out as being especially important to Puerto Rico’s future in the new economy. In addition to the US regions surveyed above, NES has chosen six international locations against which Puerto Rico should benchmark its performance: Brazil, Canada, Ireland, Mexico, Singapore, and Taiwan. Each of these countries is unique, and each was chosen because of its specific individual importance to the Puerto Rican economy. However, it is also true that many of these countries share common elements, and it is useful to briefly examine some basic statistical data, to help put the country surveys into context, and to get a better idea of where Puerto Rico stands amongst her competitors.

There are three tiers of population visible in this graph, with Puerto Rico, Ireland, and Singapore all at around four million inhabitants, Taiwan and Canada in the middle tier, and Mexico and Brazil clearly being in a different tier with well over 100 million inhabitants each. From an economist’s point of view, however, all four of the island nations on this graph would be considered “small countries,” a designation which has more to do with their respective power in the international marketplace (are they price-makers or price-takers?) than with their geographic size or population. This distinction is significant because “small countries” must follow different strategies for economic development than “large countries.”

Figure 17 serves to give a very rough idea of what the standards of living are in these six countries, and how they stack up against Puerto Rico*. GDP per capita, although it doesn’t account for important factors such as wealth distribution, is a useful tool to tell roughly how much a country has at its disposal, in terms of monetary resources, for each of its citizens. Investment in R&D, for example, is heavily dependent upon GDP per capita, because countries with a low GDP per capita are often forced to forgo investing in R&D (i.e., investing in the country’s future) to pay for pressing social welfare needs today. Less-

*Because of Puerto Rico’s unique political status as a commonwealth associated with the US (it is neither an independent country nor a US state), GDP per capita figures should not be considered to be perfectly analogous to similar figures in foreign countries.
developed countries can’t be blamed for making these decisions, but unfortunately it means that they will have a more difficult time breaking out of the cycle of poverty in which they often find themselves, at least unless they can attract investment from abroad to compensate for the lack of domestic capital resources.

**Figure 17 - GDP Per Capita in Competitor Countries in US $ (PPP)**

![GDP Per Capita Graph]

Because GDP isn’t the whole picture, however, it is useful to consider infant mortality rates, life expectancies, and other statistics which indicate the level of a population’s well-being when analyzing living standards. These two statistics comment indirectly on the level of poverty, disease, and nutrition in a country, as well as on the quality of a country’s system of healthcare.

**Figure 18 - Infant Mortality Rate in Competitor Countries (deaths per 1,000 births)**

![Infant Mortality Rate Graph]
The unemployment rate, perhaps more so than other statistics, acts as a barometer for the socio-economic well-being of a country. Puerto Rico’s high unemployment rate, which has persisted over decades, is an alarm bell telling us that Puerto Rico’s economy is in a fundamental disequilibrium. In addition to aggravating social ills, high unemployment acts as a brake on economic growth, because instead of being given an opportunity to add value to the economy, the unemployed subtract from the total welfare. Approached from another point of view, unemployed workers are potentially productive resources which are going idle. Puerto Rico’s unemployment rate would be even higher, however, had so many Puerto Ricans not chosen to move to the mainland US to find work. Puerto Rico has traditionally relied upon migration to compensate for the lack of economic opportunity on the island, but this hurts Puerto Rico over the long run, since often the brightest, most ambitious, and best-trained workers are the ones who leave – exactly the people that Puerto Rico needs to stay.
Figure 21 highlights how dependent Puerto Rico is upon the mainland US economy. This graph illustrates the erosion, due to increasing global trade liberalization, of one of Puerto Rico’s traditional advantages – free access to US markets. As trade barriers continue to shrink (America is currently discussing a free trade agreement with Taiwan), Puerto Rico will have to increase its competitiveness or risk being left behind.

Internet usage, as shown in figure 22, is useful as an informal yardstick measuring the extent to which a country is involved in the new economy. As in so many areas, Puerto Rico finds itself in a position which is clearly ahead of its Latin American neighbors, but also clearly behind where it needs to be in order to compete with the more highly-developed and technologically-advanced countries of Asia, Europe, and North America.
# The Puerto Rico Life Sciences Road Map

**April 2005**

## Targets of Opportunity:

- Priority Assigned to Target of Opportunity by Government
- Progress Attained in Achieving Target of Opportunity by Government

<table>
<thead>
<tr>
<th>Targets of Opportunity</th>
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<th>Workforce, Skills, &amp; Competencies</th>
<th>Branding &amp; Marketing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Puerto Rico</td>
<td>**</td>
<td>✓✓✓✓</td>
<td>***</td>
<td>✓✓✓</td>
<td>★</td>
<td>✓✓✓✓</td>
</tr>
<tr>
<td>Brazil</td>
<td>★★★</td>
<td>✓✓✓</td>
<td>★★★</td>
<td>✓✓</td>
<td>★★</td>
<td>✓✓✓</td>
</tr>
<tr>
<td>Canada</td>
<td>★★★★</td>
<td>✓✓✓✓✓</td>
<td>★★★★</td>
<td>✓✓✓✓</td>
<td>★★★★</td>
<td>✓✓✓✓</td>
</tr>
<tr>
<td>Ireland</td>
<td>★★</td>
<td>✓✓✓</td>
<td>★★★★</td>
<td>✓✓✓</td>
<td>★★</td>
<td>✓✓✓</td>
</tr>
<tr>
<td>Mexico</td>
<td>★</td>
<td>✓✓✓</td>
<td>★★★★</td>
<td>✓✓✓</td>
<td>★★</td>
<td>✓✓✓</td>
</tr>
<tr>
<td>Singapore</td>
<td>★★</td>
<td>✓✓✓</td>
<td>★★★★</td>
<td>✓✓✓</td>
<td>★★</td>
<td>✓✓✓</td>
</tr>
<tr>
<td>Taiwan</td>
<td>★★</td>
<td>✓✓✓</td>
<td>★★★★</td>
<td>✓✓✓</td>
<td>★★</td>
<td>✓✓✓</td>
</tr>
</tbody>
</table>

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- ✓✓✓✓✓ = goal accomplished

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Quantitative Findings: Patent Activity*

Another integral part of the data collection and analysis portion of this process was a comprehensive analysis of Puerto Rico’s patenting activity, including the number of patents and related citations, scientific and technology strength, and innovation speed. This analysis was conducted by CHI Research, Inc. of New Jersey.

*For the complete CHI Research, Inc. findings, see Appendix B

Findings:

There are relatively few patents invented in Puerto Rico – there were 238 in the 8-year period (121 in the last 4 years). The peak was in 1999 with 43. In Puerto Rico, patents come primarily from individuals and from the manufacturing facilities of large companies. There are a few highly cited patents invented in Puerto Rico but no real blockbusters. Figure 23 shows the annual output of patents invented in Puerto Rico, from 1996 - 2003.

Figure 23 - Annual Count of US Patents with Puerto Rican Inventors, 1996 – 2003
The table below shows the top assignees obtaining patents in Puerto Rico. Note that many of the patents invented in Puerto Rico are not assigned to companies or universities but are obtained by individuals. This is rather unusual (for example in New York individuals only have a small percentage of patents, with most going to large corporations like IBM). Other than individuals, top assignees include the University of Puerto Rico, GE, the Commonwealth of Puerto Rico, Gaymar Industries and then a number of smaller patenters. It may be surprising to see patents from GE and Gaymar, but both companies have manufacturing facilities in Puerto Rico.\footnote{CHI Research, Inc.}

**Figure 24 - Top Assignees of Patents Invented in Puerto Rico, 1996 – 2003**

<table>
<thead>
<tr>
<th># of Patents, 1996-2003</th>
<th>Assignee</th>
</tr>
</thead>
<tbody>
<tr>
<td>115</td>
<td>Individual Inventor/Unassigned</td>
</tr>
<tr>
<td>18</td>
<td>University of Puerto Rico</td>
</tr>
<tr>
<td>12</td>
<td>General Electric Co</td>
</tr>
<tr>
<td>9</td>
<td>Commonwealth of Puerto Rico</td>
</tr>
<tr>
<td>5</td>
<td>Gaymar Industries, Inc.</td>
</tr>
<tr>
<td>4</td>
<td>Aventis S.A.</td>
</tr>
<tr>
<td>4</td>
<td>Hewlett-Packard Company</td>
</tr>
<tr>
<td>4</td>
<td>Monsanto Co</td>
</tr>
<tr>
<td>3</td>
<td>Sepracor, Inc.</td>
</tr>
<tr>
<td>3</td>
<td>Johnson &amp; Johnson</td>
</tr>
<tr>
<td>3</td>
<td>Stryker Corp</td>
</tr>
<tr>
<td>65</td>
<td>All Others</td>
</tr>
</tbody>
</table>

The top five technology categories for Puerto Rican patents from 1996 – 2003 were:\footnote{CHI Research, Inc.}

1.) miscellaneous manufacturing (29 patents),
2.) chemicals (19 patents),
3.) medical equipment (18 patents),
4.) electrical appliances & components (14 patents), and
5.) pharmaceuticals (12 patents)
Patent activity seems to be on the increase in Puerto Rico, and Puerto Rico has an advantage over its Latin American neighbors when its smaller population is taken into consideration (Puerto Rico had 3.1 patents per million inhabitants in 2001, whereas Chile had 1 per million inhabitants, Mexico had 0.8 per million inhabitants, and Brazil had 0.7 per million inhabitants).\(^{11}\) However, Puerto Rico is not on the same level of patent activity as its European and Asian competitors (Ireland had 43.6 patents per million inhabitants and Singapore had 73.6 patents per million inhabitants).\(^{12}\)

The table below shows key patent statistics in the United States and some of Puerto Rico’s main competitor nations.

**Figure 25 - Patent Applications and Grants in Competitor Countries**

<table>
<thead>
<tr>
<th>Patent Applications and Grants in Selected Puerto Rican Competitors and the USA* xxv</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Applications for patents filed by:</strong></td>
<td><strong>Grants of patents to:</strong></td>
</tr>
<tr>
<td><strong>Residents</strong></td>
<td><strong>Non-residents</strong></td>
</tr>
<tr>
<td>Brazil</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>6 521</td>
</tr>
<tr>
<td>1992</td>
<td>2 121</td>
</tr>
<tr>
<td>1982</td>
<td>2 116</td>
</tr>
<tr>
<td>Ireland</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>1 255</td>
</tr>
<tr>
<td>1992</td>
<td>788</td>
</tr>
<tr>
<td>1982</td>
<td>434</td>
</tr>
<tr>
<td>Canada</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>5 934</td>
</tr>
<tr>
<td>1992</td>
<td>3 208</td>
</tr>
<tr>
<td>1982</td>
<td>1 936</td>
</tr>
<tr>
<td>Singapore</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>511</td>
</tr>
<tr>
<td>1992</td>
<td>N/A</td>
</tr>
<tr>
<td>1982</td>
<td>N/A</td>
</tr>
<tr>
<td>Mexico</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>627</td>
</tr>
<tr>
<td>1992</td>
<td>565</td>
</tr>
<tr>
<td>1982</td>
<td>526</td>
</tr>
<tr>
<td>USA</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>198 339</td>
</tr>
<tr>
<td>1992</td>
<td>94 017</td>
</tr>
<tr>
<td>1982</td>
<td>63 316</td>
</tr>
</tbody>
</table>

* Data were unavailable for Taiwan

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\(^{11}\) A.T. Kearney

\(^{12}\) A.T. Kearney
Quantitative Findings: Federal Funding

RAND RaDiUS Data

As we collected interview responses, our hard data collection produced supporting knowledge and some invaluable insights on federal funding of research in Puerto Rico. Tracking the federal dollar flow identifies national trends, determines the region’s relative position, and detects areas that have the potential to build critical mass in the region. RAND RaDiUS captures every federal research grant award across 23 federal departments and agencies, including the Defense Advanced Research Projects Agency (DARPA), Advanced Technology Program (ATP), and Small Business Innovation Research (SBIR) funds.

RaDiUS tracks the entire federal R&D funding portfolio on the individual award and task level, which allows for the flexibility of customizing the data aggregation into specific geographic regions of interest. These analyses provide summary pictures of all regional performers of federally funded R&D activities, not just the R&D that is taking place at regional research universities. By analyzing funding patterns from SBIR awards, along with the regional R&D funding patterns, one also can begin to understand the technology commercialization process taking place in a region.

* The RAND RaDiUS data sets detail where specific research is happening in our region. It is the most detailed information that we found to hunt out where federal dollars are really going and what federal agencies are actually playing a role in our region. And it also gave us an indication of significant gaps or opportunities. For instance we found out that there is just as much plant science research going on in our region as compared to the region we all thought was receiving the majority of those funds. If your region is not getting down to the baseline of your research funding distributions, you just do not know what is actually happening or could happen.

- Dr. Mary Walshok, UCSD CONNECT

* For a complete copy of the RAND RaDiUS data, see Appendix A

° RaDiUS doesn’t capture principle investigators that aren’t originally funded, however – all the reason to use the data to construct a new conversation and localized data gathering.
Puerto Rico received almost $60 million in federal R&D funding in 2003, a drop from the previous year. Nonetheless, the overall trend over the past decade shows moderate growth.

Figure 27 shows that federal funding to Puerto Rico comes predominantly from five different federal agencies (the Department of Health and Human Services, the National Science...
Foundation, the Department of Agriculture, NASA, and the Commerce Department), and that the Department of Health and Human Services (at $325 million, or more than half of the total) far outweighs the other agencies in providing R&D funding to the island. Figure 28 (below) shows a gradual upward trend in HHS funding to Puerto Rico over the past decade.

Figure 28 - Trends in Unclassified R&D Funding to Puerto Rico by Agency, 1993 – 2003

Figure 29 - Trends in Unclassified R&D Funding to Puerto Rico by Agency, 1993 – 2003
As shown in figure 30, federal R&D funding to Puerto Rico is dominated by the Life Science and Biotech industries ($332 million), with Agricultural Science, ‘Other S&T,’ and ‘Other’ as the next most important sectors. Investment in the other tech sectors is negligible.
Figure 31 shows that while investment in Life Science and Biotech has risen over the past decade, investment in Agricultural Science, while second-highest, has fallen dramatically.

As evident in figure 32, the vast majority of federal funding is directed at public universities, with the rest going to private universities and the Commonwealth and local governments. Funds to non-profits, businesses, and individuals are negligible.
Figure 33 shows that federal R&D funds to universities increased over the past decade, while those allocated to Commonwealth or local governments decreased over the same period.

**Figure 34 - Unclassified R&D Funding to Puerto Rico in Life Sciences, 1993 – 2003**

Federal R&D funding for the Life Science and Biotech sectors in Puerto Rico originates almost entirely (98%) from the Department of Health and Human Services, a trend which has increased over the past decade.

**Figure 35 - Unclassified R&D Funding to Puerto Rico in Life Sciences, 1993 – 2003**
Within the umbrella of the National Institutes of Health, the majority of federal R&D funding in Puerto Rico over the past decade has come from six institutes: the National Institute of General Medical Sciences, the National Center for Research Resources, the National Institute of Allergy and Infectious Diseases, the National Institute of Mental Health, the National Institute of Neurological Disorders and Stroke, and the National Institute on Drug Abuse. Federal funding from the remaining National Institutes of Health, including the National Cancer Institute, was negligible.
Qualitative Findings

Interviews*

NES determined, at the outset, that individuals and institutions within and beyond the region could provide valuable insight, knowledge, and anecdotes about Puerto Rico’s competitiveness and innovation process in technology. Over 60 interviews were conducted to understand the strengths and weaknesses in the scientific, technological, and entrepreneurial assets and mindsets.

**Interview Highlights:**

“Analyze all the strategic plans for economic development prepared for different administrations. Evaluate the two initiatives with the higher probabilities for success and make them happen. We continue ‘spinning our wheels’ with the same ideas or suggestions with no significant success stories to share with the rest of the world.” - Interview participant

“People at management levels need to get out of their comfort zone, and demonstrate with their actions a willingness approach to make things happen. More sense of urgency, more character leadership.” - Interview participant

“I would focus on creating a Center for Innovation and Technology that would be entrusted with the development of a fully integrated strategy and plan to define and implement the a new economic model for Puerto Rico based on converting Puerto Rico into a global leader in science and technology in 10 years. The organization would be lead by a proven business leader and would be funded with government funds.” - Interview participant

* For a sample of interview questions, see Appendix F

INDUNIV and PRIDCO
Surveys

Regional Mindset Survey*

NES developed a tool to gauge perceptions and values placed on the entrepreneurial and innovation cycle within Puerto Rico. Of the 1101 Puerto Rican professionals invited to take the survey, 472 participated for a 43% participation rate. Through the survey, NES sought to measure and identify ways to close the gaps in what limits the region’s capacity to advance ideas from the bench to the market. The survey also provides a set of key actions and recommendations from which a new regional model of collaboration could be found that links and leverages programs at academic research institutions, the private and public sector, and entrepreneurial interests.

Key Findings:

The survey brought to light many gaps in the infrastructure supporting Puerto Rican businesses. When asked whether or not they were satisfied with Puerto Rico’s business support services, survey respondents painted a positive picture of the banking, accounting, legal, internet, and telecom services. However, all other business support services fared poorly, especially economic development services (29% satisfaction), strategic management (46% satisfaction), and university/institutional technology transfer (37% satisfaction). There was also clearly a lack of satisfaction with Puerto Rico’s recruiting services (53% satisfaction), marketing and branding efforts (52% satisfaction), and trade & professional associations (54% satisfaction).

<table>
<thead>
<tr>
<th>Question #7: Please indicate your the level of your satisfaction with the following regional business support services as they relate to technology and life science businesses:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional business support service</td>
</tr>
<tr>
<td>Banking</td>
</tr>
<tr>
<td>Accounting</td>
</tr>
<tr>
<td>Legal</td>
</tr>
<tr>
<td>Strategic management</td>
</tr>
<tr>
<td>Recruiting</td>
</tr>
<tr>
<td>Marketing/branding</td>
</tr>
<tr>
<td>Trade &amp; professional associations</td>
</tr>
<tr>
<td>University / institutional technology transfer</td>
</tr>
<tr>
<td>Economic development services</td>
</tr>
<tr>
<td>Specialized infrastructure, facilities, and equipment suppliers</td>
</tr>
<tr>
<td>High speed internet access, telecom services, wireless access providers</td>
</tr>
</tbody>
</table>

* Response choices were very satisfied, satisfied, dissatisfied, very dissatisfied, not applicable

* To view the original survey in its entirety, see Appendix E
SWOT Analysis

By analyzing both the quantitative and qualitative data, NES was able to identify the major strengths and weaknesses of the Puerto Rican economy, as well as some of the more significant opportunities and threats that it faces. Some examples of the key strengths, weaknesses, opportunities, and threats are highlighted in the following pages.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resident expertise in pharmaceuticals</td>
<td>There is no central repository of data for Puerto Rico</td>
</tr>
<tr>
<td>Skilled and educated workforce</td>
<td>Venture Capital</td>
</tr>
<tr>
<td>Strong existing high-tech Life Sciences economy</td>
<td>Incubation/Research Parks</td>
</tr>
<tr>
<td>Special relationship with mainland US economy and government</td>
<td>Proof of Concept Testing</td>
</tr>
<tr>
<td>Attractive quality of life and climate</td>
<td>Licenses</td>
</tr>
<tr>
<td>Established legal framework</td>
<td>Patents</td>
</tr>
<tr>
<td>Political stability</td>
<td>Federal R&amp;D</td>
</tr>
<tr>
<td>Advanced telecom infrastructure</td>
<td>Industry R&amp;D</td>
</tr>
<tr>
<td>University system is a powerful asset</td>
<td>IPOs/Gazelles</td>
</tr>
<tr>
<td></td>
<td>Shortages of qualified local personnel at basic, clinical, and</td>
</tr>
<tr>
<td></td>
<td>lab levels</td>
</tr>
<tr>
<td></td>
<td>More focused S&amp;T public policy</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global manufacturing leader.</td>
<td>Other regions have organized more efficient searchable engines of</td>
</tr>
<tr>
<td>Expatriate S&amp;T Networks.</td>
<td>Life Science information.</td>
</tr>
<tr>
<td>Branding, Marketing.</td>
<td>Increased competition both from US regions and global competitors.</td>
</tr>
<tr>
<td>Puerto Rico as a global hub in pharmaceuticals and biotechnology.</td>
<td>Loss of preferential tax treatment and free-trade advantage.</td>
</tr>
<tr>
<td>Make Puerto Rico an international leader in clinical trials.</td>
<td>Socio-economic problems such as drug abuse, crime, persistent</td>
</tr>
<tr>
<td>Partnering with key academic and industry organizations throughout the</td>
<td>poverty, and lack of education.</td>
</tr>
<tr>
<td>world.</td>
<td>Economic stagnation.</td>
</tr>
</tbody>
</table>

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Examples of Strengths in the Puerto Rican Economy:

Workforce/Talent Base

Puerto Rico has a well-trained and well-educated workforce. However, it continues to export many of its most talented and creative workers to the United States. In fact, just this year the number of Puerto Ricans living in the mainland U.S. surpassed the number living in Puerto Rico for the first time ever.

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>Puerto Rico</th>
<th>U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall college enrollment in degree-granting institutions as</td>
<td>67%</td>
<td>82%</td>
</tr>
<tr>
<td>percentage of 20-24 yr. old population</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of civilian workforce with a recent bachelor’s degree</td>
<td>0.90%</td>
<td>1.29%</td>
</tr>
<tr>
<td>in science or engineering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of civilian workforce with a recent master’s degree</td>
<td>0.11%</td>
<td>0.28%</td>
</tr>
<tr>
<td>in science or engineering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of civilian workforce with a recent PhD degree in</td>
<td>0.04%</td>
<td>0.11%</td>
</tr>
<tr>
<td>science or engineering</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Puerto Rico can increase economic consequences of innovation strategies by taking better advantage of interactions between education and technology. If it doesn’t, the result will be an island workforce that is even less educated than the current one because the incentives for investing in human capital depend on the extent of job and earnings opportunities on the island. A less dynamic economy gives individuals fewer incentives to make time and financial investment in higher education. As the above table shows, there is considerable room for improvement regarding the number of Puerto Ricans receiving higher education, especially in the science and engineering disciplines.

The Biotechnology Workforce

The biotechnology industry employed 713,000 workers in 2002 and is anticipated to employ 814,900 workers in 2007. Further, the population of companies engaged in biotechnology is dynamic and growth in the biotechnology-related workforce has been vigorous, averaging 12.3% annually for those companies that provided data for 2000 – 2002. Companies with 50 to 499 employees experience the fastest growth, with an annual increase of 17.3%, while growth among larger firms was 6.2%.

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13 Economy.com, Industry Workstation, Biotechnology Industry forecast
What types of jobs will the biotechnology industry create in Puerto Rico? Or, to approach the question from an employer’s perspective, what type of skilled workforce must exist in Puerto Rico in order to convince a biotechnology company (whether it be a well-established company or an entrepreneurial start-up) to set up shop there? What type of talent pool must Puerto Rican universities be creating in order to create and maintain the critical mass of highly-educated human capital on which the biotechnology industry thrives? The table below lists just some of the jobs that are in high demand in a small biotechnology company. Note that the small biotechnology company, like all companies, has significant requirements for employees whose abilities lie in areas other than science, such as finance and administration. Medium and large biotechnology companies have similar workforce needs, but have a greater need for employees in operations and management roles.

### Overview of Jobs in a Small Biotechnology Company (1-49 Employees)

<table>
<thead>
<tr>
<th>Research: Discovery and Pre-clinical</th>
<th>Operations: Process/Product Development</th>
<th>Quality: Control and Assurance</th>
<th>Finance, Administration and Information Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>VP of R&amp;D, Senior Scientist, Scientist, Research Associate, Laboratory Support</td>
<td>Director, Supervisor, Associate, Technician, Facilities Manager, Facilities Technician</td>
<td>Director, Supervisor, Analyst, Technician, Documentation Coordinator</td>
<td>Chief Financial Officer, Accounting Manager, Application Systems Specialist, Accounting Clerk, HR Manager, Receptionist, Administrative Assistant</td>
</tr>
</tbody>
</table>

**Figure 37 - Biotechnology-Related Technical Employment by Occupation, 2002**

- Scientists - 55%
- Engineers - 8%
- Science and Clinical Laboratory Technicians - 30%
- R&D-focused Computer Specialists - 7%
### Figure 38 - Biotech Related Occupations and their Projected 10 Year Growth

<table>
<thead>
<tr>
<th>Occupation Title</th>
<th>Number Employed 2002 (000's)</th>
<th>Number employed 2012 (000's)</th>
<th>Numeric Change (000's)</th>
<th>Change %</th>
<th>2002 Median Annual Earnings</th>
<th>Postsecondary Education &amp; Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical scientists, except epidemiologists</td>
<td>58</td>
<td>73</td>
<td>16</td>
<td>26.9</td>
<td>56,980</td>
<td>Doctor's degree</td>
</tr>
<tr>
<td>Biomedical engineers</td>
<td>8</td>
<td>10</td>
<td>2</td>
<td>26.1</td>
<td>60,410</td>
<td>Bachelor's degree</td>
</tr>
<tr>
<td>Environmental scientists and specialists, including health</td>
<td>65</td>
<td>80</td>
<td>15</td>
<td>23.7</td>
<td>47,600</td>
<td>Master's degree</td>
</tr>
<tr>
<td>Biological scientists, all other</td>
<td>27</td>
<td>33</td>
<td>6</td>
<td>22.3</td>
<td>53,300</td>
<td>Bachelor's degree</td>
</tr>
<tr>
<td>Biological technicians</td>
<td>48</td>
<td>57</td>
<td>9</td>
<td>19.4</td>
<td>29,040</td>
<td>Associate's degree</td>
</tr>
<tr>
<td>Chemist</td>
<td>84</td>
<td>95</td>
<td>11</td>
<td>12.7</td>
<td>52,890</td>
<td>Bachelor's degree</td>
</tr>
<tr>
<td>Agricultural &amp; food science technicians</td>
<td>20</td>
<td>22</td>
<td>2</td>
<td>9.3</td>
<td>28,580</td>
<td>Associate's degree</td>
</tr>
<tr>
<td>Chemical technicians</td>
<td>69</td>
<td>72</td>
<td>3</td>
<td>4.7</td>
<td>37,430</td>
<td>Bachelor's degree</td>
</tr>
</tbody>
</table>

### Figure 39 - Employment in Pharmaceutical & Medicine Manufacturing

<table>
<thead>
<tr>
<th>Occupation Title</th>
<th>Total Employment</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>All occupations</td>
<td>293</td>
<td>100</td>
</tr>
<tr>
<td>Chemists &amp; materials scientists</td>
<td>15</td>
<td>37.5</td>
</tr>
<tr>
<td>Packaging &amp; filling machine operators &amp; tenders</td>
<td>20</td>
<td>6.9</td>
</tr>
<tr>
<td>Business operations specialists</td>
<td>14</td>
<td>4.7</td>
</tr>
<tr>
<td>Secretaries &amp; administrative assistants</td>
<td>10</td>
<td>3.5</td>
</tr>
<tr>
<td>First-line supervisors/managers of production &amp; operating workers</td>
<td>9</td>
<td>3.1</td>
</tr>
<tr>
<td>Chemical equipment operators &amp; tenders</td>
<td>9</td>
<td>3.1</td>
</tr>
<tr>
<td>Computer specialists</td>
<td>9</td>
<td>3.1</td>
</tr>
<tr>
<td>Medical scientists</td>
<td>9</td>
<td>3.1</td>
</tr>
<tr>
<td>Inspectors, testers, sorters, samplers, &amp; weightier</td>
<td>9</td>
<td>2.9</td>
</tr>
<tr>
<td>Laborers and freight, stock, &amp; material movers, hand</td>
<td>8</td>
<td>2.7</td>
</tr>
</tbody>
</table>
Examples of Weaknesses in the Puerto Rican Economy:

**Venture Capital and Other Sources of Capital** - Puerto Rico does not create or attract sufficient investment capital to sustain a vibrant life sciences economy.

**Figure 40 - Location of Key U.S. Life Science Venture Funds**

Life science venture funds in the U.S. are concentrated largely in the Northeast and California, with some in Texas, Washington, and the Great Lakes region as well much of the New England region (figure 36). Worldwide financing of the biotechnology industry equaled $16.9 billion in 2003, of which venture capital accounted for 19.7%, or $3.3 billion.\(^{15}\)

**Figure 41 - Total Worldwide Biotechnology Financing, 1998 - 2003 (billions of US $)**

\(^{15}\) BioWorld
Figure 42 - Venture Capital Activity in PR by Quarter, 1995 – 2004 (thousands of $)
Examples of Opportunity in the Puerto Rican Economy:

Now is the time for Puerto Rico to seize the opportunity to develop its own intellectual property through new ideas and discoveries, and to foster regional and global networks for both intellectual pursuit and improvements in the day-to-day process of creating drugs, devices, and products that save lives in every part of the world. There is a new healthcare system emerging which relies upon networks between the various players (pharmaceutical companies, start-ups, the federal government, academia, philanthropists, etc.) to spur innovation.

Regional economic development across the country has swiftly evolved around technology as a driver of job creation and wealth generation. What have emerged are industry clusters that serve as the “hot spots” of economic activity for a host of key stakeholders. Billions of dollars are currently being targeted at clusters and economic development activities. These clusters define the vital strength of a region’s capacity for sustainable economic development.
Analyzing ‘knowledge’ clusters provides a snap-shot in time of economic activity and creates an inventory of all the vital elements of the business model for a sector. The first elements – externally-focused on export products and services beyond the region – are those most recognized as the key drivers of an economy: the larger national or global companies, universities, and in some cases federal laboratories create the knowledge products and services in most technology-led clusters. However, only measuring this level of economic output limits a host of other important players in the cluster profile.

The ‘local suppliers’ represent the value chain of services and production that come from within a region to support the elements that typically export their goods and services beyond the region. The suppliers – lawyers, accountants, executive search, bankers, and indigenous angel capital investors, among others – become vital forms of cluster ‘critical mass’ building by ensuring the talent and skills are in place to grow the economic fortunes of small and medium enterprises as well as the likely evolutions of larger firms.

In turn, local ‘infrastructure’ is often comprised of the public sector role and the traditional underpinnings of a regional economy. Infrastructure such as airports, fiber optics and cable connections for high-speed internet, schools and training along with other vital contributions of the public arena create the business climate on which clusters rise or fall.

Thus clusters are important ‘snapshots’ of a region’s sectoral dynamics and suggest that engagement and inclusion of a broad base of stakeholders is both an economic and value

* By its very nature, a cluster mapping exercise represents a continuum of data gathering, and as such is most effective when treated as a dynamic effort requiring periodic updates.

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proposition for innovation communities. Clusters are also historical analysis – the traditional approach captures data on what has happened and can provide some predictive behavior of what may be in the future. While the snapshot might change from quarter to quarter or year to year, the identification of economic participants and their place in a cluster is invaluable. What makes cluster analysis critical to innovative regions is the strength of the connectivity within and between the boxes and their participant constituents as diagramed in figure 44 above.

The Hub and Node Concept of Regional Networks

The concept of regional clusters by itself, however, does not go far enough towards explaining what Puerto Rico needs to do to succeed economically in a 21st century global economy where the biggest growth opportunities will stem from new technologies, and the biggest threats will come from relentlessly increasing global competition. Puerto Rico needs to take advantage of the concept of Hubs and Nodes on multiple levels in order to reap the benefits and efficiencies of interconnectivity that it offers, and . Puerto Rico should re-think its position in the global and regional (Caribbean, Latin American) economies within the context of Hubs and Nodes, but it should also re-organize its existing regional clusters into a system of Hubs and Nodes on the island. Before developing this concept, there needs to be real business and economic intelligence about Puerto Rico.

**Figure 45 – A New Regional Model Emerging**

Then….

Self-contained regional clusters

Now….

Specialized, networked regions
Puerto Rico’s regional clusters and its Centers of Excellence must coordinate their research, discovery, scientists, and ultimately their commercialization assets (dollars, expertise, management talent, etc.) to compete globally. By integrating its clusters, Puerto Rico will be able to increase efficiency and use its resources more effectively. A commitment must be made to organizing Centers of Excellence as the nodes for Innovation Capacity Building – then linking those centers across the ‘The Life Sciences Network’ to promote innovation capacity on a domestic and global scale. Our recommendation is to address collaboration and coordination by Center of Excellence Innovation Capacity Building from the grassroots up, with a goal to scale globally.

Figure 46 - Innovation Hubs and Nodes in Puerto Rico
Examples of Threats to the Puerto Rican Economy:

Threat: Aging Population:

Puerto Rico’s aging population will increasingly strain its resources and could have a negative impact on its labor productivity and economic growth. In 1990, 9.7% of the Puerto Rican population was aged 65 and over, compared with 4.7% for Latin America and the Caribbean at large. In 2000 the figures were 11.2% and 5.4% respectively, and they are projected to grow to 13.7% and 6.4% respectively in 2010, and 17.2% and 8.3% respectively in 2020. In other words, the population over age 65 in Puerto Rico is consistently more than double the Latin American/Caribbean average. This is partially due to a lower birth rate (14.1 births/1,000 population in 2004), and a longer life expectancy (77.49 years) in Puerto Rico than in some of its Latin American neighbors.

Although a longer life expectancy is positive because it is an indicator of a high standard of living, an aging population also creates costs that a country has to bear. The costs appear primarily in two forms: First, since the elderly have greater healthcare needs, Puerto Rico will need to allocate more of its resources towards meeting those needs in the future than it does today.

And second, a greater percentage of Puerto Rico’s population above the age of 65 means that the overall participation in the workforce, already at dangerous levels in Puerto Rico (30.4%, the sixth-lowest workforce participation rate in the world), will continue to drop. In other words, the number of people in need of services will rise, while the number of people working to provide the tax dollars necessary to pay for those services will fall.

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16 United Nations CEPAL
17 “ “ “
18 US Central Intelligence Agency
19 The Economist
Threat: Declining population/Brain Drain:

The rate at which Puerto Rico’s population is growing is also steadily declining – from 1990 to 1995 the population grew at 0.9%, from 1995 to 2000 it grew at 0.7%, and it currently is estimated to grow at 0.49% for 2004. Population growth is projected to slow to 0.4% from 2005 – 2010, and to 0.3% from 2010 – 2020.\(^{20}\) Much of the fall in population is due to emigration to the mainland US, which has historically acted as a safety valve to compensate for the inability for the Puerto Rican economy to create enough jobs. Unfortunately for Puerto Rico, the emigrants are usually amongst the brightest and most productive workers with the highest potential - a “brain drain” with serious negative impacts on Puerto Rico’s reservoir of human capital. There are now slightly more Puerto Ricans living in the mainland US than there are living on the island. In order to sustain its economic growth in the face of stagnant population growth, Puerto Rico will need to increase its labor productivity and rate of participation in the workforce.

“The inability of Commonwealth’s economic model to generate enough jobs has caused discouraged workers to drop out of the labor force. Therefore, they aren’t counted among the unemployed, which is one reason Puerto Rico suffers from a low labor-force participation rate.

The low participation rate, in turn, hides the island’s real state of unemployment. It is actually much higher than official statistics portray. In 2003, if the work-force participation rate had returned to 50%, which was where it stood in the early 1950s, the unemployment rate would have shot up to 18.1%. If the labor-participation rate were 60%, as it is for Puerto Ricans stateside, the unemployment rate would exceed 30%.”

--Carlos Marquez, Caribbean Business

\(^{20}\) United Nations CEPAL
Threat: Socioeconomic Problems:

In addition to an aging and declining population, socioeconomic factors such as poverty, crime, drug abuse, teenage pregnancy, and negative trends in education present a serious threat to the Puerto Rican economy.

Socioeconomic Factors that Threaten Puerto Rico’s Welfare:

Education:
- Enrollment in primary school in Puerto Rico has shown a disturbing, if slight, downward trend in recent years – it was 350,589 in 1998, 345,467 in 1999, 342,246 in 2000, and 334,929 in 2001.[1]
- The high school drop out rate in Puerto Rico is 40%, compared with 13% in the mainland US.[2]

[1] United Nations CEPAL

Poverty:
- 48% of Puerto Rican families were living below the poverty line in 2000.[1]
- Per capita income in Puerto Rico is around $8,000, or half that of the state of Mississippi.[2]


Crime:
- The average number of homicides per 100,000 inhabitants from 1998-2000 was 17 in Puerto Rico, compared to 6 in the mainland US.[1]
- The percentage of homicides which are drug-related leapt from 1.6% in 1986 to 63% in 2001.[2]


* Although the high school drop-out rate in Puerto Rico is high, of those students who do earn a high school diploma, a large percentage then go on to complete college.
Threat: Inadequate Commitment to Research and Development:

There is no quick fix that will allow Puerto Rico to become a leader in biotechnology and the life sciences. Rather, it is necessary to make a long-term, serious commitment to increasing the quality and quantity of research, development, and commercialization being performed on the island. However, it is in this very area that Puerto Rico shows the most worrying signs of falling permanently behind its competitors.

Biotechnology is only one of the many exciting new technologies being developed in local universities, many of which may have important economic development potentials. Regional leaders should be careful not to "lock in" to one technology. It is important to create a climate in which the market can provide feedback to policy-makers as to where it is going. Then policy makers can undertake measures to reinforce the knowledge created by entrepreneurs who are the individuals closest to the action. The old strategy of regional policy makers "picking winners" has been discredited both in the U.S. and abroad.

- Martin Kenney, Professor, University of California Davis
  Author, Biotechnology: The University-Industry Complex

Numerous regions have identified the Life Sciences as their next holy grail. Candidly only a few have a chance of succeeding because a large majority do not have the underpinning of an exceedingly strong research community.

- Robert Calcaterra, President, Nidus Center and a driver of the St. Louis Plant Science Initiative

Despite these somber warnings, investing in biotechnology and the life sciences today is one of Puerto Rico’s best bets for ensuring sustainable, high value-added economic growth in the future. With its highly-skilled, well-educated, and bilingual workforce, its modern educational resources, and its existing advantage in pharmaceutical and medical device manufacturing, Puerto Rico clearly has the necessary assets in place to succeed in these exciting new areas. The key will be whether or not Puerto Rico will be able to focus its efforts and its assets strategically on the promises of the future, and whether it will be able to create a self-sustaining innovative milieu in which creative ideas flourish and are successfully commercialized into saleable products.

To succeed, Puerto Rico must spend more time preparing itself for the economy of the future and less time applying yesterday’s solutions to try to solve the problems of yesterday’s economy. Puerto Rico’s investment in R&D, both measured per capita and as a percentage of its GDP, may be amongst the highest in Latin America, but it is significantly below the level invested in R&D by all of its North American, Asian, and European competitors. Puerto Rico’s level of investment in its citizens’ healthcare tells a similar story – although higher than most of Latin America, it falls short of many of its global competitors.
Puerto Rico is facing increased competition along the entire range of its exports. Lower wage countries are competing with Puerto Rico in the agricultural and low to medium-tech manufacturing jobs. Competition from developed countries is increasing in the mid to high tech manufacturing, and even to some extent in the service sector. Even more important than competition over today’s export markets is competition in the markets of tomorrow. Puerto Rico’s competitors are making serious investments in the technologies, the knowledge, and the products that will drive the economy of the coming decades, such as biotechnology and nanotechnology.

Puerto Rico faces a dual challenge: on one hand, it is losing its traditional competitive advantages, and therefore faces increased competition for the goods and services it exports today (falling global trade barriers erode Puerto Rico’s traditional advantage of open access to the US market, and rising wages in Puerto Rico, combined with the emergence of low-wage international competition, has erased Puerto Rico’s position as a low-wage producer itself). On the other hand, Puerto Rico has not yet positioned itself to be able to take advantage of the economic opportunities of the future. Carving out a competitive space in the new economy requires some key elements which at the moment are lacking in Puerto Rico - a long-term vision, a strategic plan, coordinated investment, a risk-tolerant attitude, and a commitment towards taking action.

*Although Puerto Rico is not a country, and despite its economic integration with the mainland US, it is still useful to draw parallels between its economy and the economies of small countries.*

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**Figure 49 - The Small Country Syndrome**

Puerto Rico needs to avoid the “small country syndrome,” in which it is prevented by the limited size of its economy from taking advantage of the lucrative economic opportunities of tomorrow, many of which require large amounts of initial capital before they become profitable. Larger, more highly-developed countries have certain natural advantages in the race to profit from innovative technologies, for a variety of reasons – it is easier for them to
reap the benefits of increasing returns to scale (especially important in biotech and pharmaceuticals), they often have easier access to investment capital, both public and private, and they often have more large multinational corporations domiciled domestically, not to mention their advantages in institutional and educational infrastructure. The situation is not without hope, however – there are many examples of small countries, such as the Netherlands and Belgium, which have successfully adapted to and enriched themselves through globalization.

Puerto Rico can compete successfully with larger countries in the future, but in order to do so it must learn to “think locally but compete globally,” that is, it must learn to cooperate on a commonwealth-wide level, and coordinate activities between various corporate, academic, and government players, in order to better utilize the resources of the entire commonwealth by focusing them all on the future. For example, small countries have a limited stock of investment capital available domestically, and therefore need to find ways of attracting foreign direct investment to supplement their ability to provide the capital resources which are essential to research and development. “Asian Tigers” such as South Korea and Singapore have been extremely successfully in attracting foreign capital, which is the lifeblood of economic growth for a small, dynamic economy seeking to compete in a global marketplace. Singapore, for example, has attracted investments from more than 3,000 multinational corporations, and multinationals account for more than two thirds of
Singapore’s manufacturing output.\textsuperscript{21} The US alone had over $61 billion in assets invested in Singapore in 2003.\textsuperscript{22}

**Figure 51 - Percentage of World Expenditure on R&D by Country/Region**

Latin America has only 715 researchers per million inhabitants, and spends on average only $48,000 per researcher\textsuperscript{23}. In comparison, the United States has 3,697 researchers per million inhabitants and spends $203,000 per researcher; in the European Union the figures are 2,211 and $167,000, respectively; in Japan, 6,498 and $102,000\textsuperscript{24}. The ‘new industrial economies of Asia’ have less researchers per million (595) than the Latin American average, but spend more than twice as much per researcher on average ($111,000) than Latin American countries do.\textsuperscript{25}

In 2001 Puerto Rico was granted 3.1 patents per million inhabitants, which, while better than its Latin American neighbors (1.0 patents were granted per million inhabitants in Chile, .8 in Mexico, and .7 in Brazil), was far behind competitors such as Ireland (43.6) and Singapore (73.6).\textsuperscript{26}

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\textsuperscript{21} US Department of State  
\textsuperscript{22} US Department of State  
\textsuperscript{23} UNESCO  
\textsuperscript{24} UNESCO  
\textsuperscript{25} UNESCO  
\textsuperscript{26} A.T. Kearney
Investments in research and development remain far below that of the United States and competitor regions. The Commonwealth maintains low patent production and its federal research funding is weak. R&D spending at universities is being crowded out by other spending categories leaving publicly research programs under funded.

<table>
<thead>
<tr>
<th>Year</th>
<th>Amount in Millions of Dollars</th>
<th>Amount as Percentage of U.S. Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972</td>
<td>10.42</td>
<td>0.40%</td>
</tr>
<tr>
<td>1980</td>
<td>18.13</td>
<td>NA</td>
</tr>
<tr>
<td>1990</td>
<td>44.07</td>
<td>NA</td>
</tr>
<tr>
<td>2000</td>
<td>74.52</td>
<td>0.25%</td>
</tr>
<tr>
<td>2001</td>
<td>63.75</td>
<td>0.19%</td>
</tr>
</tbody>
</table>
The Puerto Rico Life Sciences Road Map

April 2005

INDUNIV and PRIDCO

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### R&D Benchmarks in Puerto Rico, Compared to the U.S. Average

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>Puerto Rico</th>
<th>U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average annual number of Small Business Innovation Research (SBIR) awards per 10,000 establishments</td>
<td>0.20</td>
<td>3.6</td>
</tr>
<tr>
<td>Average annual SBIR award dollars per $1,000 of Gross State Product (GSP)</td>
<td>$0.00</td>
<td>$0.06</td>
</tr>
<tr>
<td>Average annual amount of Small Business Investment Companies (SBIC) funds disbursed per $1,000 GSP</td>
<td>$0.09</td>
<td>$0.33</td>
</tr>
<tr>
<td>Academic R&amp;D per $1,000 of GSP</td>
<td>$1.44</td>
<td>$2.89</td>
</tr>
<tr>
<td>Federal R&amp;D obligations per $1,000 of GSP</td>
<td>$0.24</td>
<td>$4.52</td>
</tr>
</tbody>
</table>

---

**Figure 53 - Investment in Healthcare by Region**

Puerto Rico must continue to reject the trend towards low investment in healthcare evident in the rest of Latin America and the Caribbean, both for the well-being of its citizens and for the strength of its economy. The most telling indicator on figure 53 is the low placement of the bubble representing Latin America and the Caribbean along the Y axis, for this shows the low priority that healthcare is given in these countries with respect to other expenditure options. While Puerto Rico would fare better than its Latin American and Caribbean neighbors in terms of both per capita public investment in healthcare and healthcare spending as a percentage of GDP, it would still score below developed Europe, the Nordic countries, Japan, and the mainland US.

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**Figure 53 Translation:**

- Y axis: “the priority given to public investment in healthcare (% of GDP)
- X axis: “per capita public investment in healthcare: 0-2400 (US $)
- Northwest quadrant caption: “countries with less public resources but a high priority on healthcare.” Bubbles in this quadrant: World Average (red), less-developed Europe, Asia.
- Northeast quadrant caption: “countries with greater public resources and a high priority on healthcare.” Bubbles in this quadrant: Developed Europe, Nordic Countries, Japan, USA.
- Southwest quadrant caption: “countries with less public resources and low priority for healthcare.” Bubbles in this quadrant: Latin America and the Caribbean (green), Africa.
Targets of Opportunity

Critical to becoming competitive in the current technology-focused and agile economy is the ability of a region to leverage current strengths and opportunities to achieve excellence and become a global leader. Given the breadth and competitiveness of the technology industry, it is impossible to excel in every area. Targeting allows a region to hone in on a particular field and gather the specialized resources, talent, and assets necessary to become a premier destination for scientists, researchers, entrepreneurs, investors, and corporations interested in a specific industry.

Targeting a handful of scientific and technological opportunities does not come easy. As Michael Porter of Harvard University says regarding strategic planning: it’s about choices, it’s about making decisions to stop doing certain things before starting new activities. Thus, in deciding to identify these targets of opportunity, Puerto Rico must purposefully choose to rationalize its resources and leadership in a select set of research, discovery, and commercialization strategies.

To address the challenges identified by the Road Map stakeholders, six elements of a Scenario were prioritized for work by small action teams of academic, industry, public sector, and national expertise. These six elements served as the basis for discussion leading to the Fundamental Actions and Big Ideas outlined later in this document.

At the outset, we set a framework for target selection:

- A mix of short-term economic payoff and long-term growth opportunities.
- Areas with a solid foundation in basic science and either realized or potential innovation (patent) activity.
- Existing federal funding flow or the strong potential to attract significant federal funds.
- Collaborative efforts underway or the potential for inter-institutional collaboration.
- The ability to build public and private support around future investment.

The six selected targets of opportunity were:

- Cluster Mapping & Engaging Broader Stakeholders
- Resident Expertise in Pharma and Biotech Manufacturing and Facilities Management
- Expatriate Networks for Science and Technology
- Leveraging Existing Initiatives for Puerto Rican Healthcare
- Workforce, Skills, & Competencies
- Branding, Marketing, and Positioning as a Global Hub/Node

Note that each of the selected six targets of opportunity represents an area in which Puerto Rico has the basic foundation necessary to build a competitive advantage in the global environment. However, the methodology for selection of a target is not a predetermined or set formula.
Cluster Mapping & Engaging Broader Stakeholders

| Background       | Puerto Rico has several industry associations linked to cluster strategies: Pharmaceuticals, Biotechnology, Medical Devices, Health Care, and Communications & Information Technology.  
|                 | Approximately 56,000 jobs are directly related to high tech.  
|                 | PR is benchmarked to other locations.  
| Reason Selected | Current cluster arrangements in Puerto Rico consist of loose associations and confederations of related industry groups, non-reflective of a true cluster definition  
|                 | “Clusters are groups of complementary, competing, and interdependent industries, organizations, and individuals that drive wealth creation in a region, primarily through export of goods and services.”  
| Puerto Rico Scenario | Stronger advocacy for a technology driven economy by non-science and non-technology stakeholders will provide critical voices to the political-public sector as well as to the broader public.  
|                 | Mapping the clusters will identify vital networks of relationships that strengthen proximity and social capital to complete initiatives and sustain results.  
| Explanation      | Clusters are snapshots of current economic activities, drivers of that activity, and the inventory of a wide range of institutions and individuals that participate in the economy. When building global cluster networks, PR must be on the same page with other regions’ definition to uniquely link assets, people, and resources  
| Tactics          | Complete the mapping exercise NOW!  
|                 | Cluster Summits with all stakeholders introduced to the broader opportunities and required action steps to make Puerto Rico competitive in light of global competition and industry trends  
| Metrics          | Employment, payroll increases  
|                 | New Capital investments (tradition and risk capital)  
|                 | Increased Deal flow, transactions within clusters  
|                 | Gaps filled with specific talent and skills  

Resident Expertise in Pharma/Biotech Manufacturing and Facilities Management

| Background | • Global pharmaceutical manufacturing in Puerto Rico ($60 billion in infrastructure).
  • Puerto Rico has the 2nd largest FDA office.
  • Facilities design, construction, management/operations leadership.
  • Regulatory-responsive manufacturing, operations, and logistics. |
| --- |
| Reason Selected | • Current cluster arrangements in Puerto Rico consist of manufacturing related industries, organizations, suppliers and government groups, non-reflective of a true cluster definition
  • “Clusters are groups of complementary, competing, and interdependent industries, organizations, and individuals that drive wealth creation in a region, primarily through export of goods and services.” |
| Puerto Rico Scenario | • Stronger advocacy for a technology driven economy by non-science and non-technology stakeholders will provide critical voices to the political-public sector as well as to the broader public.
  • Mapping the clusters will identify vital networks of relationships that strengthen proximity and social capital to complete initiatives and sustain results. |
| Explanation | • Newly developed curricula emerging in key thought leadership centers like San Diego and Seattle could provide the basis for partnerships.
  • Sense of the Singapore/Ireland strategies. |
| Tactics | • Two to three global airlines to make Puerto Rico a hub.
  • Bundled services – architecture, engineering, construction, maintenance, vendor-suppliers.
  • Global certification programs – (facilities, QA/QC, etc.) with UCSD and University of Washington. |
| Metrics | • # of U.S./Global certifications issued.
  • # of tons moved in/out of Puerto Rico related to health care and the life sciences.
  • # of U.S./Global manufacturing services with offices in Puerto Rico.
  • # of strategic alliances with industry partners for certification development. |
## Expatriate Networks for Science & Technology

### Background
- Population centers of Puerto Ricans in the United States
- Examples of research/technology/industry in those locations
- Puerto Rico Federal Affairs regional offices
- Famous Puerto Ricans in key agency positions
- Example of United Kingdom strategy for expatriates

### Reason Selected
- AT Kearney analysis of key brain-drain and intellectual flight
- Key resources off the island provide critical link to passionate/committed Puerto Ricans
- Population demographics are becoming vital research strengths in genomic/proteomics

### Puerto Rico Scenario
- A global network of scientific, technological, and entrepreneurial resources is created to advance both the investment in and results of Puerto Rico’s Innovation Lifecycle®
- Puerto Rico will not be able to attract all future pharma activity – but competitors will not “steal” Puerto Rico’s pharma industry if Puerto Rico is seen as the knowledge hub for pharma.
- Puerto Rico needs to maintain and build its brand for science and technology by leveraging on and off island relationships. This in turn will open up collaborative opportunities abroad.

### Explanation
- Other global regions networking their expatriate scientists and technology interests around research collaborations, citizen genomics, and other unique advantages
- British Expatriates Network for Science and the role of the Minister of Science and Technology

### Tactics
- Identify key Puerto Rico leadership in science-technology and wealth creation activities in the 10-12 top population centers
- Identify research institution collaborative partners
- Identify potential targets for R&D sabbaticals on the island
- Form Global Puerto Rico Network and host kickoff forums in the 10-12 locations
- Host semi-annual forums in Puerto Rico around research, commercialization, innovation

### Metrics
- # of returning scientists/research private investigators
- # of strategic alliances
- Amount of new investment dollars in research and commercialization
# Leveraging Existing Initiatives for Puerto Rican Health Care

## Background
- Telemedicine, Smartcards, C&IT cluster studies have been conducted but sustaining and leveraging results has been a challenge. In turn, new incentives have been put in place for Sect 936, clinical trials, bioprocess plant and other related infrastructure.
- Healthcare challenges remain for Puerto Rican citizens.

## Reason Selected
- To improve the economy without ties to improving the quality of life and health for Puerto Rico’s citizens would be irresponsible.
- Some of the best minds in health care in the world are indirectly linked to Puerto Rico through the bio, pharma, and IT sectors and therefore can offer potential insight and council.

## Puerto Rico Scenario
- Puerto Rico creates a global best-practice model in health care by linking clinical discovery and research to providers, insurers, employers, and patients in a 21st century comprehensive Puerto Rico jumpstart health care initiative.
- The promise of telemedicine, Smartcards, and health information catalyzes a new cluster convergence to serve the needs of all citizens and leading to significant improvements in the treatment and diagnosis of diabetes, cancer, and hypertension illnesses.

## Explanation
- Health insurance leaders and doctors interviewed point towards potential clinical centers of excellence in Asthma, Hypertension, Cancer, HIV, Organ Transplant, and other areas

## Tactics
- Puerto Rico should jumpstart the healthcare Initiative as an integrated system of research linking patient care partners from bedside to market.
- Convene a forum of health care agencies, hospitals, and providers, insurers, large employers, life science industry, and health experts to design a new pilot project.
- Puerto Rico becomes a Caribbean-Latin American Global Node for Comprehensive Cancer Research and Treatment in partnership with U.T. M.D. Andersen Cancer Center Houston

## Metrics
- Reduction in key illnesses
- Reduction the cost of medicine
- Increased utilization of telemedicine, smart cards, and health information services
- New employer/industry/provider partnerships driven by quality of life indices.
## Workforce, Skills, and Competencies

### Background
- The growth of an industry cluster acts in parallel to the skills and competencies of the regions talent pool as noted in the U.S. Dept of Labor recent assessments of biotech, and life sciences cluster development.
- Little efficient data on job growth, characteristic by sector in Puerto Rico and by region, while job characteristics are receiving greater focus by major institutions in Puerto Rico.
- UPR and Politécnica are #1 and #2 for # of hispanic engineering students.

### Reason Selected
- Building out the clusters will demand even greater concentrations of skill development in Puerto Rico.
- Leverages resident knowledge and expatriate relationships for training, curricula design, etc.
- Broadens the impact of the job opportunities for a larger group of citizens and stakeholders.

### Puerto Rico Scenario
- Puerto Rico is recognized for its unique skill development programs by increased U.S. federal funds in workforce initiatives.
- The talent pool grows commensurate with industry demand so that no time gap exists.
- Next generation Puerto Ricans surveyed state a very positive outlook for career pathways in the life sciences.

### Explanation
- Puerto Rico is involved in a serious, expensive, and on-going war for talent
- The competitive advantage for Puerto Rico will be the continuous creation of a talent pool that focuses on career pathways along the workforce continuum
- US Department of Labor is focusing greater resources on High Tech Job Growth Initiative with special emphasis on Life Sciences

### Tactics
- Puerto Rico Workforce Continuum – high schools/community and technical colleges/four year institutions/industry/public workforce system convene the Puerto Rico Skills Team to design pathways to jobs.
- A center of excellence workforce learning facility is created in the four major life science hubs in Puerto Rico.

### Metrics
- Number of new skills development pathways created and launched
- Number of certifications produced.
- Number of new federal workforce dollars directed toward Puerto Rico
Branding, Marketing, and Positioning as a Global Hub/Node

**Background**
- Dollars spent on promoting Puerto Rico are not aligned to key messages of new economic drivers
- Anecdotal perspective on PR as seen through the eyes of visitors in airport gateways: beaches, casinos, rum, golf – but not science and technology!

**Reason Selected**
- Puerto Rico’s competitiveness is often defined by incentives vs. strengths in knowledge creation or competencies
- To position Puerto Rico’s science and technology future citizens, visitors, and targeted interests must be made aware of current strengths to attract jobs and investment dollars
- Disparate messages and tactics do not leverage resources mixing quality of life and technological innovation

**Puerto Rico Scenario**
- 25-40% of Puerto Rico’s branding budget is spent on the education and awareness of the island’s scientific and technological activities.
- The hospitality and tourism industries are vital partners with industry and academia in designing and delivering the business, scientific, and entrepreneurial offerings
- Surveys on the future identify PR’s life sciences among culture, arts, music, food, and quality of life as reasons to relocate and/or expand PR operations

**Explanation**
- PR is still not seen by key decision-makers or general public as a force in S&T
- Marketing dollars are spent on the tourism and hospitality industries – but there is no linkage with the desire for the New Economy workforce to be in places with quality of life and unique health/recreation/wellness locations

**Tactics**
- Scientific, technical research sabbatical program designed as a partnership of hospitality, cluster organizations and academia.
- Form the Puerto Rico Innovation Team comprised of key marketing and branding strategists to target critical global conferences, meetings, forums – and construct the Puerto Rico Technology Pavilion

**Metrics**
- Dollars spent on marketing related to PR Science &Technology
- Volume of sabbatical partnerships formed
- Level of market awareness the new PR message by key off-island interests
- Number of scientific conferences and technical trade shows supported by the Puerto Rico tourism company.
Hot Team Recommendations*

The following actions have been identified by the Hot Teams to close the gaps and meet the opportunities presented along the Pathway to Innovate:

- Identify products in the drug development pipeline that can either be manufactured or are manufactured in Puerto Rico, or that their clinical trials can be done in Puerto Rico. Consider contracting Generans Life Sciences to identify products with good fit with Puerto Rico capabilities and those with clinical trials targeted to the Hispanic population.

- In order for our universities to remain closely aligned with industry needs, this work/study consortium should represent all local universities and gather and post all work/study opportunities in life sciences. Main objective is to report industry trends to its support network (academia, suppliers, etc.). Promote alliances between academia and industry to achieve objective.

- Since a significant amount of funds are provided through federal grants, Puerto Rico should have a Grant Support Committee with its mission to provide reviews and relevant information/experience that will help local and Puerto Rico candidates increase there rate of success in soliciting federal grants for PR and abroad.

- Website for “Life Sciences Resources related to Puerto Rico”: Our local life sciences industry needs an easily accessible marketing arm that will withstand continuity. To assure continuity a good part of it has to be supported by self-input from various parties. The answer is in a website initially designed by Induniv/CIT and later kept updated by industry members who themselves would be interested in being identified with life sciences industry in Puerto Rico. Some content areas may be manufacturing participants/Current Products/Capabilities, metabolic disorders expertise, resident experts, and scientists and industry employees abroad.

  - We need to identify what government incentives will be provided for each phase (what will make PR more attractive than the mainland US or Europe?)
  - Potential benefits (high level) for companies bringing closer the entire supply chain. This is related to process reliability (product robustness, increased performance, efficiency, quality, Cycle Time of product development, etc.)
  - Develop Education Program for team participants on the medical health areas.
  - Capitalize on CNC to accelerate the approval phases.

* For a complete copy of the Hot Team recommendations, see Appendix D
Strategic Commitments:

A Grass-roots effort by over 200 individuals led to the creation of the Road Map, which is designed to foster:

The linking of expertise on the island
The linking of expertise off of the island
The leveraging of expertise on the island
The leveraging of expertise off of the island

The Road Map process has led to the identification of four key Strategic Commitments:

1.) Agree upon a new business model. Global competition and industry trends are working against Puerto Rico’s current business model.

2.) Taking action is not an option, it’s a necessity. Puerto Rico will lose its strong-hold in the life sciences unless specific action is taken.

3.) Puerto Rico must focus its resources and efforts on a few key Next Steps. It currently has too many competing and conflicting programs and initiatives.

4.) A collaborative, consensus-based, integrated strategy is necessary. All Stakeholders must come together around the Road Map as the driver of innovation.

Before forming the Hot Teams, NES came together with key members of the community for a series of brain-storming sessions in order to come up with Puerto Rico’s targets of Opportunity. Recognizing the urgency of the situation, the participants worked quickly to set a time frame and to identify key actions to take within the six target areas. These actions then formed the core of the Hot Teams’ strategic commitments.

Common to all four strategic commitments is the recognition that Puerto Rico needs to change direction in order to take advantage of the opportunities available in the 21st century innovation economy. The strategic commitments make it clear that Puerto Rico needs to agree upon and implement a bold new strategy, and that it needs to do so expeditiously.

As stated in the fourth strategic commitment, it is essential that the key players in Puerto Rico come to a consensus on the Road Map. They should view it as a guide and a starting point for agreeing upon and embarking upon Puerto Rico’s new strategic direction.
Fundamental Actions

There are fundamental issues which absolutely must be addressed if Puerto Rico is going to maintain its competitiveness in the global marketplace. These Fundamental Actions will form the foundation which is a prerequisite to building a sound and prosperous innovation-based economy.

### Five Fundamental Actions Critical to Addressing On-Going Challenges

<table>
<thead>
<tr>
<th>Fundamental Actions</th>
<th>Why We Need to Implement these Actions</th>
<th>What actions do we envision ourselves taking in the…</th>
<th>…Short Term (6 - 18 months)</th>
<th>…Medium to Long Term (&gt; 19 months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.) Create Strategies and Offices for Grant Management and Innovative Funding</td>
<td>The efficient and effective management of federal, industry, and philanthropic investments in our R&amp;D requires that we create both a means of appropriate compliance and a strategy for increasing the flow of dollars to Puerto Rico.</td>
<td>Creating a Science &amp; Technology Trust Fund</td>
<td>Exploiting channels to funding from the NIH, the NSF, NASA, and other federal and private sources (industry, philanthropy)</td>
<td></td>
</tr>
<tr>
<td>2.) Make Significant Investments in Basic Research Teams and Facilities</td>
<td>With 38 areas of Life Science in which to excel, we must select a handful of areas that leverage our advantages and our own needs for improving our quality of life. Cancer, diabetes, cardiovascular, and infectious diseases are among our strategic and unique advantages.</td>
<td>Building upon the basic and translational leading to Applied Centers of Excellence</td>
<td>Leveraging relationships and expanding our research</td>
<td></td>
</tr>
<tr>
<td>3.) Create a Future Workforce Learning Resource Center</td>
<td>Unless we adopt proactive solutions to our workforce challenges and increase our capacity to train and educate our workers, Puerto Rico’s contribution to excellence in labor and skills will be devalued by global competitors.</td>
<td>Strengthening our Human Capital</td>
<td>Positioning our Skills and Competencies</td>
<td></td>
</tr>
</tbody>
</table>
| 4.) Create a Puerto Rico Science & Technology Global Network and Data Portal | Over 4 million Puerto Ricans live in the top ten research, science and technology communities in the U.S. and several hundred are in positions to impact the future of the Commonwealth’s competitiveness. We must link with this passionate talent pool through a common website and the creation of a Puerto Rican Academy in Science and Technology Hall of Fame | • Building our expatriate Network  
• Creating a one-stop data portal to access and leverage assets | • Nurturing our expatriate network  
• Leveraging our expatriate network |
| 5.) Improve and Increase Marketing and Branding Efforts | Telling the Puerto Rico Innovation Story far and wide is now critical so that we can attract, recruit and retain the necessary know-how and excellence. We must connect our agenda with the tourism industry so as to increase their understanding of and ultimately their economic contribution to our agenda. | • Positioning Puerto Rico in the Life Science arena  
• Marketing Puerto Rico as the place to be in Life Sciences Value Chain | • Building Brand Recognition  
• Gaining Global Recognition of Puerto Rico as a Biotech Hub |
Figure 55 below is a flow chart showing the potential links and interactions between the various institutions and initiatives proposed above, such as the Science and Technology Trust Fund.

**Figure 54 - Potential Links and Interactions Within Puerto Rican Life Sciences**

The “S&T Innovation PR” will be the mechanism to enable vision 2025 innovation economic development strategy.

*The Advisory board would be composed of representatives from the Pharma, Bio, MD, HC, Construction and C&IT Clusters, 2 representatives from the academic community, 1 from the government, 1 from INDUNIV, 1 from PRMA, 1 representative to deal with funding issues, 1 from the scientific media, and 1 Entrepreneur.*
**Big Ideas**

In addition to shoring up the foundation of its innovation economy by concentrating on the fundamentals, Puerto Rico needs to have the confidence and the vision to think big. In order to carve out a place for itself in the global economy, and to meet the challenge posed by increasing competition from abroad, Puerto Rico will need to come up with a few Big Ideas – three or four forward-looking thrusts in which Puerto Rico can concentrate its resources, which will help it differentiate itself from its global competitors.

<table>
<thead>
<tr>
<th>Big Ideas</th>
<th>Why We Need to Implement these Ideas</th>
<th>What actions do we envision ourselves taking in the...</th>
<th>...Short Term (6 - 18 months)</th>
<th>...Medium to Long Term (&gt; 19 months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.) Creating a physical and virtual innovation zone</td>
<td>In order to connect its centers of excellence in discovery and development, Puerto Rico must have a centralized hub for leveraging proximity of talent and know-how linked to activities in various locations on the island and (in the future) off the island.</td>
<td>Networking our relationships to expand research and commercialization outcomes</td>
<td>Exploiting cluster synergies</td>
<td></td>
</tr>
<tr>
<td>2.) Expanding upon clinical trials and clinical research</td>
<td>Puerto Rico must create a center that aggregates global interest in trials around the unique genetic base of its population. Puerto Rico needs to use the proximity of global pharmaceutical know-how and the presence of the FDA to take its expertise in drug manufacturing along an earlier pathway of development and approval.</td>
<td>Focusing on selected clinical diseases: Cancer First, then cardiovascular diseases, infectious diseases</td>
<td>Gaining recognition as being experts in genetic, proteomic, and computational biology</td>
<td></td>
</tr>
<tr>
<td>3.) Leveraging Puerto Rican Expertise in High-Tech Manufacturing</td>
<td>Resident in Puerto Rico is a talent pool of companies and firms that are considered global leaders in the design, construction, operation and maintenance of very expensive and highly sensitive manufacturing campuses. As manufacturing becomes a long-term hot-button issue for increased economic development, Puerto Rico must create a means to both brand itself as a repository for such know-how and ‘sell’ its knowledge to interested market players.</td>
<td>Consolidating our resident expertise in designing, constructing, and operating technology facilities</td>
<td>Promoting our resident expertise through global learning</td>
<td></td>
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</tbody>
</table>
Big Idea Number 1: Creating a physical and virtual innovation zone

In order to connect its centers of excellence in discovery and development, Puerto Rico must have a centralized hub for leveraging proximity of talent and know-how linked to activities in various locations on the island and (in the future) off the island. In the short term, Puerto Rico should network its relationships to expand research and commercialization outcomes. In the medium to long term, Puerto Rico should exploit its cluster synergies.

Innovation

Innovation is not simply about technology or the adoption of a technological tool; it is about creating new governance models and new collaborative paradigms, finding new ways to use technology to address challenges and exploit opportunities, and doing so in a continuous fashion.

Innovation and the effective management of technology have become a top priority for nations as well as companies to stimulate economic development and strengthen their competitiveness. Over the past ten years, a new global innovation system has evolved in the U.S., with support from government and industry for basic research in universities, nurtured by rapid growth in venture capital and implemented by industrial firms through strong investments in R&D, capital equipment, and information technology. This highly complex system of innovation is also based on closer collaborations and increasing alliances among industry, universities and government labs.

More than simply utilizing technology, innovation is the ability to take new ideas and translate them into commercial outcomes by using new processes, products or services in a way that is better and faster than the competition. The ability to do this requires a social, inclusive process among individuals, institutions, and organizations that results in new business models, new forms of engagement, and ultimately, new companies. Today, new firms create a greater portion of job growth than do established larger companies. In the New Economy, innovation and productivity are the cornerstone of competitiveness, and ultimately prosperity.

Why is Innovation Important?

Innovation, according to Peter Drucker, is the purposeful response to change. In a period of constant flux, science and technology require purposeful decision-making and strategies by states and regions seeking to build clusters of economic and technological growth. No longer can haphazard approaches or episodic events drive the necessary collaboration to meet the challenges of a competitive scientific and business marketplace. Innovation of business and economic models is now a critical objective of any industry, particularly in the technological arena.
The Innovation Lifecycle® is like a relay race, a seamless, circular pattern with four stages. In each stage, the baton must be passed smoothly and skillfully to ensure the successful completion of the cycle and the beginning of another. Funding, infrastructure, a clear understanding of the technology transfer process and risk, and appropriate business skills all represent strategic batons and potential hurdles in the race to innovate and commercialize.

Managing the complete Innovation Lifecycle® is key to developing a healthy economy.

Figure 55 – The Innovation Lifecycle®

The knowledge creation/conception stage is the development phase. This involves idea generation, research and development, and patents. Crucial in advancing to the next stage of the Lifecycle® are internal, federal, “angel,” and/or entrepreneurial capital.

The technology transfer/formation stage is typified by clinical trials, regulatory filings, and business planning, a phase in which the product/process proves its worth. Entrepreneurial services and support structures, investment capital, and partnering are needed to progress to the next stage.

Following clinical trials and regulatory approvals, the product/process enters the commercialization/growth stage. At this time, a company usually hires additional personnel, files an IPO, and begins early stage manufacturing production.

At the cluster and network/maturity stage, the company begins to perform in a more traditional fashion: analyzing internal business processes for improved efficiency, developing long-term marketing objectives, and, most important, delivering the product or process to the public.
Within each of the four main quadrants of the Innovation Lifecycle® (conception, formation, growth, and maturity) are specific indicators which represent steps along the path towards innovation (clinical trials, M&A activity, etc.). Strength across all of these elements is necessary in order for Puerto Rico’s Innovation Lifecycle® to become robust and fruitful. While Puerto Rico definitely has existing advantages in many of these areas, in other areas it is weaker. The challenge for Puerto Rico will be to address its weaknesses in the broader Innovation Lifecycle® (indicated with red arrows in figure 57 below) while at the same time exploiting current strengths.

**Figure 56 – Weaknesses in Puerto Rico’s Innovation Lifecycle®**

![Diagram of the Innovation Lifecycle®](image-url)

- Conception
  - Proof of Concept
  - Incubation/Research Parks
  - Clinical Trials
- Formation
  - Testing
  - Venture Capital
  - Collaborations/Partnerships
- Maturity
  - Licensing
  - Regulatory Approval
  - IPOs/Gazelles
- Growth
  - Universities & Research Institutions
  - Federal R&D
  - Industry Consortia & Partnerships
  - M&A Activity
  - Product Pipeline
  - Economies of Scale
  - Value-add
  - Labor Market/Graduates
  - Business Planning
  - Job Creation
  - Industry R&D
  - Regulatory Environment
  - Value-add
  - Conception Formation Growth Maturity

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Big Idea Number 2: Expanding upon Clinical Trials and Clinical Research

The future of Puerto Rico’s Life Sciences industry depends in a large part upon its success in becoming globally recognized as a leader in conducting clinical trials for new pharmaceutical products, as well as physical and psychological therapies. Developing a specialization in performing clinical trials is a natural step for Puerto Rico, because it will capitalize upon existing strengths and advantages on the island. This Big Idea focuses the observations and recommendations of at least two of the Targets of Opportunity (Resident Expertise in Pharmaceuticals and Biotechnology and Global Positioning) into action in a specific area.

Specializing in clinical trials will take advantage of existing Puerto Rican strengths, such as:

1) The extensive know-how and facilities of island’s pharmaceutical and biotechnology clusters.
2) The strong research capabilities of the island’s university system.
3) The presence of federal agencies such as the FDA and the NIH on the island.
4) The singular nature of the Puerto Rican population, which offers researchers a pool of possible trial participants who belong to a unique genetic base and whose socioeconomic situations and lifestyles are very similar to those of the mainland US.

The potential benefits of developing an island-wide specialization in clinical trials are significant. In addition to the obvious direct and indirect economic benefits (increased high-tech, high-paying jobs, a re-vitalization of both private sector and university research capabilities, and spill-over effects into related industries, to name a few), the benefits to society could be considerable:

Medical research focusing on Puerto Rico’s unique population would mean greater medical knowledge about that population, and possibly the development of specific treatments and cures for ailments which are more prevalent in that population. Increasing medical understanding of characteristics that are unique to Puerto Ricans and other Hispanic ethnicities is of paramount importance, as the limited availability of health data on Hispanic subgroups has been blamed for deterring progress in the development of appropriately targeted public health policies.27

In addition, Puerto Ricans could benefit in the near term from the increased quality and availability of medical care that would arise from increased investment in clinical trial capacity. Faced with such clear advantages, the question that the Puerto Rican Life Sciences community should be asking itself is not whether Puerto Rico should strive to become a global leader in clinical trials, but rather why Puerto Rico does not already occupy the high ground in this area, vis-à-vis its global competition.

27 Zambrana and Carter-Pokras, 2001
A Unique Genetic Base

The following statistics help to show what are some of the most important issues are concerning the health and well-being of Puerto Ricans. Conducting Clinical trials in Puerto Rico that target medical issues that are endemic to Puerto Ricans will optimize benefits both to the Puerto Rican population and to the medical community at large.

**Figure 57 - Percentage of Children with Diagnosed Conditions**

![Chart showing percentage of children under 17 years with selected diagnosed conditions by race/ethnicity and specified origin: US, 1997-2000](chart_image)

Occurrences of developmental delay, ADD, and learning disabilities in Puerto Rican children are comparable with the rates amongst other ethnic groups; however, Puerto Rican children clearly suffer from asthma at a much higher rate (figure 58). Figure 59 (below) shows that the increased occurrence of asthma in Puerto Ricans is true for adults as well as children. Figure 59 also shows that Puerto Ricans at least as likely to suffer from diabetes, heart disease, chronic obstructive pulmonary diseases, and (with the exception of black non-Hispanics) hypertension as other ethnic groups.
Figure 58 - Percentage of Adults with Diagnosed Conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Black, non-Hispanic</th>
<th>White, non-Hispanic</th>
<th>Cuban</th>
<th>Mexican</th>
<th>Puerto Rican</th>
<th>Other Hispanic/Latino</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes</td>
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<td>Heart disease</td>
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<tr>
<td>COPD**</td>
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<tr>
<td>Hypertension</td>
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<tr>
<td>Asthma</td>
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</tbody>
</table>

Age-adjusted percent

*2010 target for hypertension based on measured blood pressure. No 2010 targets were set for heart disease, COPD, and asthma prevalence.
**Chronic obstructive pulmonary diseases (also known as chronic lower respiratory diseases.)
Data are age-adjusted to the 2000 standard population.
Source: National Health Interview Survey, National Center for Health Statistics, CDC.

Figure 60 shows that instances of diabetes in Puerto Ricans rise significantly with age, with Puerto Ricans in the 18 – 24 year age group being less likely to suffer from diabetes than other ethnic groups, while Puerto Ricans in all three higher age groups are at least as likely, if not more likely, to suffer from diabetes than other ethnic groups.

Figure 59 - Percentage of Adults with Diagnosed Diabetes by Race/Ethnicity/Origin

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Black, non-Hispanic</th>
<th>White, non-Hispanic</th>
<th>Cuban</th>
<th>Mexican</th>
<th>Puerto Rican</th>
<th>Other Hispanic/Latino</th>
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<tr>
<td>18-24</td>
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<tr>
<td>25-44</td>
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<td>45-64</td>
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<td>65+</td>
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</table>

Percent

* Value is less than 1 percent.
Source: National Health Interview Survey, National Center for Health Statistics, CDC.
Figures 61 and 62 show statistics for smoking (a leading cause of cancer) by Puerto Ricans, both compared to other ethnic groups, and broken down by age group. Although Hispanics/Latinos as a group smoke less than other ethnic groups, Puerto Ricans tend to smoke more than other Hispanic/Latino groups, such as Cubans and Mexicans (figure 61). The percentage of smokers is particularly high amongst 25 – 44 year old Puerto Ricans (over 30% of the total population [figure 62]).
One of the most serious health issues facing Puerto Rico today is HIV/AIDS. The mortality rate from HIV on the island of Puerto Rico in 1999 was four times greater than that in the mainland US (figure 63). The mortality rate from HIV in 1999 was seven to ten times greater amongst Puerto Ricans than it was amongst other Hispanic Latino ethnic groups such as Cubans and Mexicans (figure 63). In 1994, AIDS was the fourth-leading cause of death in Puerto Rico, and the leading cause of death for women in the 25 – 39 year old age group.\textsuperscript{28}

AIDS is particularly threatening to Hispanic women, who are about seven times more likely to have AIDS than non-Hispanic whites.\textsuperscript{29} Use of injected drugs, or heterosexual sex with a user of injected drugs, together account for about 80\% of AIDS cases among Puerto Rican-born women in the continental US.\textsuperscript{30} Many within the Puerto Rican medical and academic communities have already realized the gravity of this situation, and important research on AIDS is being conducted at Puerto Rican universities. The effort to position Puerto Rico as a global leader in clinical trials should leverage and expand upon these current initiatives in the fight against AIDS in Puerto Rico.

\textsuperscript{28} Departamento de Salud, 1997
\textsuperscript{29} Díaz, 1996
\textsuperscript{30} Díaz et al., 1993
Current Clinical Trials Activity in Puerto Rico

Scientists estimate between $7 million and $9 million is spent on clinical trials in Puerto Rico each year. Spending typically falls into one of five different types of clinical trial: treatment trials, prevention trials, diagnostic trials, screening trials, or quality of life trials. Funding for clinical trials in Puerto Rico either comes from the government (such as the federal government, through the NIH, or the Commonwealth government, through the university system), private sources (such as philanthropical foundations), or from corporate sponsors (such as the pharmaceutical companies). It is in Puerto Rico’s best interest to make a concerted effort to attract greater investment in clinical trials from all of these sources.

Puerto Rico is currently participating in the “Study of Tamoxifen and Raloxifene (STAR)” breast cancer prevention clinical trial, which is designed to determine whether the osteoporosis prevention drug raloxifene (Evista) is as effective as tamoxifen (Nolvadex) in reducing breast cancer risk. The study runs through 2010. Presently there are 10,397 participants in the US, 43 of who are in Puerto Rico. That amounts to just 0.41% of the US participants, despite the fact that the Puerto Rico’s population (3.95 million) accounts for 1.32% of the sum of US and Puerto Rican populations (298.75 million [294.8 million plus 3.95 million]). In other words, even though Puerto Ricans are participating in the STAR clinical trial, they are being under-represented by a factor of 3.2.

One area which is a prime candidate for increased research in Puerto Rico is breast cancer, which is the leading cause of cancer deaths among Hispanics. Some key issues which Puerto Rican researchers should approach regarding breast cancer include:

- The fact that Hispanics have a lower breast cancer rate than whites and blacks (the rate for Hispanics is 69.8 per 100,000, compared to 111.8 per 100,000 for non-Hispanic white women and 95.4 per 100,000 for black women).
- The fact that the breast cancer rate for Hispanics is growing faster than it is for women of other ethnicities.
- The fact that the mortality rate for breast cancer is so much higher in Hispanics than in other ethnicities.

According to Dr. Christopher Li, of the Fred Hutchinson Cancer Research Center in Seattle, socioeconomic factors (such as the lack of access to healthcare, or differences in the quality of healthcare available) “are likely to play the most important role” in the difference in breast cancer mortality rates found in different ethnicities, which means that this unfortunate trend
can be reversed.\textsuperscript{36} For instance, one new study suggests Puerto Rican women are 50\% more likely to receive substandard care for breast cancer.\textsuperscript{37} The survival rate is lower in Hispanic women largely because of the advanced stages of the disease at time of diagnosis.\textsuperscript{38} Only 38\% of Hispanic women above the age of 40 have regular mammograms, which is the best way to detect breast cancer in its early stages.\textsuperscript{39}

### Closing the Gap in Clinical Trials

The fact that the National Institutes of Health (NIH) are currently recruiting Puerto Ricans for 170 different clinical trials shows that there is strong demand for participants with Puerto Ricans’ unique genetic base. However, almost all of these clinical trials are based in the US, so Puerto Rico is receiving very little in the way of the positive externalities – the knowledge, know-how, and indirect economic activity that tend to trickle down into the communities where the research is based. What’s more, based on the size and genetic significance of the Puerto Rican population, the number of NIH-sponsored clinical studies in Puerto Rico should be much higher than 170. The problem is that Puerto Rico is not considered a hub for medical research – if it were, then the key research activities would be occurring on the island, stimulating innovation, and leading to commercialization opportunities as well.

One of the Puerto Rico’s most glaring shortcomings regarding clinical trials is that although cancer is one of the greatest threats to Puerto Ricans’ well-being, the National Cancer Institute (NCI, a branch of the NIH) is not currently performing any clinical trials in Puerto Rico. Nor is Puerto Rico involved in the Community Clinical Oncology Program (CCOP), a program which has been described by Dr. Peter Greenwald, Director of Cancer Prevention at the NCI, as “the primary force behind prevention, cancer control, symptom management, and quality of life research.”\textsuperscript{40}

The CCOP is a network of research centers across the US that enables physicians and patients to participate in clinical trials designed to answer specific questions about the effectiveness of new ways to prevent, detect, diagnose, and treat cancer. Although the CCOP has been in existence now for over twenty years, and although there are 66 CCOPs located across the US, eleven of which are specialized in researching cancer in minorities, there are no CCOPs located in Puerto Rico. The establishment of a minority-based CCOP center in Puerto Rico should be a key element of the island’s strategy to close its gap in clinical trials.

\textsuperscript{36} American Cancer Society  
\textsuperscript{37} American Cancer Society  
\textsuperscript{38} Breast Health Online  
\textsuperscript{39} American Cancer Society, National Cancer Institute  
\textsuperscript{40} National Cancer Institute
Big Idea Number 3: Leveraging Puerto Rican Expertise in High-Tech Manufacturing

Resident in Puerto Rico is a talent pool of companies and firms that are considered global leaders in the design, construction, operation and maintenance of very expensive and highly sensitive manufacturing campuses. As manufacturing becomes a long-term hot-button issue for increased economic development, Puerto Rico must create a means to both brand itself as a repository for such know-how and ‘sell’ its knowledge to interested market players.

In the short term, Puerto Rico should consolidate its resident expertise in designing, constructing, and operating technology facilities. In the medium to long term, Puerto Rico should promote its resident expertise through global learning.

Manufacturing Asset Base

Puerto Rico has set the global standard for the development and operation of efficient process manufacturing. Productivity growth in the manufacturing sector continues to be among the highest in the world. Puerto Rico’s export-oriented manufacturing economy has not stimulated sizable growth in the island’s support service industries, however. Financial, accounting, and legal services as well as risk capital remain import industries despite growing demand. Puerto Rico’s proximity to both the Latin American and US economies provides it a strong competitive advantage as a transport and logistics hub to facilitate and coordinate the growing volumes of trade between the continents.
As Figure 66 shows (above), employment in labor-intensive manufacturing is on the decline. Given the intense competition from low-wage Asian competitors, this is trend is not surprising. Nor is it likely to reverse. More important to Puerto Rico’s future are its high-tech manufacturing jobs. Figure 66 shows that employment in this sector is holding relatively steady – a better trend than that in labor-intensive manufacturing, but it would be better still if employment were rising in the high technology manufacturing sector.

It’s significant to note that while industry accounts for 42% of Puerto Rico’s GDP, it employs only 20% of the labor force. What this means is that on average, manufacturing jobs create twice as much wealth for the economy as service jobs. There are a number of reasons for this – first of all, as we have seen, a large percentage of Puerto Rican industry is in high-technology, high value-added areas.

In contrast, the majority of its service jobs are unskilled, low-paying jobs in tourism or related sectors. Factory jobs are also inherently more productive in general than service jobs, as they are more capital-intensive and benefit more from technology and economies of scale. Puerto Rico needs to maintain and increase this advantage in productivity, as it is the key to competing successfully with competition from low-wage countries. The downside to higher productivity in industry is that it is more difficult to create new jobs in this area than it is to create new service sector jobs – Efficiency gains through technology often mean more work can be done with an equal or even lesser number of workers.
Accommodation and Food Services as a sector is representative of unskilled service labor in general. This sector is particularly important to Puerto Rico, because of the important role that the tourism industry plays in its economy (tourism accounts for roughly 7% of GNP and 60,000 jobs)\textsuperscript{41}. It is clear from figure 68 not only that workers in this sector receive significantly less in Puerto Rico than they do in the mainland US, but that they are experiencing a downward trend in wages. While this sector represents an important foundation of Puerto Rico’s economy, in order to succeed in the future Puerto Rico must shift its emphasis towards creating more higher-skilled, higher-wage jobs.

Health Services is a very important sector which will grow even more important in the next two decades as Puerto Rico’s population ages and the healthcare needs of senior citizens increase. Although wages in this sector grew steadily throughout the 1990s, wage growth has stagnated since 2000, and the wage differential between Puerto Rico and the mainland has increased (figure 69).

\textsuperscript{41} http://welcome.topuertorico.org/economy.shtml
Although only 20% of the Puerto Rican labor force is employed in industry, industry represents 42% of Puerto Rico’s GDP. Manufacturing, especially of pharmaceuticals and medical instruments, is still the backbone of the Puerto Rican economy. Wages in manufacturing are on average about two thirds the level of those in the mainland US, making Puerto Rico a very attractive location for American companies to build production facilities (figure 70). On the other hand, Puerto Rican wages are higher than wages in many of its Latin American neighbors and Asian competitors, and as a result Puerto Rico is experiencing intense competitive pressure in manufacturing.

The manufacture of medical instruments and supplies is a key component of Puerto Rico’s manufacturing sector. It is a relatively high-technology industry in which Puerto Rico has a certain competitive advantage, and it pays comparatively well.
However, while wages in this sector continue to rise, employment has dropped (figure 71). Whether this is due to the increased substitution of capital for labor, or to other factors such as the changing competitive environment, it is a worrisome trend in an economy experiencing chronically high unemployment.

The employment trend in pharmaceutical manufacturing is much more positive (figure 72). This sector serves not only as the current backbone of the Puerto Rican economy, but is also the foundation upon which Puerto Rico is building its high-tech economy of the future.

Puerto Rico’s electronics industry may act as a springboard as well, and in fact Puerto Rico is well-positioned to take advantage of future opportunities in high-tech electronics manufacturing. However, as the downward employment trends in figure 73 show, the electronics sector is currently suffering, most likely due to intense foreign competition.
Conclusion

Summary of the Road Map Process and Conclusions:

The Road Map process has told the story of innovation and economic development in Puerto Rico, and shown that Puerto Rico is an island in transition which stands at a crossroads. Global trends in science and technology which Puerto Rico can take advantage of to spur growth have been identified, as well as competitor regions and countries which are already taking advantage of those trends.

Through analysis of the relevant data and input from key stakeholders on the ground, both gaps and opportunities have been identified in Puerto Rico’s competitive position. Through the Hot Team process, small action teams of academic, industry, public sector, and national expertise coalesced around six Targets of Opportunity:

- Cluster Mapping & Engaging Broader Stakeholders,
- Resident Expertise in Pharmaceuticals and Biotechnology,
- Expatriate Science & Technology Networks,
- Leveraging Existing Initiatives,
- Workforce, Skills, & Competencies, and
- Branding & Marketing.

Concentrating on these Targets of Opportunity allowed the Hot Teams to avoid wasting time and resources on less-promising possibilities. Instead, the Hot Teams were able to hone in on a particular field and gather the specialized resources, talent, and assets necessary to become a premier destination for scientists, researchers, entrepreneurs, investors, and corporations interested in that specific industry.

The recommendations which came out of the Hot Team process provide a clear picture of what it will take for Puerto Rico to close the gaps and meet the opportunities presented in the Road Map. Critical to success in meeting these objectives will be the extent to which Puerto Rico can create consensus around the four strategic commitments:

- Agree upon a new business model
- Taking action is not an option, it’s a necessity
- Puerto Rico must focus its resources and efforts on a few key Next Steps
- A collaborative, consensus-based, integrated strategy is necessary

What should Puerto Rico do now?

Puerto Rico needs to concentrate on the recommendations stemming from the Fundamental Actions (which will form the foundation for prosperity and innovation and help Puerto Rico maintain its competitiveness in the global marketplace), and the Big Ideas (forward-looking
thrusts which will help Puerto Rico differentiate itself from its global competitors). The table below lists the next steps Puerto Rico should take over the next three years and beyond, including specific actions and critical milestones to mark its progress.

### Next Steps and Critical Milestones

#### Immediate/Short Term (0 - 18 months)

<table>
<thead>
<tr>
<th>Next Steps</th>
<th>Specific Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Digital Portal for Research, Technology &amp; Skills</td>
<td>Design digital portal, collect readily-available existing data, survey for future data to be captured, launch site that is searchable and updatable. Form Data Architecture Team immediately.</td>
</tr>
<tr>
<td>2. Puerto Rico Science &amp; Technology Global Network</td>
<td>Identify initial list of expatriate-related organizations and lists to survey. Create the email network among survey respondents, link the network into the Digital Portal, host first annual Puerto Rico S&amp;T Innovation Network Summit and Hall of Fame recognition luncheon. Link network members to on-island implementation teams.</td>
</tr>
<tr>
<td>3. Future Workforce Learning Resource Center</td>
<td>Design the Puerto Rico Workforce Continuum of high schools, community and technical colleges, four year institutions, and industry and public workforce system representatives around pilot career pathways. Utilize the Mayaguez project as the test-bed initiative.</td>
</tr>
<tr>
<td>4. Physical and Virtual Innovation Zone Puerto Rican Hubs and Nodes</td>
<td>Physical Innovation Zone – first and foremost, the Governor, Legislature, and Civic leaders need to agree that Puerto Rico will invest in academic research at a level that is commensurate with global competition. Then, build the human and physical infrastructure to attract research grants and contracts as well as recruit top-flight principal investigators. Upgrade over 1 million sq ft of laboratory space (estimated time and cost = 10 years, $3 billion). Support development of Roosevelt Road Science Park Concept Proposal. Begin the construction of the Molecular Science Complex, the Biotech Pilot and Center for Processing Research, and the Pharmacy School on a new Health Science Center Campus. Issue a global RFQ around the concept of financing, master developer, and advisor for the Campus. Virtual Innovation Zone – simultaneously construct a commercialization center and staff an Office of Commercialization and Innovation that attracts experienced management talent and technology transfer skills by linking a hub concept with the existing nodes across the island. Initiate the Innovation Zone concept by capturing the best principles, performing site visits, and recruiting a globally-recognized director for the Innovation Zone program.</td>
</tr>
<tr>
<td>5. Research &amp; Commercialization Center and Incubator [C&amp;IT] (Technology Transfer)</td>
<td>To achieve critical impact from the investment in basic research, create the Innovation Incubator program that focuses on the value chain of vendors, suppliers, products and services in growth companies ($10-30 million) and a handful of start-ups. Form a capital development fund that identifies an initial core of patent-based opportunities, licenses, and attracts emerging technologies that connect with the science agenda outlined above to Puerto Rico. Create an operating model for island-wide commercialization incubators.</td>
</tr>
<tr>
<td>6. Marketing and Branding of Puerto Rican Technology Capabilities</td>
<td>Create a S&amp;T Marketing Working Group that will identify best practices in branding and marketing strategies leading to a new $10million one-year campaign in partnership with Puerto Rican Tourism, Convention-Visitors, and related public relations efforts of the PRFAA. Support the initiative through the creation of the Expatriate Global Network by hosting 8-10 regional briefings on the Road Map. Identify 3-5 national and global conferences in which to hold networking events, and secure 1-3 global life science-related conferences in Puerto Rico.</td>
</tr>
</tbody>
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#### Medium Term (19 - 36 months)

1. The creation of a Puerto Rico Grant Management and Funding Strategies Team
2. The creation of a Global Manufacturing Facility Design and Operation Certification
3. The establishment of Centers of Excellence in Applied Research

#### Long Term (> 3 years)

1. The establishment of a Global Center for Clinical Trials and Clinical Research
2. The establishment of a Regional (Caribbean, Latin and South America) Comprehensive Cancer Center
Endnotes:

i US Central Intelligence Agency
ii New Economy Strategies, LLC
iii New Economy Strategies, LLC
iv New Economy Strategies, LLC
v New Economy Strategies, LLC
vi US Central Intelligence Agency, A.T. Kearney
vii United Nations CEPAL
viii Marquez, Carlos. Caribbean Business.
ix A.T. Kearney
x Bloomberg Markets
xi Ernst & Young, Global Biotechnology Report 2004
xii New Economy Strategies, LLC
xiii Ernst & Young, 2003
xiv State of California Governor’s Office, May 2003
xv New Economy Strategies, LLC, The Brookings Institution Center on Urban and Metropolitan Policy, 2002
xvi US Central Intelligence Agency
xvii US Central Intelligence Agency
xviii US Central Intelligence Agency
xix US Central Intelligence Agency
xx US Central Intelligence Agency
xxi US Central Intelligence Agency
xxii United Nations Statistics Division
xxiii CHI Research, Inc.
xxiv CHI Research, Inc.
xxv World Intellectual Property Organization
xxvi RAND RaDiUS
xxvii RAND RaDiUS
xxviii RAND RaDiUS
xxix RAND RaDiUS
xxx RAND RaDiUS
xxxi RAND RaDiUS
xxxii RAND RaDiUS
xxxiii RAND RaDiUS
xxxiv RAND RaDiUS
xxxv RAND RaDiUS
xxxvi RAND RaDiUS
xxxvii 2004 Southern Innovation Index, Southern Growth Policies Board
xxxix US Department of Commerce
xl US Department of Labor
xli US Department of Labor
xlii Draper, Fisher, and Jerretson
xliii BioWorld, Biotechnology Industry Organization
xliv PricewaterhouseCoopers MoneyTree
xlv New Economy Strategies, LLC
xlvi New Economy Strategies, LLC
xlvii New Economy Strategies, LLC
xlviii New Economy Strategies, LLC
xlix US Central Intelligence Agency
l The Economist
The Puerto Rico Life Sciences Road Map

April 2005

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ii New Economy Strategies, LLC
li UNESCO
liii UNESCO, *A.T. Kearney
liv National Science Foundation
lv 2004 Southern Innovation Index, Southern Growth Policies Board
lvi Tecnología para la Organización Pública
lvii New Economy Strategies, LLC
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lix National Health Interview Survey, National Center for Health Statistics, CDC
lx National Health Interview Survey, National Center for Health Statistics, CDC
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lxiv National Vital Statistics Surveillance System, National Center for Health Statistics, CDC
lxv New Economy Strategies, LLC
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lxvii United Nations CEPAL
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lxix Economagic.com, New Economy Strategies, LLC
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