

# **Puerto Rico in Search of a New Development Strategy: The Legacy of Low-Wage Manufacturing in a High-Tech Global Economy**

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## Executive Summary

***Context and Motivation.*** Manufacturing has been the primary force driving Puerto Rico's economic development. However, the expansion of the Island's manufacturing industries as part of Operation Bootstrap relied on a combination of privileged access to the U.S. market, abundant low-wage workers, tax incentives, and a stable policy environment that are no longer available on the Island. Moreover, globalization and changing market conditions have eroded the development value of mass-market manufacturing and placed a premium high-technology and high-skill production. Today, the manufacturing sector continues to generate nearly half the Island's GDP and employ nearly 10% of its labor force. However, its survival as an engine of economic development requires new strategic approaches toward supporting the sector— strategies that identify the competitive assets which Puerto Rico has retained as a legacy of past development and then adapt these assets to meet the demands of specific dynamic industries within the contemporary global economy.

***This Report.*** This document conveys the results of an exploratory study designed to identify the legacy of Puerto Rico's postwar development strategy and the potential of that legacy as a platform for further economic growth and development. It is based on a broad-based reading of secondary sources on recent economic and political developments on the island and on two rounds of interviews that were conducted in 2011 and 2012. In the first round, we held a series of open-ended interviews with key informants from business and government about the island's current economic situation. The second round was a much more targeted set of interviews with individual companies and various organizations and institutions that were working with them. These interviews examined the specific activities in which these firms and organizations were engaged to strengthen manufacturing's competitive position and enhance its contribution to economic growth and development more broadly.

*Findings.* The first set of interviews was on the whole extremely pessimistic and focused on the obstacles to further growth and prosperity. Business leaders expressed a universal recognition that the old development strategy had run its course. They articulated the need for leadership to construct an alternative but also expressed a sense of disillusionment with government and the highly partisan politics which seems to dominate policy. In contrast, the second round of interviews, consisting of field visits to manufacturing plants, revealed how a new development strategy that draws on the legacy of the past has in fact already begun to emerge. It has three components:

- *Regional Development in the Knowledge Economy.* This strategy is based on an operating alliance of local actors supporting local entrepreneurship and educational reforms, under local government leadership and using a combination of local and outside financial resources. Specific examples include two regional development organizations, PRTECH and INTECO, that have been active in coordinating investments and supporting the development of new firms in higher-skilled, “knowledge” industries such as software, aerospace, and medical equipment manufacturing.

Together PRTEC and INTECO seem to address many of the complaints and concerns about the Island’s economic development which emerged in our first round of interviews: its drift, lack of direction, and the partisanship of central government. It is in this sense that the two organizations point toward a new development strategy. Specifically in this respect, some of their distinguishing characteristics include:

1. *Stable leadership* and staff that includes government, business, and university representatives in order to foster long-term, cross-sector, and bipartisan cooperation.
2. *Diversified funding* sources that partially circumvent the tight constraints the economic crisis has placed upon spending by the Commonwealth government.

3. *An explicit development strategy* that articulates a set of specific industrial targets which take into account the advantage of particular regional characteristics. This strategy involves the creation of regional organizations and institutional relationships to help meet these industrial targets.
- *Upgrading Existing Manufacturing.* This second strategy involves upgrading the efficiency, quality, and value of production at existing manufacturing facilities by employing advanced production management techniques, rendering companies already located on the island more competitive. The Puerto Rico Manufacturing Extension (PRiMEX), has been the leader of these efforts on the Island. It provides consulting services to firms in a wide variety of industries focusing especially on “lean” production techniques that improve efficiency by reducing in-process inventories and implementing total quality control and root-cause analysis. This emphasis on efficiency represents a strategic approach for holding on to and expanding employment at manufacturing facilities that are already in operation but that are under threat of closing or moving in response to increased competition.
  - *Expanding the Local Value-Added of Multinational Companies.* This third strategy arises from the efforts of managers and engineers in the branch plants of multinational companies to expand the range of activities performed on the Island from traditional manufacturing production to associated services and product development. An example of this strategy is Microsoft’s effort to facilitate the emergence of a software industry on the Island to design peripherals for Microsoft products in Latin America. These efforts have led the company to become heavily involved with both INTECO and PRTEC. Further examples are local manufacturing operations that have positioned themselves as intermediaries who offer their parent companies “design for manufacture” consulting services.

*Puerto Rico's Competitive Advantages in Manufacturing.* All three strategies are based on a view (held implicitly by some actors, explicitly by others) of the comparative advantages that arise from the legacy of Puerto Rico's earlier manufacturing development. This legacy consists of

- A pool of highly skilled production and craft workers,
- A pool of professional workers with experience in manufacturing management and engineering
- A privileged position in regulated U.S. markets—markets where intellectual property protection is of special importance.

While currently under increasing competitive pressure, the Island's success in the pharmaceutical industry has been based on these factors and its nascent aerospace and medical device industries draw potential from the same advantages.

*Looking ahead.* This report recommends an in-depth research program, based in Puerto Rico but with the possible aid of MIT, that would extend these findings and identify policies which would support and sustain the development of a full-fledged alternative to the immediate postwar development strategy. This research program should deepen and consolidate knowledge about the three components of the nascent development strategy described above:

- *Regional Development.* There are three key questions related to regional development strategies. First, why have INTECO and PRTEC seemed to function better than the regional development organizations created in three other regions (INTENE, INTENOR, DSUR)? Answering this requires an examination of the latter three organizations as well as a more in-depth study of INTECO and PRTEC to better specify the scope of their success. Second, how were the founders of INTECO able to develop a coherent strategy for that region and induce cooperation among municipalities governed by different political parties and by leaders with individual ambitions? Third, what was the role of PRIDCO been in PRTEC's success and what does it imply about the renewal of this historically important development institution?
- *Upgrading Traditional Manufacturing.* Future work should survey what local manufacturers and the Puerto Rican branches of multinational companies have done

to: a) upgrade production techniques; and, b) try to capture higher value-added activities within their industries. Researchers could then interview the companies that are most advanced in both areas in order to identify the forces which are propelling their efforts and to look for clues for how laggard companies could be induced to follow.

- *Expanding the Local Operations of Multinational Companies.* A set of in-depth interviews and a written survey of the local branches of manufacturing multinationals, parallel to the one proposed above, would permit us to judge 1) how extensive the expansion of branch plant activities within their parent companies has been; 2) what can be done to support those efforts already underway; and 3) identify interventions to encourage the dissemination of this strategy.

## *Introduction*

This report documents the results of an exploratory study designed to identify the legacy of Puerto Rico's post-WWII development strategy rooted in low wage, manufacturing production and the potential of that legacy as a platform for further economic growth and development, presumably built on a different, and hopefully more robust, strategy. It is one of a series of exploratory studies on the Island's economy that we are conducting at MIT with the support of the Foundation for Puerto Rico. This paper summarizes the findings of the exploratory project and then identifies a more definitive research project designed to develop the ideas that emerged in the preliminary research.

In defining the focus here on manufacturing, three caveats in order. First, we excluded completely the pharmaceutical and biopharmaceutical industries from our purview. This leaves out roughly one-half of the current manufacturing sector, and the part of the manufacturing sector—indeed of the Puerto Rican economy more generally—that has been most dynamic in recent years. But it was thought that the dynamics of the pharmaceutical industry and the factors making for the Island's success in this area were peculiar and the general lessons which could be drawn from them quite limited. In retrospect, we think that this was probably a mistake, a point upon which we will expand below. In subsequent work, we hope to integrate the two pieces of the study.

A second caveat relates to agriculture and food processing. These, too, are the subject of a separate study and we did not attempt to cover them here, but again there are general lessons to be learned from the food industry in Puerto Rico, and lessons from the manufacturing legacy for food processing which we hope to draw out in later work. Finally, while we will talk here about the manufacturing legacy, manufacturing as an analytical category in economic analysis is somewhat anachronistic. In the past, the manufacturing sector tended to produce standard goods through mass production techniques. There is now an increasing tendency to produce specialty goods tailored to niche markets and to the needs of particular customers, or to combine standard products with software and services which differentiate and customize them. To this extent, the old division between manufacturing and services is blurred; the legacy of a manufacturing strategy is often found in these other areas, a point which clearly emerged in our company visits. In other words, one might expect to find the legacy of the island's

earlier focus on manufacturing production in design, software, or other activities which would generally be classified as services.

The report begins with the broader picture—what might be called the conventional wisdom about the structural constraints on Puerto Rico’s development—that emerged in our initial interviews. The second section describes the contrast that arose from the company visits and other interviews in the latter part of the study. This section describes the outlines of an alternative manufacturing development strategy that is arising in the field. Finally, the third section concludes by proposing the set of research projects that would need to be carried out in Puerto Rico in order to design and implement policies that could fully develop the elements of firm-level strategy that we have identified into an economic development strategy for the Island’s manufacturing industry more broadly.

### *The Conventional Wisdom: Puerto Rico’s Development Impasse*

People on the Island are not optimistic about its economic prospects. But they distinguish sharply between short run problems associated with the U.S. economic crisis, and possibly some financial mismanagement on the island and a much more fundamental structural crisis. The focus in our discussions was on the latter. Here, the conventional wisdom which emerged again and again in the first round of interviews is that the Island’s economy is in serious trouble because it has exhausted the potential of its postwar development strategy and has not managed to construct an alternative to replace it. The old strategy, Operation Bootstrap, was dependent on low-skilled manufacturing plants attracted to the Island by wages lower than any other location within what was then the protected domestic market of the United States. The Island was able to leverage this wage advantage through special tax incentives and governmental subsidies afforded by its special commonwealth status, which other jurisdictions could not provide. This strategy was eroded in the course of the late 1990s: a) by globalization and the opening of the U.S. economy to imports from lower wage, developing economies abroad (particularly Mexico through NAFTA and then China); b) through technological changes and changes in consumer tastes which shifted demand away from mass production to more differentiated products that require more highly skilled engineers to design and



develop and more highly educated labor to produce; and c) by changes in the U.S. tax code and regulatory legislation which limited Puerto Rico's wage and tax advantages.

This basic structural problem has been aggravated by the political environment and the deteriorating fiscal situation. The Commonwealth government had become, according to our interviewees, dysfunctional: politics had degenerated into partisan squabbles, with no effective leadership or development strategy. There is little continuity in programming from one Administration to another: each has tried to install its own people in existing programs and/or change the programs in order to take political credit or deny it to the opposition.

The lack of government leadership contrasts sharply with the role government had played under Operation Bootstrap and the extensive organization under PRIDCO and FOMENTO. Those agencies acted not only to recruit companies and attract them to Island locations from the States, but once a company located on the Island they sought to hold it there through continual interaction with management and an aggressive effort to identify their needs and concerns and to respond to them. Emblematic of the new, dysfunctional role which politics has come to play is the conflict surrounding the Science, Technology and Research Trust. This was an organization set up as an independent institution and designed to lead a new development strategy, rooted in a "knowledge economy", but its professional leadership was driven out of office when the government changed.

*Groping for Alternatives: Puerto Rico's quest for entrepreneurship and the knowledge economy*

It is not completely obvious what an alternative economic strategy would look like, but discussion generally focuses on two approaches that, in the end, may not be completely different from each other. These alternatives are widely discussed in other countries which, like Puerto Rico, have relied historically on attracting low wage manufacturing as a development platform and now feel forced by circumstances to find an alternative (such as Ireland, Singapore and Mexico), and in a somewhat different guise, have been also discussed in the scholarly literature. One is the idea of the "knowledge economy", presumably the impetus for the Technology Trust initiative. The

model here is something like Silicon Valley in California or Cambridge in Massachusetts in which economic development is driven by new products. The discussion generally focuses on products coming out of information technology or developments in biology and bioengineering. But one might look in other areas such as new materials or scientific instruments. The products in this model are generally brought to market by small entrepreneurial firms, and thus an emphasis is placed on venture capital and an entrepreneurial culture. The small firms may then grow into major companies (e.g., Google, Facebook, Apple) or they may be bought out by larger concerns (a pattern typical in the pharmaceutical industry and in medical devices).

The other model is one in which the economy moves up the value chain of more traditional industries, steering away from the low wage mass production that is characteristic of Operation Bootstrap, toward more highly differentiated products, the greater value-added activities associated with product design and development, and an emphasis on the provision of services which help the customer use the products that are produced in a more effective or efficient manner. This model is not generally associated with entrepreneurship, but—in the sense that the services associated with product differentiation and customization lend themselves to the development of small-scale, innovative firms—it is also fostered by an innovative, entrepreneurial economy. A significant difference is that entrepreneurial service firms generally require less capital and are hence less dependent on a venture capital industry.

These two strategies are related in the sense that the more highly value-added activities are often thought to involve new technologies, especially product customization and differentiation through software (although this need not be the case). But this second strategy suggests that the older manufacturing base and the knowledge associated with it would serve as a platform for moving upmarket in a way that the idea of a knowledge economy does not. In other words, the knowledge economy model, taken at face value, seems to suggest that Puerto Rico must compete with such high-tech centers as Silicon Valley and Cambridge, Massachusetts, which are linked to elite world-class universities, while the value-chain model implies that the new development strategy builds on a base of a legacy that is already present. Both strategies, however, require a much more highly skilled labor force than that which sustained mass-production manufacturing during

Operation Bootstrap. This points toward the strategic importance of the Island's educational system, albeit in a way that is more closely linked to scholarly research in the first strategy than the second.

In our initial discussions on the Island, both of these strategies were frequently mentioned, though in largely in vague, abstract terms. Our interviews gave no sense that Puerto Ricans understood these strategies in a way which provided a guide to action, nor that actions—the Technology Trust being a major exception—had been undertaken to achieve them. We did encounter a tremendous amount of entrepreneurial activity, and one felt that a definite ideology of entrepreneurship was developing on the Island. However, our interviewees spoke about entrepreneurship as a thing in itself, without reference to the larger context in which the entrepreneurial businesses operated and as though personal motivation, and not the broader economic environment, was the key to the Island's economic success. They spoke almost as if entrepreneurship constituted a cohesive development strategy in the sense that Operation Bootstrap, or the knowledge economy or moving upmarket, were strategies of development.

Actors placed lot of emphasis in these discussions on pharmaceuticals as the one part of the manufacturing sector which had held its own in recent years. But some saw that as an expression of special characteristics of the industry which made it especially sensitive to the tax advantages of a Puerto Rican location, not relevant to the manufacturing industry more broadly. They talked about the industry's success on the Island as fragile, under heavy threat from technological changes and increasing global competition (the very forces which had undermined the Island's bootstrap strategy originally), and not an expression of forces which could also stimulate growth in other sectors.

A final issue that emerged in our initial interviews—and one that seems particularly relevant to this project—is the use of consultants from outside of Puerto Rico in evaluating economic performance and generating development strategy. As outsiders ourselves, we were particularly sensitive to this theme. There are a seemingly endless series of reports extending well back into the early postwar period discussing the Island's economy and examining various approaches to improving it. The authors of these reports range from scholars and academics to private consulting firms and government agencies.

For example, one review of reports on Puerto Rican economic strategies from 1966 to 2002 lists 16 reports by Commonwealth agencies, three reports by the U.S. government, and 14 reports, mostly by outsiders, commissioned by local government and nongovernment agencies. Between 2004 and 2006 an additional six reports were added to the list, three by outside consultants, two by Puerto Rican government agencies and one by the U.S. government. Since 2006, there have been at least two other major studies, one by the U.S. government and one by the Brookings Institution working with the Center for the New Economy (CNE) in San Juan. Some of them involve people from the Island as advisors or participants in one form or another, but the reports are almost never generated on the Island itself. And this raises the question as to why all this expert advice has not been more successful in helping the Island to address its problems.

### *The View from the Field: emergent strategies for manufacturing growth*

A very different view of the development prospects on the Island was generated when we left San Juan to conduct a second round of interviews at field sites arranged for us by the Puerto Rico Manufacturing Extension (PRiMEX).<sup>1</sup> The field sites were not in any sense random, but—and this is important in assessing what we found—the sites were chosen to expose us to successful *companies*. They were not selected to illustrate the emergence of a new development strategy; such a strategy did, however, begin to emerge in the interviews. That strategy had three pillars: one was a series of regional development centers. A second can be seen in the efforts of PRiMEX itself to upgrade existing manufacturing facilities and redirect their efforts for competing from a low wage strategy to one based on productive efficiency. A third pillar of the new strategy is represented by efforts of the Puerto Rican managers in U.S. branch plants, which had located on the Island initially in response to tax incentives, to move upmarket within their companies toward higher value-added activities.

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<sup>1</sup> PRiMEX is an extension agency that was created in 1986 as part of a U.S. federal program under the National Institute of Standards (NIST) to upgrade small and medium sized businesses.

### *Regional Development in the Knowledge Economy*

There are actually five regional centers, but two of them stand out: INTECO, centered in Caguas in the South center of the Island and PRTEC in Mayagüez in the West. The other three centers are less active, for reasons that we did not explore.

#### *INTECO*

INTECO is a tripartite organization whose governing board brings together representatives of the municipal governments in the region, representatives of local businesses, and university representatives. It operates under a special law passed by the Island's Legislature in 2003 to permit this form of organization, which was previously nonexistent on the Island. The organization has a permanent staff, the principle members of which have been there from its inception in 2003. It has a range of projects focused on building a science and technology infrastructure as a platform for future development and the development of technology-oriented businesses, the majority of which, it seems, have been software developers. Those projects include: the upgrading of the curriculum in primary and secondary schools of the region to place greater emphasis on science and technology; the creation of a new elite (and very selective) high school oriented toward science and technology; and a business incubator to promote technology-oriented entrepreneurial ventures. It has also developed a variety of new programs at the university level to meet the needs of local business that were designed cooperatively by business leaders and university faculty.

Examples of the most successful companies associated with INTECO include a firm developing software for the management of municipal finance and services and a company that is basically focused on prototype development for manufacturing that began with design software but is now linking the design to the production of hard models. A third company is developing packaging for pharmaceuticals. INTECO has also been working closely with Microsoft to promote peripherals development (about which more below).

INTECO is by common consensus the creation of the William Miranda Marín, the charismatic mayor of Caguas, working in close alliance with the Sistema Universitario Ana G. Méndez. The law permitting the tripartite structure under which it operates was

designed by Miranda who then shepherded it through the Legislature. Miranda conceived of the organization as part of a broader municipal development program for Caguas. The structure and focus is the outgrowth of field visits that he organized and led to regional development centers in the United States (notably North Carolina) and Europe. Miranda managed to persuade and cajole leaders of the other *municipios* in the region into active participation, despite the fact that these leaders came from the two parties which have found it so difficult to work together at the national level. The INTECO organization has managed to circumvent not only the political obstacles which plague the national government's development projects, it has also circumvented the financial constraints faced at the national level by drawing upon contributions from municipal government as well as federal and foundation grants. The financial contributions from local government seem particularly significant since they indicated a real, as opposed to rhetorical, commitment to the development strategy.

### *PRTEC*

PRTEC was founded at about the same time as INTECO, and is structured in a manner very similarly, with a board of local government, businesses and universities. Like INTECO, it sees itself as fostering cooperation among these three constituencies. It also has a stable, permanent staff. But its organization does not seem to depend on the special legislation which sanctions the organizational structure of INTECO. It is unclear, moreover, exactly where the initial impetus came from, and it is not rooted in local *municipios*. The central government, and in particular PRIDCO, has been much more important in its operation, and the organization has received a good deal more funding from PRIDCO. The staff director at PRTEC himself underscored that they recognized the problem of continuity in central government development policy and deliberately used PRTEC as a vehicle to circumvent that problem. In fact, he left the impression that this had been an important part of the motivation for creating the agency in the first place. But PRTEC, like INTECO, also gets supplemental funding from the Federal government and foundation grants. Some of its activities parallel those of INTECO, including the creation of a new business incubator and the development of university curricula,

programs and degrees oriented to the needs of local businesses. Microsoft has been active here too in promoting the training of software developers.

PRTEC, however, has focused on a cluster strategy emphasizing aerospace and medical devices and has used PRIDCO financial and technical support to promote firms in these industries very much along the lines of the traditional PRIDCO model, although it should be emphasized these are not the traditional low-wage, low-skilled manufacturing industries that were the focus of the old PRIDCO strategy. It has had, moreover, notable success as measured by the traditional development yardstick of employment creation. The aerospace cluster, for example, began from nothing at the beginning of the last decade. Since then, it has attracted millions of dollars in investment and added hundreds of jobs annually, and it now employs thousands of Puerto Rican workers.<sup>2</sup>

Together PRTEC and INTECO seem to address many of the complaints and concerns about the Island's economic development which emerged in our first round of interviews: its drift, lack of direction, and the partisanship of central government. It is in this sense that the two organizations point toward a new development strategy. Specifically in this respect, their distinguishing characteristics are six-fold: first, they have been in existence for a relatively long period of time (since 2003). Second, they have stable leadership and staffing, which is, or has been at least, impervious to the election cycle. Third, they have a board of directors (also stable), composed of representatives of government, business and universities; the organizations see themselves as bridging across these different stakeholders and promoting the kind of cooperation among them that is necessary to generate development. Fourth, they have multiple sources of funds, and, in this sense, they partially circumvent the tight constraints the economic crisis has placed upon spending by the Commonwealth government. Fifth, they are committed to a well articulated development strategy, which

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<sup>2</sup> See for example "Se dispara la industria aeroespacial." March 10, 2007. <<http://www.cienciapr.org/es/external-news/se-dispara-la-industria-aeroespacial>>. retrieved 7/7/2013; "Despega la industria aeroespacial en Puerto Rico." March 19, 2010. <<http://www.noticiasonline.com/D.asp?id=28598>>. retrieved 7/7/2013; and "Crece la industria aeroespacial en la Isla." Sept. 28, 2011 < <http://yasta.pr/crece-la-industria-aeroespacial-en-la-isla>> retrieved 7/7/2013.

basically incorporates both the theme of the knowledge economy and of moving upmarket. They have translated these themes into a series of specific industrial targets, designed to take advantage of their regions' particular location, history and characteristics: In INTECO, the emphasis has been on software, but on software focused on particular service areas and manufacturing; PRTEC has focused on aerospace and on medical devices. Finally, they have also created new institutions. Both have created incubators for start-up entrepreneurial firms. INTECO has created a technically oriented high school designed to steer students into scientific and engineering degrees. Moreover, they have worked to reorient existing institutions. They have attempted to mold the degrees offered in local universities to the specific needs of industry in the surrounding areas, sponsoring new teaching programs and new forms of technical certification.

The rhetoric surrounding these new institutions is very similar to the vague references to the knowledge economy and to the discourse of entrepreneurship that we encountered in our initial interviews. But it was not only rhetorical; it was grounded in practice and programs and was rooted in a recognition of the importance of the broader economic and business environment in which the individual business people operate. The "knowledge curriculum" is directed at the specific needs of business as articulated by firms in the region; those firms hire the graduates both as interns while they are still in school and as employees when they graduate, so the programs are continually tested against the requirements of practice. Correspondingly, the entrepreneurship is directed at the kinds of economic activities which the organizations have determined are consistent with a broader regional development strategy.

Whether the new strategy here is likely to produce enough jobs to make a serious dent in the Island's employment deficit is of course a different question. A second important caveat is that only two of the five regional centers appear to be operational. However, it appeared that regional cooperation was definitely emerging as a new strategy of development. Moreover, the strategies employed by these regional development organizations were based on an articulated view of the comparative advantages that arise from the legacy of Puerto Rico's earlier manufacturing development. This legacy includes a pool of highly skilled production and craft workers, a pool of professional workers with experience in manufacturing management and engineering, and a privileged



position in regulated U.S. markets, markets where intellectual property protection was of special importance. Thus, instead of seeing pharmaceuticals as a particular and peculiar case, these actors saw it as an example of an industry which drew on these advantages and hence could serve as a general model that could undergird the development of other industries, albeit probably not at the same scale. Aerospace, for example, grew up after 2001 because of the renewed emphasis on doing activities which involved strategic military technology within U.S. national borders. Medical devices, like pharmaceuticals, are within the regulatory jurisdiction of the FDA, which is concerned not only with the efficacy of the devices but also with the conditions under which they are manufactured.

### *Upgrading Existing Manufacturing*

PRiMEX (Puerto Rican Manufacturing Extension) is leading the effort to upgrade production techniques in manufacturing on the Island. It is an organization created in 1986 as part of a federal program under the National Institute of Standards (NIST) and designed to upgrade small and medium sized businesses. NIST and PRiMEX offer what might be thought of as consulting services. These services are directed at making manufacturing companies aware of the latest developments in the organization of production and helping them to adopt new approaches to upgrade their production facilities. Most of the techniques which NIST and PRiMEX have been promoting are an extension of approaches that originated in Japan and are generally referred to as “lean” production. These include, most notably, the elimination (or at least reduction) of in-process inventories, total quality control, and root-cause analysis.

What is significant here, we believe, is that, although these techniques have been known and widely discussed in the management literature for almost thirty years, and despite the fact that PRiMEX itself has been in existence and promoting these techniques on the Island for almost as long, some of the Island’s leading manufacturing facilities are only now becoming interested in them and beginning to adopt them. It is notable as well that many of the Island plants with which PRiMEX is working are branch plants of major multi-national companies, rather than the small- and medium-sized businesses for which the NIST manufacturing extension program was designed. One tends to think of these large companies as more attuned to the latest techniques for manufacturing management.

However, there is a certain selectivity to the companies that have, at least historically, chosen to locate their manufacturing on the Island. That selection works to bias manufacturing on the Island toward companies that look toward low wages and taxes, rather than management and organization, as they make location decisions.

Two examples which came up *incidentally* (in the sense that they were not anticipated when the companies were selected by PRiMEX for our visit and were as much a surprise to our guides as they were to us) in the course of our interviews will illustrate this point. One is a manufacturing plant which, at the behest of the company headquarters in the U.S. mainland, had hired a Japanese consulting firm to come and train the plant in lean production techniques. The Japanese firm was chosen despite the fact that it was extremely expensive and its trainers spoke neither English nor Spanish, so the training had to be provided through consecutive translations. PRiMEX could have provided equivalent training in Spanish (and/or English) at considerably lower rates (probably one half to one third those of the Japanese). What we found most surprising was that the headquarters company was apparently just discovering Japanese management in the new millennium and felt compelled to go to Japan to learn about it, whereas leading manufacturing firms in the U.S. have known about these techniques for some time, and there is an enormous literature, not only about the techniques themselves, but about how to adapt them to the cultural and business environment of the U.S., which is so different from the Japanese context in which the techniques were “invented”.

A second case was a company that switched only recently from a very rigid assembly line organization of production to a system of bench assemblies. The new system was considerably more flexible than the old one in at least two respects: first it was easier to switch from one product to another; under the chain assembly, the whole line had to be reorganized and retooled each time the product changed. Second, the new system could be more easily adjusted to different sized runs of a product; the workers were cross-trained in several operations and hence it was possible to move easily from short runs in which a single worker effectively built the whole product (or a significant part of it) to longer runs in which each worker did one or two operations, as they might on the assembly line. What was particularly interesting about this example is that the company—which we have worked with and studied in other contexts—is in many ways

emblematic of the conflicts which plague not only Puerto Rico but U.S. manufacturing more broadly, as it attempts to compete against low-wage production abroad. The company's basic competitive strategy is to produce a very large number of distinct (and specialized) products, and over time it has used increasingly sophisticated technologies to expand its product capabilities. It thus sees itself as (and in fact actually is) particularly innovative and entrepreneurial in its approach to the market. It has been featured as an example of this strategy of customized mass production in prominent business texts. This competitive strategy has never been compatible with chain assembly, and it lends itself to small batch production using highly skilled workers who can move from one of its multiple products to another in response to product demand. But surprisingly, it has instead operated its manufacturing facility in Puerto Rico using low-skilled labor and attempted to deal with product variety by maintaining large inventories. During the whole period in which the company has been producing in Puerto Rico, it has been fighting a battle with excessive inventories associated with the very wide range of product components which its strategy entails. So, why is the company only now abandoning chain production? The answer seems to be that, despite its advanced product design and marketing strategy, the company has always sought to minimize product costs by locating manufacturing in low-wage areas which offer tax advantages. It was this which led to its initial location in Puerto Rico. It has a second plant in one of the very small Southern Caribbean islands where the wage and tax advantages are even greater than in Puerto Rico, but which is truly primitive in terms of worker skills and plant organization. It also has new facilities in Mexico and in China, both of which were chosen as low-wage production locations.

These two cases, especially the latter, suggest that the Island's production efficiency has been handicapped by the legacy of its older low-wage strategy and the traditional mindset of the companies which that strategy attracted. As a result, plants which might have sought in other contexts to compete by improving productive efficiency and introducing new management techniques have instead sought to compete through minimizing wage rates. This may be particularly true of Puerto Rico because of its position within the broader U.S. market, but it may actually be a trait of U.S. manufacturing companies more broadly, and helps explain why the U.S. as a whole has

been so laggard in adopting Japanese manufacturing practices. It would also explain the speed with which U.S. production has moved to low-wage locations in China, Mexico, and Central America despite the considerable problems they have had working out the logistics and coordination problems associated with these locations. The first case related above—of the U.S. company turning to Japanese consultants in 2012 for management techniques which have been well known and widespread in the U.S. for some time—also suggests an excessive focus on wage rates, as opposed to management practices.

What does this imply about the future of manufacturing on the Island? It is doubtful that the PRiMEX approach could actually attract new manufacturing facilities to the Island. Here, in fact, the wage rates and the tax advantages are probably extremely important in attracting managerial attention when a company is choosing a new location. But it certainly seems that the emphasis on efficiency is a reasonable approach to holding on to manufacturing facilities that are already in operation and have already made substantial investments in a Puerto Rican location that would be lost if the company its production operations. Moreover, if the existing facilities can be made more competitive through these reforms, their owners could be induced to expand production (and employment) on the Island as well. The strategic advantage of preserving these firms is suggested by the third kind of initiative we encountered: efforts of existing facilities to extend the range of activities in which they are involved beyond simply production.

### *Expanding the Local Value-Added of Multinational Companies.*

The third approach to using the legacy of the earlier postwar manufacturing strategy as a platform for further economic development is suggested by the efforts of branch facilities of multinational companies to move beyond production into other corporate activities. These endeavors are hard to explore and document because they typically involve complex maneuvering within the organization, in competition with other parts of the company in other locations, and because the people engaged in them are not anxious to have their efforts generally known. However, we came across several initiatives of this kind in our interviews. Three will illustrate the point.

The first of these, actually not at all secret or confidential, is the effort of Microsoft to facilitate the emergence of a software industry on the Island to design

peripherals for Microsoft products. As a company spokesman explained to us in interviews, Microsoft was initially attracted to the Island by the relatively low wages and the tax advantages, as was typical under Operation Bootstrap. Its initial operations on the Island were facilities to burn CDs. However, once located in Puerto Rico, Microsoft has been actively seeking other activities to support the company's competitive position. This is generally true at all their locations, but Puerto Rico is specifically viewed as a potential platform for the servicing markets in the Caribbean and Latin America. That potential was sufficient to attract a German manager from the Brazilian branch of the company to head the Puerto Rican operation. The efforts to create a peripherals industry have led the company to become heavily involved in both INTECO and in PRTEC and, through these organizations, in the development of curricula at the high school and the university level.

On a less optimistic note, the future of Microsoft is heavy tied up with the movement toward cloud computing, and the placement of cloud facilities is the major prize currently up for grabs in the company's locational decisions. The very high energy costs on the Island preclude Puerto Rico from being a candidate; although countries with a similar development history, based on low-wage manufacturing and also trying to develop a strategy of moving toward high value-added activities, are strong candidates for the cloud centers in their regions (e.g., Ireland for Europe and Singapore for Asia).

The other examples we encountered of efforts to expand the range of activities beyond production are not as open or explicit as Microsoft's efforts. In one large manufacturing facility of a major technology company, we met a team of engineers which was positioning itself as the intermediary between the company's design facilities in California and manufacturing production. Their notion was that they would guide new products from the basic idea and crude prototype developed in the lab to a manufacturable prototype, before bringing new products into commercial production in the facility in Puerto Rico. Significantly, the role they were proposing to play was based on their knowledge of production developed through experience in the Puerto Rican facility, but the role itself was as an intermediary between design and production, basically the provision of what would be classified as a business service. Also of significance, the engineering unit and the role which they were coming to play in the

company grew out of a Commonwealth government grant program that was originally a recommendation of an Arthur D. Little consulting report. The R&D group in California began working with the engineering group in Puerto Rico because the grant made the services of the PR engineers essentially free. The budgetary constraints within the parent company at the time were such that the R&D group would otherwise never have been able to bring in “outsiders,” even drawn from other divisions of their own company, to provide this service. A second group in the same Puerto Rican facility, a software diagnostics group that was set up by the plant manager, was also seeking to become “inside” consultants to other company facilities on the mainland.

A second plant we encountered was moving to play a bridging role between design and production very similar to that in the first company, using production workers rather than engineers. They sent a team of production workers from Puerto Rico to the company’s product development facility in the U.S. to participate in the final design stage before the product was handed off to the plant on the Island to be produced. The team made a number of suggestions, which were incorporated into the product design, to facilitate the manufacturing process by making it easier for production workers to maneuver on the line and reach the parts of the assembly they were working on. The production worker “consultants” also managed to reduce the number of different parts involved in assembly and to standardize a number of components, further reducing parts inventories.

In these last two cases, the new role of the Puerto Rican branch plant played off the idea of “design for manufacture”—the idea that one could significantly reduce the cost of a product by standardizing the parts and reconfiguring the elements of the product in ways that facilitates the production process and reduces the parts inventories required to sustain production.

Again, it is doubtful that the role these plants were coming to play within their respective companies would ever have been enough to induce the company to locate the plant in Puerto Rico in the first place. But given the fact that the facility was already there, one could imagine that the expanded roles the plant was coming to play within the company would induce the company to maintain its Puerto Rico location and possibly expand it. Certainly that was the way in which the people involved conceived of their efforts.

### *Toward Future Research*

My own work for this project has been focused on the question of what kind of economic growth strategy could be built upon the legacy of low-wage, unskilled manufacturing that was the fulcrum of the highly successful development strategy of the initial postwar decades (Operation Bootstrap), which has now run its course. We identified three basic elements of such a legacy strategy, each of which is in one way or another already in operation, if not fully recognized as such. Time and budget limitations did not permit us to explore any of these elements in depth, let alone gauge how they might be strengthened and extended. We concluded, nonetheless, that these pieces of the manufacturing legacy are sufficiently promising that they warrant further exploration.

Such a project would have scholarly interest in the context of debates in a number of countries and international agencies about how to use low-wage manufacturing as a base to move upmarket into what is commonly but rather vaguely termed a “knowledge” economy. It would certainly be important in Puerto Rico in both a “psychological” and a “real” sense. It would be important psychologically because of the widespread pessimism on the Island about its economic prospects, a pessimism which makes it difficult to hold anyone accountable for success or failure. It could also prove important in a real sense if indeed the elements we have identified were, on closer inspection, to prove to have the potential that our initial work suggests.

Subsequent work should draw much more heavily on the scholarly researchers and expertise in Puerto Rico itself. There is actually a considerable knowledge base on the Island in each of these areas. The Island experts may be too closely associated with the elements of a development strategy with which they have been working to be a credible voice in the policy debates on the Island, and possibly too closely associated with particular projects too narrowly conceived to see their potential strategic significance. To the extent that this is true, MIT participation would give the work of people on the Island itself more credibility and visibility, albeit with MIT playing at most an advisory role.

The three areas we outlined in the body of the text are: 1) a regional development strategy; 2) upgrading existing manufacturing facilities to make them more reliant on

efficiency and less on wage levels and taxes for their competitive advantage; and, 3) moving upmarket in existing branch plants of national companies into higher value added corporate activities. In each of these areas, the research that needs to be carried out in order to gauge their potential and to understand how they might be extended as a development strategy is as follows.

*Regional Development.* There are three key questions related to regional cooperation as a development strategy. One is why the regional development organizations created in two of the Island's regions seem to function better than the ones created in three other regions. This involves, in part, looking at the organizations in the three laggard regions (INTENE, INTENOR, DSUR), which we did not do at all. But it also requires a more in-depth study of the two successful regional development initiatives, INTECO and PRTEC. These two regions, and their initiatives, actually have rather different histories. INTECO was really the work of William Miranda Marín, and we need to know in some detail what exactly he did to induce cooperation within the initiative among municipalities governed by different political parties and by leaders with individual ambitions. It is important also to understand how he developed a coherent strategy for the region and identify the role of the field trips he organized and of various consultants from the Island and from elsewhere. The transition from William Miranda Marín to his reportedly less charismatic son will help to sort out the role of different factors here.

Similarly, in the development of PRTEC the central government through PRIDCO played a more prominent role than in the case of INTECO, one which seems to contradict the view that PRIDCO is outdated and ineffective. Particularly, in thinking about the extension of the regional strategy, it is important to understand how much this is true and exactly what the new role of PRIDCO has been and how it came to innovate in this way.

There are actually several researchers on the Island with MIT connections who are knowledgeable in these areas. One is a professor at UPR Rio Piedras who has a MIT DUSP Ph.D. and who was actively engaged as a consultant with both INTECO and PRTEC. She would certainly be a major player in this project and possibly, assuming her



work does not compromise her objectivity in the eyes of the audience on the Island, could lead it. There are also two DUSP students who did their Masters degrees on INTECO.

*Upgrading Traditional Manufacturing.* For the work on upgrading existing companies, one could look to PRiMEX for leadership. They may already have done some of the necessary analysis as a foundation for their own work. Basically what is required here is a list of the Puerto Rican facilities of multinationals and then a survey of what each of those facilities has done to: a) upgrade production techniques; and, b) try to capture higher value-added activities within the company.

One could then subsequently interview the companies that are most advanced in both areas in order to identify the forces which are propelling their efforts and to look for clues for how laggard companies could be induced to follow. Again, MIT might serve as a consultant in this effort, helping to structure the research, drawing out its policy implications, and giving it visibility in the policy debates, but our role would be subsidiary to the role of Island institutions.

*Expanding the Local Operations of Multinational Companies.* Here again a study survey, parallel to that suggested for upgrading manufacturing above, would permit us to judge 1) how extensive the expansion of branch plant activities within their parent companies has been; 2) what can be done to support those efforts already underway; and 3) encourage the dissemination of this strategy. This research would have to operate on two levels: a series of in-depth interviews based on personal contacts and a broader survey based on a written questionnaire. The need for personal contacts again dictates a study rooted on the Island rather than at MIT or at other “outside” research facilities.