

HP's R&D and HPPR HPTC: Aligning with the Leaders while Advancing Puerto Rico's R&D Competitiveness

September 2005

By

Lueny Morell, Director University Relations, HPLabs, Palo Alto, Chiqui Santos, VP and General Manager HP ISB Americas, and Lucy Crespo, General Manager HP PRMO

Executive Summary

This white paper presents HP's strategy, how staying focused innovation is critical to delivering high tech, low cost, best customer experience, as described by Mike Lynberg, HPNow, May 12, 2004. It also highlights HP Puerto Rico's operation strategy to add/bring more value to the company by engaging in the innovation and discovery processes in partnership with Puerto Rico's Government, industry and academia. The process by which HPPR developed its Technology Center and its major outcomes and future opportunities for HP and Puerto Rico's transformation into a knowledge based economy are described.

Innovation and Discovery

How important is innovation? Successful companies know that ideas are a precious currency and innovation an essential capability. Without innovation — turning good ideas into useful products and solutions that anticipate and meet changing customer needs — they are condemned, at best, to a desperate struggle to catch up and, at worst, to eventual obsolescence. "Leadership is not inevitable and even great leadership positions can slip away, and great brands can become tired and irrelevant," HP CEO Carly Fiorina has said. "Success, leadership and relevance require work day in and day out, and they also require the ability to change ahead of markets, not behind markets."

An integrated approach to innovation

To change ahead of markets and lead, HP recognizes that innovation must be fostered and managed across the company as a whole. Indeed, HP is a complex system of businesses, technologies, systems and capabilities, which together give the company a unique market position and competitive advantage. To make the most of its diverse parts, the company needs an integrated strategy — as mentioned earlier in this series — and an integrated approach to innovation.

The Office of Strategy and Technology (OST), led by Executive Vice President and Chief Strategy and Technology Officer Shane Robison, provides a companywide system of processes and governance that together provide guidance to decision-makers throughout HP. Within this

framework, OST works with HP's business groups to execute a "focused innovation" investment strategy: Invest in areas where HP can create unique value and partner for the rest.

"I've said many times that this company can do anything, but it cannot do everything," Carly observed. "We invent and add value on top of industry standard technologies and partner for the rest. Being focused allows us to get the most from our technology investments and greatly increases our ability to lead in areas critical to our future success."

Technology roadmaps

HP invests nearly \$4 billion (US) a year on research and development (R&D). To ensure HP invests the right amount, in the right places and at the right time, HP Labs, business R&D, chief technology officers (CTOs), marketing leaders and advisory boards work collaboratively. Together, they analyze technology forecasts, market and business drivers, and competitor and partner assessments to develop Technology Roadmaps. These roadmaps shape strategy around long-term products and technology directions, as well as partnerships and investments.

HP's technology advisory councils

To ensure that HP is leading technology change, the Office of Strategy and Technology (OST) has a number of advisory boards, including:

- The Strategic Technology Advisory Board — a group of luminaries from the IT industry
- The Customer Technology Advisory Board — a group of CIOs and other executives representing some of HP's most important customers
- The Chief Technology Officer Council — 15 of HP's senior technology leaders who meet regularly to assess and guide innovation at HP

OST also facilitates regular meetings of the Board of Directors' Technology Committee, a subset of the HP Board of Directors, which influences and evaluates major decisions related to innovation at HP.

To get the most from its investments in innovation, HP builds on industry standards and focuses on areas where it can add unique value and lead. This means that HP does not try to be everything to everybody; rather, it leverages the roughly \$10 billion that its partners collectively spend on R&D — partners such as Intel, Microsoft and Oracle — and makes strategic choices to innovate in ways that will bring unique value to customers and create a competitive advantage for HP in the marketplace.

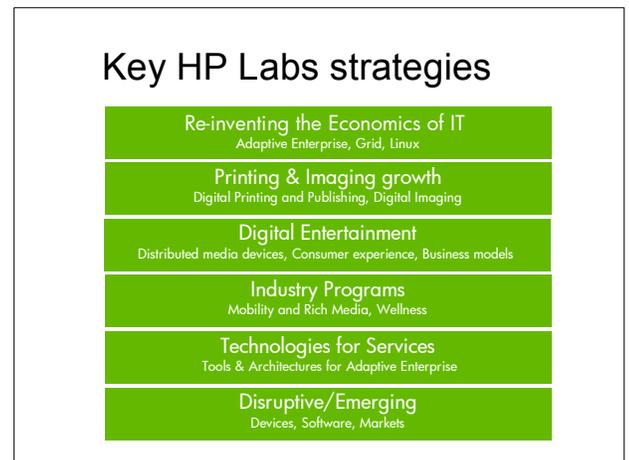
In addition, HP maximizes the return on its R&D investments — and executes on its strategy — by leveraging innovations across the company. For example, HP's leadership in digital imaging technology is being applied to new markets such as digital projectors, and HP's expertise in printing is being leveraged across systems ranging from entry-level home photo printers to high-end office printers, to commercial-quality digital presses. ***In Puerto Rico, HPPR's leadership***

in thermal inkjet technology is being applied to healthcare/life-sciences solutions.

Inventing the future

As HP's central research organization, HP Labs' mission is to deliver breakthrough technologies and technology advancements that meet customer needs, provide a competitive advantage to HP and create new business opportunities. Scientists and engineers in HP Labs also pursue fundamental research in select areas — for example, nanotechnology.

CTOs for HP's many businesses work with HP Labs and HP's business leaders, and report into OST. They are accountable for translating the broader company and industry perspective into a specific technology agenda that will help each business to win. Dick Lampman, director of HP Labs, noted, "CTOs and the product teams in HP's businesses focus on innovations that can be brought to market within about three years, and we focus on technologies that can be brought to market in three to 15 years. In a sense, we are all working to invent the future. The future we're helping invent in Labs is just a little more distant — but it tends to get here pretty fast."



Collaborating with HP's businesses

When an HP Labs invention nears marketability, a product team is formed in the appropriate business to make it a success with customers. For instance, the Utility Data Center (UDC) product is being transferred from the Labs to the Technology Solutions Group, where it will become the first example of HP's Adaptive Enterprise vision.

Labs researchers also sometimes help their division partners with longer-term projects. "We have started on a number of ideas and then realized that it will take five or six years or more to develop the necessary technology for them," said Rich Duncombe, director of the Advance Product and Device Lab in HP's Imaging and Printing Group (IPG). ***"When that happens, we reach out to our research partners in IPG, HP Labs and even universities or national labs when appropriate." HP has selected the University of Puerto Rico at Mayagüez as one of the top tier universities in the US, together with MIT and Georgia Tech. As one of its principal research academic partners, HP has engaged UPRM in research projects of international recognition (Gelato: itanium 64 on Linux platform research, joining the Pittsburgh Supercomputing Center, and Singapore bioinformatics Institute among others) and of new emerging technologies, such as Digital Publishing, where they will be writing the technology papers in this new area of research. As a result, HP has donated***

around \$500K in equipment and resources to UPRM and is supporting faculty and graduate students in HP's areas of research interest.

Inventors in HP Labs collaborate frequently with HP's businesses, meeting regularly with HP's product teams. "A team from Labs was here last week," commented Dan Forlenza, vice president, Notebook R&D. "They had sessions with our desktop, mobile and handheld groups, and we shared our projects and discussed some of our challenges with them. They, in turn, made us aware of some of the technologies they're developing."

In addition to working with technology transferred from HP Labs, business groups invest significantly in innovation of their own. ***HPPR research and development portfolio is currently focused on four HPL key strategic areas: Adaptive Enterprise, Grid and Linux, Life-sciences/Wellness (including tools for the adaptive enterprise), and Digital Publishing.***

Innovation in HP's businesses is often evolutionary; that is, product teams focus on making incremental improvements to HP's products and solutions, based on customer input and fresh insights from the innovators themselves. These evolutionary improvements are extremely important as HP endeavors to extend its lead in certain product categories and build success in others.

Product managers, HP Labs researchers, CTOs and key technology partners collaborate to develop Strategic Architectures for HP's product and solutions. This enables horizontal consistency by aligning HP products, solutions and services, to ensure that products work together and leverage industry standards.

The unique requirements of certain customer groups, or potential customer groups, also drive innovation at HP. For example, product teams in HP's Personal Systems Group (PSG) invented a rugged jacket for HP's Tablet PCs so physicians and other hospital workers could clean them with antiseptics without damaging them, and so the tablets would be more durable if dropped or bumped in a busy hospital setting.

Another example of product innovation is making HP notebook computers lighter and more durable than those of its competitors, and to make them run cooler and with less fan noise. In addition, the Notebook PCs team has a number of other, confidential innovations in the works, all based on leading edge technology that will enhance the customer's experience and make HP Notebooks an even better value in coming months — high tech, low cost, best customer experience.

The innovators' dilemma

As companies such as Kodak and Sears demonstrate, evolutionary innovation is sometimes insufficient to ensure long-term success. Clayton Christensen, a professor at Harvard Business School and author of *The Innovator's Dilemma* and *The Innovator's Solution*, observes that large companies can become so focused on serving existing customers and making steady

improvements to their existing products and services that they sometimes lose their ability see and produce revolutionary breakthroughs — innovations that would create entirely new customer segments.

How does HP get around this dilemma? How does it focus on immediate customer needs while also nurturing and providing resources for new and potentially disruptive ideas? "To begin with, HP has always been quite good at being its own tough competitor," observed Duncombe in IPG. "The textbook example is how HP Labs created inkjet technology, which competed directly with HP's LaserJet technology."

In addition to breakthroughs produced by HP Labs, HP's businesses also have mechanisms in place to ensure the capture and development of revolutionary ideas that can be brought to market within two or three years. In IPG, for example, Duncombe leads a function called New Business Creation, which is dedicated to identifying, capturing and developing new business opportunities for IPG. **One of the R&D divisions at HPPR is part of Rich's team, having already identified several new business opportunities for IPG and HP.**

All HP business groups have teams in place charged with creating new businesses. "We move some disruptive ideas to Labs, and others we foster ourselves," said Gary Campbell, CTO, Enterprise Storage and Servers. "Linux is a good example of a disruptive technology being developed within the company."

Another R&D division at HPPR has developed a partnership with HPL in Palo Alto around one of HP's principal technologies and businesses: Adaptive Infrastructure, which involves technologies for Grid Computing and the concept of the Utility Data Center.

For HP—an early visionary in distributed computing concepts - grid computing is more than a utopian dream. HP's grid-enabling products are already helping enterprises draw upon IT resources everywhere in the world to meet their computing needs. Grid-enabling is a key element of HP's virtualization strategy, in which organizations move toward combining disparate resources into virtual pools, thereby making them more accessible, manageable, productive, and cost effective.

There are a lot of definitions of grid computing floating around, but all of them share the common theme of harvesting and aggregating geographically dispersed computing power and data. In keeping with its notion of grid computing

News release



HP Becomes First Commercial Member of CERN Large Hadron Collider Computing Grid
HP resources to be part of operational version of CERN's massive computing project to manage, analyze research data

PALO ALTO, Calif., Jan. 27, 2004 – HP (NYSE:HQP) today announced it will support an operational grid for the Large Hadron Collider (LHC) at CERN, the European Laboratory for Particle Physics.

The LHC, the world's largest scientific instrument, enables research into the fundamental nature of matter. It is in the final stages of construction at CERN's facility outside Geneva.

HP will link computing resources of its HP Labs locations in Palo Alto and Bristol (U.K.) as well as HP Brazil and HP Puerto Rico to CERN's LHC Computing Grid (LCG) to help manage and analyze the massive quantities of data expected to be produced by the facility.

HP joins in the second phase of the project. CERN is launching LCG-2, the latest version of the software for the massive computing grid dedicated to the LHC. The first phase of the LCG project – LCG-1 – involved a limited number of sites around the globe. With LCG-2, the list of contributing sites is expected to grow rapidly into an operational, worldwide computing grid that will scale to the proportions necessary to accommodate the data produced by the LHC.

"HP is thrilled to be the first commercial member of CERN's LCG and to bring our technology to bear on this global grid collaboration of epic proportions," said Dick Lampan, senior vice president of research and director, HP Labs. "HP's commitment to grid computing spans scientific applications to enterprise deployments, and an opportunity to participate in the LCG will provide us with unique insight into the functionality and complexity of large-scale grid environments. Ultimately, HP's grid customers around the globe will reap the benefits of this collaboration."

When it becomes operational in 2007, the LHC will collide tiny fragments of matter (protons and nuclei) head-on to explore the fundamental laws of nature in intricate detail. These experiments are expected to produce

Editorial contacts:
John Rosenberg
Hil E. Knevel for HP
+1 415 281 7167
jrosenberg@hpl.hp.com

HP Media Hotline:
+1 866 266 7272
pe@hp.com
www.hp.com/go/newsroom

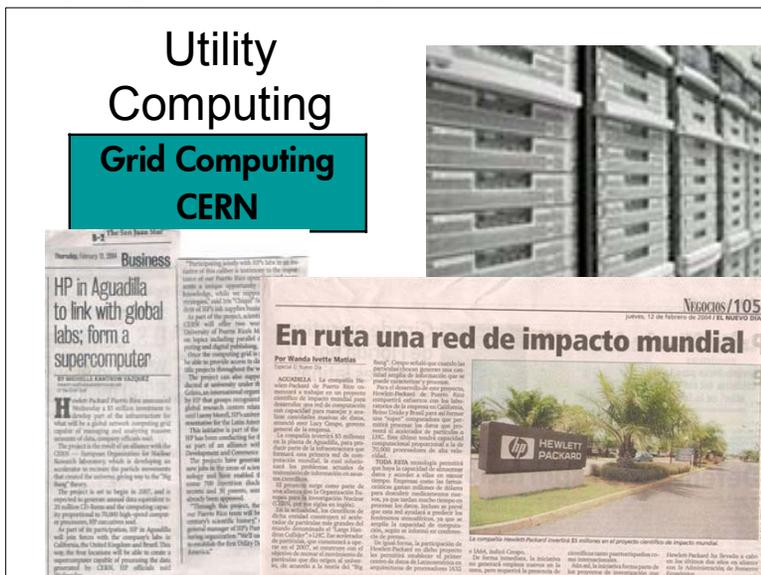
Hewlett-Packard Company
3000 Hanover Street
Palo Alto, CA 94304
www.hp.com

as a real and increasingly essential business resource, HP's definition is straightforward: Grid computing is a middleware infrastructure that allows applications to securely share resources managed by different organizations in widespread locations. Middleware—software that allows communication among applications that were not designed to communicate with one another—allows organizations to access resources controlled by different organizations or located in geographically separated areas, with the goals of enhancing productivity, maximizing resource utilization, and achieving seamless collaboration. Grid computing is a complex and still-evolving technology. For reasons of security, authentication, and plain old logistics, many businesses are not ready to take part in external grid configurations. But that doesn't mean that they can't immediately enjoy the benefits of virtualization. HP is delivering many virtualization capabilities to individual businesses via its **Utility Data Center (UDC)**. The UDC helps solve the all-too-pervasive problems of scattered databases, storage sprawl, and isolated networks and servers by bringing them all under its virtual roof—a drag-and-drop environment that lets organizations view, allocate, and reallocate all of their resources on the fly.

It's important to understand that HP UDC and grid computing are different-but-complementary technologies that can work together to give you the best of both virtual worlds. Both provide resource virtualization and optimization; but while grid computing provides virtualization across geographic or organizational boundaries, HP UDC focuses on a company's internal data center. And as part of its virtual resource management capabilities, HP UDC can help address the security concerns of sharing internal resources and data on a grid. HP UDC can tightly control what resources an organization shares, and when and with whom it shares them. HP UDC can protect sensitive data and processes, exclude busy servers, and restrict shared computer cycles to the least busy times of the day.

Last January 2004 HP announced that it will support CERN, the European Laboratory for Particle Physics (the largest physics lab in the world), to be part of the operational version of its massive computing project to manage and analyze research data that its Large Hadron Collider (LHC) Computing Grid (LCG) will generate. LCG will be one of the first Operational Grids (24x7),

which has started operations early 2004 with about 20 sites and has a goal of being fully operational by 2007 with a total supply capacity: 100'000 PCs for 20 PB data. Several applications are targeted to run on LCG: Physics, Bio Informatics, Digital Media, Digital Publishing. **Tests are already being programmed and conducted between CERN, HP Labs (Bristol, Palo Alto), HP Puerto Rico and HP Brazil.**



As a result of these partnerships HPPR is currently building the third Utility Data Center for HP worldwide (besides Palo Alto and Bristol, UK), being able to expand its R&D and bring it to researchers on the Island in this new area of technology but also developing infrastructure capability and the human resources capabilities as its academic partner faculty and students (UPRM, and by default, the UPR system) partner with top researchers around the world and run experiments and applications in this unique IT infrastructure.

Nurturing new ventures inside HP

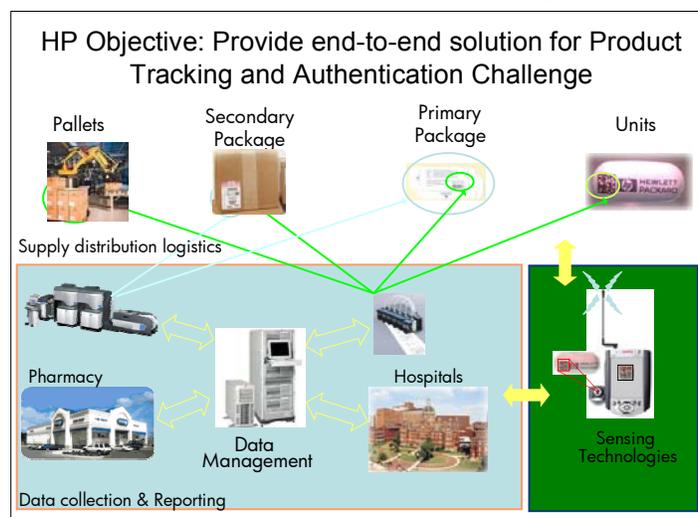
Christensen and other experts on innovation within large companies say that revolutionary and disruptive new ideas should be managed separately from the rest of a large organization, because new ventures need to have a different mind-set than established companies, and they need different resources and processes to succeed. For example, they need to be able to proceed intuitively, rather than backing their decisions up with heavy research and analysis.

"We set up separate teams to incubate our new businesses in IPG," said Duncombe. We don't physically move them away from IPG, because we want them to be able to tap the ideas and resources of our core businesses. But they are funded separately, and they are managed differently. The emphasis is not on profit performance in the early stages, but on learning and putting the right things in place for long-term success." ***HPPR has produced in 2 years more than 700 invention disclosures, 74 trade secrets and 30 patents, while some of the products developed by the Puerto Rican researchers are already being manufactured in Puerto Rico.***

Incubation for innovation

Similarly, the Strategic Initiatives team in OST, led by Felice Swapp, is focused on identifying business development opportunities and proof of concepts that support HP's strategic growth areas, including mobility and digital entertainment — rich media creation, management and distribution, as well as rights management.

Using technology roadmaps, the Strategic Initiatives team develops pilot programs with alliance partners such as Starbucks and other industry leaders to tangibly demonstrate proof of concepts that align with HP's strategic initiatives. ***In Puerto Rico, HPPR leaders are***



participating in Puerto Rico S&T Roadmaps, C&IT and LifeSciences, providing opportunities for leveraging and bringing new opportunities for HP operations and for Puerto Rico. Evidence of this is the end-to-end Product Tracking and Authentication solution HPPR is currently developing for the pharma/biotech industry, a pioneer event for the industry as well as the possibility of establishing new solutions and standards for the FDA.

Innovation, value and a great experience

Innovation is vital to HP's success now and in the future. It is required to solve complex problems and provide exceptional value for enterprise customers, create "smart offices" that are affordable for small and medium-size businesses, and to create experiences that enrich customers' lives.

"Innovation is our lifeblood," Carly has said. "The HP Invent logo is not just an advertising tagline. It is a fundamental representation of our past, present and future. Our challenge is to innovate in ways that are meaningful to our customers, and to do so at a price they can afford with an experience that sets us apart."

"To harness the tremendous innovative potential of this company, we must build on our tradition of market-changing technology innovations," added Shane Robison. "We must look across the whole system — across HP and our partnerships — to leverage the power of our portfolio and deliver unparalleled value to customers."

HPPR HPTC: the Future

HP has been operating in Puerto Rico for more than 25 years. In partnership with the Puerto Rican Government and thanks to its unique incentives, HP Puerto Rico has managed to successfully respond to the global economy and the challenges and opportunities it continuously brings to the table. Nevertheless, we realize that manufacturing is not enough, especially since other jurisdictions around the world such as Singapore, Ireland and Taiwan have already shifted from a manufacturing-based economy to a knowledge-based economy, which means adding activities and expanding the value chain. Engaging in the discovery and innovation process, the R&D. Facing this challenge, one HPPR's division asked questions such as:

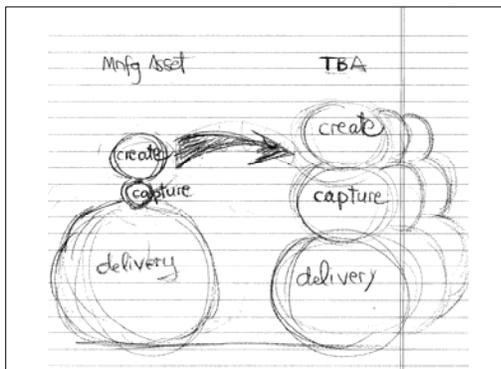
- If our success is a function of the value we add, where should we invest?
- Is being a world class manufacturing operation enough?
- What are our real/perceived boundaries? How real are perceived boundaries?
- Given the need for transformation, who owns this process? Who is going to make it happen?

These questions initiated a transformation in 1999, that etched a new vision: that of HPPR becoming a **Total Business Asset for HP**, that is to add more value to what it was currently

bringing in manufacturing (delivering quality products for the company) and engage in creating and capturing new business for HP.

The transformation process involved the following steps:

- Share and align vision with business strategies
- Characterization of threats & challenges (both internal and external)
- Characterization of ecosystem
 - Puerto Rico and the region
 - Alignment with our business strategies
- Development of our opportunities' portfolio based on strengths and capabilities and re-conceptualizing our Business Model: Total Business Asset and Deliver, Capture and Create new opportunities.



Creating value means invention, discovery (IP, Methods, Processes, Unique widgets....). **Capturing value** means capturing the created value by generating a business model that can make money. And **delivering value** means execution of the business model where value is delivered to the market. Thus, for ISB this transformation meant engaging in R&D, one of the reasons why HPTC needed to be established. A formal R&D organization, with goals, strategies and metrics for success was needed to facilitate the

innovation and creation process.

In the case of HPPR's Enterprise Systems business operation (known as Puerto Rico Manufacturing Operation or PRMO), the motivation to establish an R&D operation was to enhance Puerto Rico's value chain contributions to HP and to the business. PRMO HPTC serves as an HP-wide technical resource in the design, development and delivery of process, systems and product solutions. Currently, this HPTC R&D team is focused on research of innovative areas of critical importance for HP businesses and HPLabs: Adaptive Infrastructure and High End Computing Systems Architecture, Distributing Computing (Grid), Business Intelligence, and Supply Chain Applications. These R&D teams and centers of excellence develop, deploy and commercialize:

- Business unique web centric applications, on demand solutions, pay per use capabilities. The solutions are HP-UX-Linux focused, product oriented, and integrate converging technologies
- Business Intelligence Solutions that enable the development, management and deployment of analytical models
- Supply Chain process, system design, and development services for Global Operations IT

PRMO's HPTC offers HP a unique and very attractive value proposition to HP based on its ability to:

- Tap into wealth of technical experts available locally (highly skilled technical, business and management resources)

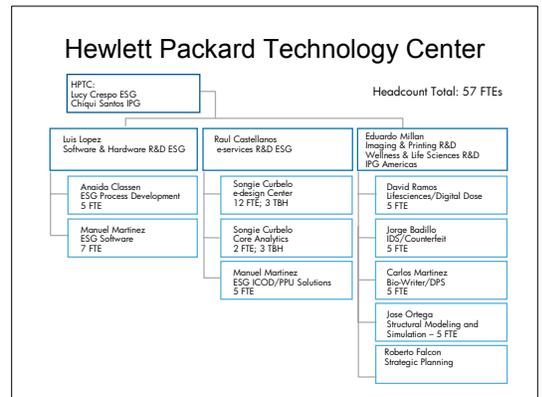
- Attract and retain top experts
- Lower fully loaded cost than USA
- Ease of setup and ongoing collaboration
- Leverage existing infrastructure and expertise
- Be at a convenient time zone with language advantages to conduct business
- Be an attractive design partner and pilot

Thus, in 2001 HPPR decided to approach the Government of Puerto Rico and invited to partner and venture in this new economic development strategy. Through its Pridco office granted HPPR a 5 year grant to establish the first bona fide R&D operation in Puerto Rico: HPPR’s Technology Center. The main goals of this center were to:

- enhance the company value
- enhance Puerto Rico’s economy
- focus on R&D of new technologies
- leveraging and enhancing HP and partners human capital and resource capabilities.

And its major objectives were, namely,

1. Design and develop products and processes that will enable revenue for HPPR from manufacturing and sales in the range of \$500 M per year once the products and processes are released
2. 50-75 new R&D jobs
3. Strengthen HPPR competitive position
4. Acquire and generate the necessary R&D skills to continue attracting business into HPPR
5. Enable partnerships and collaborative efforts with academia for the betterment of the process of preparing qualified professionals
6. Identify specific market opportunities and niches around the world where HP TC can focus resources in an attempt to guarantee its long-term viability and growth



Today, HPTC has a 57+ R&D organization, with three (3) research teams:

1. Software & Hardware R&D
2. e-services R&D
3. Imaging & Printing and Wellness & Life Sciences R&D

The table below summarizes some of the outcomes during the first two years of operations (2002-03):

Human Capital	57 HP R&D current 6 HP to be hired 22 HPPR lab-technical support 24 UPR associates (inc. 13 faculty)
R&D Projects	57 completed or ongoing

Intellectual Property generation	701 invention disclosures 30 patents (8 granted & 22 pending) 74 trade secrets over 75 publications and conference presentations
Business development and Puerto Rico	40 new products/processes developed enabling \$931 M of mfg revenue
Puerto Rico development	<ul style="list-style-type: none"> • R&D related Royalties Tax Withholdings: <ul style="list-style-type: none"> - \$32 M • HP Investment <ul style="list-style-type: none"> - \$11.1 M • R&D Employee Tax Withholdings <ul style="list-style-type: none"> - \$1.6 M • R&D related Municipal Tax ("patente") <ul style="list-style-type: none"> - \$1 M

Conclusion

We believe HPTC has achieved or exceeded all of HPTC’s objectives. The Center has established strategic alliances with HPL, HP BU’s Labs, Academia and other partners which are opening new areas of opportunities, such as Grid Computing, UDC, LifeSciences/Wellness that are aligned with Puerto Rico’s Industrial Clusters. These opportunities create an invaluable resource for Puerto Rico scientists and engineers providing a unique landscape and horizon to partner with top research groups around the world. We also believe there is an opportunity to further enhance current R&D activity in Puerto Rico in our Island’s quest to move to a knowledge base economy and the HPTC story can be used as a showcase to enable further investments in Puerto Rico to accelerate this transformation.

Acknowledgment

This white paper/briefing has been written with text adapted from **“Innovating to Lead: focused innovation is critical to delivering high tech, low cost, best customer experience”** by Mike Lynberg, HPNow, May 12, 2004