

# Accelerating Innovation @ HP Labs through University Collaborations

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## Abstract

*As the world's largest technology company, HP recognizes that innovation is vital to the revenue and relevance of our company. HP Laboratories is HP's central research group working on breakthroughs across HP's businesses and is at the core of that effort. HP Labs balances exploratory research with an entrepreneurial approach so innovative technology can be transferred more rapidly into commercial applications for customers. To do this effectively, HP Labs focuses research around high-impact areas where the company's customers are facing their biggest challenges and that represent the biggest growth opportunities for HP. This paper describes HP Labs' Open Innovation strategies, and the role university partnerships play in accelerating and augmenting the pace of innovation. It describes some of the programs, activities and outcomes of how HP Labs is weaving together minds, ideas and resources from around the globe to advance technology. Programs discussed include the HP Labs Innovation Research Program, the showcase cloud computing initiative Open Cirrus™, as well as intern, developer and post doc programs. Finally, the paper shares the benefits, challenges and lessons learned from the Open Innovation model.*

## 1. Introduction

According to Henry Chesbrough, "Open Innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. [This paradigm] assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology." [1]

HP recognizes that innovation is key to our company's vitality. However, in today's globalized world, ideas and innovation can appear both inside and outside of the company walls, and the path to commercialization today can take many different routes. In order for a company to successfully bring new products to market, it can no longer remain "closed" to the larger innovation ecosystem to which it belongs. Therefore, in order to capitalize on the global wealth of knowledge and ideas and accelerate the rate of creation and innovation, HP Laboratories (HP Labs), HP's central research group, works with partners in the international innovation network to advance a common technology vision.

HP Labs' goal is to join ideas, resources and minds together to amplify our research investments through partnerships with industry, government and academia. Open Innovation projects underway include joint research with universities worldwide, research programs co-funded by governments, and collaborations with customers and partners. The HP Labs Innovation Research Program, now in its third year, offers the global university research community an opportunity to partner with HP Labs on cutting-edge research topics, while organizing HPL's academic collaborations into a strategic and visible portfolio. The showcase initiative Open Cirrus™ has brought multiple corporate and university partners together to advance a shared cloud-computing agenda. Finally, focused engagement with government agencies in the US, UK and selected strategic geographies helps broaden HPL's reach and ability to conduct critical IT research. In developing each program, HP Labs targets one or more of the key outcomes of Open Innovation: bringing together minds, ideas and resources.

Another dimension of Open Innovation is technology transfer. Corporate research operations create business value through technology transfer. Thus, by working closely with key partners in their business units, they commercialize innovations that result from research. Once a specific technical approach has been demonstrated successfully, there are a number of ways in which companies can derive value from their work. In most cases, innovations become products or solutions for the company, commercialized by existing businesses or instigating the creation of a new business. However, many companies also pursue licensing the intellectual property they have created, spin-out technology into start-up companies, or use their results as input to future research projects.

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1 | The Ninth International Conference on Education and Information Systems, Technologies and Applications, July 19-22 2011, Orlando, Florida

## 2. University Collaborations: HP Labs Innovation Research Program

Now in its third year, the HP Labs Innovation Research Program (IRP) offers the global university research community an opportunity to partner with HP Labs on cutting-edge research topics, while organizing HP Labs' academic collaborations into a strategic and visible portfolio [2]. Designed as a global, open, competitive, annual call for proposals, each year HP Labs publishes a series of research topics on our public web site that are related to the 21 big bet research projects at HP Labs, and interested researchers are invited to submit proposals for a collaborative project that aligns with one of the solicited topics. IRP has attracted over 1,000 proposals from more than 250 universities in nearly 40 countries in three years. In 2008, IRP's inaugural year, HP Labs selected 45 projects at 35 institutions in 14 countries to receive HP Labs Innovation Research Awards. Since then, the program has grown due to its success: in 2010, HP Labs selected 65 projects at 52 institutions in 16 countries to receive awards. The results of these collaborations speak for themselves: in just three years, 179 papers detailing IRP-funded research were either published or accepted for publication, and 34 HP invention disclosures were filed [3, 4, 5, 6]. HP Labs has found that the Open Innovation model of partnering with about 60 university projects with the 21 big bet projects at HP labs results in about 3 university projects (each with one professor and one graduate student) per project. A typical big bet project at HP Labs involves 15-20 researchers. Using the Open Innovation model, HP Labs "expands" the intellectual capacity of the team with 3 professors and 3 graduate students, who bring complementary skill sets to bear on important research areas.

Professors who are collaborating with HP Labs have also commented on the value the IRP has provided to them and to their students: "My students get the opportunity to work on problems with a practical application," said Professor Kwan-Liu Ma of the University of California, Davis. "Furthermore, through our partners at HP Labs, we are able to obtain industry perspectives of each problem, leading to more comprehensive solutions." The benefits are also tangible for HP: Professor Ma's team is working with Kimberly Keeton, Senior Research Scientist in the Storage and Information Management Platforms Lab, on visually representing the complex relationships between documents and people, addressing the massive scale and overwhelming complexity of enterprise information. "Working with Professor Ma and his students has provided us with visualization expertise that we don't currently have in our lab," explains Keeton. "His world-class background isn't just contributing to our research agenda, it's helping us do things we wouldn't have been able to do otherwise."

The IRP includes attraction of external funding as a key element of proposal evaluation. 2008 projects averaged a 1:1 match of external funding to HP Labs' investment, considerably increasing the impact of the program, and enhancing their ability to contribute to HP's research agenda through support of additional students and other project resources [3].

In addition to supporting multi-year projects, the IRP program has also helped provide "seed" funding to attract external investments, as in the UK, for example. A 2008 IRP project, in the field of Enterprise Information Management, has continued with funding from the UK Office of Naval Research (ONR), providing future returns after one year of HPL funding. The Principal Investigator states that the initial IRP funding helped "prime the pump" for his work to successfully attract significant funding from the ONR.

### 2.1 Single Collaborative Framework

Many of the historical challenges in engaging in productive partnerships between universities and industry have revolved around varying viewpoints on the role of intellectual property and legal frameworks for collaboration. Over the years, HP Labs has developed numerous successful research partnerships with universities, and has found that the start of the working relationship can sometimes be delayed by a lengthy review of the legal framework for the collaboration.

Due to the size of the program being created in 2008, the HP Labs team realized that a way to quickly execute a large number of awards and agreements on a yearly basis was needed, and began to devise a strategy for a single collaborative framework. Developing a legal framework that all potential partners could agree on (on a world-wide basis, no less) was a daunting task. A critical success factor was to work closely with several university research administrators as trusted partners, in order to develop a framework that could be acceptable both to universities and to HP, allowing each party to pursue its fundamental mission.

The approach is that both parties must have mutual freedom of operation: the university partner must have freedom to advance the creation and dissemination of knowledge, as well as to freely publish the results of the

research; HP must also have freedom to conduct future research and to pursue its own strategies for commercialization.

A single-project Collaborative Research Agreement (CRA) for the IRP was developed and made available online [6] at the start of the call, providing university research administrators the opportunity to review it prior to submission of proposals. In order to ensure that faculty do not submit proposals without their institution's review, proposals are required to include a signed letter from a university official that confirms that the university has reviewed the agreement. Only when the proposal is successful is the university required to sign the agreement with HP. The reaction from colleagues in academia has in general been positive: by engaging in an open and transparent process where all partners are equal, HP has managed to create the foundation for a systematic program that can truly support collaboration, and not simply "gifts" or donations.

While the HP Labs Innovation Research Program has been highlighted in this report as a flagship example of HPL's Open Innovation strategy in action, many other university programs take place at HP. For example, HP Labs has led or supported programs such as: HP Labs India's HP Innovate 2008 and 2009 competitions, where undergraduate engineering students in India interested in technology entrepreneurship have the opportunity to present their innovative ideas in the field of computer science and engineering [7]; the UNESCO-HP project to reduce "brain drain" in Africa through grid computing; and HP Labs Russia's highly-successful HP Institute of Technology program, which has established a Research and Education Center in St. Petersburg State University, providing opportunities for post-graduate students to collaborate with HPL Russia [3].

### **3. Commercial Collaborations: Open Cirrus™ Global Cloud Computing Testbed**

Building on HPL's tradition of establishing major industry and academic consortia, as well as collaboration with HP customers and partners, HPL also puts a strong focus on developing strategic commercial collaborations.

In July 2008, HPL led efforts to develop [Open Cirrus™](#), a shared, open Cloud Computing Research Testbed, building on over eight years of research collaboration and co-funding with Intel (most recently through the Gelato Federation) [8]. As founding members of Open Cirrus, HP, Intel and Yahoo! are collaborating on an internet-scale, global testing environment designed to encourage research on the software, services, datacenter- management and hardware issues associated with cloud computing.

A collaborative initiative between industry, government and academic partners, Open Cirrus consists of fourteen "centers of excellence," to date, run by the three companies and their partners at Infocomm Development Authority of Singapore (IDA), University of Illinois at Urbana-Champaign and Georgia Tech in the US Karlsruhe Institute of Technology in Germany, the Russian Academy of Sciences, the Malaysian Institute for Microelectronic Systems (MIMOS), the Electronics and Telecommunications Research Institute (ETRI) in South Korea, the China Mobile Research Institute (CMRI) and Guangzhou Research Institute, and the Supercomputing Center of Galicia (CESGA) in Spain [9]. Each center hosts a cloud computing infrastructure with 1,000 to 4,000 processor cores.

Not only are HP's partners in Open Cirrus contributing significant computing and financial resources to the project, several government funding agencies have also contributed funds, including IDA in Singapore, the Ministry of the State of Baden-Württemberg (MWK) in support of KIT in Germany, and the US National Science Foundation (NSF) in support of UIUC. HPL continues to play a leading role in Open Cirrus' development, with the Central Management Office (CMO) housed at HPL, as well as hosting the first Open Cirrus Summit [10] in Palo Alto, CA in June 2009.

### **4. Government Collaborations: Examples from the US and Mexico**

#### **4.1 A US Pilot - Corporate Research Postdoctoral Fellowship Program**

In March 2009, HP Labs - with the support of several other corporate research labs - approached the US National Science Foundation (NSF) with the idea of establishing an Industrial Research Innovation Post-Doc Fellowship Program. This program would allow top science and engineering post docs to work on industrial research and development and partner with industrial scientists in developing the next generation of engineering and IT-related technologies, increase opportunities for tech transfer into new businesses opportunities, advance their careers and finally, enhance the possibility of creating innovations in the engineering/science curriculum. The initiative was seen as particularly relevant to the contemporaneous economic situation, enhancing participants' likelihood of obtaining a job and/or creating new jobs through new business creation while the US and global economies

recovered. The program would also provide opportunities for future engineering professors to acquire real-life engineering experience and impact the engineering/science curriculum.

The idea presented in March to the Engineering Directorate (Engineering Education and Research Centers Division) was very well received. In May 2009, NSF asked the American Society for Engineering Education (ASEE) to submit a proposal to support a number of engineering post docs in corporate research labs for one year.

Since 1893, ASEE has provided intellectual leadership and accomplished professional support for educational activities that advance the United States' science and engineering enterprise. This history of both dynamic collaborations with other science and engineering organizations and innovative, socially-oriented programs, has established ASEE as an integral contributor to collective efforts to build the nation's human capital in science and engineering. With its 48+ years of experience administering student and faculty fellowship programs, over 20 years of experience managing postdoctoral fellowship programs, and its industrial relationships, ASEE was uniquely positioned to manage such a program.

Thus, in early September 2009, NSF granted ASEE funds to establish the Corporate Research Postdoctoral Fellowship Program to encourage the involvement of creative and highly-trained engineers in areas of great interest and relevance to the nation as it faced economic challenges. This program provided recent engineering PhD recipients the opportunity to conduct post-doctoral research in a corporate setting. NSF funded close to 80 post doc positions in 2010. Each research fellow received a stipend of at least \$75,000 plus health insurance benefits, of which the host company would provide a minimum of \$27,500 and other non-cash support [11].

HP Labs was able to recruit 5 post docs students under the NSF-ASEE program and researchers are very satisfied with them:

*“Matt has been an invaluable addition to the CeNSE team at HP Labs. With his strong leadership and technical writing skills, Matt already has a conference publication and was the lead on a proposal submitted to DARPA for a large, multi-year research program on MEMS sensors. Matt quickly took charge of the CeNSE demonstrator on the 1501 Page Mill campus and got the hardware integrated into our site and started collecting data. He brought fresh ideas and techniques that allowed him to get this system working very quickly. Matt's expertise in MEMS, testing, and data analysis was leveraged by [HP's businesses] to understand sensor stability critical to the program deliverables. The ASEE/NSF program has allowed us to add high caliber talent to our team and enabled immediate and significant progress in our research. I hope the program can be extended to allow the contributions to continue and build upon the already significant momentum.” – Peter Hartwell, HP Labs NSF-ASEE Post Doc Mentor, November 2010, and manager of the Central Nervous System for the Earth (CeNSE) program at HP Labs.*

Due to the extraordinary interest and response to this program, in 2011 NSF is piloting a similar program opportunity to participants in their Graduate Research Fellows program. With an extra summer stipend, a group of Engineering MS and PhD students will have the opportunity to spend 10-12 weeks in corporate research labs in 2011.

#### **4.2 Mexico's Jalisco State Government Partnership: the GUAPO Project**

Since 2005, HP Labs has been developing research collaborations with universities and public research centers in Mexico. The strategy has primarily focused on engaging Mexican engineering and science students in HP Labs' projects aligning universities' research interests to HP Labs' research portfolio. In an effort to develop talent in Mexico, enhance the speed of innovation at HP Labs, and create new jobs in the region, the HP Guadalajara Prototyping Organization (GAPO) was established in October 2010, jointly sponsored by HP Labs and the Government of the State of Jalisco in Mexico [12]. HP Labs is currently hiring 20 recent engineering graduates to become extended members of the research teams in Palo Alto.

#### **4.3 Open Innovation Benefits**

**For participants and the economy:** In a time when the global economy is facing enormous challenges, creating jobs must continue to be a top priority. Some of these jobs should also produce significant technological and scientific innovation that will allow economies to recover and begin to create new opportunities for business growth and prosperity. Government-Industry-Academia Programs like the ones described above can support efforts to create an atmosphere in which employees may prosper, businesses may thrive and the economy grows.

Participants in these kinds of programs enjoy both near-term and long-term benefits: in the near-term, they can obtain an immediate position at a prestigious industrial research lab, providing them with a stable job and income, as well as critical career development opportunities as they continue to develop their research capacity. In the long-term, participants may be offered full-time positions in participating companies and their research labs, or may find that their networking and experiences have prepared them to join the faculty at a research university or another company in their area of expertise. Participants in such programs who choose an academic career could bring new curriculum perspectives and approaches to engineering/science education as well as expand the research horizons by bringing new hard problem areas.

Some participants may embrace opportunities to transfer technology inventions into start-up businesses, and may start their own companies. In sum, these positions can provide key economic stability to participants while preparing them to further develop their careers and contribute to the economy in years to come.

**For Corporate Labs:** Many corporate research laboratories, such as HP Labs, are proud to offer opportunities to a large pool of qualified post-doctoral candidates through these kinds of programs. It is clear that these programs offer significant benefit to companies, providing the chance to advance critical scientific, engineering and IT research at a faster pace, during a time when hiring full-time researchers is a challenge. Faster research outcomes are likely to lead to increased opportunities to transfer technology to businesses and/or spin-out companies and more opportunities for growth. This program also allows corporate labs to identify top technical talent who may be recruited for full-time positions after their industrial research fellowship position is finished.

#### 4.4 Other Government Collaborations

In addition to co-leading development of the ASEE-NSF program described above, HPL also partners with governments around the world to jointly support Open Innovation programs. In the UK, for example, HP Labs teams with the UK Engineering and Physical Sciences Research Council (EPSRC) to support graduate and post-graduate studentships at the HP Labs Bristol site.

In February 2010, HP Labs opened a new research facility in Singapore. HP Labs Singapore researchers are focusing on developing an enterprise cloud software platform, dubbed Cirious, and will contribute to research efforts already underway at HP Labs sites in Palo Alto, California and Bristol, England. The opening of this new research lab is the culmination of many years of successful Open Innovation activities in Singapore, including close collaboration with universities, government agencies (including the Infocomm Development Agency and Economic Development Bank), and industry partners. Close relationships with stakeholders in the local and regional innovation ecosystem, such as university engineering departments, university researchers, and student interns, have been a key element of HP Labs Singapore's successful development and launch. [13]

HPL also partners with HP Brazil to incorporate university scientists in Brazil into their projects as part of an annual set of investments funded by HP Brazil through government tax incentives for external research, building on many years of successful partnering with HPL. In 2009, 27 projects were underway at 11 leading Brazilian universities; focus areas of the work include Cloud Computing, IT Analytics, Nanoelectronics and Cybersecurity, among others.

### 5. Lessons Learned and Recommendations

As HP Labs continues to develop Open Innovation programs at HP Labs, several key lessons have emerged:

- **Shared Risk.** A partnership where both parties share risk means both parties are invested in the collaboration and its ultimate results. Additionally, relationships are of critical importance in building trust and a collaborative environment.
- **Look for Complementary Expertise and Experience.** Work with partners who can enhance your own research capabilities, instead of looking to universities to “outsource” R&D.
- **Start Small.** When building a new relationship, start small and prove successes early and often so that stakeholders can clearly see the value of the partnership and will thus be more supportive of growing the collaboration over time.
- **Shared Risk, Shared Benefits.** A research and development partnership where both parties share risk means both parties are invested in the collaboration and its ultimate results. Additionally, relationships are of critical importance in building a shared vision, trust and a collaborative environment. Successful

partnerships also depend on a keeping a balance of benefits or return on investment for each party involved, so that each clearly sees the advantage of continuing the partnership.

- **Set clear goals.** Industry researchers are measured on many of the same outcomes as academics, but collaborations with real customers are driven by a very different set of metrics. While technical papers and presentations are important for both academic and corporate researchers, business outcomes, invention disclosures and tech transfer are critical for corporate research labs that engage with customers and other industry partners. Make sure that everyone involved with a project knows what is expected of them, including faculty and student researchers and customer partners. Successful research partnerships stem from concrete outcomes that are recognized as valuable by both parties. This leads to a more predictable, productive, and positive collaboration.
- **Flexibility.** Recognize that while partners may have similar research aims, their goals and approach may be different. Reasonable collaborative and IP terms allow both parties to pursue their fundamental mission. Similarly, partners should also evaluate each situation individually: research in IT differs greatly from, say, research in biotechnology, and each case has its own requirements and characteristics.
- **Listen to your stakeholders.** Ultimately, any Open Innovation program should be in service to its stakeholders; when designing a new program, ensure that all participants have what they need to be successful, and positive results will follow [3].

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