Strategies for Building Successful Company-University Research Collaborations

Steve Fraser – CTO Office, HP Labs, HP Inc. Palo Alto CA, USA, sdfraser@acm.org
Dennis Mancl – MSWX Software Experts, Bridgewater NJ, USA, dmancl@acm.org

ABSTRACT
Company strategies for building and leveraging industry-university research collaborations are many and varied. This paper reports on strategies observed at North American technology companies including BNR, Northern Telecom, Qualcomm, Cisco, Bell Labs, Lucent, and Alcatel-Lucent. Strategies included a range of tactics focused on leveraging intellectual property portfolios, benchmarking processes and products, recruiting experienced technical talent, cost avoidance and reduction, and philanthropy. The strategies reported here build on the tactics reported in a paper presented by the first author at the second ICSE Workshop on Software Engineering Research and Industrial Practice held in Florence, 2015.

CCS Concepts
• *Social and professional topics~Economic impact*
• *Social and professional topics~Computing industry*
• *Software and its engineering~Collaboration in software development*

Keywords
University research; strategies; tactics; company collaborations

1. INTRODUCTION
As reported at the IEEE's Second ICSE Workshop (Florence, May 2015) on "Software Engineering Research and Industrial Practice" [1], the translation of invention into a useful innovation with business value is often quite challenging. Some innovations when translated to product – while useful and practical – have failed to be widely adopted (e.g. Betamax, laser disks, etc.). Others have taken considerable time to become successful. For example, "mobile" telephones took 40+ years to become widely adopted – this is in contrast to the "World Wide Web" (WWW) which took ~10 years to achieve broad adoption. Observations reported in this paper are derived from experiences at companies developing software, hardware, and systems to deliver computing, communications equipment, and IT services.

There are two primary motivations for company-university research collaborations – innovation and talent. As Henry Chesbrough [2] noted in his book on open innovation, the universe of "smart people" is always greater than the set of company employees. University collaborations bring more smart eyes to problems, and they provide a source of talent including graduate students, Post-Docs, and other researchers (e.g. professors) with advanced knowledge and experience.

The motivation for companies to engage in university research collaboration is based on a variety of needs including: continuous innovation of products and services; building and sustaining organizational learning and capability development – e.g. new skills, knowledge, etc.; attracting and retaining talent; avoiding costs; and marketing the company's innovation brand. These needs are balanced against the risks of contaminating company intellectual property; exposing company trade secrets; and making wasteful investments that do not translate into a reasonable return on investment (ROI).

In order to guide research strategy, companies have a variety of inputs at their disposal, ranging from trends in sophisticated innovations within their product/services (engineering) development community to customer and market changes and competitive analysis. These inputs can be positively complemented with research relationships at universities, research consortia, standards organizations, etc. A concept useful for evaluating technologies and building relationships – which research collaborations play into – is that of a "Technology Radar" [3] which identifies, assesses and helps increase the visibility of innovation trends.

The challenge is to determine the right mix of investments to deliver optimal ROI (Return on Investment) – both in terms of targeted technologies, funding, and sponsor attention/time.

The strategies in this paper are written from the "industry perspective" – to highlight and detail the artifacts and activities that are critical for a research sponsor to manage a successful company-university collaboration. The paper also includes important lessons for researchers.

2. EXPLORE AND INSPIRE INNOVATION

In any company that uses technology, the technology base is constantly evolving. What will you be doing five or ten years from now? Are you thinking about how to upgrade your current products, processes, and practices?

Even companies that are naturally innovative on their own can benefit from research collaborations. These strategies can be used to leverage and extend innovation work (Table 1).

Collaborative research is an efficient way to explore some potential future ideas: it leverages the creativity of some external experts, and it inspires innovation of internal experts. Research can have an enormous impact if it directly inspires new products or innovates new features of an existing product. However, even without a direct product impact, the innovations may improve internal product development processes or they might inspire new business models.

Table 1. Extending innovation with external research

Strategies	Artifacts, structures and activities
Scout future technologies	- Acquire new ideas - Inspire internal staff to innovate – to expand the technology base - The research might inspire new products, processes, services, and business models
Solicit and fund research proposals	- Advertise RFPs (Request For [research] Proposal) to identify opportunities - Invite favored partners to make proposals - Issue "grand challenges" and promote "contests" to encourage many university researchers to start exploration of a key topic
Provide extra resources for innovation	- Leverage external resources - Evaluate, explore, and prototype ideas; trial technologies; temporarily staff projects - Strategically reduce the chances of being "blindsided" by unexpected innovations in some related (or unrelated) technologies
Innovate – instead of reacting to change	- Evaluate intellectual property portfolios - Develop licensing strategies to leverage research outcomes - As an active and visible player in a relevant technology domain, a company increases opportunities for engagement

There are several strategies to establish a collaboration partnership. The most direct is to negotiate a research contract, which is an agreement that specifies the details of the work, payment, and ownership of the research results.

A second approach is participation in a consortium, where the collaborative work program is defined by the consortium management (a mix of university researchers and company sponsors). Both of these approaches can be expensive to manage, and there should be clear agreements about the intellectual property rights in every collaboration to avoid mismatched expectations.

A third option is to fund research with gifts. From a company perspective, gifts help build relationships, promote brand, and support early exploratory work – however there can be no expectation of delivered value other than a tax benefit. While university researchers prefer gift funding, because gifts have fewer "strings," gifts must be at "arm's length" and there can be no expectation of reciprocity.

No matter which approach is used to fund research, research proposals can be solicited through private or published research RFPs (Request for Proposals), "grand challenges" or "contests" inspiring multiple proposals in a specific research area.

Industry and university researchers can "cross-check" each other – for example, they can run trials on prototype products and tools, validate and benchmark new algorithms and practices, and evaluate alternative processes and approaches. Also, a company needs to actively review their existing intellectual property, address gaps, and decide how to profit from any new innovations. This may include sharing and licensing the results of some innovations.

3. ORGANIZATIONAL DESIGN

Companies and universities enter into collaborative relationships with different goals and different values. In order to meet the "learning goals" on both sides of the collaboration, a company needs to set up the collaboration activities to include structured interaction and strategic information exchanges.

Table 2 illustrates the artifacts, structures, and activities within a company to help focus interactions and knowledge sharing in the context of research collaborations.

Collaboration between organizations is rarely easy and spontaneous. Not only is it difficult to set up corporate research collaborations with university researchers, it is hard for most companies to promote and manage information sharing between separate organizations within the company. The most important "first step" is to create a structured way to share information. Both formal and informal channels are useful. Research reports, training materials, and technology forum meetings are the easiest way to share information about completed research, key concepts, and useful tools. Reports and talks can inspire others to apply and extend research results. Informal communication such as wikis and Git sites can be useful for sharing incomplete work and getting feedback on early prototypes. It takes a lot of management effort to create and promote training programs, forums, and formal collaboration sites. If there is no management support, these communication mechanisms may reach and influence only a very small community.

Table 2. Collaboration tactics

Tactics	Artifacts, structures and activities
Share ideas internally	• Formal: research reports, training programs, tech forums • Informal: hackathons, dialog through internal wiki, Git, social media o The goal is to disseminate ideas and develop capabilities internally
Track objectives	• Specific performance objectives for company staff in collaboration and innovation outcomes o Objectives create incentives for staff to work together and enable assessment of innovation results
Foster community	• Connections between innovators within the company • Projects to leverage research results in real-world products o Use collaboration to attract and retain talented professionals

Use agile project planning and development	• Agile plans and roadmaps, updated by researchers on a regular basis
	• Joint delivery of results in iterations
	   o Research and innovation are inherently agile
	   o Some results are papers, some are "development kits"

Collaborative work should be tracked as a specific corporate objective. The collaboration outcomes will vary depending on the research domain and product area. In some cases, collaborations can be evaluated in terms of "the number of new product features" that trace back to collaborative research efforts. But the impact of research collaborations can also be linked to improvements in internal development practices (more efficient product development, better quality, fewer customer complaints). There are two reasons for tracking objectives: it increases the incentive for staff members to participate in visible collaboration efforts, and the data from the objectives will be one input to determining the return on investment in collaborative work.

A big obstacle to innovation can be the relative isolation of many technical staff. If there is a "community of innovators" in the company, each individual contributor is less isolated. A good cohesive community will attract new contributors – and this can help to retain talented professionals.

Finally, an agile approach is almost essential for managing effective collaboration. For most research and innovation efforts, the products and activities will evolve over time as the teams learn more from each other. Any initial "roadmap" must be adjusted on a regular basis as the parties learn more. In most agile management approaches, the team members themselves are participants in negotiating priorities, setting and revising the work agenda, and evaluating the work items as they are completed. The work items might be "papers" or "development kits" – depending on the goals and research domain.

4. MAKE ROI VISIBLE

Companies and universities have a shared interest in delivering research results that have tangible value to the company. As the financial sponsor of the collaboration effort, the management of the company wants a research

collaboration to have an impact on the technology that they are able to offer to customers. In the world of research, the conventional notion of ROI (Return On Investment) is not always a precise science, but it is important for decision makers to have access to key information about the goals and scope of research collaboration efforts (Table 3).

Table 3. Making ROI Visible

Tactics	Artifacts, structures and activities
Track relationships	• Document who is involved in the collaboration (who are the sponsors, staff, and students who are participating) • Key artifacts: proposals, grants/contracts/gifts, reports • Investments made by all collaboration partners ○ Time, training, talent
Assess results and impact	• Develop a "tech radar" – a clear summary of status and results • Provide input to strategic plans and product roadmaps
Set and manage expectations	• Periodic discussions between company and university researchers and research managers (sponsors) ○ Avoid contractual and compliance "surprises"

An essential priority for a company engaged in external research is to build and maintain an up-to-date database of all external research collaborations and other related contacts with universities. In some large companies, there may be so many separate collaboration efforts in progress that no one in the company is sure of all the programs or the costs of the research collaboration. At a minimum, this database should track the universities involved, the primary contacts in the collaborative relationship, and the areas of research. The database can have links to the documentation of each grant, contract, or gift, as well as the details of the staff and students working together, and the ongoing investments and intellectual property developed by each party.

In addition to this external research relationship database, a company should have a "Technology Radar" [3] – a tool to show summaries of the status and results of current collaborations. The summaries can be used both to manage the collaboration efforts and as inputs to a company's strategic planning and product roadmaps. A tech radar helps to identify duplication and gaps in the research program and to find the projects that might be reevaluated after changes in the company's market and product mix. Also, a tech radar can identify technical areas where a company might direct its resources for new product development, internal training, or quality initiatives.

Collaboration databases and a tech radar are not enough to manage industry-academic collaborations. There also must be continuing dialog about goals and expectations. University researchers and company staff need to understand both the goals and the constraints of the other parties. For example, any work that involves the participation of students must be structured around the constraints of the academic calendar and employment considerations including ITAR regulations (International Traffic in Arms Regulations). Regular discussions between the principal sponsors can avoid surprises that might cause conflicts over rules and resources.

5. TALENT PIPELINE

Through funding, mentorships, and engagement – research projects provide a fertile opportunity for company post-graduate recruiting (PhDs/Post-Docs). Collaborations have a positive impact on technology transfer from university research to product development. The skills, experience, social networks, and passion of new grad PhD/Post-Docs are at the core of effective person-to-person technology transfer.

A PhD/Post-Doc recruiting program should be viewed as "talent-centric." The intent is for a company to place exceptional full-time and intern candidates identified through university research collaborations. This is in stark contrast to a company's "requisition-centric" recruiting program for high volume hires, where multiple candidates are interviewed to fill one role.

Unlike undergraduate candidates, PhD/Post-doc hire candidates often have strong opinions on the type of work (industry development, advanced development, research, academic) they wish to pursue – and they may seek a specific organizational fit. Additionally, these candidates will have significant experience in development, presentations, and thought leadership. After all, they've just had to defend their ideas before the senior members of their field through thesis defenses, conference presentations and journal papers.

When PhD/Post-Docs new grads who have formerly collaborated with the company decide to remain in academia – this should be seen as a different, but equally important opportunity to fund the new academics in their first university position, possibly leading to a career research relationship with the company!

6. INNOVATION BRAND

Company-university partnerships are a win-win marketing opportunity. Universities win because their company associations demonstrate they are visibly connected with real-world problems – which attracts students and gives them excellent context to prepare for their post-university challenges. Association with a real-world company context helps contribute to a refreshed and relevant curriculum. Companies benefit through their association with top tier institutions ("top tier" may be relative to local geography) – and this visibility may help to attract talent or provide product marketing collateral.

Visibility may be achieved through donations to support new buildings, endowed chairs, computer labs, specialized software, etc. We note that there is a difference between funding research – and supporting infrastructure – which may or may not take away from sales opportunities. For example, donating computers or communication gear to support the university's IT infrastructure might substitute for equipment that might otherwise have represented a company revenue opportunity.

Company support for university research and education might foster benefits in terms of government support – e.g. matching funds – or perhaps as part of an integrated plan to provide economic development in response to tax breaks or other benefits attractive to the company.

7. DIFFERING PERSPECTIVES

Since perspectives on the motivation for research partnership differ (Table 4), it is useful to be aware of these differences and possibly offer awareness "training" for company sponsors. First, expectations differ for the participants in the collaboration: companies are in the business of delivering shareholder value, but universities are focused on fostering broader open communities of learning – moving knowledge forward and sharing results both through advanced curricula and research.

Table 4. Differing Perspectives: Company *versus* University

	Company	University
Expectations	• Shareholder Value	• Community Value
Open Innovation	• Exploration • Company "Community" good	• Exploration • Academic "Community" good
Scale + Scope	• Benchmarking • Flexible "resources" • Brand visibility	• Real-world calibration • Increased funding • Business context
Standardization	• Curriculum influence • Policy influence • Standards development	• Curriculum benchmarking • Policy development • Standards engagement

Talent Migration	• University recruiting
	  ○ Leverage research
	  ○ Tech transfer
	  ○ Visiting staff
		• Talent placement
		  ○ Sabbaticals/ consulting
		  ○ Student internships
		  ○ Full time hires

Business Value	• License/leverage IPR*	• Develop/license IPR*
Philanthropy	• Benefactor of goodwill	• Recipient of goodwill

* IPR – Intellectual Property

Companies are interested in the availability of "flexible" resources, particularly in the early days of exploration when outcomes are not clear. "Flexible" outsourced resources help companies avoid the cost of spinning up an internal research team on short notice with only a small probability of success. However, this cost benefit analysis must be weighed against the issues of company IPR contamination and the exposure of trade secrets.

Association with a top tier university may also have significant innovation brand value to a company. There is a certain "cachet" to be associated with the likes of MIT, Stanford, University of California, McGill, ETH, UCL, etc. The benefits of collaboration may also include government matching funding, which mitigates the costs of external

research. But to repeat our earlier warning: collaboration may also introduce risks, such as exposure of company trade-secrets and IPR (Intellectual Rights) contamination.

University researchers are also interested in "real world calibration" and business context – to promote relevance of results. Also, in light of declining government funding, it is important to attract (new) funding, either through philanthropy, directed research contracts and/or IPR licensing.

8. INTERACTION CHANNELS

Interaction between companies and universities takes many forms – but generally can be characterized by a variety of channels including: collaboration partnerships (generally project focused), knowledge sharing (conferences, lectures – either on campus or at the company, short-courses); student learning and mentoring (research projects, fellowships, internships, etc.); and philanthropy (equipment donations, endowed chairs, center/project funding, etc.).

Table 5 details the strengths and weaknesses of the various research collaboration strategies. Contract research under the blanket of a "Sponsored Research Agreement" (SRA) is often seen as the most effective form of collaboration, followed by participation in consortia.

Table 5. Diversity of Collaboration Programs

	Consortia	Directed Research	Gift Research	Talent Programs
Primary Governance	PIs + Industry Sponsors	Industry	University	Joint programs
Project Selection	Often PIs select based on advice from industry	Company negotiates with PI/University	Company selects from PI proposals	Developed by company in partnership with university
Payments	Annual Fees	Specified by SRA contract payment schedule	Committed to by company	Depends on program
Term	Flexible – often self-renewing	Specified in contract terms	Generally fixed term (~1 Year)	Varies with commitment
Strengths	Critical mass, tech sensing, IPR sharing, publicity, good will, tax benefit*	Tangible IPR deliverables, tax benefit*	Exploration, good will, publicity, lower overheads, tax benefit*	Talent development, good will, tax benefit*
Weaknesses	Expense, limited selection influence	Overhead costs, lengthy negotiations	Arm's length nature of relationship	Difficult to leverage lack of ROI, expense
Risks	Company IPR contamination, exposure of company IPR	Indemnification issues, 3rd party rights, often lengthy negotiations	Gift ethics, tax issues, compliance and overhead cost	Contractual issues, employment issues – e.g. ITAR, etc.

Possible Government Research or Philanthropic Tax Benefit

9. GIFTS VS DIRECTED RESEARCH

Corporate gifts are much appreciated by universities – since they come with few "strings" – to avoid any expectations of quid pro quo by the company. However, in the 21st century, there are by necessity some "strings" in the form of restrictions on how the funds may be used, as well as limits on who may direct gift usage (Table 6). For example, philanthropic funds should be used for the purpose for which they were designated: research effort rather than "parties" or frivolity. Similarly, at least in the US, there are administrative restrictions regarding the redirection of funding from research intent to terrorist, religious, political, etc. designations.

Companies use gifts to support exploratory research. The benefits of such gifts often outweigh the challenges. However, companies must take action to ensure that research gifts do not create a problem to related "insider information." Gift funded exploratory research should benefit the entire research community, and a donor company must follow good "gift ethics" – to ensure that there is no appearance of reciprocity including privileged access to research results (e.g. before results are made public). If benefits flow to the community for all to leverage – and the gifting process follows clearly established guidelines on ethics and process – then research gifts can be a valuable research community funding mechanism.

Table 6. Trade-offs: Gifts *versus* Directed Research

	Gifts	Directed Research
Intellectual Property Rights (IPR)	• No IPR or other reciprocity	• Exclusive Royalty Free • Non-Exclusive Royalty Free • Negotiation required
Non-Disclosure Agreements (NDA)	• No NDAs	• Contract terms and/or NDA • Publication (sooner than later)
Setting Research Direction	• Solicit proposals • No "directed" research	• Negotiate research contract • Milestones, deliverables, etc.
Cost Factors	• Gift \$ + Overhead • Lower overhead	• Contract \$ + Overhead • Higher overhead

Both universities and companies require due diligence when entering into gift agreements to ensure compliance with appropriate laws and in some countries (e.g. the US) – guidelines concerning research overheads. While SRAs (research contracts) in the US have attracted overheads approaching 75% or more, gifts have traditionally required smaller administrative overheads under 10%. Companies may also identify and partner with philanthropic foundations to:

- Simplify accounting and manage gift processing
- Ensure "arm's length" compliance, particularly important when there is a duality of relationship (e.g. donor, vendor)
- Separate operational funds from gift funding to decouple research collaborations from quarterly corporate cycles

10. COLLABORATION STRATEGIES

As described by [4] there are well established "influence" strategies that may help broker company-university collaborations – for example:

- Companies may fund new roles, establish budgets for external research, set staff performance objectives to engage in specific fields of research, technology, services, etc.
- Companies and company research sponsors establish partnerships through personal connections – e.g. university alumni, publications, conference interactions, etc.
- The scarcity of researchers in specific fields or companies interested in related research may help accelerate negotiations between interested parties – in the same way that regional development may be sparked by tax-break incentives.
- "Social proof" may attract key thought leaders from academia to visit innovative companies and deliver tech talks – which in turn may inspire and accelerate innovation within company engineering communities.

The influence strategies listed above and other factors, when used in concert at the right time [5], have proved effective based on author observation in attracting and sustaining interest for the introduction and adoption of software technologies. Visible executive sponsorship at the CTO and CEO level have also proved valuable both in motivating middle management and inspiring the company engineering community.

11. COMPANY SUCCESS FACTORS

Success factors (Table 7) may be collected and presented as a dashboard to observe trends. Some examples: Are staff achieving their external research objectives? How many meetings (whether face-to-face, by telephone, web collaboration tools, etc.) are held? What outcomes were achieved? Has research delivered useful IPR resulting in product value and business impact? Over time, what is the profile of university engagement? For example, are there a few key universities (20% of the total engagements) with many deep relationships (projects, consortia) while the remaining universities (80% of the total company engagements) have only one or two collaborations with little or no measured ROI? If so – perhaps a shift in engagement strategy is warranted?

Table 7. Collaboration Success Factors

Success Factor	Examples
Systematic Process to Select and Prioritize Projects for Collaboration	• Evaluate projects based on relevance to company/sponsor interest, proposal focus (including budget, outcomes, talent acquisition opportunities), funding availability and other company specific criteria
Impact on Company Researchers	• Recognize and reward company research sponsors and champions
Publications	• Foster a simple process for publication clearance • Enable a visible list of publications (to promote and support company innovation brand) – external website, internal website, annual report, etc.
Intellectual Property Rights	• Inspire innovation in a new product, product portfolio or service • Create new open source

Talent Acquisition	• Hire students as interns or full-time employees
	  – Students who have been involved in company research collaborations
	• Establish collaborations with new professors
	  – Extend relationships initiated while professors were students or post-docs

Government Incentives	• Leverage matching government funding for research programs
	• Leverage tax benefits
	  o Tax deductions for gift-funded projects
	  o Tax credits and incentives for investment in research efforts

12. OBSERVATIONS AND SUMMARY

Table 8 summarizes the strategies and tactics that the authors have found useful to broker external (to companies) research collaborations and foster effective tech transfer. In the authors' opinion, failure of any one of these strategies jeopardizes both current relationships and the future of collaboration. In some ways – the "innovation" part of the collaboration is "easy". The challenge is to translate innovation into value – and to make that value visible to all stakeholders as necessary.

Churn within industry is particularly hard on academic partners – since the change may not be immediately visible outside the company. For example, a reorganization might lead to the "disappearance" of company sponsors, contract managers – or even executive sponsors. Other elements of "churn" may include market downturns – which may have an immediate effect on payments or interest in sustaining a collaboration beyond the current quarter or fiscal year.

We reiterate that "Open innovation" [2] strategies are essential to promote the sharing of ideas and organizational (rather than simply individual) learning. However, we must keep in mind that the benefits of "openness" must be balanced against the obligations imposed by licensing restrictions. Georges Haour and Laurent Miéville's [6] *From Science to Business: How Firms Create Value by Partnering with Universities* outlines the successes and challenges of a variety of open research collaborations and their economic impact. This is in contrast to Jon Gertner's [7] *The Idea Factory: Bell Labs and the Great Age of American Innovation*, which reports on the "old school" monopoly-funded proprietary innovation strategy of "old" AT&T from the last century. Collaboration can accelerate innovation and increase the impact of research results – as suggested in Ben Shneiderman's study of university-industry collaboration [8] *The New ABCs of Research.* There is value in increasing the diversity of minds working on a problem – it can inject fresh thinking and lead to new solutions.

Table 8. Summary of Strategies and Tactics

Strategies	Tactics
Inspire company innovation through external research	• Scout technologies & expertise to inspire company technologies, services, business models, etc. • Solicit/review/fund university research proposals, publish "grand challenges", organize "contests"

	• Leverage external resources to evaluate, explore, prototype & trial technologies • Evaluate intellectual property portfolios & develop licensing strategies for research outcomes
Company organization to leverage collaboration and learning networks	• Disseminate ideas & develop capabilities internally: tech forums, learning programs, training, hackathons... • Develop performance objectives to incent, assess, reward collaboration & innovation outcomes, etc. • Foster communities of practice & interaction – connect, leverage, develop, retain senior talent, etc. • Support agile iterative product planning (roadmaps), development, and deployment (e.g. developer kits)
Develop and sustain a pipeline for senior talent (PhDs/Post-Docs/Professors)	• Identify, leverage, recruit, and retain expertise through the collateral of research investments • Encourage company experts to give university talks – and invite researchers to give company talks/demos • Organize directed internships & sabbaticals that translate into full-time hires & long-term relationships
Market company innovation brand	• Associate with top tier universities: research philanthropy, equipment donations, fellowships, chairs, etc. • Influence policy and standards, benchmark prototypes, encourage open "app" development where relevant • Leverage government programs (funding, regional development, etc.) • Create visibility through conference sponsorship and participation, (joint) publications, standards, etc.
Make ROI Visible – Track/manage research investments and assess impact	• Track relationships (sponsors, staff, and students), proposals, investments, results, talent, contracts/gifts, etc. • Assess results/impact, develop a "tech radar", provide input to: strategic plans & product road-maps • Set & manage both university & company expectations – avoid contractual & compliance "surprises"

We suggest that an excellent source of guidance may be found in a forum until recently hosted by the National Academy of Science in the US – namely the University Industry Demonstration Partnership (UIDP) [9]. The UIDP has published a number of relevant guides – including a "Researcher Guidebook" [10] and an "Intellectual Property Quick Guide" [11]. Our experience garnered at multiple companies, confirms that the power of collaboration should never be underestimated – whether planned or serendipitous.

13. ABOUT THE AUTHORS

Steven Fraser is based in Silicon Valley and has served as an innovation catalyst with global influence for Fortune 500 Companies including: HP Labs, Cisco, Qualcomm, and Nortel. In addition to a year as a Visiting Scientist at Carnegie Mellon University's Software Engineering Institute (SEI) consulting on Domain Engineering (software reuse) and team practices he has organized over 75 software engineering conferences, panels, workshops, and tutorials. Steven holds a doctorate in Electrical Engineering (specification validation and software process engineering) from McGill University in Montréal, Canada and is a senior member of both the ACM and the IEEE. His interest focuses on alleviating the "soft" challenges (e.g. teamwork, collaboration, design trade-offs, decision making, etc.) of developing and deploying products highly dependent on software and brokering valued industry-university research collaborations.

Dennis Mancl has over 30 years of experience as an internal consultant on software design and agile development practices within Alcatel-Lucent and AT&T, with considerable experience in assisting software project teams with design patterns, requirements modeling, reengineering, and software quality practices. Dennis holds a doctorate (Computer Science) from University of Illinois at Urbana-Champaign, USA. As an independent technology coach and educator based in New Jersey, Dennis is sharing his strategies for bringing together researchers and product development experts.

14. REFERENCES

[1] Steven Fraser (2015). Reflections on Software Engineering Research Collaborations: From Ottawa to the Software Engineering Institute to Silicon Valley. SER&IP@ICSE 2015: 5-10.

[2] Henry Chesbrough (2003). Open Innovation, Boston, MA, USA: Harvard Business School Press, ISBN 1-57851-837-7.

[3] R. Rohrbeck, J. Heuer, and H.M. Arnold. The Technology Radar – An Instrument of Technology Intelligence and Innovation Strategy. The 3rd IEEE Intl. Conf. on Management of Innovation and Technology, Singapore 2006: 978-983.

[4] Robert B. Cialdini (2008). Influence: Science and Practice (5th Ed). ISBN: 978-0205609994.

[5] Everett Rogers (2003). Diffusion of Innovations, 5th Edition. Simon and Schuster. ISBN 978-0-7432-5823-4.

[6] Georges Haour and Laurent Miéville (2011). From Science to Business: How Firms Create Value by Partnering with Universities, Great Britain, Palgrave and Macmillan.

[7] Jon Gertner (2012). The Idea Factory: Bell Labs and the Great Age of American Innovation. Penguin Press, ISBN 978-1-59420-328-2.

[8] Ben Shneiderman (2016). The New ABCs of Research. Oxford University Press.

[9] University Industry Demonstration Partnership (UIDP) main website. http://www.uidp.org

[10] UIDP Researcher Guidebook (2012). http://www.uidp.org/researcher-guidebook

[11] UIDP Intellectual Property Quick Guide (2014). http://www.uidp.org/uip-ip-quick-guide