

# Investing in Software Design

From Technology to Culture: How Collaboration and Communication Matter

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## ABSTRACT

Companies that design, develop, and deploy software products at scale face a learning gap. To be effective, software developers need to continuously conceptualize, collaborate, and communicate – to share and learn from each other. To sustain a competitive edge, companies need to invest in collaborative learning. Recommended investments include a mix of education and collaboration programs to share design ideas: for example, internal conferences, facilitated workshops, subject matter knowledge networks, and talent exchanges. In this experience report, we outline strategies that reflect the authors’ experiences from software product organizations spanning multiple development centers across six continents.

## CCS CONCEPTS

• Software and its engineering~Designing software • Social and professional topics~Computing education • Human-centered computing~Collaborative and social computing systems and tools

## KEYWORDS

Software design, Experience report, Coaching, Collaboration, Communication, Culture, Education, Forums, Talent, Workshops

## 1 Introduction: Building on Past Investments

In our experience, developers acquire design skills through many learning experiences, both academic and professional. This paper outlines company-based learning investment strategies that have worked for us. We share techniques that can improve the adoption of design practices within specific application and company contexts. We encourage a collaborative approach that improves communication across corporate dimensions – geographical, functional, technical, organizational, and hierarchical.

We subscribe to Peter Freeman and David Hart’s broad definition of design as a concept that “encompasses all the activities involved in conceptualizing, framing, implementing, Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. For all other uses, contact the Owner/Author.

*Designing '24*, April 15, 2024, Lisbon, Portugal  
© 2024 Copyright is held by the owner/author(s).  
ACM ISBN 979-8-4007-0563-2/24/04.  
<https://doi.org/10.1145/3643660.3643944>

commissioning, and ultimately modifying complex systems – not just the activity following requirements specification and before programming.” [1]

The “design context” for software design in industry often requires intensive and diverse teamwork spanning many cultures and global teams [2]. New staff face a formidable design learning curve. Onboarding is more than orientation, because new staff need to expand their design knowledge by learning:

- Corporate product-specific “software in-the-large” collaborative design strategies (both practices and tools)
- How (and why) to innovate and evolve legacy software created by others to deliver customer value
- How to extend legacy code bases developed by other organizations, including corporate acquisitions and merger partners

Additionally, companies benefit when developers improve their communication and coordination skills to share tacit knowledge about relevant problem domains. Inter/intra-team communication has always been a challenge when managing large and growing teams, as described by Fred Brooks decades ago in “The Mythical Man-Month” [3].

New product development often requires learning and applying emergent technologies. A “learning company” supports adaptive learning strategies – to effectively acquire and adopt new practices [4] and ensure competitive advantage. In the authors’ experience, companies use multiple learning strategies that combine book learning with experiential learning.

Design in a corporate environment is a team activity. System design and coding is not done in isolation, the software is built on the shoulders of the “giants who come before us.” In some of our previous work detailed in [5] we discovered that some early-career staff were less interested in teamwork and more interested in “design glory.” They chose to work alone or preferred to innovate new designs rather than leveraging existing work. Their university education had ingrained in them two academic values: the importance of individual work for personal credit for technical work and the need to avoid the perception of plagiarism.

In addition to collaboration challenges, the authors have observed several knowledge and skill gaps among early-career software professionals.

There is a wealth of design literature that describe patterns, processes, and review practices, plus architectural styles. However, early-career designers do not always fully appreciate the value of these sources, until they are faced with complex design issues in a

product team environment. Software design in industry needs to account for multiple concerns including usability, security, reliability, testability, maintainability, and the legal risks associated with open-source code reuse. Early-career skills gaps are no one's fault, since it takes many years to acquire capabilities in code reading, useful design idioms, and software maintenance practices.

Many designers need to be aware of design “blind spots.” “Unconscious bias,” if unchecked, may create unacceptable obstacles for all or part of a system's user community. Companies are motivated by financial concerns to avoid system designs that could perpetuate racial, gender, or cultural bias. It is also important to account for physical capabilities such as color blindness or left-handed versus right-handed preferences [6].

Onboarding programs expose new hires to company specific practices including code reviews, inspections, code refactoring, audits, and design for maintainability. These practices foster developer productivity and product resilience. Experienced staff also benefit from a variety of ongoing learning experiences to keep abreast of evolving technologies and applications such as cybersecurity, DevOps, AI/ML, streaming, gaming, or location-based services.

Early adopters accelerate how a company comes up to speed with new technologies. They evangelize the benefits to product groups first locally – and then across the company. As a design practice evolves to become more disciplined, tacit knowledge is ingrained in toolkits and frameworks [7].

Companies evolve their software designs by coalescing internal product knowledge, code bases, open source, and corporate acquisitions. Reuse of design patterns, software frameworks, and open-source repositories has proved to be a powerful design accelerator in our experience.

However, investing in software design presents challenges to corporations. Stock market expectations frequently motivate company management to seek low-cost shortcuts to product delivery. Similarly, corporate leadership can drive design investments in unpredicted directions. For example, a cost-cutting initiative might lay off 50% or more of a design team and then expect those remaining to double or triple their productivity to finish the product – not realizing until too late that critical tacit product knowledge was lost! Another challenge is that software program managers may fail to modernize their design efforts due to schedule and budget compression.

## 2 Programs to Support a Learning Company

To catalyze collaborative design outcomes and foster learning companies, the authors developed programs ranging from one-day workshops to multi-year company-university partnerships. Each program fostered “learning how to design better” to inspire product innovation.

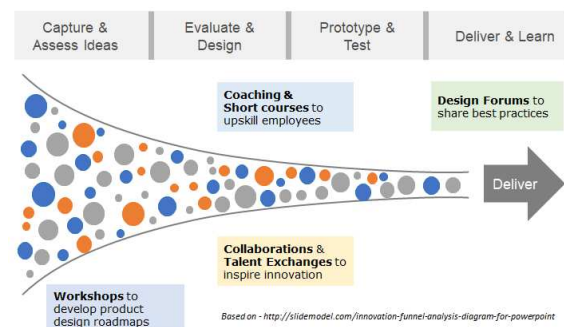
Some programs were local, such as a workshop series specific to one business unit or location. Other programs were less localized: Design Forums were global – spanning multiple company locations and included external presentations by customers and university partners. Based on our experience, a

systematic, multifaceted company education strategy can be effective. The authors have successfully developed corporate programs that include peer learning, internal forums, workshops, short courses, coaching, and even a specialized industry software master's program (delivered at the company by a consortium of universities).

To reiterate, in the authors' experience, a collaborative approach can be effective to modernize staff design skills. A company-wide education strategy may include:

- Coaching Networks (of experts and facilitators) to support the company adoption of new design practices.
- Design Workshops orchestrated by neutral facilitators to catalyze design strategies and product roadmaps.
- Design Forums for staff to share design practices via company-wide proprietary hybrid (in-person and virtual) conferences that feature peer-reviewed papers, presentations, keynotes, workshops, and tutorials.
- Company-University Collaborations to foster research partnerships and education programs to accelerate the adoption of emergent technologies (e.g., cloud, software defined networks, neural networks, AI/ML).
- Talent Exchanges to connect experts and inspire product innovation through student internships, professorial sabbaticals, and company visiting scientist or adjunct roles at institutions such as the CMU's SEI.

To determine which knowledge transfer strategies are most appropriate, the first step is to diagnose the organizational context. It is much easier to start small with a department rather than an entire business unit. An organization should iterate and add other strategies as warranted by early successes, as well as track successes and learn from failure. Design Workshops and informal Company-University Collaborations are also good strategies to start with, while Design Forums and Talent Exchanges generally require broader executive sponsorship.



**Figure 1. The Cone of Innovation: Strategies that Translate Ideas to Product Delivery**

The “cone of innovation” is a simple view of the progress of a collection of potentially successful ideas – from initial brainstorming to implementation and delivery. The process of innovation requires design. Teams design systems and products, but they don't work in isolation. System design requires

investments in learning and collaboration so that staff can better share ideas, new processes, and adopt new best practices.

Leaders need to increase the speed and effectiveness of the innovation delivery funnel. Companies benefit as products reach consumers faster with greater user adoption.

A company's success is directly linked to its ability to deliver. In our opinion, a mix of corporate and personal investments in design skill and knowledge should emphasize experiential learning.

Each company will have its own investment timeline, funding model, and economic tradeoffs. Some companies establish training programs with topics ranging from technical to societal. Other companies leave employees to learn on their own. Yet another option is to grant paid time off for staff to organize their own learning program.

However, we believe that an integrated set of activities to foster design skills is more effective. A strategic investment program will blend corporate funding for training and coaching in three dimensions. First, programs will create awareness for emergent technologies. Second, coaching and training will develop team capabilities (skills and tools) and deliver value. Third, cultivating “communities of practice” will grow an internal technical community that sustains company progress.

Executives support is essential for major corporate programs, including Design Forums, integrated training and coaching, plus collaborations and talent exchanges. But support for even modest programs such as volunteer coaching will encourage a learning culture. Initial costs might start low with volunteers and informal partnerships. For Design Forums with dedicated program managers and IT support, costs can rise quickly to over \$50k USD. For Company-University Collaborations in North America, costs can quickly reach \$1M/year USD for a mix of multi-year research projects, talent exchanges, and consortium memberships.

### 3 Design Workshops

The purpose of Design Workshops is to bring together key stakeholders (designers, managers, customer proxies, etc.), for neutrally facilitated discussions and to consider tradeoffs in design strategies, program roadmaps, and product vision.

In a Design Workshop, a trained facilitator structures the discussion neutrally so that the ideas rather than idea proponents are debated. The facilitator keeps the participants on track, applying approaches like Nominal Group Techniques (NGT), categorization methodologies, Interpretive Structural Design (ISM), and tradeoff analysis. Facilitation techniques and design workshop processes were detailed in [8, 9] – and have been organized both in a proprietary company context and at public conferences (OOPSLA, SPLASH, XP ...).

Workshops pull together practitioners who don't necessarily know each other. Workshops help expand a company's internal technical networks.

Debate is valuable. At the conclusion of a Design Workshop, the participants might not be in complete agreement, but this doesn't mean that the workshop was a failure. In fact, an early discussion of design options and tradeoffs will generally make the

final design better. A good facilitator is trained to elicit concrete examples and scenarios from participants rather than allowing people to air complaints that they don't like someone else's design idea. A workshop is an opportunity to share, learn, and discuss. Even the experts will often discover that their initial perspectives need to be adjusted. Workshops have proved useful in identifying departmental duplications, and in one case at BNR/Nortel, avoided \$22 million in contractual penalties.

## 4 Coaching Networks

The purpose of a Coaching Network is to connect an informal group of internal experts who are available to mentor, educate staff, offer advice, or share design patterns relevant to specific problem domains. Networked coaches can leverage connections to others to provide advice, if faced with an unfamiliar problem. With emergent software technologies, designers benefit from Coaching Networks. Coaches have in-depth practitioner knowledge in programming languages, design processes, and tools.

Coaches are essential to support the introduction of collaborative design techniques to an organization such as pair programming, code refactoring, and project retrospectives. Experienced coaches with domain knowledge are also key organization change agents to introduce Scrum, Kanban, and Lean techniques. Coaches are often system architects or senior designers with large, long-lived products or product family experience. These designers are often familiar with the history of how the product's design has evolved. They are part of the “oral tradition” of product design. Coaches can also be experts in tools and technologies used across the company.

Some companies have sponsored special Communities of Practice [10] within their technical community – groups of internal experts that are tasked with sharing of technical ideas and practices in a specific area, such as a community of testing technology experts. The mission of a coach goes beyond directly helping members of a company's technical community. Coaches need to stay current in their technology. As champions for lifelong learning, they act as exemplars and are key advocates for design investments.

## 5 Design Forums

The purpose of Design Forums is to increase visibility for design best practices and to share key learnings – including learning from failure.

Initially introduced as part of a software reuse initiative, Design Forums were organized at BNR (Bell Northern Research [the research arm of Nortel]) as a grass-roots internal proprietary conference to share design practices and design experiences across a 20,000-person global product development organization.

Sharing between organizations was difficult due to the compartmentalization of product organizations and the geographic span of the company with design centers in Australia, Austria, Canada, China, France, Germany, India, Ireland, Japan, Turkey, UK, and USA. While many company engineers frequently

published in external technical conferences and journals, design knowledge was not shared widely within the company.

With the success of the first forum, BNR/Nortel's Computing Research Lab (CRL) management team immediately requested a second forum to be held within six months. This initiated a regular cadence of semi-annual and later annual forums.

Since corporate cost-cutting measures limited travel, a proprietary "Conference Down the Hall" was attractive to design staff who could not otherwise participate in ACM, IEEE, or other conferences. To allay the fears of design staff management that too much time would be spent away from product development, the first forum encouraged contributions previously published in ACM and IEEE public conferences. Speakers were requested to add a 'story-behind-the-story' not included in public presentations.

Starting with the first forum, a double-blind peer review process was used to select papers and presentations. The review process determined if content was ready to present or required additional incubation – and provided feedback to authors. The double-blind review process was essential to avoid the influence of author seniority on the selection process. Otherwise, contributions from senior leaders might be given a bye while junior staff contributions might be ignored.

Staff contributions were solicited related to Design Forum themes that included: Architectures and frameworks; Capture and reuse of design rationale; Collaborative design across time zones; "Does design reuse reduce time-to-market?"; Hardware and software co-design; Keeping documentation alive; and Translating customer complexity into competitive design.

While published forum "themes" were used to solicit contributions, program session topics were often emergent – based on submission reviews. Accepted papers were grouped into sessions by topic and if necessary, the time zone of the presenters. While the largest core of attendees was "in person" at company headquarters, there were many virtual presenters (and attendees) from around the world.

Until the late 1990s Design Forums (later rebranded as QTech at Qualcomm and CTech at Cisco), depended solely on ISDN video conferencing networks, with as many as 28 participating video sites. In the 21<sup>st</sup> century, telepresence combined with web conferencing (Cisco WebEx, Skype, Zoom) made remote virtual participation increasingly attractive – even to "local" remote attendees.

The production team for the BNR/Nortel Design Forum was headquartered in Ottawa (time zone GMT-5). The production team managed video, audio, and Q&A coordination. Additionally, the Santa Clara (GMT-8) and Harlow UK (GMT+0) design centers hosted keynote speakers in addition to presentations by local design staff. While some presenters from regional BNR/Nortel design centers found ways to travel and participate at company headquarters, most regional staff presented virtually, which meant that presentations by staff in India and UK needed to be early in the presentation day, which ran generally from 9 am to 5 pm in Ottawa. Presentations from Santa Clara would be featured later in the program (afternoons in Ottawa).

The programs were anchored by external keynotes featuring academic or industry leaders in software design, architecture, and

implementation. Speakers and their topics included: Marc Andreessen, Tim Berners-Lee, Ward Cunningham, Bill Joy, and Don Tapscott on the influence and evolution of the web; Barry Boehm, Grady Booch, Fred Brooks Jr., Doug Schmidt, Ivar Jacobson, Steve McConnell, Dave Parnas, and Mary Shaw outlined challenges related to various aspects of program design – from requirements to economics; Whitfield Diffie, Nancy Leveson, and Ed Yourdon focused on security and safety concerns; while Arno Penzias spoke on disruptive technologies.

Visible executive support and internal forum marketing (Figure 2) was essential. High-level sponsorship encouraged design staff to participate and overcame the reluctance of managers to permit staff to take "time off" from product development. It was also important to have "proceedings" – both printed and video. The recordings served staff who were unable to attend in real-time and printed (later digital) materials allowed everyone to reference and review forum content post-event.



Figure 2. Internal Marketing for Corporate Design Forums

At Qualcomm's QTech, proceedings helped catalyze the company's first technical journal and contributed to organizational memory. "Best Paper Awards" and customized conference tchotchkes (swag) provided additional incentives for participation, both by presenters and attendees. In the days of video conferencing, when staff gathered in video conference rooms, catered breaks and lunch offered additional motivation to attract attendees. Once established, forums would attract more than two thousand staff for a three-day event.

BNR/Nortel Design Forums helped avoid design duplication when staff at Maidenhead (UK) and Richardson (Texas, USA) discovered they were building identical products – albeit for different customers. Virtual workshops and tutorials helped foster improved learning and communication across international company design centers.

## 6 Company-University Collaborations

The purpose for Company-University Collaborations is to inspire product design, acquire talent, benchmark or market products, and upskill employees with innovative technologies.

In the 20<sup>th</sup> century, companies sought to nurture new technologies and viewed intellectual property as a "secret sauce" to be protected to maintain competitive advantage. Today, companies are embracing "Open Innovation" [11] approaches, where company staff collaborate with both universities and other companies. Company-University Collaborations contribute to new products and services through design inspiration, education, and Talent Exchanges.

Sample Company-University Collaboration programs include: short courses by university professors, software engineering master's degree programs (e.g., ConGESE – the Ontario Consortium for Graduate Education in Software Engineering program), product benchmarking programs to validate the competitiveness of product designs (e.g., Cisco's TritonSort partnership with UCSD), and broad spectrum research collaborations to inspire new product designs.

## 7 Talent Exchanges

The purpose of Talent Exchanges is to help a company to inject new design ideas and perspectives through Open Innovation strategies [5, 11]. Interns and professors on sabbaticals bring new ideas into an organization unconstrained by the norms, beliefs, and values of the company. Talent Exchanges foster two-way information flows: academics and students obtain industry design experience while industry experts can share design expertise with academics through adjunct professorships and visiting scientist roles.

Both universities and companies must be mindful of intellectual property rights and whether NDAs (non-disclosure agreements) are either necessary or enforceable. Another concern (at least in North America) are Export Compliance (ITAR) regulations that govern certain technologies and access by non-US citizens. Failure to license visiting or full-time company staff in compliance with ITAR regulations can lead to negative consequences including staff termination and corporate penalties.

## 8 Design Through Virtual Collaboration

Many organizations have learned to initiate and sustain ongoing engagement with the tech community through university, company, or broad-spectrum conferences such as those sponsored by professional societies. However, in 2020, the COVID-19 pandemic drove companies and universities to move most of their collaborative activities to a virtual format. "Virtuality" has had positive impacts besides limiting the pandemic contagion.

Going virtual increases global accessibility by participants. It also reduces costs for participants and risks for organizers. The authors feel that virtual options will undoubtedly expand [12] over time, since cost reduction will always be a motivating corporate factor. The design knowledge transfer strategies we have outlined will catalyze innovation, whether companies use face-to-face, virtual, or a mix of interaction modes.

Design knowledge transfer strategies can have unanticipated benefits. Although the objective may be to guide the adoption of best practices, collaboration and communication strategies accelerate innovation in other positive ways. Knowledge transfer helps to bring new staff members up to speed, captures and records corporate memory, bridges corporate silos, fosters collaboration across business units, and harnesses employee enthusiasm for innovation.

## 9 Evaluating Investments

It is not easy to measure the value of knowledge transfer strategies. The set of stakeholders is very diverse, and that makes it a challenge to find general agreement on assessing the return on investment (ROI). Measurements of the impact and value will be mostly indirect. In our experience, the success of Design Forums was established by tracking trends on submissions, percentage of submissions accepted for presentation, audience size, general audience satisfaction, and executive sponsorship. The impact of Coaching Networks can be assessed with a six-month retrospective. If development groups start using the new technology and tools effectively, then the knowledge transfer succeeded. Visible management support and stable funding is often a key success factor.

Our two most important funding lessons learned over 30+ years: Do not forget to build a broad base of sustained executive support (both program sponsors and program customers) and do not rely on a single funding source for a program's budget. A program with a single executive champion makes a program more prone to cancellation, unlike programs with federated sponsorship and budgeting.

Strategy	Program Investment
Design Workshops	Facilitated team sessions (half to two days), costs include facilitation and staff participation
Coaching Networks	Experts on call, cost varies with loaded labor rate of the coaches
Design Forums	Program management, IT infrastructure, Staff costs for presenters and attendees
Company-University Collaborations & Talent Exchanges	Program management, Funding for collaboration participants, Program expenses (e.g., contracts, research gifts, in-kind donations)

**Table 1. Summary of design investment strategies**

At BNR/Nortel and Alcatel-Lucent, new staff were put through intensive multi-week design courses featuring instructor-led courses and hands-on experience to learn about company-specific tools and processes. At Qualcomm, "Engineering Onboarding" was developed for engineers to complement the original half-day onboarding program focused on company mission, organization, and HR benefits. The Engineering Onboarding Program was delivered to provide new company staff with an overview of design tools, ACM/IEEE digital library access, standards, and open-source software ethics. It is essential for company staff to understand the negative consequences of misusing open-source software code in their designs.

At Cisco, "Agile-Lean Coaches" programs started with informal pilots before launching formally with executive support. Design strategies included promoting Lean thinking, Lean start-up strategies, and technical debt reduction, with a focus on teams and culture. At HP, virtual discussion sessions were used to raise awareness of Company-University Collaborations. These sessions shared the different collaboration approaches of the global HP

design centers in Brazil, Canada, Germany, Singapore, Spain, UK, and the US.

At Alcatel-Lucent, expert coaching was an important part of technology adoption. For over a decade, a central organization in Bell Labs delivered “jumpstarts” (training plus follow-up coaching) in a wide variety of design, coding, and testing techniques, and each business unit sponsored both coaching and tool development. There was an annual assessment of the overall impact on business-unit projects. Informal internal Coaching Networks were also effective in design improvements in every large business units. Some of the most successful volunteer-developed training was eventually taken over by the corporate education center.

## 10 Observations

Software design is more than models, methods, and coding. It is a human activity that requires communication, collaboration, domain knowledge, and expertise spanning multiple disciplines. Software design requires lifelong learning, both for individuals and software development organizations. Learning requires investment and executive support. Without the indicator of executive support through ongoing funding, corporate programs tend to falter. The authors found that it was important to collect “success stories” and feedback following a program retrospective to share with internal customers and executive sponsors. At BNR/Nortel, positive feedback from the first Design Forum (and early Design Workshops) helped attract funding and additional sponsors!

Organizations need to capture design knowledge through collaboration and communication. Design Workshops and Design Forums help foster connections and the propagation of practices developed through experience. Talent Exchanges and open innovation collaborations are also key to inspiring new products and attracting and retaining staff. Individuals need to manage their careers and keep their skills current – either through corporate programs – or by attending or contributing to public conferences. Sometimes the best way to learn is to teach. Individuals and organizations can benefit from both!

While our approaches do not address all design investment challenges, we have found them effective in raising visibility for design practices in large multi-site development organizations. Our learning programs can be grown incrementally – an important consideration since corporate program funding may need to grow or retrench proportionally in response to stock market “surprises” or changes in corporate leadership.

Design Workshops, Design Forums, Coaching Networks, Company-University Collaborations, and Talent Exchanges have proved effective. These programs can be initiated both by bottom-up grass-roots design staff and top-down through visible executive sponsorship. In summary, continuous investments to improve

design team learning, communication, and collaboration are essential to achieve product portfolio competitiveness.

## ABOUT THE AUTHORS

Steven Fraser is based in Silicon Valley and has led tech R&D collaboration programs for: HP Labs, Cisco, Qualcomm, BNR/Nortel, CMU’s SEI, and Innocex. Steven holds a doctorate in Electrical (Software) Engineering from McGill University in Montréal, Canada and is a senior member of both the ACM and the IEEE. As a knowledge transfer consultant and educator, he has organized over 100 software conferences, panels, and workshops.

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. Dennis holds a doctorate (Computer Science) from University of Illinois at Urbana-Champaign. As an independent technology coach and educator based in New Jersey, Dennis is sharing his strategies for bringing together researchers and product development experts.

## ACKNOWLEDGMENTS

Special thanks go to the workshop’s anonymous reviewers. We also thank Robert Crawhall, Erik Lundh, Bertrand Meyer, Landon Noll, Ken Power, Werner Wild, and Rebecca Wirfs-Brock for their constructive suggestions.

## REFERENCES

- [1] Peter Freeman and David Hart. 2004. The science of design for software-intensive systems, *Commun. ACM* 24, 8 (August 2004), 19-21. <https://doi.org/10.1145/1012037.1012054>
- [2] Steven Fraser and Dennis Mancl. 2013. Dimensions of diversity, equity, and inclusion, *SIGSOFT Softw. Eng. Notes* 48, 2 (April 2023), 18-21. <https://doi.org/10.1145/3587062.3587068>
- [3] Frederick P. Brooks, Jr. 1995. *The Mythical Man Month, Anniversary Edition*. Addison-Wesley, Reading, MA.
- [4] Peter M. Senge. 1990. *The Fifth Discipline*. Doubleday, New York, NY.
- [5] Steven Fraser. 2021. Five Strategies for the Future of Work: Accelerating Innovation through Tech Transfer. Experience report from XP 2021 Conference. <https://doi.org/10.48550/arXiv.2402.01764>
- [6] Laszlo Bock and Brian Welle. 2013. You don’t know what you don’t know: How our unconscious minds undermine the workplace. Retrieved February 9, 2024 from <https://blog.google/inside-google/life-at-google/you-dont-know-what-you-dont-know-how/>
- [7] Mary Shaw. 2010. Research toward an engineering discipline for software. In *Proc. FSE/SDP Workshop on Future of Software Engineering Research (FoSER '10)*, November 2010. ACM, New York, NY, 337–342. <https://doi.org/10.1145/1882362.1882431>
- [8] S. D. Fraser and C. S. Saunders. 1993. Enhanced reuse with group decision support systems. In *Proc. Advances in Software Reuse*, March 1993, Lucca, Italy. IEEE, 168-175. <https://doi.org/10.1109/ASR.1993.291706>
- [9] Steven Fraser. 2015. Reflections on Software Engineering Research Collaborations, In *Proc. IEEE/ACM 2nd Intl. Workshop on Software Engineering and Industrial Practice (SER&IP)*, May 2015, Florence, Italy. IEEE, 5-10. <https://doi.org/10.1109/SERIP.2015.10>
- [10] Etienne Wenger. 1998. *Communities of Practice: Learning, Meaning, and Identity*. Cambridge University Press, Cambridge, UK.
- [11] Henry Chesbrough. 2003. *Open Innovation*. Harvard Business Review Press, Boston, MA.
- [12] Steven Fraser and Dennis Mancl. 2024. Virtual and the Future of Conferences, *Commun. ACM* 67, 2 (February 2024), 32-34. <https://doi.org/10.1145/3624638>