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Creating Greater Synergy Between HCI Academia and Practice

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Abstract. This paper presents perspectives from both academia and practice on how both groups can collaborate and work together to create synergy in the development and advancement of human-computer interaction (HCI). Issues and challenges are highlighted, success cases are offered as examples, and suggestions are provided to further such collaborations.

Keywords: Human-computer interaction · Synergy · Academia · Practice · Research · Industry

1 Introduction

According to Wikipedia, human-computer interaction (HCI) focuses on the design and use of computer technology. For a technology to be successful and be embraced by its users, the sociotechnical factors, which include not only the technology but also the users and their environments, must be taken into consideration. Hence, the field of HCI crosses many disciplines including information systems/science, computer science, psychology, sociology, organization science, communication, business administration, engineering, and ergonomics [1–3].

Academia and practice have long been concerned about the gap that exists between them [4–7]. In the context of this paper, we are focusing specifically on the field of HCI. Questions and issues that have arisen include: Are students today meeting the needs of

the HCI and User Experience (UX) industry? Is academic research in HCI applicable and useful to HCI practice? Can HCI academia and practice work together to establish greater synergy in their profession and discipline, and if so, how?

2   Perspectives from HCI Academia

Four HCI academicians offer their perspectives on how the gap between academia and practice can be bridged and their suggestions on creating synergy between HCI academia and practice. They are: Dennis Galletta from University of Pittsburgh, Fiona Fui-Hoon Nah from Missouri University of Science and Technology, Gavriel Salvendy from Purdue University, and Hong Sheng from Missouri University of Science and Technology.

Perspective from Dennis Galletta (University of Pittsburgh). I believe that practice and the academy have synergies that provide great opportunities for interaction.

Innovations that are widely communicated have the best chance of further improvement over time, and eventually becoming mainstream. If innovations remain in academic journals, they merely remain as untested ideas or platforms for understanding the innovations. On the other hand, innovations that stay in an organization remain as proprietary technologies, and users are then forced to do painstaking research to discover which products have the best combination of unique and immature innovations. Innovations that are found through research (whether from the academy or from the corporate lab) and widely communicated and/or evaluated through academic journals and conferences will be on a quicker cycle to lead to further innovations that can be enjoyed by all.

In earlier days of our field, 30+ years back, research teams such as [8, 9] were pioneers of this interaction. Three examples from these two research teams should be helpful. I have chosen older examples because the world has had time to realize their value and extend their impact.

Gould and Lewis [8] provided a framework of three simple principles to design usable systems (through early focus on the users and task, testing, and iteration). Their survey revealed that surprisingly, very few designers describing their practices mentioned any of those principles. This disparity, and the simplicity of the framework, was appealing to researchers; as of this writing, Google Scholar reports 1,630 citations. Two years later, Gould et al. [10] reported how they applied their framework to a successful design of the Olympic Message System in 1984, attributing much of their success to those principles. In the following years, several practitioners set up usability labs. Some even have made available tools to support user testing and make it affordable. Examples of on-line tools in this area are Usertesting.com and Openhallway.com. Today we know much more about the sample size that is needed for testing, e.g., Hwang and Salvendy [11] has come up with the "10 ± 2 rule" indicating that designers should test with at least 8 to 12 subjects.

Card, Moran, and Newell [9] reported a hierarchy of models of expert user performance, which included the keystroke model. The first two authors were practitioner-researchers from Xerox's Palo Alto Research Center, and the third was an academic from Carnegie Mellon University. They pooled their resources to create a set of parameters and techniques for modeling error-free user behavior, which could

predict the time it would take for highly experienced users to accomplish tasks using quantitative techniques rather than testing them in actual use. To date, not only have there been over 6,500 citations of that work, but in the 1980s, many devices and software packages were evaluated using that framework.[1]

There were two influential applications of the keystroke model. The first, "Project Ernestine," [13] saved NYNEX $2 million by avoiding the purchase of a "modern" GUI-based system; the keystroke model revealed an excessive amount of sequential operations for which operators had to wait, as compared to the faster but cruder-looking legacy system's parallel operations which could be performed while operators were doing other things. The second was IBM's "In-keyboard pointing stick," now known as the Trackpoint©, included on Lenovo's Thinkpad© line, as well as on many higher-end Dell, Toshiba, and HP laptops. Ted Selker of MIT's Media Lab, designed this red "eraser head," as some call it, a pointing device placed between the G, H, and B keys. Selker [14] found it to be 20 % faster in mixed keyboard and pointing tasks because users no longer needed 2 s to reposition the hands from the keyboard to a separate mouse and back. The efficacy of the pointing device was supported by the keystroke model as well as by performance of actual subjects, as depicted in a video by Rutledge and Selker [15].

The final example is again from Card, Moran, and Newell [9] in the foundational work that led to the development of the Xerox Star© workstation and the world's first graphical user interface (GUI) operating system. Many of its features led to the design of the first MacIntosh© and Windows© operating systems. Researchers at Xerox needed to painstakingly evaluate many alternative designs [16]. Tuck [17] reported that Apple refined the designs of their GUI by working with "psychologists, artists, teachers, and ordinary users." Tuck reports that they even used children in a California elementary school because kids "gave the truest reaction to basic interface issues." The innovations provided by the Xerox Star project were widely publicized in journals and conferences. This applied research resulted in innovations such as the mouse, Ethernet, Microsoft Word (a descendent of BravoX), laser printing, and other vital innovations that are still offered today, sometimes as hidden components of more well-known products (see [18]).

These examples demonstrate the synergy of practice and academia, suggesting a cycle of (1) innovations enjoyed by a firm, (2) widespread sharing of the innovation's concepts in academic literature, and then (3) further innovations derived from the academic concepts. Industry has benefited, demonstrated by the success of Apple's and Microsoft's operating systems, Ethernet and laser printing, the persistence of the Trackpoint©, and the savings enjoyed by NYNEX. The academy has also benefited our understanding of computer uses in new ways as we can now abstract across the successes and failures to extract general meaning and frameworks, and provide new building blocks for further research. Academics can study practice, widely communicate its innovations, and provide unique understanding across many products, companies, or applications. Practitioners who refer to analysis from the academy can integrate old and

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[1] As an aside, one of my recent publications used the keystroke model and novice testing to demonstrate a vivid difference between ease of use and ease of learning. Comparing the four major smartphone platforms in terms of ease of use, Blackberry was first and iPhone was last. Comparing them on ease of learning, the order reversed [12].

new ideas and enhance the academy's work. An iterative cycle of this process can be considered as synergistic because the combination is more powerful than the sum of the two sides.

Perspective from Fiona Fui-Hoon Nah and Hong Sheng (Missouri University of Science and Technology). Being immersed and teaching in a department that integrates business and information science & technology, the field of HCI takes on high precedence in our curriculum and research agenda. As a STEM-oriented university where STEM stands for **S**cience, **T**echnology, **E**ngineering and **M**athematics, the Missouri University of Science and Technology places a strong focus on entrepreneurship to commercialize and roll out into practice the technological innovations and inventions that take place on campus. Hence, bridging research and practice is one important goal and a key success factor of the campus. However, collaborations with industry are still lacking and questions arise as to how we can better train and prepare our students for practice in the HCI/UX area.

From the perspective of providing better and more relevant HCI/UX training to our students, we find that internships, co-ops, and collaborations with industry on research projects offer valuable training and experiences to our students. With regard to collaborations with industry in the HCI/UX area, integrating such collaborations into classes is a powerful and effective way to bring practice-relevant training to students. Having HCI/UX practitioners as guest speakers in classes and serving on the advisory board of major programs can help to foster synergistic effects in bridging practice into academia. Having joint regional and international conferences/workshops/seminars involving academics, students, and practitioners is also desirable for creating and enhancing such synergy.

From the perspective of collaborating on HCI/UX research, there are mutual benefits for both parties to work together. As mentioned earlier, such research collaborations offer greater opportunities for students to work on practice-oriented research projects and apply what they have learned in the classroom to practice. It may also offer academics the opportunity to publish rigorous and practice-oriented research, all in one. Practitioners can benefit from the rigor of scientific research, from relatively inexpensive (or less expensive) labor from students to work on their projects, and from using the university environment to test and assess the HCI/UX aspects of their products and services (e.g., as a beta site).

Despite the many advantages and benefits, there are challenges that will need to be addressed, some of which include intellectual property rights and the somewhat different priorities and performance evaluation criteria of practitioners and academics. Having a mutual understanding of each party's goals and priorities, and striving for a mutual goal that is beneficial to both parties are keys to the success of collaborations.

Perspective from Gavriel Salvendy (Purdue University and Tsinghua University). Both industry and academia got their thrust and evaluation messed up. In industry, typically over 90 % of R&D function is allocated to short term developmental objectives that can germinate revenue for the corporation in the short term. Long term basic research which may have major impact on new products and services is typically downplayed or missing in the current industry objectives. In all or most university programs with the

exception of business schools, the top priority is for faculty to bring in lots of research funding. For research output, less research oriented universities simply count the number of papers the faculty authored. The more research intensive universities look at the impact of the journal where a paper is published and the citation of the faculty but there is no emphasis on the impact of the research for societal needs. Based on the above observations, collaborations between industry and academia on basic research are warranted in order to design and produce far reaching high impact innovative products and services for the benefit of mankind. One way of springboarding such collaborations is by having industry sponsor a one full day meeting during a conference, such as HCII, that is attended by individuals from industry and academia in order to generate a white paper on the subject of interest to industry that would provide a road map for high impact international research.

3   Perspectives from HCI Practice

Four HCI practitioners who have received rigorous research training in their doctoral education offer their perspectives on how to address the gap between academia and practice and provide their suggestions on creating synergy between them. The HCI practitioners are: Melinda Knight from Microsoft, James Lewis from IBM, John Pruitt from Dell, and Anna Wichansky from Oracle.

Perspective from Melinda Knight (Microsoft). As the lead of a small team within a large organization, I have two primary objectives: finding and maintaining an outstanding team of world-class researchers, and ensuring that my team and I are providing the most action-able insights possible, activated towards current and future product opportunities in a timely way. We work in a format that roughly mirrors the scientific method: pose a research question, understand existing insights, form a hypothesis, determine the appro-priate method for the investigation of the research question (if that question has not already been answered by the broader HCI or Microsoft community), execute new research or interpret the existing research, frame up the set of insights derived from the investigation … and then activate it to produce real product change.

Activation — the translation of a finding, evidence, speculation, or certainty into a tangible, positive outcome for a customer — is the measure of success for us. Simply put, activation means getting insights into a product, and it includes much more than conducting and communicating research. While academia's culture is one of "publish or perish," for HCI practitioners in industry, the notion is "ship or sink." First, we must start from a research question that will have impact on the products our industry is shipping. We must manage time, budget, and scope of our research question to align with the product schedule in order to ensure that activation is even possible. Yes, our insights must be well-formed, our research plan sound, and our methods appropriate to the level of confidence needed to inform the decision. And yes, we strongly agree that documenting those insights is critical so that others who come after us can jump to the next activation point faster (or deactivate and redirect, as is sometimes the case). But our goal, and the measure of any body of research's true success — and our success as HCI practitioners — is activation.

This is a key point on which industry and academia, and by association, HCI education and training, differ. Conducting outstanding research is not a complete or sufficient outcome, but a step along a journey towards another goal. For my team, that journey also includes project management, leadership across interdisciplinary teams, and understanding how to interpret research results and recommendations in the context of a project timeline, technical constraints, market forces, and myriad other factors. Those are the skills I look for when I interview HCI grads and professionals. It is not the tools in their tool belt, or the number of citations they have produced. Knowledge of tools and number of citations indicate research potential, and are an important foundation for a great industry researcher. Strong qualitative and quantitative skills, mastery of statistical methods, and a background in experimental design are all valued as they are the foundation. The next layer up, however, is critical. I need colleagues with the ability to partner, frame, storytell, and prioritize a research insight to move a product forward.

Across industry and academia, *insight* is our common currency. As HCI practitioners, we share a goal to develop greater understanding of human needs, habits, beliefs and capabilities, and examine how new or existing technologies might best support and enhance these across diverse contexts. Ideally, industry would pause following the launch of a product to exhale those insights that led to (or away from) the customer outcomes embodied in a product solution. That broader sharing remains a challenge for us in many respects. Some revelations are becoming more common, as product teams put forth design language and human interface guidelines for developers of new technologies; however, the specific research findings that led to a piece of advice are not always revealed. I would ask academics to help your industry peers move further and faster by framing your research findings in ways that are actionable and accessible. Seek out and value the application of those findings as a measure of their success. Note product adoption in line with your peer-reviewed articles and publications, or consider it the ultimate citation. Doing so would increase the effective power of your work and afford experimentation and evaluation of your insight at scale.

Two practical barriers we have encountered to partnering with academia include IP and a focus on research funding. Greater partnerships could be facilitated by avoiding competition for IP on joint work, and leading with how existing and future insights could be activated in industry products and timelines vs. leading with the question of "What's in it for the university?" Where there is an opportunity for activation, money follows. Finally, I would implore us all to prepare the next round of HCI practitioners, be they targeting academia or industry, with those skills in project management, team management, and persuasive fortitude which will make them valued and valuable wherever they land.

Perspective from James Lewis (IBM). Given a goal of creating greater synergy between HCI academia and industrial practitioners, one question is, "What are the opportunities for synergy?" I joined IBM in 1981 as a human factors engineer with a master's degree in Human Factors Engineering from New Mexico State University. I haven't conducted research on this topic, but reflecting back on my personal history, here are some of the opportunities I've observed.

Internships. Internships bring students (and in similar but rarer programs, faculty) from academia and give them industrial experience – i.e., experience that can shape their future research activities as academicians in a way that also benefits industrial practice. Before I joined IBM as a regular employee, I interned in the summer of 1980, and that experience helped me decide to pursue industrial rather than academic work. Over the following decades, the Human Factors department in Boca Raton often had several interns (including John Pruitt, also on this panel) working side-by-side with seasoned professionals. Interns can be very influential on industrial practices in a given department given their up-to-date knowledge of applicable research and new analytical methods. Both academia and industry benefit from a robust internship program.

Doctoral Committees. I have twice had the opportunity to participate on the doctoral committees of interns with whom I have worked, one from the University of Central Florida and the other from the University of Miami. Both interns conducted research that had strong industrial value while also accomplishing the research goals required for their doctorates [19, 20].

Practical Courses. Some HFE and HCI professors teach practical courses in which they reach out to industrial practitioners to present design or research problems to the class. The students then, typically in teams, apply the design and research methods they've been learning to the problem. To complete the project they present their work to the practitioner.

Scientific Advisory Boards. Recipients of grant money often need to put together scientific advisory boards as part of their research process. When possible, board membership should be offered to qualified industrial practitioners. In addition to the collaboration via the board, there may also be opportunities for joint research or publication. Recently, I worked with one of the academic members of the Center for Research and Education on Aging and Technology Enhancement (CREATE) on a paper for the Journal of Usability Studies [21].

Professional Societies/Meetings. Membership in professional societies and participation in professional meetings can bring academic researchers and industrial practitioners together (e.g., this panel). Connections made through these activities sometimes result in collaboration. An inhibitor for industrial practitioners is a common lack of financial support for membership and attendance.

Publication. Participation in the publication process can bring academia and industry together. For this to happen there must be venues that are open to contribution by industrial practitioners and industrial practitioners need to be able to (1) recognize which aspects of their work are publishable and (2) work for companies that encourage (or at least don't actively discourage) publication. Ideally, journals in applied areas such as HCI should make an effort to include industrial practitioners on their editorial boards and as reviewers.

Continuing Education. Industrial practitioners can hone skills and connect with academic researchers through continuing education. These opportunities may take the form of short courses such as those offered by the University of Michigan or through tuition reimbursement benefits. For example, IBM essentially paid for my PhD in psycholinguistics, which I then applied for a number of years to help commercialize IBM's speech technologies.

Conclusion. There are a number of opportunities for synergy between HCI academia and practice, which requires investment from both sides. Academia should focus on increased outreach to practitioners, identifying good candidates for participation on committees and boards, providing opportunities for "reverse internships" (bringing qualified practitioners on campus or over the Web to teach a class/course or participate in a research activity), and creating venues for applied publication and presentation. Excellent examples of publication opportunities have been fostered by Gavriel Salvendy, who founded the International Journal of Human-Computer Interaction and the HCII conferences. Industry should create work environments that, while still supporting the goals of the company, provide incentives to practitioners to participate in the broader HCI community (e.g., reimbursing the membership fee for a professional society as a benefit, paying for conference attendance contingent on conference participation, awarding external publication, and seeking academic partners for R&D projects).

Perspective from John Pruitt (Dell). As we consider the question of how to improve the synergy between HCI academia and industrial practice, the first logical response is WHY? To what end do we desire to have better synergy? What is the requisite outcome for either party? For me, that question leads to the discussion of motivation and incentive. What truly motivates an individual practitioner, professor, student, department, team, or broader institution to devote time, energy, people and finances to collaborate across party lines? I posit that our motivations can be quite different and that acknowledging them upfront can lead to better collaboration, transparent negotiations, and win-win situations.

Let's consider first a corporate setting. What matters to almost any corporation is the bottom line. Is there a business case, product or process improvement, protectable and monetize-able intellectual property? For the practitioner in a corporate setting, practical innovation that can be productized and owned may be the primary outcome. In such a case, the specific institution (are they top 10 or lesser known) or individual (published and tenured or just establishing themselves) may matter less as long as they are an expert on the right topics, open to targeted collaborations toward a specific end, and willing to turn over ownership of the outcome to the sponsoring corporation. When considering longer term (promotions and careers), the skills and accomplishments gained in climbing the corporate ladder typically does not make an individual attractive to an academic institution and vice versa.

My own experience is that academic partnerships for HCI in usability and design related research often offers a less costly alternative to consulting agencies when needing to extend my team's capabilities and available resources. The relations are often less

formal, more friendly and open. The difficulty typically lies in the fact that business timelines are typically condensed while project goals as well as product requirements can shift suddenly as organizational, industry and competitive changes occur. Agencies can turn on a dime, academic collaborations usually can't or don't. Further, project outcomes for the corporation need to be conclusive, actionable and perhaps show a visible return on investment. Academic collaborations can sometimes be satisfied with simply knowing the previously unknown and creating a call for further research. The research (and gained understanding) is the end, not necessarily a means to an end. For higher level research endeavors (understanding process, the larger system, a particular domain, uncovering innovative ideas), doing so may be fine. For more tactical or product specific work, it likely isn't. Finally, the research topic and findings for a business are largely held as private and protected. Publishing and conference participation is not typically encouraged in many organizations, or at least not explicitly supported. Patent protection, on the other hand, typically is encouraged and even financially incented for the practitioner.

As I consider the academic perspective, what matters might be the reputation of the target corporation, its ability to fund the collaboration, or the possibility of publishing the work (as opposed to being more secretive and protective). For the professor or research associate, will it further their line of investigation, improve their understanding of the domain, give access to certain valuable resources, or lead to further discovery? For the advisor or the student, will it give the student a better opportunity for employment later – real-world experience, connections, a fuller resume or portfolio? Again, for the corporation, not only is the intern's direct work important, but such a relationship allows for a long-term evaluation of a potential employee – a 3-month interview with benefits.

Of course, there is no single perspective or motivation that covers any institution or individual, in academia or industry. Motivations likely overlap some or even reverse in certain situations. They are complex and vary over time. I will also note that the specific motivational examples here revolve around my own primitive notions of traditional academic institutions to traditional businesses. There are many complexities and variations that could be called out in brilliant detail. On the academic side, there is likely a strong division between top tier universities focused on basic research and others that range from more applied research to mostly focused on education and training. On the business side, HCI and UX concerns (and the professionals who do this work) are no longer concentrated in tech companies. Banking, automotive, fashion, health care – you name the industry, and there are likely UX professionals working on interesting problems. The business objectives, processes and working environments must be all over the map. Still, the point here is that understanding motivations and being open about them may encourage new avenues of collaboration, or at least, more productive, mutually beneficial partnerships – a truly concerted effort. It is typically the case that motivations and deliverables are different between parties, but both sets of needs must be met in order for great collaborations to happen.

As James Lewis and others have pointed out, there exist today several good avenues of collaboration between these worlds – joint or one-party funded projects (corporate sponsorship), advisory boards, committees and standards bodies, sabbatical appointments, student internships, visiting/guest instructor/lecturer, targeted conferences, etc.

But, are these the only ones, the rights ones, or are there other, perhaps yet discovered alternatives? Perhaps joint goals, motivators and incentives can be created? Imagine a joint business endeavor or product line between a business and university, or the creation of a "corporate" university/campus or research institute. Imagine there being time-shared employees who spend part of their time in academic settings and part in corporate; students who move seamlessly between the two. The nature of education and business may need to evolve for greater HCI collaboration to happen.

Perspective from Anna Wichansky (Oracle). After receiving my Ph.D. in experimental psychology with concentration in human factors engineering, I felt I was not experienced enough in this very applied field to teach others; therefore, I embarked on an industry career which led to several jobs in high tech. I reasoned that after a long stint in industry (maybe up to 10 years!), I would have enough hands-on knowledge and practical skills to help guide young professionals in an academic setting. Now, after almost triple that time, I feel I might be able to articulate some of the attributes I wish for in a job candidate, particularly a fresh-out master's or doctoral grad who is anxious to get into high tech.

I will concentrate on two areas where I see regrettable lack of skills and knowledge in new HCI grads: product design, and experimental design and statistics. This may have to do with the university they come from, the survey nature of HCI academic programs, and the broad intellectual orientation of the individual who goes into any multidisciplinary field.

In the design area, most new grads come in without a working knowledge of a design process. From some programs, they understand design theory, but they have never started with a blank sheet of paper (or screen) and created a working product from start to finish. From other programs, they think that design is programming, so they start coding on the first day, and attempt to create a product "bit by bit." From still other programs, they attempt to test and analyze their way into product creation. While all of these approaches are complementary and play a role in the design process, they don't produce an actionable design. This is why high tech companies still hire most product designers from design schools granting BFA and MFA degrees, as they come in knowing a design process.

Professional designers understand that product architecture is a very advanced skill. Less experienced designers start in apprentice and journeyman roles, first creating smaller components such as icons and then whole workflows and features that merge into the grand design. Understanding what a design process is, how to follow it, where a project is in the process, and how to work with others to get it done, are things that could be taught through project workshops, design jams, hackathons, and internships, if the HCI program has faculty members who have this experience themselves.

Experimental design and statistics is truly an area of expertise where "what you don't know can hurt you." Many new HCI hires come in thinking they can do a brief survey on a product prototype with five of their colleagues and find out if it is usable. Or they just want to have "a conversation" with users about their product with no prepared questions. They do not have sufficient knowledge of experimental design, including techniques to minimize experimenter and subject biases, use of control conditions, or

the effects of confounding, to prepare a methodologically sound study. They may not wish to conduct statistical tests, yet they do not understand that their results can be badly flawed and lead to the wrong design decisions if they do not test enough users. Their findings may not be representative of the user population, or may be merely anecdotal considering the small sample size. Yet companies make million dollar decisions based on these findings. If new grads cannot get enough depth in experimental design and statistics in their HCI programs, they should at least be made aware that this isn't one of their strengths, and how to recognize and support someone who is equipped to design and run a study. At the very least, they should know when they need to do a controlled behavioral study, and what type of study is needed based on the stage of the design process.

Two academic researchers from University of Dayton and Rochester Institute of Technology recently published results of surveys of new human factors professionals in their first jobs, hiring managers, and human factors students in academic programs about their expectations of HF/E programs. The results were keyed to the BCPE ergonomist formation model. While the details of the results differed based on whose perspective was being surveyed, there was common agreement on a couple of key areas [22]:

> The "take-home" message from the three surveys is quite clear: To better prepare new HF/E professionals for the demands of the workplace, their training should include practice in design, project management, working in interdisciplinary teams, and making persuasive arguments for human factors in all project phases. These are topics that could be incorporated into any college curricula on any topics, and we hope that educators hear this message loud and clear.

4   Conclusions

This paper offers perspectives from HCI practitioners and academics on ways in which greater synergy between HCI academia and practice can be achieved. The authors are the panelists at the 2015 HCI International Conference that is to be held in Los Angeles, California from August 2–7, 2015. The panelists will present their views at the conference and are looking forward to receiving comments, feedback and suggestions from the audience on how to achieve the mutual goal of closing the gap between HCI academia and practice, and, further, how to create greater synergy across them.

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