Industrial HCI Research: A Personal and Professional Perspective

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In this article we give you some personal perspective on the changing role of human-computer interaction (HCI) researchers practicing in industry over the last 25 years and look to the future. We identify long-lasting themes and emerging trends and add some insight from our experiences working in IT research and development. These experiences include collaborating as team members on a series of HCI research projects during 15 of over 20 years at IBM Research. We also describe what it has been like having a two-person HCI household over the years.

In a recent publication, we discussed three case studies of design and evaluation of usable technology in industrial research in order to provide a big-picture view of HCI research in industry (Karat & Karat, 2010). We highlight some of the themes and extend and build on these ideas. We hope that our perspective gives you some insight regarding industrial HCI and possibilities for collaboration in the future.

Some Background on Us and How We Work Together

First a little bit about who we are. We met as graduate students in the psychology department at the University of Colorado in 1976. John was studying cognitive psychology with a focus on human problem solving, and Clare-Marie was studying social psychology with a specialty in management of teams. Human factors of computer systems was not our target field—indeed the field did not exist in anything approaching its current form. We met in a class on the use of computers in psychological research. John was a teaching assistant, and Clare-Marie was a student. Our first conversation occurred when John accused another female graduate student named Fran and Clare-Marie (the only two women in the class and the department) of cheating on the Fortran programming assignments in the class.

The three of us discussed this matter for a little while, and Clare-Marie and Fran insisted that they were not cheating but working together collaboratively as a team; they had worked together on the programming tasks and had identical solutions. The three of us came to the solution that Fran and Clare-Marie could work on the programming tasks together as long as at the end, when the approach to the task was understood, they tailored their programs with different variable names and the like so the two solutions were not identical. This was an initial experience of John and Clare-Marie having two very different perspectives on a topic and coming to an agreement through discussion about how to proceed. We will return to this point later.

We were married and had our quirky honeymoon while on the way to work for the United Nations in Bangladesh for a year. This was an opportunity that John's advisor described as "orthogonal to your research path" and that arose from John's professional ties with researchers at Johns Hopkins University. Those researchers were then part of a United Nations effort and asked John to join the project to teach computer and behavioral science skills to Bangladeshis so they could help to guide their own country forward. After we talked about it, we decided taking a year to work overseas and travel would give us valuable experiences while we helped others. We finished our graduate studies after we returned, moved to Austin, Texas, and after different 5-year stints in software development at IBM, ended up in the IBM Research Division—John in 1987 and Clare-Marie in 1991. It was unusual then, and remains so today, to move from development into research at IBM. Coming in from development, we had a good idea of current issues customers were grappling with and also had a wonderful set of HCI associates that we continued to interact and complete some research with over the years.

Many changes occurred during our 20 plus years in research, which we might suggest in summary as a shift in focus from the role of computational technology on individual work with a cognitive psychology focus, to a much broader focus on the role of information technology in our lives as social beings, and with an emphasis on social issues. We benefitted from this trend by mixing cognitive and social psychology aspects in our own research and both have proved to be necessary for understanding uses and potentials for IT. Understanding people and their relationship to technology requires attention to a broad array of issues.

Now we'll give you some context about our work situation. We were Research Staff Members at IBM Research. We worked in separate groups for many years, and then as our research interests converged, we worked on some of the same projects together. There is a management rule in IBM that a married couple can both work for the same manager, but cannot work in a hierarchical arrangement where one person reports to the other. Over the years, IBM has flattened the management structure and has fewer managers with larger groups. So, for example, our research department had about 14 people in it, and about half of them were on our team.

We had a little miracle happen for us in 1999 when our son Zac was born within days of our 20th wedding anniversary. We weren't supposed to be able to have children, and yet, after a trip to Paris after Clare-Marie co-chaired CHI 98, we found she was pregnant. We have often told people that our experience is that the third time you visit Paris, you get pregnant, so consider that in your plans. After our son was born, working together was both valuable and risky. Did we really need more "together" time? Would we be able to leverage mutual awareness of current focus areas, deadlines and constraints and still juggle schedules around parenting responsibilities? Coordinating travel and taking care of a sick child presented real challenges. For example, sometimes we both needed to be away at the same time. We had to take turns and set up guidelines that neither one of us should be away more than two nights if possible until our son was 5 years old. Sometimes, this meant that one of us presented the other's paper at a conference, and we had to keep trips all business and give up tourist time in interesting places in order to get back home. On the other hand, sometimes it was possible for the three of us to travel together. We participated in several CHI conferences when there was CHIkids for our son. We were even able to plan university visits overseas (e.g., University of London) after CHI, where our son sat in the back of the auditorium, listened to the seminar and audience questions, and enjoyed it. We were involved in establishing the SOUPS conference and were able to bring Zac along when he could take part in summer camps about dinosaurs at the Carnegie Museum in Pittsburgh. (We are delighted that Zac tells us that he wants to be a scientist when he grows up.)

We decided that overall it was a clear value to both of us to collaborate on research during this time. It was a risky decision to make, in that we had most of our "eggs in one basket" and so there were career risks in play. And a number of people thought that spending so much time together professionally and raising our child must add tremendous stress to our relationship. For us, this was not the case; the collaboration at work and home made us stronger. We work, take care of family, and play together. Crazy, eh? Sometimes, of course, there were disagreements over priorities. No relationship is without some strains. But we had learned when Clare-Marie was in the IBM Consulting Group years earlier before our son was born, and home only on weekends for nine months, that that situation put more stress on our relationship than juggling home life with our son. We did have other research projects and external volunteer activities independent of each other that ran concurrently with our major research project each year, so there were opportunities for each of us to go our own way professionally as well.

There is one other important point about working together professionally. We believe that our team members became comfortable with John and me having different perspectives and ideas; we generally did not agree with each other more than about half of the time during the initial discussion of a topic, and yet would agree and reach consensus at the end of the discussion with the team. Team members laughed sometimes about our debates of ideas. Remember the story at the beginning about the teamwork that was viewed as "cheating"? John enjoyed retelling this story to put new team members at ease. This open social environment was important for healthy group dynamics and facilitated people feeling that everyone knew they each had a respected voice and an equal chance to contribute to shaping the way forward for the team based on the team's analysis of the options discussed.

The debates we had among the multidisciplinary members of the group were effective in surfacing issues and helping the team identify good decisions and solutions towards achieving project goals, and we continuously learned from each other. While Clare-Marie was the project leader (elected by the team to this role), she had no line management authority in running the multimillion dollar projects the team committed to. She used a democratic leadership style with the group. The team met with our department's manager once a week to keep him or her informed about team member activities (also, the department manager was asked by other managers to provide input for evaluations and promotions for team members outside our department; however, Clare-Marie provided no input to our manager's evaluation of team members within our department). Towards the end of each year, our team needed to propose our next year's research plans (generally three to four projects at different stages of the research cycle) to our management chain and potential sponsors within IBM as well as outside the company. Over the years, we proposed research and worked collaboratively with colleagues in academia and other companies, as well as with HCI engineers in IBM product divisions, as appropriate to the research goals. Project plans were finalized at the beginning of the year, with a reasonable level of detail about the research goals and project milestones. Quarterly reviews occurred on progress towards goals, and we had ongoing communication with our sponsors about activities and any needed changes to plans. Our research collaboration continued until we had both retired from IBM by mid-2011 and formed the Karat Consulting Group, specializing in HCI design, evaluation, and training.

We personally believe that it is vital for HCI professionals to do outreach to schools and mentor students to engage and excite them about career possibilities as HCI researchers in science and technology. We have mentored middle school, high school, and graduate students, as well as volunteered within the ACM SIGCHI, INTERACT, and SOUPS communities while at IBM Research, and have continued these volunteer efforts now with our consulting group. For example, John mentored several Intel National Science Competition high school students, including one who did an HCI project, was a finalist, and met the President of the United States! More recently, John is mentoring junior high students in an underwater robotics club. These students compete to design and build remote operated vehicles in a national competition. We have worked together to go into middle and high school science classrooms over the years to give students a brief overview of careers in science and technology and also to provide a hands-on experience in brainstorming about usable technology. These outreach sessions take place in one class period in coordination with the science teacher. Finally, some of our favorite times at research occurred during the summers when we mentored and learned from graduate students who joined the team from around the world.

Trends in HCI Work in the International Community

What changes have occurred across the last 25 years in HCI focus areas in the international community? We identified four main trends in earlier work (Karat & Karat, 2003) and briefly characterize them here. First, the focus of HCI research and practice has moved from *interface* to *interaction*. This trend started fairly early in the history of the field, though some confusion remains (e.g., what does the "I" stand for in "HCI"?) as there is still a tendency to at least talk about designing the interface rather than designing interaction (or, more currently, designing the user experience).

Second, the pace of change in computing systems has accelerated from slow changes in technology to rapid ones. We began our studies in the early days of personal computers at a time when issues associated with the usability of mainframe systems were still relatively important. The technology stood still long enough for us to study it and its users in great detail. Although behavioral science provided the HCI field with many tools and theoretical frameworks for observing behavior, these methods have generally been suited for use in fairly stable environments and not as means for providing design advice in rapidly changing ones. Relatively newer approaches, such as integrating the use of scenarios into HCI design work, are part of the shift to approaches that fit the technological reality of the HCI design space.

Third, the population impacted directly by the technology has moved from relatively few users to essentially everyone. We moved from studying small groups of dedicated users (e.g., system administrators and specialists) for whom operating a computer was their main task, to studying knowledge workers looking for productivity tools, to studying how computers could be seen as providers of entertainment. Beyond the office, we looked at the value of information technology for everyone, young and old alike, and with a wide spectrum of skills, and physical, personal, and social environment characteristics. We still design some systems for specific users, for example medical professionals or air traffic controllers, but even when we do we assume the users have considerable experience with other systems and try to leverage general technology expertise.

Finally, there has been a broadening of the industrial HCI conception of the role of technology from focusing on office work productivity to considering a broad range of use. One indication of the rise in importance of looking beyond productivity alone has been the attention given to evaluating the total user experience. Value-sensitive design and considering the application of HCI methods to entertainment applications have become increasingly important (Karat, 2003).

Trends in the Industrial HCI Research Environment

HCI research in industry has changed greatly over the last three decades. In the 1980s and into the mid-1990s, there was incredible growth and freedom in high technology industry for researchers, HCI and otherwise, in terms of their ability to determine research agendas and goals. Research not directly tied to specific product development was seen as an important means for turning technology potential into new areas of use. To give you an idea of the level of freedom that existed in those days, a researcher was required to meet with his or her manager only once a year. Many researchers worked on their own projects in isolation. Since the mid-1990s, the pressure of the global marketplace and the ever increasing pace of change in technology have put pressure on industrial research divisions around the world to provide quicker results in focused areas. The organization came to understand that to address opportunities, researchers needed to work in multidisciplinary teams and coordinate with other areas of the company. The transition to this new focus created a significant stress for many researchers. Some researchers simply could not accept this new view and left industry for academia. We had always seen the focus on customer or business value as a reasonable distinction between academia and industry and so agreed with most of the spirit of the new approach. However, the demands of the work situation could get absurd. Our midlevel management was at one point impatient about progress in our line of research (Couldn't we solve a huge technical problem in the field right now?). John took this with good humor and suggested to the team that we meet at 11 a.m. the next Tuesday to invent a major breakthrough in research during the meeting. The team laughed.

Many research divisions have been dissolved or absorbed into less basic research oriented R&D organizations in companies around the world. For those industrial research divisions that remain, there is generally now a tighter association between product and services groups, and the research groups tend to focus their work on those product and service domains. This association may be tied by the funding that the product and services groups provide in exchange for expected deliverables from research organizations. Clearly, when there are expected deliverables on a schedule, there will be an impact on the type of research conducted. More research now is of an incremental nature than in the past. It extends the research on a fairly well defined path. We see this shift to incremental research in other industries as well: healthcare, pharmaceutical research, and others. And having been members of NSF research review committees, we see the proposal submissions there as shifting toward incremental research as well.

There are exceptions to the picture described above. Large, multiyear projects can free researchers to be more innovative and take more risks. We were part of a research division that made a set of "big bets" that involved larger teams on multiyear projects focused on breakthrough goals in science and technology, and we were lucky to contribute to a few of them. It is essential that researchers be allowed to take more risks and think "big sky." This is how in the past, paradigm shifts have occurred following breakthrough research (Kuhn, 1996). We truly hope for the health and wellbeing of research divisions in industry, as well as for the good of society, that the pendulum swings back from its current position of incremental research to a more growth oriented portfolio of research projects with healthy amounts of risk taking on potentially valuable new technology.

Focusing researchers on real problems has benefits. As researchers have seen how technology impacts the lives of so many, they seem to have become more comfortable with larger issues. Industrial HCI researchers are increasingly as concerned about how the technology impacts the very young and the aging as we are interested in office workers. Associated with this concern is a shift to looking beyond individual activity and cognition for appropriate theoretical guidance to HCI work. Theoretical approaches such as activity theory or distributed cognition move the focus away from concentrating on the individual that dominated HCI for so long to a view of the roles of humans in a larger, interconnected world (Suchman, 2007).

Our Approach to the Practice of Research: General Guidelines

The industrial research setting has influenced the HCI research completed across time, as well as approaches, methods, and techniques employed in industrial research. In our own experience, our HCI research was influenced by whom we were doing it for. Ralph Gomory, Director of IBM Research from 1970 to 1986, often stressed that in an industrial research setting, projects often have a dual mission of advancing science while also being valuable to the organization. We often found ourselves in discussion about how to serve both science and industry. Multiple perspectives are indeed valuable in setting HCI research goals, and having access to people with different perspectives on what questions you should try and address can provide inspiration. Through our professional colleagues, we were able to understand fundamental challenges in a domain of inquiry. The sponsors were able to point out their view of key user and system requirements or issues that framed a business issue or opportunity. To understand the user and system requirements more fully, we included a variety of HCI activities with users, employing a diversity of approaches that could be tailored to suit different contexts. This model was quite different than the approaches we learned and used in graduate school.

While we had a high level plan worked out about the time, people, and resources available for the HCI research, it is in the nature of industrial research environments as with practitioner engagements in general that dramatic changes can happen with projects due to changes in business priorities. Thus, we needed to be ready to adjust plans and still complete deliverables. Sound familiar? Our experience suggested allocating around 30% of the project time to frame the issue (see Figure 1). When we completed this first phase of framing the question, as with all the other phases, we considered different ways to triangulate on the data in answer to key questions we were focusing on. We asked people in different roles; asked the question in different ways and through different methods to obtain congruent validity or cross-validation. This information helped us consider tradeoffs when we needed to adjust to changes during the project based on external events.
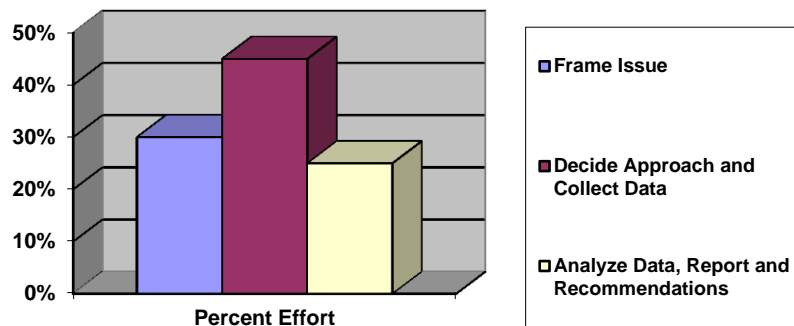
Figure 1. High level view of relative effort for HCI research project stages

We established and fostered a strong relationship with our sponsor as well as future potential sponsors by understanding their requirements and how we might deliver value to them. Again, sound familiar? On one long-term research project that spanned five years, our contact point in the sponsor organization changed from year to year, and we needed to understand each person's view of the potential value of our research and other opportunities to show value. It can be annoying to have to be continually in the role of "educating your management," but viewing it as a fact of research life helped us focus on long-term goals. John and Clare-Marie shared this responsibility and thus distributed the frustration.

As to design and evaluation methods used in industrial HCI research, we found that it was important to plan on using multiple types of methods. These ranged from relatively less intensive methods including observation, interviews, and surveys, to more resource demanding and expensive methods such as group usability walkthroughs of prototypes onsite at customer locations or individual usability testing sessions in the laboratory. We learned over our decades of research, that generally two to three iterations on a prototype are necessary to achieve an efficient, effective, and pleasing interaction experience and set of valued functionality in the technology. Clients were generally accepting of the two to three iterations on a prototype because they saw the clear improvement in the deliverable and in our past cost-justifying usability research on which the approach was based (e.g., Karat, 2005). We committed significant time and effort to identifying and recruiting target users to work with in the HCI research related to the new technology. Working with true representative users is crucial in completing high quality HCI research that is "valuable to the field and vital to the company." Deciding the approach and collecting the data generally consumed 45% of the project schedule.

In industrial research there are many different ways to demonstrate and assess the value of HCI research. In the last 25% of a project schedule, we synthesized and interpreted the results and communicated that understanding to others. This included completing the data analysis, making recommendations for your sponsors to implement, transferring research ideas and technology to the sponsors (by working together with the development team, in some cases over several years), updating the organization's strategy based on the results, providing new data to managers and co-workers on the value of HCI research, and writing external publications, filing patents, and preparing research proposals for funding of follow-on or new research projects. To be sure, being able to secure project funding repeatedly is a clear sign that the HCI research completed in industry is valued. We built an internal reputation about the value of the HCI research the team completed. The more value provided to sponsors, by creating usable and useful technology that the sponsor can use to address customer issues or opportunities, as well as patents and external publications that draw interest and focus to the quality and innovation in the technology, the more the team's research skills are in demand within an organization.

Looking to the Future

We think that the HCI field has become increasingly diverse in the last 25 years, and that it will continue on that course. In our view, the fundamental idea in the emergence of user-centered design (UCD) was to emphasize iterative processes whose goal was the development of usable systems. As we continue to develop new terms to describe variations on the specifics of the methods we use, it seems more appropriate to stress that partnership in design is more critical to success than trying to identify who it is centered on. Certainly there is general agreement that usable systems are achieved through involvement of potential users of a system in system design. But, we think that there is a need for somewhat less specificity about the exact role that users play in the design process than some people argue for. When we look at the HCI field, we are impressed by the range of ways people are developing to bring about design partnerships between users and R&D teams.

Evaluation will always be a fundamental part of HCI research, but how we do it will continue to evolve. Measuring the effectiveness, efficiency, and satisfaction of users trying to carry out tasks in particular contexts is how we define measuring usability. While there is an affective component of this measure—user satisfaction—it has generally been regarded as a less powerful measure; it is more subjective and in the productivity-oriented end just not as critical. As this trend continues, there is a significant shift in focus within the HCI field from people interacting with computers, through people interacting with information, to people interacting with people through technology. Looking beyond the role of technology to complete a task to technology's role in making a better world takes some expansion of the focus of the field of HCI. We need to be able to ask, "Will people value this technology?" and not just "Will people find this technology useful?" Measuring such value goes beyond economic notions. It should consider all aspects of a system that a user might feel makes owning and using it important. Such benefits can be identified, measured, and given a role in HCI design. We think that topics such as appearance and aesthetics will play an increasingly important role in HCI design (Laurel, 1993).

The design activity itself has emerged as a central focus within HCI. The HCI field is increasingly interested in the design process: How it should proceed, and who needs to take part in it. The field has discovered that there are many views on what the term "design" means and different ways to view the measurement of quality of a design. For most people within the HCI community, "good design" still implies a sense of "fitting a purpose" that can be empirically validated. As the field increasingly moves more toward considering systems that people value for purposes other than as tools, industrial HCI researchers are finding an increasing need to consider aesthetics and other factors that can contribute to the value of a system or an artifact. The contribution of satisfaction to the usability equation will be a topic of increased attention. We think these trends emphasize a new challenge to HCI research and practice. It just isn't possible to always find a measurable objective task to orient HCI engineering methods toward making easier or more efficient. It will take more than just asking if someone is "satisfied" with an experience to trying to understand more fully why they might "value" it—where value can suggest a number of considerations (e.g., ethical issues in Nardi & O'Day, 1999). While the field might still have a long way to go in making user-centered design common practice, the basic tools for task analysis and performance measurement are already well covered in the usability field. While adopting evaluation techniques to cover affective areas certainly does offer significant challenge and attention, the HCI field does seem to be the right home for these new challenges, and many within it will be interested in this direction.

Some Final Thoughts

We have offered some observations on what an industrial researcher does, drawn from our own experiences and our relationship. We think that research and practice are coming to parallel each other, and that the boundary between the two is often unclear. We viewed our efforts as contributing to better, more usable systems—this is not really different from how a user experience designer would describe what they do. Because part of our charge was always to be "famous for our science," we published research that we conducted to meet the objectives of the research community. In this research, we described who was trying to do what using technology. The evolution of the HCI field and of the workplace has encouraged us not to stop at the observation and description roles, but to offer design and design guidance as well. We

believe that this is very similar to what goes on in the world of the practitioner. We do not find it critical to try and identify the difference between research and practice. It seems far more valuable to simply try and learn from each other's experiences in working toward common goals.

So what is our advice to you? If an HCI friend becomes your sweetheart, you do not have to run away. If you love each other, jump in and get married, work together, and even raise a child together if that's right for both of you. Be flexible, listen, trust your instincts, communicate well, and you will find your way through many challenges and identify or create many opportunities to pursue your goals. Be strong, have a sense of humor, and give back to help the next generation of HCI scientists and practitioners change the world.

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