Introduction

2 Research Methods in Human–Computer Interaction

There is a general consensus that the field of human–computer interaction was formally founded in 1982. This is the date of the first conference on Human Factors in Computing Systems in Gaithersburg (Maryland, United States), that later turned into the annual ACM SIGCHI conference. So, at the publication time of this book, the field of human–computer interaction (HCI) is around 30 years old.

However, this is a deceptively simple description of the history of HCI. The field draws on expertise existing in many other areas of study. People were doing work before 1982 that could be considered human–computer interaction work. There is a fascinating article (Pew, 2007) that describes work on a project for the Social Security Administration in the United States starting in 1977. The work on this project could easily be described as HCI work, including task analyses, scenario generation, screen prototyping, and building a usability laboratory. Pew also describes presenting some of his work at the annual meeting of the Human Factors Society in 1979. Ben Shneiderman published *Software Psychology,* considered one of the first books on the topic of HCI, in 1980. The terms "office automation" and "office information systems" were popular in the late 1970s. At that time, you could find articles that could be considered HCI-related, in fields such as management, psychology, software engineering and human factors. In an interesting article on the history of office automation systems, Jonathan Grudin describes 1980 as the "banner year" for the study of office automation systems, after which, the number of people studying the topic dwindled, and many of them re-focused under the title of human–computer interaction (Grudin, 2006b). Still others point to seminal papers as far back as Vannevar Bush's "As We May Think," which looks surprisingly relevant, even today (Bush, 1945).

The field of human–computer interaction is really an amalgam of other fields, including computer science, sociology, psychology, communication, human factors engineering, industrial engineering, rehabilitation engineering, and many others. This is what makes HCI such a fascinating area of study and, at the same time, so complex. In the late 1970s and early 1980s, computers were moving out of the research laboratory and "secure, cooled room" into the home and the office. The use of mainframes was transitioning into the use of minicomputers, and the more popular personal computers were making their debut: Apple II series, IBM PC/XT, and the Commodore/Vic. It was this move, away from large computers in secure rooms used only by highly trained technical people, to personal computers on desktops and in home dens used by non-technical people in much greater numbers, that created the need for the field of human–computer interaction. Suddenly, people were using computers just as a tool to help them in their jobs, with limited training, and personal computers became a marketed product to home users, like stoves or vacuum cleaners. The interaction between the human and the computer was suddenly important. Non-engineers would be using computers and, if there wasn't a consideration of ease of use, even at a basic level, then these computers were doomed to failure and non-use. In the current

context, where everyone is using computers, that may sound a bit odd, but back in the 1970s, almost no one outside of computing, engineering and mathematics specialists were using computers. Computers weren't in school classrooms, they weren't in homes, there were no bank machines or airline check-in machines, before this shift towards non-engineering use. This shift created the sudden need for the field of human–computer interaction.

1.1 Changes in topics of HCI research over time

The original HCI research in the 1980s was often about how people interacted with simple (or not so simple) office automation programs, such as word-processing, database, and statistical software. The basics of interfaces, such as widgets, dialog boxes, and error messages, were the focus of much research. Some of the classic HCI articles of the 1980s, such as Norman's analysis of human error (Norman, 1983), Carroll's "training wheels" approach to interface design (Carroll and Carrithers, 1984), and Shneiderman's work on direct manipulation (Shneiderman, 1983) are still very relevant today. Towards the late 1980s, graphical user interfaces started to take hold. In the late 1980s and early 1990s, there was growth in the area of usability engineering methods (and the Usability Professionals' Association was founded in 1991). But there was a major shift in the field of HCI research during the early to mid 1990s. As the Internet and the web gained wide acceptance, there was a need to research new types of interfaces and communication, such as web pages, e-mail, instant messaging, and groupware. This caused an increased number of research fields to be included under the umbrella of HCI, especially communication.

Around 2004–2005, the focus of research shifted more towards user-generated content that was shared, such as photos, videos, blogs, and wikis. On December 26, 2006, Time Magazine famously named "You" (the end users who generate content) as the "person of the year." The research focus is no longer on something as simple as task performance in statistical software, but is now focused on collaboration, connections, emotion, and communication. The focus isn't on workplace efficiency any more, but is now on whether people like an interface and want to use it. Terms such as "tagging," "friending," and "recommendations" are core components in today's HCI research. But, of course, that will change!

Every time there was a shift in the focus of research, there was a need to adapt or develop new research methods. HCI isn't a research area with a 100-year history. So whenever a new research approach is needed, it tends to be adapted from existing research methods in other fields, primarily the social sciences and engineering. Research methods in HCI are always changing, developing, and improving. And that's a good thing. But for those doing research that falls under the general umbrella of HCI, the question is, where to look for guidance on performing research?

Despite historic roots in the early 1980s, only in the last five years or so have individuals been able to graduate from universities with a degree that is titled "Human–Computer

Interaction" (and the number of people with such a degree is still incredibly small). Most people in the field of HCI have degrees in computer science, information systems, psychology, sociology, or engineering. This means that these individuals come to the field with different approaches to research, with a certain view of the field. Even students studying human–computer interaction frequently take classes in psychology research methods or educational research methods. But taking just an educational or psychological approach to research methods doesn't cover the full breadth of potential research methods in HCI.

Ben Shneiderman said that "The old computing is about what computers can do, the new computing is about what people can do" (Shneiderman, 2002). Since HCI focuses on what people can do, it involves multiple fields that involve the study of people, how they think and learn, how they communicate, and how physical objects are designed to meet their needs. Basically, HCI researchers need all of the research methods used in almost all of the social sciences, along with some engineering and medical research methods.

HCI research requires both rigorous methods and relevance. It is often tempting to lean more heavily towards one or the other. Some other fields of research do focus more on theoretical results than on relevance. However, HCI research must be practical and relevant to people, organizations, or design. The research needs to be able to influence interface design, user training, public policy, or something else. Partially due to the philosophies of the founders of the field, HCI has had a historic focus on practical results that improve the quality of life (Hochheiser and Lazar, 2007). At the same time, the research methods used (regardless of the source discipline) must be rigorous and appropriate. It's not sufficient to develop a new computer interface without researching the need for the interface and without following up with user evaluations of that interface. HCI researchers are often placed in a position of evangelism where they must go out and convince others of the need for a focus on human users in computing. The only way to back up statements on the importance of users and human-centered design is with solid, rigorous research.

Due to this inter-disciplinary focus, and the historical development of the field, there are many different approaches to research currently used in the field of human–computer interaction. A group of researchers, all working on HCI-related topics, often disagree on what "real HCI research" means. That is one of the reasons why Preece *et al.* (1994) provided interviews with leading HCI figures, all of whom come from different backgrounds and points of view. There are major differences in how various leaders in the field perceive the existence of HCI. Be aware that, as an HCI researcher, you may run into people who don't like your research methods, are not comfortable with them, or simply come from a different research background and are unfamiliar with them. And that's OK. Think of it as another opportunity to be an HCI evangelist. (Note: As far as we know, the term "interface evangelist" was first used to describe Bruce Tognazzini. But we really think that the term applies to all of us who do HCI-related work.) Since the goal of this book is to provide a guide that introduces the reader to the set of generally accepted research practices within

the field of HCI, a central question is, therefore, how do we do measurement in the field of HCI research? What do we measure?

1.2 Shifts in measurement in HCI

In the early days of HCI research, measurement was based on standards for human performance from human factors and psychology. How fast could someone complete a task? How many tasks were completed successfully, and how many errors were made? These are still the basic foundations for measuring interface usability and are still relevant today. These metrics are very much based on a task-centered model, where specific tasks can be separated out, quantified, and measured. These metrics include task correctness, time performance, error rate, time to learn, retention over time, and user satisfaction (see Chapters 5 and 10 for more information on measuring user satisfaction with surveys). These types of metrics are adopted by industry and standards-related organizations, such as the National Institute of Standards and Technology (in the United States) and the International Organization for Standardization (ISO) (see http://zing.ncsl.nist.gov/iusr/ for more information).

While these metrics are still often used and well-accepted, they are appropriate only in situations where the usage of computers can be broken down into specific tasks which themselves can be measured in a quantitative and discrete way. However, many of the phenomena that interest researchers are not easy to measure using existing metrics or methods. Many of these phenomena cannot be measured in a laboratory setting using the human factors psychology model. These metrics for performance may not be as appropriate when the usage of a new technology is discretionary and about enjoyment, rather than task performance in a controlled work setting (Grudin, 2006a). After all, how do you measure enjoyment or emotional gain? How do you measure why individuals use computers when they don't have to?

Another example is that you may want to measure why people no longer use a specific interface; you can't measure them on using that interface. This is not just a theoretical question. Research has shown that many people start using the web but then lose interest or find it hard to use and stop using it; other people have the ability and access to the web but simply are not interested (Horrigan, 2007; Lenhart, 2003). You may not be able to use experimental laboratory research to learn why people don't use technology. If you want to examine how people use portable or mobile technology such as PDAs and cell phones, you can't study that in a controlled laboratory setting. If you want to study how people communicate with trusted partners, choose to perform business transactions with someone they don't know on another continent (as often happens with Ebay), or choose to collaborate, you need to find new ways of research and new forms of measurement. These are not research questions that can be answered with quantitative measurements in a short-term laboratory setting.

Consider Wikipedia, a collaborative, open-source encyclopedia. Currently, more than two million articles exist in English on Wikipedia (Reagle, 2009). At least 75 000 people, according to recent estimates (www.wikipedia.org), spend their own time creating and editing Wikipedia entries. What causes them to do so? What do they get out of the experience? Clearly, task and time performance would not be appropriate metrics to use. But what metrics should be used? Joy? Emotion? A feeling of community? Lower blood pressure?

While at first, some of these measurements might seem a bit odd, there are researchers currently examining how computer frustration impacts on pulse and blood pressure (Picard, 2000). Techniques from medicine, such as facial electromyography (EMG) and electroencephalography (EEG) are being adopted in HCI research (Grimes *et al.*, 2008; Hazlett, 2006). It's not surprising: if you have been trying to complete a task and have suddenly encountered a "blue screen of death," you know that there are some physiological impacts. Researchers are working on measuring these things. What about technologies that allow people to send a hug over a distance to someone wearing a vest that inflates to simulate the sensation of a hug (Mueller *et al.*, 2005)? How would you measure success? Emotion (Isbister *et al.*, 2006)? Feelings of love (Kaye, 2006)? How about technologies that provide information to you on energy usage, with the end goal of lowering your carbon footprint (Gustafsson and Gyllenswärd, 2005)? What's the measurement of success there? Your monthly electricity bill?

Note that there is no such thing as a perfect data-collection method or a perfect data-collection effort. All methods, all approaches, all projects have a flaw or two. One data-collection effort does not lead to a definitive answer on a question of research. In scientific communities, the goal is generally for multiple teams to examine the same research question from multiple angles over time. All of these efforts, if they come up with the same general findings over time, give evidence for the scientific truth of the findings. This is often known as "triangulation". One data collection effort, yielding one paper, is interesting in itself but does not prove anything. If you have 15 teams of researchers, looking at similar research questions, over a period of 10 years, and they all come to the same general conclusion about a phenomenon, then there is some scientific proof for the phenomenon. The proof is even stronger when multiple research methods have been used in data collection. If all of the research teams replicate the same research methods over 10 years, then there is the remote possibility that the methods themselves are flawed. However, the weight of evidence is strengthened when multiple research methods are used.

In HCI, there are some situations where the evidence over time supports a specific finding. One clear example is the preference for broad, shallow tree structures in menu design (see the "Depth vs Breadth" sidebar). Multiple research studies have documented that broad, shallow tree structures are superior (in terms of user performance) to narrow, deep tree structures.

Research In Practice

Depth vs Breadth in Menus

Multiple research studies by different research teams, throughout the history of the HCI field, have examined the issue of the trade-off between depth and breadth in menus. Generally, tree structures in menu design can be implemented as narrow and deep (where there are fewer choices per level but more levels) or as broad and shallow (where there are more choices per level but fewer levels). Figure 1.1 shows three menu structures.

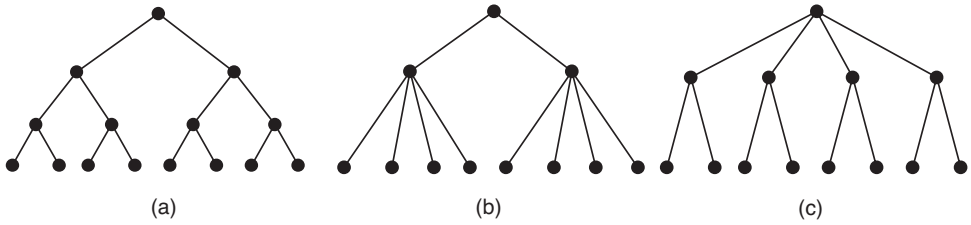

Figure 1.1 Types of tree structure in menu design: (a) Narrow–deep: three levels with two choices at each level; (b) broad–shallow: two choices followed by four choices; (c) broad–shallow: four choices followed by two choices.

The research has consistently pointed to broad, shallow tree structures as being superior to narrow, deep structures. There are many possible reasons: users get more frustrated and more lost, the more levels they must navigate; users are capable of dealing with more than the 7 ± 2 options often cited in the research literature (since menus deal with recognition, not recall), and strategies for scanning can lead to superior performance. Different research methods and different research teams, examining different users, have all come to the same conclusion. So over time, the superiority of broad, shallow tree structures has become well-accepted as a foundation of interface design. Some of the better-known articles on this topic include:

Kiger, J.I. (1984) The depth/breadth trade-off in the design of menu-driven user interfaces. *International Journal of Man–Machine Studies.* **20**(2):201–213.

Landauer, T.K. and Nachbar, D.W. (1985) Selection from alphabetic and numeric menu trees using a touch screen: breadth, depth, and width. *Proceedings of the SIGCHI conference on Human Factors in Computing Systems*, 73–78.

Larson, K. and Czerwinski, M. (1998) Web page design: implications of memory, structure and scent for information retrieval. *Proceedings of the SIGCHI conference on Human Factors in Computing Systems*, 25–32.

Miller, D. (1981) The depth/breadth tradeoff in hierarchical computer menus. *Proceedings of the Human Factors Society 25th Annual Meeting*, 296–300.

Snowberry, K., Parkinson, S., and Sisson, N. (1983) Computer Display Menus. *Ergonomics*, **6**(7):699–712.

Wallace, D.F., Anderson, N.S. and Shneiderman, B. (1987) Time stress effects on two menu selection systems. *Proceedings of the Human Factors and Ergonomics Society 31st Annual Meeting*, 727–731.

Zaphiris, P. and Mtei, L. (2000) Depth vs Breadth in the Arrangement of Web Links. *Proceedings of the Human Factors and Ergonomics Society, 44th Annual Meeting*, 139–144.

In contrast, other research topics in HCI still have no clear answer, with multiple studies that yield conflicting findings. For instance, what is the minimum number of people required for usability testing? See Chapter 10, where the debate still rages on, as there is no agreed answer (Lindgaard and Chattratichart, 2007). There may be some research questions to which the answers change over time. For instance, in the late 1990s, web users tended to find download speed to be one of the biggest frustrations (Lightner, Bose and Salvendy, 1996; Pitkow and Kehoe, 1996). User habits and preferences are fluid and there may be changes over, say, a 10-year period (factors such as increased availability of broadband Internet access may also play a role). The biggest frustration for web users right now would most likely be viruses or spam. When the web first became popular in the mid-1990s, web-wide subject lists and in-site navigation were popular methods for finding items; now, search boxes are far more popular methods for finding what you want (and it is possible that the introduction of Google played a role). When it comes to user preferences, there can be many different influences, and these preferences may change over time. This is yet another reason why one research project, at one point in time, does not make scientific fact.

You should never get disappointed or upset when you find out that another research team is working on a similar research question. You should get excited, because it means that both research teams are moving closer to the end goal of some definitive scientific answers. The chances are very high that your research method won't be exactly the same, your research questions won't be exactly the same, and your human participants won't be exactly the same. The fact that other research teams are interested in this topic shows the importance of the research area and strengthens your findings. Perhaps you should be more worried if no one else is interested in your research.

1.3 Inherent conflicts in HCI

It would at first seem that, with enough research, you could simply decide which design is best by optimizing some specific measurement, such as task performance or time performance. But HCI design and research is rarely that simple. Often, there are inherent conflicts in human–computer interaction research and design. We make trade-offs and accept "better solutions" rather than optimal solutions. We have multiple stakeholders and not all of them can be satisfied. Design is not simple and it's not an optimization problem. Good HCI research allows us to understand the various factors at play, which design features work well for which users, and where those trade-offs are, so that we can make an informed decision. That's not to say that we make perfect or optimal decisions.

For example, we can learn how to make interfaces that are far better than our current interfaces. However, users may not prefer those interfaces because they are so different from the current interfaces. So maybe we should modify our interfaces gradually, making only minor changes each time? Keyboards are a perfect example of this. We know how to make keyboards that are more ergonomic, with key layouts that allow for much faster typing. However, the keyboard layout predominantly used with the Roman alphabet is still the QWERTY key layout. Why? We have far superior designs. The QWERTY layout comes from the time of typewriters, when we had to worry about hammers striking each other. Clearly, that's no longer a problem. However, people have been comfortable with the QWERTY layout for years and the other key layouts have not caught on (despite their clear superiority from a design and usability point of view). So we still use the QWERTY layout. It's a trade-off. You want to make interfaces that are much better but users want consistency. In the short-term, a totally new interface lowers user performance, increases user error, and lowers user satisfaction. In the long-term, a newer interface may improve performance and result in higher satisfaction. Just researching a new interface isn't enough; you need to understand how users may or may not choose to adopt it. Of course, there are sometimes new interfaces, new devices, that just leap ahead with a totally different design and users love it, such as the Apple iPod device. You shouldn't create a totally new design, apparently, unless it's something so cool that users want to spend the time to learn how to use it. Well, how do you measure that? How do you decide that?

Another example of an inherent trade-off is at the intersection of usability and security (Bardram, 2005; DeWitt and Kuljis, 2006). We want interfaces that are 100% easy to use. People focused on computer security want computers that are 100% secure. By definition, many security features are designed to present a roadblock, to make users stop and think, to be hard. They are designed so that users may not be successful all of the time. The best way to make a 100% usable interface would be to remove all security features. Clearly, we can't do that. On the other hand, when success rates for users on security features are below 50%, we have a problem (Sauer *et al.*, 2010). Current techniques, such as passwords, human interaction proofs (such as CAPTCHAs), and security questions all leave a lot to be

desired (from the point of view of both usability and security). What's the answer? Is it eye scans and finger scans? Are users ready for that? Right now, the typical user has so many passwords that they simply can't remember them or they choose easy-to-remember (and easy to crack) passwords (Chiasson *et al.*, 2008). Users may write their passwords on a sheet of paper kept in their wallet, purse, or desk drawer, or they click on the feature that most web sites have saying, "Can't remember your password? Click here!" and their password is e-mailed to them. And a password sent in e-mail isn't secure either! Research presented at the annual ACM Symposium on Usable Privacy and Security (SOUPS) attempts to address that inherent trade-off. Simply put, stakeholders may not be willing to value workplace efficiency over security of workplace data. So, lower workplace efficiency with some level of data security may be the acceptable trade-off. Again, HCI research addressing these trade-offs, these intersections of multiple priorities, is important, so that better decisions can be made.

Another consideration that has recently come to the forefront is the idea of sustainable interaction design (Blevis, 2007). While people working in the field of information technology may often be focused on new and better devices and design, faster machines, and faster processing, this can lead to high energy usage and a lot of waste. Sustainability means trying to encourage users to limit their energy usage (Chetty *et al.*, 2009), to keep using current devices, and to reduce the amount of technology waste by allowing current devices to be repaired or retrofitted, rather than just throwing the device out (Mankoff, Blevis *et al.*, 2007). It's possible that, with research, we could develop a new type of computer that would be incredibly easy to use and superior in many ways to our current computers. But would a better computing experience be worth it, if millions of current personal computers would end up in landfill, poisoning the earth and water?

Being user-centered, as HCI tends to be, also means being concerned about the impacts of technology on human life. In the past, this meant that HCI researchers were interested in repetitive strain injuries from computer usage, whether spending lots of time on the Internet made you depressed, and whether computer frustration could impact on your health. Currently, the issue is how all of our technology creation, usage, and disposal impacts on the quality of our life and the lives of future generations and on whether persuasive devices and social networking can be used to encourage us to lower our ecological footprint. (Gustafsson and Gyllenswärd 2005; Mankoff, Matthews *et al.*, 2007). So there's yet another trade-off: is optimal design sustainable design? If not, it's probably not the best choice. Let's go back to our keyboard example: if all keyboards in the English-speaking world were changed over to a different key layout (say, the DVORAK layout), there might be some initial resistance by users but, eventually, user performance might improve. However, how would those millions of keyboards in landfill impact on the quality of human life? This is a new point to evaluate when considering how we do research in human–computer interaction. What is the ecological impact of our research? What is the ecological impact of new interfaces or devices that we build? While it's likely that we won't know in advance

what type of ecological impact our research work will lead to, it's an important consideration as we do our research, yet another inherent challenge in HCI.

1.4 Interdisciplinary nature of HCI research

While HCI has historically been inter-disciplinary, involving people from multiple fields, there have usually been one or two fields that have dominated the agenda alongside computer science (Grudin, 2006a). This might influence which research methods are considered to be most appropriate at a specific point in history. At the beginning, the dominant fields might have been human factors, engineering, and psychology (which, for instance, all support the experimental design model). Currently, the dominant fields may be leaning more towards library and information science, and art and design (Grudin, 2006a). More and more work in the area of HCI is now being done in design schools, information schools, and library schools (Olson and Grudin, 2009). As interface and interaction research moves away from desktop computers to portable devices, smart phones, tangible and wearable computing, audio, touch, and tactile computing, there is a natural involvement of the disciplines that have experience in these areas. Terms such as "information design," "information architecture," and "interaction design" are more prevalent. So, the combination of new disciplines that drive the HCI agenda and the current focus on enjoyable, discretionary (non-work-related) usage and users influence the use of new research approaches.

Shneiderman has named this new approach to research "Science 2.0." The idea is that to study today's research questions, there are so many variables involved (such as collaborations, empathy, and trust among individuals) that reductionist methods in the laboratory do not allow researchers to fully understand what is happening (Shneiderman, 2008). Multi-method approaches, possibly involving case studies, observations, interviews, data logging, and other longitudinal techniques, may be most appropriate for understanding what makes these new socio-technical systems successful.

The old methods of research are comfortable: hypothesis testing, statistical tests, control groups, and so on. They come from a proud history of scientific research, and they are easily understood across many different academic, scientific, and research communities. However, they alone are not sufficient approaches to measure all of today's phenomena. The same applies to the "old standard" measures of task correctness and time performance. Those metrics may measure "how often?" or "how long?" but not "why?" However, they are still well-understood and well-accepted metrics, and they allow HCI researchers to communicate their results to other research communities where the cutting-edge tools and research methods may not be well-understood or well-accepted. The field of HCI has begun to apply research methods from the social sciences, and we encourage the reader to start using some new research approaches that are not even in this textbook! Please be aware that people from other disciplines, as well as your "home discipline", will probably challenge the appropriateness of those research methods!

It is important to note that inter-disciplinary research, using multiple research methods, is not always easy to do. There are many challenges that can arise, in many cases due to the individual cultures of each of the disciplines involved. While the HCI community might be considered by some to be an inter-disciplinary community, many other conferences, professional organizations, and individuals keep the focus on their primary discipline. When inter-disciplinary research gets filtered through single-discipline evaluations, there are many challenges that can occur. Some of the challenges are well-known, such as how some disciplines (e.g. computer science) focus more on conference publications and others (e.g. management information systems) focus on journal publications (Grudin, 2006a). Some disciplines focus on single-author publications, while others focus primarily on group-author publications. Some disciplines are very open about sharing their results, while others keep their results more confidential. Some disciplines are very self-reflective and do research studies about their discipline (trends of research, rankings, funding, collaborations), while others do not. Some disciplines are primarily focused on getting grant money, while other disciplines are less interested, or can even be leery of the influences of outside sponsors. Even the appropriate dress at conferences for each discipline can vary widely. And inter-disciplinary researchers can sometimes have problems convincing others at their workplace of the quality and seriousness of their work. But all of these are primarily concerns with an individual's professional career or with administrative issues (Sears *et al.*, 2008).

There are more serious, but less well-known, challenges related to inter-disciplinary research. As discussed earlier in this chapter, no research method, approach, or discipline is perfect. In reality, a research project is a series of steps and decisions related to data collection. For instance, there is a theoretical foundation for the data-collection effort, there is a research method involved, often human participants are recruited and involved, there is data analysis, and then there is the discussion of implications involved. Different disciplines can sometimes be most interested in, and more focused on, different steps in the research process. While no one would ever say, "I'm not interested in the research methods," in many cases, there are steps that are considered of less interest to people from a certain discipline. And there may be historical roots for that. For instance, as described in Chapter 5, there are large data-collection efforts that use strict controls, in fields such as sociology, and those data sets are available for researchers internationally to analyze. However, no such central data sets exist for human–computer interaction and it's not considered a standard practice to publish your data sets or make them available to others. It's a very different model in other fields. That may lead to a focus on certain stages of research more than others.

(Note: We expect the following paragraphs to be a bit controversial; however, we do believe strongly, based on our experience, that they are true.) One discipline might have an expectation that a specific step (such as research design) is done "perfectly," but that it is acceptable to give more flexibility in other steps (such as the types of participants). The management information systems community of HCI researchers has a well-known focus on the theoretical underpinnings of any research. Computer-science-based HCI researchers have much less interest in theory and much more of an interest in the practical outcomes

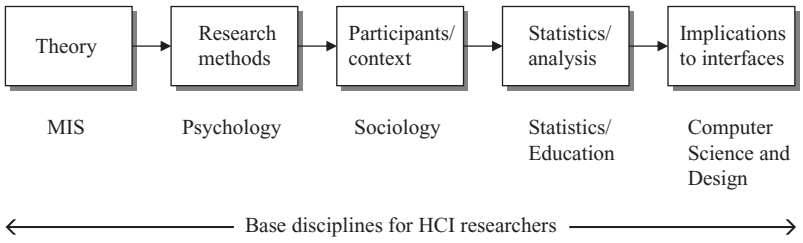

Figure 1.2 How disciplines focus on certain phases of the research process.

of the research on interfaces (although Carroll, 2003 is a noteworthy effort on theory in HCI). This distinction is seen, for instance, in the Technology Acceptance Model, which is core theory and has central importance for HCI researchers focused on management information systems, but is not well-known or of much interest to the HCI researchers focused on computer science (Davis, 1989; Venkatesh and Davis, 2000). While general computer science researchers have a great deal of theory in, say, algorithms, HCI research in computer science does not have a major focus on theory.

When having inter-disciplinary discussions and working on inter-disciplinary teams, it's important to be aware of these distinctions. Sociology-based HCI research tends to focus on the demographics of the research participants and determining if they accurately represent the population of interest, while this is not considered critical in computer science, where computer science students are often used as participants (even when not appropriate). Psychology-based HCI research tends to focus on an ideal and clean research design. HCI research based on computer science and on design is focused more on the implications for interfaces, although computer science may focus more on the technical underpinnings while design focuses more on the look and feel of the interface. Figure 1.2 provides an overview of which stage of research tends to be focused on most by different disciplines. These are just generalizations, obviously; all disciplines want excellence at all stages of research, but it is true that disciplines tend to focus more intensely on particular stages of research. The good news is that we want all of these different groups focusing on improving each stage of the research process. We WANT different groups looking at research through their different lenses. We want to get that triangulation, where people look at the same research questions, using different methods, different approaches, and different lenses, over time, with the goal of discovering some scientific truths.

1.5 Communicating your ideas

It is important, for a number of reasons, to become familiar with the research methods in different disciplines. You need to be able to communicate your research methods, and the reasons why you chose some and not others, in a very convincing way. When you submit journal articles, conference papers, or book chapters, you never know who will be reviewing

your work. The chances are good that your work will be reviewed by people who come from very different research backgrounds. There really isn't one "HCI background."

The same is true of grant proposals. A large percentage of HCI research is funding-intensive. It involves graduate students, new equipment, and paying human participants to take part in research. Often, to get ground-breaking, large-scale research, funding must be available. Funding is secured through submitting multiple grant proposals to government organizations, NGOs, and private organizations. When you submit these grant proposals, you never really know the research background of the proposal reviewers. While many organizations strive to ensure that the reviewers are experienced and knowledgeable, this is no guarantee that the reviewers will come from a similar background to you. You need to be able to compare the different research methods available for your proposed research and explain why one method seems to be superior to another. Or, preferably, why you used a few research methods, but did not choose to include another specific research method.

1.6 Research and usability testing

We are often asked about usability testing, and whether or not it is considered to be "research." While the actual methods used in some types of research and usability testing are very similar, the goals of research and usability testing are very different. Both experimental research and usability testing may sometimes involve quarantining the user in a separate environment and asking them to perform a series of tasks without outside help, and they involve quantitative measurement of performance.

However, the goal of usability testing is simply to find flaws in a specific interface (or series of interfaces). A small number of users may take part in usability testing and it can be structured or unstructured. In usability testing, there is no claim that the results can be generalized – the goal is simply to find flaws in a specific interface to help the interface developers improve the interface. If that involves jumping in and helping a user or changing the tasks mid-process, that is acceptable. Usability testing can be messy but that's OK. See Chapter 10 for more information on usability testing.

Summary of Chapters

Given that the topic of research methods in HCI is so broad, we have tried to give approximately one chapter to each research method. However, the book starts out with three chapters revolving around the topic of experimental design. Whole books and semesters have focused on experimental design and, when you include all of the statistical tests, this simply can't be contained in one chapter. Chapter 4 can be useful for methods other than experimental design (for instance, statistical analysis is often used in survey research). For researchers using statistical software and advanced statistical analysis, additional reading resources are likely to be necessary.

Chapters 5 and 6 cover surveys and diaries, two key research approaches from the field of sociology. While surveys are used far more often than diaries in HCI research, there are some emerging research projects using the time diary method. Again, a number of textbooks have been written solely on the topic of survey design. Chapters 7, 8, and 9 are based on research approaches popular in the social sciences. Case studies, interviews/focus groups, and ethnography have also been popular approaches in business school research for years. The five research approaches in Chapters 5 to 9 – surveys, time diaries, case studies, interviews, and ethnography – are often useful for understanding "why?" questions, whereas experimental research is often better at understanding "how often?" or "how long?" questions.

Chapter 10 provides useful information on how to manage structured usability tests, in cases where usability testing is a part of the package of research approaches. Chapter 11 focuses on analyzing qualitative data, which might have been collected from case studies, ethnography, time diaries, and other methods. Chapter 12 and Chapter 13 focus on methods of collecting research data through automated means. One method is automated data collection indirectly from humans, through their actions on a computer, including key logging and web site logs. The other method involves data collection directly from humans through sensors focused on the body, such as facial EMG and eye-tracking. Chapters 14 and 15 focus on issues that arise in working with human subjects. Chapter 14 covers general issues, such as informed consent, and Chapter 15 deals with issues specific to participants with impairments.

We hope that you enjoy reading this book as much as we enjoyed writing it!

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Discussion Questions

1. What were some of the major shifts in the topics of HCI research from the original focus on word-processing and other office-automation software? Discuss at least two shifts in the focus of research.
2. What are the standard quantitative metrics that have been used in HCI research since the early 1980s?
3. What are some newer metrics used in HCI research?
4. What is triangulation? Why is it important?
5. Why doesn't one published research paper equate to scientific truth?
6. Name four disciplines that have helped contribute to the field of human–computer interaction.
7. Describe three professional challenges of inter-disciplinary research.
8. Describe three research-design challenges in inter-disciplinary research.
9. How is experimental design different from usability testing?
10. Describe three inherent conflicts in human–computer interaction.
11. What do you think the field of HCI research will look like in 20 years?

Research Design Exercise

Imagine that you are going to be researching the topic of why people choose to take part in an online community for parents of children with autism. What are some of the reference disciplines that you should be looking into? What types of people might you want to talk with? What types of metrics might be appropriate for understanding this community? Come up with three approaches that you could take in researching this online community.

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