Transforming HCI: The Art, Science and Business of User Experience Design

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Over the past thirty years, our approach to designing technology has evolved in response to a dramatically changing marketplace. Many of these changes were a reaction to an ever-increasing shift in peoples' expectations for and use of technology. The result is a sure-to-continue cycle where technological innovation and better design elevates user expectations, further driving future design and innovation. In response to these changes, the human computer interaction discipline (HCI) must reexamine past research and professional practices and make appropriate accommodations to better serve new technologies, conditions and market pressures. The need for this review should not be viewed as a failure of past efforts. Instead, this is simply a continuation of the discipline's ongoing evolution from industrial psychology to human factors and then to HCI.

This chapter examines changes in the marketplace for technology products over the past thirty years and proposes transforming our traditional HCI framework based an expanded perspective offered by user experience (UX) research and design. This chapter will begin by examining the conditions that drove this change and then offer a more detailed review of the human elements relevant to emerging technologies as well as research necessary to meet the more sophisticated demands of the evolving technology and marketplace. The chapter concludes by proposing a process that supports each of these elements thereby increasing the probability of a successful product design.

Changing Market Conditions

If the HCI discipline has learned anything over the last three decades it is that we can rarely force change without the need first existing in the user community. Of course, there will always be an exception for extraordinary technological breakthroughs, but even in these cases you can typically trace the success of a given innovation to the fulfillment of an unmet human need or the delivery of unique value.

Factors influencing the success of new technology offerings have evolved dramatically over the past three decades. During the 1980s and 1990s, success was determined almost exclusively by the power, stability, and functionality of new technologies. This was the correct strategy at the time given technology delivered value by lessening the drudgery of a previously manual activity or through previously unobtainable levels of productivity, quality or safety. However, the competitive advantage offered alone by this focus diminished over time. In response to pressures from the marketplace, the technology community continued to produce innovative technologies with an ever-increasing focus on the goals, values and abilities of the end user (Raskin 2000). Along this journey, the HCI discipline shifted from a role of enhancing design late in development, to influencing the early design, and finally to a strategic role of defining the design space. In an issue of *Interactions* dedicated to reimagining HCI, Panu Korhonen (2011) of Nokia captured this transformation of the profession nicely:

> *"In the early days, HCI people were told 'Please evaluate our interface and make it easy to use.' That gave way to 'Please help us design this user interface so that it is easy to use.' That in turn, led to a request 'Please help us find what the users really need so that*

> *we know how to design this user interface.' And now, the engineers are pleading with us 'to look at this area of life and find us something interesting."*

Increasingly, a deep and systematic focus on the user is emerging as a key competitive differentiator in the most progressive product development groups and for leading business service providers, particularly for those operating in hypercompetitive markets.

Naturally, a close consideration of the user in product design does not minimize the importance of the technological components of product development; it simply suggests that those qualities are rarely sufficient alone to ensure success in a world where powerful technology has become the norm. Figure 1 depicts the evolution of product design over the past three decades from the early days of a pure engineering focus to one focused on usability and now the user experience. In this model, each stage is a pre-requisite for the next. Accompanying that shift is a progressively deeper integration of the user experience strategy in the development and business culture. In the 1980s, the success of a product was determined almost exclusively by the power, performance, functionality and its ability to enable work efficiently. Once these critically important goals were met and became commonplace, users came to expect this as a standard and then demanded that a given technology become more useful and usable (Veryzer and Borja de Mozota 2005). Usability was soon defined by ease-of-learning, transfer-of-learning, and a close mapping to users' abilities and usefulness focused on users' goals and what they valued (Dumas and Redish 1999). We then saw the pattern repeat again. Once usability and usefulness became best practices in the marketplace, users then demanded a deeper, far-reaching, and carefully orchestrated user experience. A component of that stage was the move towards minimal design (simplicity) as seen in the lean startup movement (Ries 2011; Maeda 2006), reducing the load imposed by the system, and by focusing on those aspects of the product that users value most

(Dixon, Freeman, and Toman 2010). This approach to product design stands in stark contrast to the bloated, feature rich development strategy of the past where we looked to incremental feature enhancements to sustain a product through the market lifecycle. That was a time characterized by an incomplete understanding of the requirements of the user community leaving us with no alternative but "just-in-case-design." Finally, UX considers the affective component of the experience as well as how the experience can be extended beyond the technology itself to every touch point with the customer (Norman 2003; Walters 2011; Khalid and Helander 2006).

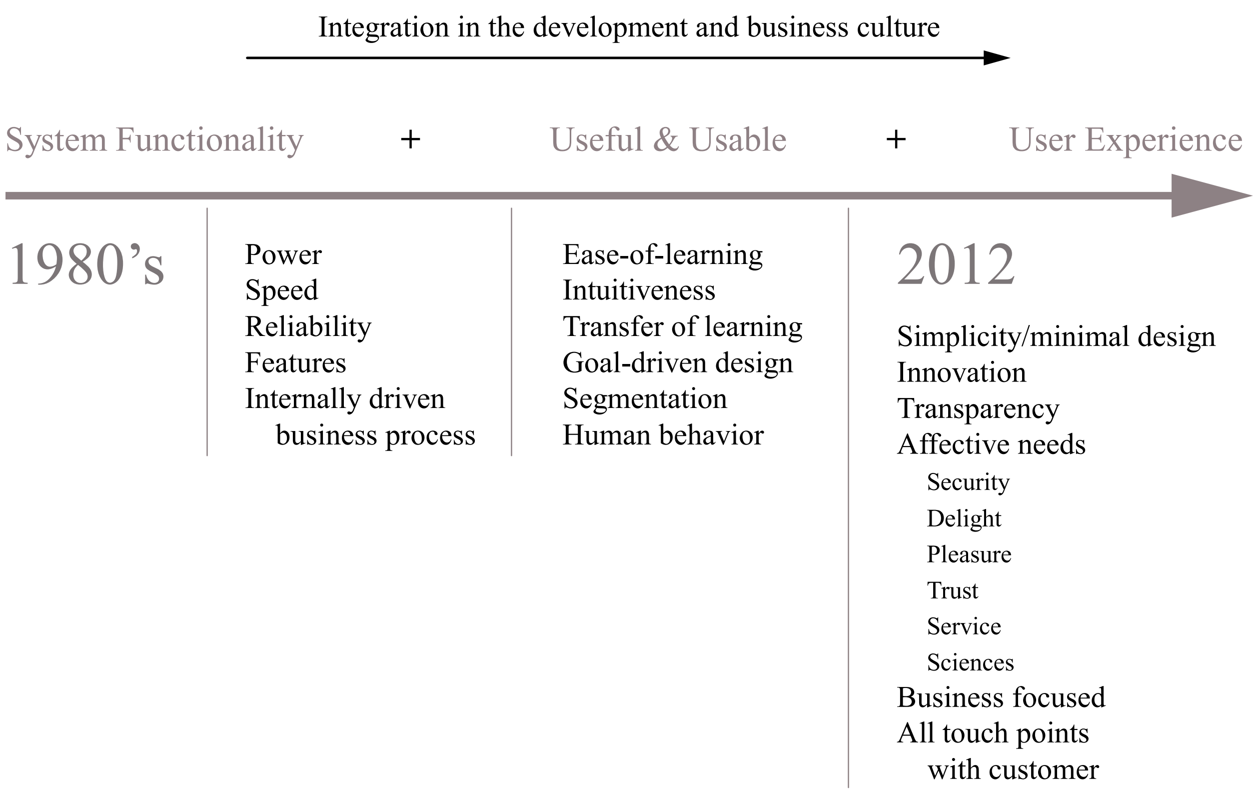

Figure 1: The evolution of product design over the past three decades.

Three dominant market forces contributed significantly to this evolution:

1. The evolving expectations of users

2. The expanding diversity of the user community
3. The growing application of technology in all aspects of our lives

Evolving expectations of users A key characteristic of human behavior is that our expectations evolve based on a continually changing base of experiences. Each new experience that delivers greater value, pleasure, performance, or efficiency creates a new and elevated expectation. This behavior governs all aspects of our human experience (Eysenck, 2012). In the case of technology, this change is partially a product of constantly improving technology. In a changing marketplace, user expectations evolve based on the enabling qualities of each new technology, interaction design potential, and with each increase in product usability. In short, what was once a successful "standard" of excellence in the 1990s is no longer acceptable to today's more demanding user, a trajectory that will continue in perpetuity. The lesson learned in the marketplace is clear, technology producers who recognize and respond in a timely fashion to this new product life cycle will thrive while those who do not will fail (Christenson 1997; Martin 2009).

Expanding diversity of the user community Further contributing to the changing marketplace is the significantly expanding diversity of users (Langdon, Lewis, and Clarkson 2007). Gone are the days when we designed for a homogeneous community of well educated, highly motivated, technologically savvy, and adaptable users. In the past, this community was required to "bend" to the demands of powerful systems that were often misaligned with their needs and abilities. Fortunately, this population was willing and able to make the required accommodations based on highly developed abilities and motivated by the value derived from the system. Today, the system must increasingly bend, to varying degrees based on context, to the user while still serving the larger purpose of the system. Today's user might be less technologically savvy, illiterate, unmotivated, cognitively or physically disabled, elderly, or living in a developing country. The topic of universal accessibility is addressed later in this chapter. User experience for "all" has raised the art and science of system and interaction design to previously unknown levels of sophistication.

Growing integration of technology in all aspects of our lives Finally, users were more capable and willing to "bend" when a limited number of technologies required this accommodation. This too has changed. In many areas of the global marketplace, technology has "penetrated" each and every aspect of our lives: our homes, communication, social communities, transportation systems, work, education, entertainment, commerce, government, and healthcare.

Our understanding of the human information processing system has long confirmed that we possess finite resources for interacting with our environment (Wickens and Hollands 1999). As ubiquitous technology places ever-increasing demands on people, their capacity to manage this workload is challenged. If technology is to continue enriching and improving our lives, new technology must impose a lighter load by more closely aligning with the values and abilities of the user. This clearly requires designers to develop an increasingly deeper understanding of user's interactions with technology and the alignment of that interaction with the strengths and limitations imposed by the human information processing system.

A Common Framework

No technology sector is insulated from these market forces. Separately, the pressures of this change have been felt in business information technology, commercial software/hardware, consumer electronics, government systems, games, social media, healthcare, entertainment, and transportation. Rather than approaching each of these sectors as a unique challenge requiring a unique framework for understanding users, a common approach can be identified and appropriate support found in the merged UX and HCI disciplines. A fractured strategy, focused on individual sectors, will ultimately weaken the larger cause and fail to fully leverage a shared research agenda.

Moving forward, the merged HCI-UX discipline can take great comfort in knowing that the traditional behavioral and perceptual foundations of the HCI discipline continue to serve us well. However, the range of behaviors and perceptual inputs will expand and the complexity of the interaction across sub-variables will increase. This is a challenge the discipline has met in response to past innovation. Expansion of the research agenda is particularly necessary in the social, emotional, aesthetic, and cultural elements of the user experience. On the interaction design front, we will continue our progress to full integration of multi-modal interaction -- audible, haptic, and auditory (Heim 2007). Here we must examine how a particular mode best supports an interaction requirement and manage the complex and difficult to predict interactions across these interaction modes.

While we work to identify a common research and practice framework to accommodate diverse industries, it remains useful to recognize that unique challenges do exist within industry sectors. For example, making the case for focusing on the customer is relatively clear in the commercial marketplace for hardware, software and consumer electronics. More challenging is the case for business IT and government systems – these are difficult, but not impossible. In the case of IT, our past focus on business rules, work processes, productivity and the enabling qualities of the technology often occurred at the expense of the users responsible for implementing, supporting and using the system (Babaian et al. 2010). This often resulted in high failure rates, partial implementations, slow and incomplete adoption of the system, and unexpectedly high total lifecycle costs. In the case of government systems, we have witnessed a slow and steady march to making government and healthcare available to the public through information and communication technologies (Becker 2005; Sainfort et al. 2012; McClelland 2012). Here too, acceptance and use of these systems is critically dependent on the ease of use and quality of the user experience. E-government and e-health possess tremendous potential for improving people's lives; however, we will only realize this potential when the supporting systems are accessible to the larger population (Gribbons 2012; P. Croll and J. Croll 2007; Borycki and Kushniruk 2005). Any solution focused narrowly on the enabling ICT without a clear consideration of usability and the user experience is likely to fail.

From HCI to UX

Building on a traditional HCI foundation, the user experience promotes the careful alignment of human behaviors, needs, and abilities with the core value delivered through a product or service. Depending on context, this experience may have psychological, social, cultural, physiological, and emotional components – most likely, a combination of all five. In contrast to traditional HCI, UX broadens the scope of the human experience considered in interaction design including the emotional, social, internationalization, and accessibility. Similar to traditional HCI, the UX discipline defines the optimum experience through the detailed study and assessment of the user in the appropriate use environment. Even here we see a need to move from less formal modes of inquiry to more rigorous methods such as ethnographic inquiry. Ultimately, UX design applies these theoretical principles and research practices with a goal of exercising greater control over users' response to a design. In other words, they strive to produce predictable outcomes for the system consistent with a set of desirable, defined and measurable goals.

UX and a Holistic View of Product Design

UX also embraces a more holistic view of product design. In the past, user requirements were often defined in a vacuum, most often assuming ideal conditions. Learning from the shortcomings of past practice, UX identifies, manages, and accommodates the various business and development forces in play that might necessarily or needlessly influence the finished product design and eventually compromise the user experience.

As depicted in Figure 2, user goals are compared to business goals and where the conflict between these two cannot be resolved, tensions are documented and their effects minimized in the design. As goals are moved to implementation, the UX practitioner then assess the impact of technical and regulatory requirements on the user experience. Given that the regulatory requirements must be supported, tensions between those requirements and the abilities and expectations of the user must be noted and accommodated. Under ideal circumstances, technical requirements would specify leading-edge technologies that align with and support the user's expectations and abilities. In many cases – sometimes driven by business goals – older technologies are employed, existing code is re-purposed, and requirements for compatibility with other systems drive technical requirements. Tensions then arise with users' expectations and abilities. In the final analysis, user experience design recognizes that unavoidable tensions can exist within a system yet still produce acceptable results if these tensions are properly managed and when the perceived value of the system exceeds the workload required by the suboptimum interaction experience. The converse is true for a misaligned system that delivers marginal value at high interaction costs.

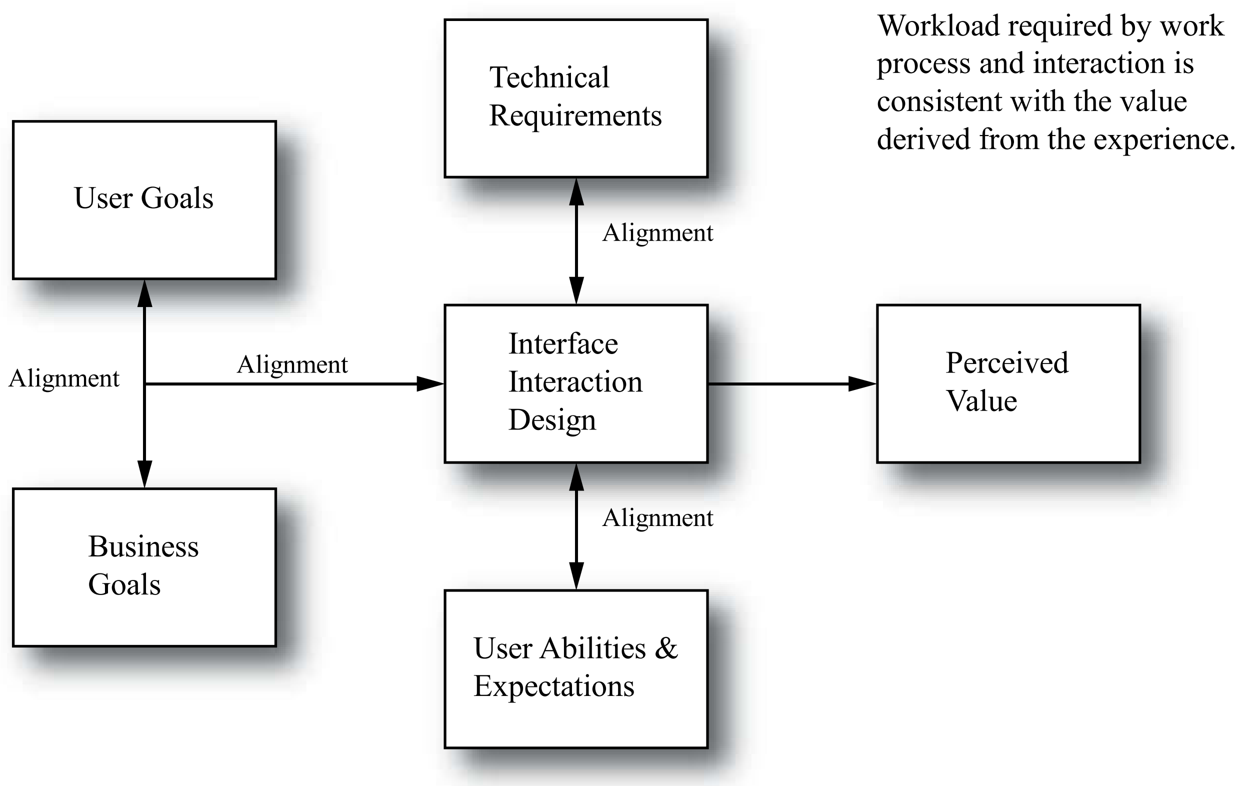

Figure 2: UX and product design model.

UX meets Business

In contrast to traditional views of HCI, UX balances business and user needs given its growing contribution to competitive differentiation. As noted earlier, the "differentiation value" of the user experience has grown as many technologies and business services become commoditized in hyper-competitive markets (Pine and Gilmore 1999). In this new role, we must deeply integrate UX theories and practices in the development process as well as in the strategic framing, pricing, and competitive positioning of products and services. Finally, we must recognize the contributions of UX in non-technology based areas such as process design, customer support or invoicing -- further expanding the influence of the discipline.

In the past, one would rarely hear discussions of HCI's contribution within the ranks of senior executives or see HCI play a prominent role in the producing organization's marketing or product positioning. This is not the case with UX where we now find the discipline prominently displayed in competitive positioning and advertising – in the most extreme cases, the experience becomes the brand as seen in companies such as Apple, Facebook and Amazon. Recognizing that strategic value, many development organizations have subsequently promoted UX professionals to senior executive ranks.

User experience's journey up the value chain in the business organization could not have come at a more opportune time. Paralleling the advancement of the UX profession is a growing need in business to continuously innovate products, services and processes as well as innovation's critical role in sustaining long-term competitive advantage. While the business community often frames this discussion in the context of "design thinking," a careful examination of that "movement" reveals that many of its foundational concepts and practices are consistent with UX theory and practice. Roger Martin (2009), Dean of the Rotman School of Management at the University of Toronto, builds a compelling case for the value of design thinking in his book *The Design of Business*, characterizing this strategy as the next competitive advantage in the business world. Tim Brown (2009), CEO and President of IDEO, makes an equally compelling case for design thinking in his book *Change by Design*.

For more than thirty years, the UX discipline and its HCI predecessor advanced many of the foundational principles and practices found at the core of the design thinking movement.

We also see the convergence of business and UX in an emerging line of marketing research that examines the features of technology that drive a purchase or adoption decision. Emerging research in this area suggests that the features that drive a purchase decision are often the very same features that compromise the user's experience with the purchased product (Rust, Thompson, and Hamilton 2006; George Group 2012; Zhao, Meyer, and Han 2012). UX professionals must work closely with their marketing colleagues to strike an artful balance between driving the purchase decision while fostering a positive long-term user experience. Examining the tension between the behaviors that drive adoption/purchase decisions and those that determine long-term satisfaction with the product's use is an important addition to the UX research agenda.

Each of these changes – UX to business and business to UX – is recognition of the previously discussed market conditions and a reflection of the fact that while technological innovation alone may be adequate for the initial success of a product it is rarely adequate to sustain long-term success in the marketplace.

Ethics and Unintended Consequences

As the UX discipline extends its reach beyond the early challenges of enabling work, improving usability, extending productivity and expanding interaction design capabilities, the discipline is increasingly likely to encounter far more complex and unexpected issues resulting from people's use of technology and a deeper understanding of the depth and breadth of the user experience. Clearly, new technologies have always produced unintended secondary consequences as noted by historians (Kranzberg and Pursell 1967). What has changed is the pervasiveness of these consequences and their severity. As a consequence, the UX discipline must consider and debate its contribution to and responsibility for the unattended consequences of new technologies, some of them with a clear ethical dimension. Issues examined within this section include:

- Accommodating and Influencing User's Behavior
- Human Cost of Automation and De-Valuing Work
- De-Skilling
- Erosion of Privacy
- Dangers of Distraction

While fueling an ongoing discussion within the profession, these issues will also contribute to the discipline's research agenda moving forward.

Accommodating and Influencing User's Behavior As we deepen our understanding of human behavior, we have increased our ability to deliberately influence and control users' behavior through system design. While design has always had this effect to some degree, the implications moving forward are potentially more far-reaching and significant based on the potential of emerging technologies. A case in point is an growing desire to subtly alter the irrational behavior regularly exhibited by people.

Ariely (2008) demonstrates convincingly the endless number of occasions where people make poor choices in critical aspects of their lives, thus challenging the traditional view that people exhibit logical, rational behavior in important situations. Ariely suggests that this irrational behavior is so predictable that we need to question our traditional view of what constitutes rational behavior.

Contributing to this behavior are various emotions and biases that direct our actions in irrational ways. In response to the predictability of this sub-optimum behavior, some suggest that we should direct this behavior to a more positive and beneficial outcome. Sunstein and Thaler (2008) correctly propose, based on a deep understanding of human behavior, that we can design "choice environments" that make it "easier" for people to choose what is best for them, their families, and society; thereby minimizing the possibility of irrational responses, biases, and emotions. The authors are careful to frame this proposal in a positive fashion with careful safeguards to protect one's freedom of choice while producing more positive outcomes in terms of health, financial security, and personal happiness.

Such thinking has interesting implications for user experience design since it would be the designer who frames the experience – both the interaction and the information design – to produce an outcome some authority deems "in the best interest of the user." In an ideal world, this all seems well and good if there were some objective measure of which outcome was in the best interest of the user. Despite the designer's best intentions, they must be cognizant that the selections they make in creating the optimum "choice environment" are subject to the very same biases they are trying to minimize and that these biases operate outside of their conscious control. In the worst case, UX designers must also consider that for every product with the "best intention" there will be another that deliberately "nudges" the user to ends not in the user's best interest, but to those of a different stakeholder.

This creates a vexing ethical conundrum for user experience designers. On the one hand, they recognize that human behavior often results in sub-optimum choices and actions. On the other hand, they recognize that they have the potential, through design, to affect that behavior in other ways --- positive and negative. At the very least, this begs the question: "how do UX professionals define their ethical responsibilities as they subconsciously influence users' decisions or actions?" The case of producing negative outcomes is clear, less clear is who determines what is "positive" and the recognition that the line between the two is often not well defined.

As the UX profession gains a deeper understanding of human behavior and its implication for interaction design, they have begun to question past practices. For example, system designers typically create products assuming a rational user. Based on the goal of supporting a logical, rational response; they conduct research to determine appropriate information support, an optimum sequence of actions, optimum feedback, and ideal outcomes. This research is likely to validate the initial assumptions because the research activity engaged the conscious, "rational side" of the user's mind. This information is then captured as user requirements and scenarios that are implemented and supported through the system design. The designer is then surprised when the user – now guided by natural, emotional behaviors outside their conscious control – interact with the system in an unexpected, sub-optimum fashion (Kahneman 2011). Traditionally, interaction designers would characterize this behavior as "carelessness," "laziness," or "human error." This raises yet another challenging question: can the UX designer predict and accommodate this behavior without falling into the manipulation trap described previously?

Human cost of automation and De-valuing work So much of the HCI discipline's early effort was driven by the desire to improve human performance and productivity while reducing errors. Few questioned the value of these gains – gains achieved by optimizing the system design, augmenting human ability, and automating various components of the supported activity. At the same time, some in the discipline have examined the human cost of automation (Parasuraman and Mouloua 1996), a discussion not limited to the loss of jobs. While most applaud automation when it eliminates dangerous, repetitive, or tedious work, other forms of automation often come at the cost of diminishing the intellectual and emotional value of that work. In some cases, such as the level of automation found in fast food restaurants or warehouse fulfillment centers (McClelland 2012), it has reached a state where work is nearly de-humanized, opportunities for worker growth diminished, and the value of rewarding work stripped away. Given the UX professional's role in designing that experience, what responsibility does the profession have for these undesirable outcomes?

De-Skilling Over the past two decades, there have been tremendous advances in the development of powerful intelligent support systems that augment human intelligence in the most demanding environments. For example, modern aircraft have grown so complex that pilots can no longer operate the aircraft without an "intelligent" assistant, particularly in situations of catastrophic failure. The positive benefits of this technology enable the use of sophisticated technologies and improve safety (Charette 2010). At the same time, the UX research agenda must examine the possible "deskilling" effects of automation on the operator and evaluate the ability and need of the operator to respond in the absence of intelligent support (Zuboff 1982). Similar discussions are also present in the medical community where medical professionals, including doctors, are increasingly employing powerful diagnostic systems with the same benefits and concerns raised in aviation (Berner 2008). Moving forward, UX professionals must go beyond the positive, intended outcomes of the technologies they design and consider the unattended consequences of new technologies for the user. In some cases the gains will clearly outweigh the negative consequences and the loss accepted. In others, the level of support and automation might warrant reconsideration. Whatever the outcome, it is critical that UX designers initiate this conversation.

Erosion of Privacy The case of remote monitoring technologies for the elderly and children provide another interesting case of unintended consequences. As life expectancies increase in many societies, so too has the attention directed to improving the quality of life for this population. With the best of intentions, technologies have been developed and employed to remotely monitor the daily activities of independently living elders --- their every movement, what and how much they eat, and when they take their prescribed medications. Such advances have enabled a high-value goal of elders to live independently in a place of their choosing. While the benefits are clear, an unintended consequence is the loss of privacy and dignity – also highly valued by the population – as a consequence of monitoring beyond their control. Similar technologies are also employed by parents to monitor their children's every movement, how fast they are driving, and their location at any moment in time. Product designers create each of these technologies focused on the positive intended consequence; however, each technology is accompanied by an unintended outcome of the loss of privacy, dignity and perhaps independence.

Dangers of Distraction: Finally, the convergence of technologies in many use environments produces an attention load that threatens the very limits of human capabilities. A case in point is the ever-increasing integration of communication, navigation, and entertainment technologies in automotive design. While these technologies deliver unquestionable value and pleasure to the driver and passenger, they divide the operator's attention in ways that distract from the primary driving task – a situation creating life threatening situations for all who travel our roads and highways (Beede and Kass 2006). What responsibility do UX professionals have in situations such as these where we might focus on only the positive outcome of a technology and either intentionally or inadvertently fail to recognize possible negative consequences? The ever-increasing likelihood of distraction and its consequences should become an area of intense focus in the discipline's research agenda.

At the end of the day, UX professionals must increasingly consider where their responsibilities lie, with the product organization that reaps financial gains from the technology they sell or with the user who will suffer possible negative or potentially life threatening consequences of these products. Because the occurrence of these events has become more frequent and the consequences more severe, the profession can no longer avoid this question.

UX for All Users

Moving forward, the UX discipline must embrace all users, not simply those of a certain ability, economic class, or region of the world. The discipline must avoid the past narrow focus on capable, economically desirable populations and instead address the needs of an increasingly diverse user community; for example, those of a poor illiterate farmer in a developing nation using ICTs to better manage the planting, harvesting, and marketing of his crops. A serious mistake was made in the past where the discipline focused on an artificial designation of the "typical user" and "typical behavior" and relegated accessibility and internationalization to the periphery -- factors the designer addresses once the core produced is created. This approach communicated that each of these activities were optional and virtually eliminated them from common practice. Instead, we must seamlessly integrate universal design (Shneiderman 2000) and internationalization (Marcus and Gould 2012) into the core design in all but the most regionalized product directed to homogenous populations.

It is easy to understand why the previous approach was adopted. First, the foundational psychological research focused primarily on western subjects. Secondly, the cognitive/perceptual research most often assumed an optimally functioning individual. Third, the early marketplace for technology and the HCI profession's connection to this marketplace initiated and perhaps perpetuated this bias. Because technology now touches users of unimaginable diversity in every corner of the world, the discipline's past approach is no longer acceptable either in theory or practice.

Global The UX movement must become a movement for all users, not simply an experience based on the values, beliefs, and behaviors of one geographic region or the other. The discipline has long understood that the sensory component of the human experience is the same in almost every practical way. In other words, the register of colors, sounds and touch sensations is essentially universal (Ware 2000). In contrast, how these signals are encoded and acted upon during higher levels of cognitive processing will vary across cultures. In some cases there will be significant differences (Matsumoto and Juang 2008). Over the past several decades, research in the field of intercultural psychology has offered invaluable insight into cultural difference in areas such as communication, creative thinking (Paletz and Peng 2008), collaboration, learning (Li 2003), evaluation, decision making (Briley, Morris, and Simonson 2000) and the like (Berry et al. 2011; Kamppuri, Bednarik, and Tukiainen 2006). This research has implications not only for the internationalization of the interaction experience but also for the research methods we use to study users and how we interpret those findings.

Universal Design As discussed earlier, a distinctive characteristic of today's technology marketplace is the incredible diversity of the user community, with an ever-increasing likelihood that the user might be illiterate, cognitively disabled (Gribbons 2012), physically handicapped (Jacko et al. 2012), or elderly (Czaja and Lee 2008). The UX academy and profession must be at the vanguard of creating an inclusive environment where all users fully realize the remarkable benefits of technology. This is especially important given technology is interwoven into the very fabric of our lives at home, work, civic engagement, wellness, and play. For years, the HCI profession led the crusade for addressing the needs of special populations, first those with physical disabilities, then the unique needs of the elderly, and lastly those with cognitive disabilities. This crusade eventually coalesced under the universal design moniker. The UX movement must advance this cause by more deeply and seamlessly integrating universal design principles into the core tenets of the discipline.

The first principle of universal design dictates "provide the same means of use for all users: identical if possible – equivalent when not" (Story 1998). When executed properly, the required accommodations are transparently embedded in the system, interface and interaction design and are unlikely to affect development costs or create obstacles for the nondisabled. It is widely accepted in the accessibility community that the required accommodations typically improve the usability of the product for every user (Dickinson, Eisma, and Gregor 2003; Gribbons 2012). If all people are to have equal opportunities to become contributing members of society and fully participate in civic activity, the UX discipline must ensure that technology is accessible to all.

This goal is especially critical in the areas of e-health, e-government, and the economic benefits afforded by technology in the workplace.

User Experience Design

As noted earlier in this chapter, HCI has evolved from a rather narrow testing-focused Human Factors (HF) discipline to the much broader design approach of User Experience. New technologies, novel user interfaces, and the expanding number of relevant contexts require an increasing set of design solutions and research that informs them. Information technology developed many innovations with some emerging as "game changers" for the field. This section will examine some of these innovations and consider how they contributed to the emerging user experience discipline. Innovations reviewed include:

- Commercialization of the Web
- Social Networks
- Mobile Computing
- Multi-Modal Input
- Applications to Apps
- Games

In the mid-80, computers were standalone machines used mainly for office-related tasks like text processing, creating simple graphics, and computing with spreadsheets (Gentner and Nielsen 1996). They were accompanied by a set of manuals often just as large and heavy as the computers themselves. Relatively few games were available and, since neither the necessary advanced network infrastructure nor the World Wide Web were yet developed; almost nobody was connected to the Internet.

In such a context, where the focus was on individual users performing a task efficiently with minimal errors, HF methods were appropriate. These methods could be used to measure whether the necessary functionality was present and accessible to the user, and whether the tasks could be executed efficiently. Naturally, the focus was on the psychological and physiological characteristics of the user and the functionality and efficiency of the computer interface.

Interestingly, as simple as these interfaces may appear in the light of today's advanced ubiquitous computing devices, we cannot claim that the design of these so-called simple interfaces was ever mastered. A brief look at the interfaces in our daily surroundings will illustrate very quickly that the field still struggle to get even the simple interfaces right.

The World Wide Web

The World Wide Web (WWW), itself enabled by the existence of the Internet, was more of an enabler than a game changer. Web sites started to sprout here and there, but the mostly academic users did not do much more than share documents. The interfaces with their static pages were rather a step backwards, and this minimal interaction did not require HCI to do anything special (Myers 1998). This was all changed by the commercialization of the WWW and social networks.

Commercialization of the Web As early as 1994 one "could even order pizza" on the web as Press (1994) somewhat incredulously stated. Online businesses slowly realized that web sites had to appeal to customers in ways similar to brick-and-mortar stores. The shopping experience had to become appealing, or at least not upsetting. This included making sure that transactions were not only safe using secure web protocols, but that the customers trusted the businesses enough to hand over their credit card numbers. Furthermore, many of these online businesses had to deal with highly diverse customers that became increasingly global over time. Many sadly learned the bitter lesson that an attractive pitch to one group of customers may be offensive to another.

When is an interface like a web site trustworthy (Hampton-Sosa and Koufaris 2005; Kim and Benbasat 2010)? This was uncharted territory for HCI given its previous narrow focus on human-machine interactions. Furthermore, too often, trust and risk are predominantly addressed from a technology perspective (Camp 2000) even though that approach alone is problematic. Users need to decide whether they trust the people behind the technology. Web sites had to reduce the appearance of risk, build long-term relationships, and the reputation of the e-commerce business (Lanford and Hübscher 2004; Lynch 2010). These are issues not easily approached with traditional HF methods alone. Social interactions between individuals and businesses became very important. The trustworthiness of a site cannot be easily tested in a lab setting because, for instance, people will spend their own money very differently than the experimenter's fake money.

Social Networks The World Wide Web also enabled online communities (Erickson 2011), typically focused on specific issues or goals, and social networks, which are much more focused on individuals (Howard 2010). Commercial sites tend to automate as much as possible and use as few as possible people on the business side of the interaction. Thus, whereas the interaction between people is often at the center of social networks, between a business and its customers the interaction is a necessary but only secondary design focus. As a result, person-to-person interaction on business sites are often less than optimally designed, sometimes to such a degree that discourages communcation altogether.

In social networks, user experience no longer focuses on individual users alone, but must now be designed for social interaction between individuals. Some individuals know each other, some do not. Privacy issues become important as it may not be clear to all users what information is accessible to whom. Real-world analogies are often severely flawed and may result in incorrect expectations, complicating these issues (Gentner and Nielsen 1996; Neale and Carroll 1997). For example, it is very easy to be linked—maybe indirectly—to people one is not aware of. These indirect connections often have no consequences in the real world, but this may not be the case in the virtual space. Do users realize this given that the conceptual model of these linkages is often less than clear? Interestingly, some interfaces may even take advantage of these confusions. However, this could be considered unethical and not consistent with the goals of UX design.

With the incredible growth of online communities and networks into millions of users, the diversity of the users has also increased (Wade 2011). Differences across these users are no longer limited to interests and languages but also different alphabets, social norms, educational and literacy levels to name just a few. As discussed earlier, accommodating such multidimensional diversity is a huge problem considering that designing for a narrowly and well-defined audience tends to be difficult enough.

Because of such web-enabled interactions, UX needs to deal more with interactions between people including conceptual models of complex social interactions as they are defined by the various social networks. Privacy issues have also become increasingly more important given their legal implications.

Mobile Computing

Mobile computing was enabled in the mid-nineties by the availability of wireless networks and was initially mostly restricted to simple cell phones (Pierre 2001). Nevertheless, cell phones were soon commonplace all over the world including third-world countries. With the arrival of smart phones, their access to all the content on the WWW and many other services on the Internet through apps, the cell phone morphed into a general computing device enabling true ubiquitous computing. For many users, making phone calls has become a secondary function of these devices.

Integration in daily life Over 87% of the world population had a mobile subscription for a cell phone in 2011 (Ekholm and Fabre 2011). The availability of smart phones is much lower at the moment at 17% of the population but growing quickly, and already two thirds of Americans between the ages of 24 and 35 own a smart phone (Nielsen 2012). Besides smart phones, many other interfaces use mobile computer technology and are neither considered computers including car dashboards, TVs, thermostats, and watches. Computational interfaces have become part of many people's daily life so transparently so that it sometimes takes a power outage to realize they are now an inseparable component of our lives.

Multi-Modal Input

Frequently, new technologies like the WWW or mobile computing are the driving or enabling forces of new interfaces resulting in a challenge within the UX community to find appropriate ways to deal with them. Such technologies consist of hardware like ambient displays, augmented reality, haptic interfaces, and affective computing as well as software like adaptive interfaces and recommender systems. Early implementations of new interfaces based on technological progress alone are typically rather awkward to use.

It is important that UX does not simply react to new technologies, hardware or software. From the very beginning of the innovation and design process, UX must be part of shaping how to use them and how to design optimum user experiences enabled by new technologies (Sproll, Peissner and Sturm 2010). User experience design, as the name implies, must be integrated early in the design process and not limited to testing before release. Thus, the UX community must be part of the development of new interfaces. The members of this community must help discover and adopt new interaction methods and technologies to improve the existing user experience for a more diverse group of users who are demanding innovative interfaces, not just incremental improvements.

Computer input in the past was limited to keyboards and mice. However, this too is changing rapidly because they are too large and cumbersome to support ubiquitous computing. Many tablet computers and smart phones avoid the use of physical keyboards and rely heavily on gestures, voice input, and virtual keyboards. Most of these alternatives to physical keyboards and mice, like voice and gestures input, are often ambiguous and imprecise and therefore, cannot be taken literally. They need to be interpreted often based on the user's input history, her preferences, the physical location, time of day, and so on.

Users have also adapted to the new, somewhat limited interfaces. For instance, they have developed new languages because of message-length restrictions in SMS messaging on cellphones, microblogging and online chat applications (Honeycutt and Herring 2009).

The old interaction paradigms need to be completely revised by shifting the tedious operations to the computer. Intelligent support can provide the necessary methods for multi-modal user interfaces. Direct manipulation requires the user to implement the tasks using mouse and keyboard but this is no longer necessary. For instance, take the remote control. We used to have to "program" them so that we could watch the show later, then this got reworded to "recording" a show, and finally, the universal remote managed to figure out for us which devices to turn on if we want to listen to a CD or watch a TV show. A goal-oriented approach lets us state our goal and the system will take care of the rest (Faaborg and Lieberman 2006). For instance, telling the system that we want to watch the news will result in different choices, for instance, depending on the person asking for it and the time of day.

Intelligent approaches are necessary to support emerging interfaces. Intelligent agents interpret imprecise and ambiguous inputs; they reason about what actions need to be executed proactively; they execute certain tasks autonomously; and they can create individualized experiences by adapting the interface to the user. This approach is in contrast to the typical direct-manipulation approach where the user has to tediously implement an action one simple step after another. Adaptive interfaces are already individualizing experiences in educational applications including museum exhibition guides and in many recommender systems used in e-commerce sites (Aroyo 2011; Brusilovsky 2012; Brusilovsky, Ahn and Rasmussen 2010).

However, many of these intelligent user interfaces require a user model consisting not only of information explicitly provided by the user but also behavior data collected by the interface. Related to the earlier discussion of unintended consequences, this raises serious privacy issues that need to be taken into consideration during the design process; they cannot be treated simply as an afterthought.

New technologies open up completely new ways to interact with computational devices as well as with the real world via computational devices. Considering how tricky it can be to develop a “normal” user interface, it is not surprising that applications of new interface technologies are often initially sub-optimal. This should not keep us from using them. However, it is critical that the UX community actively participates in helping to shape the use of new technologies in ways consistent with the abilities and goals of people.

The user experience with many of these new technologies can be aptly described as reality-based interaction (Jacob et al. 2008). The goal is to go beyond the stale WIMP (window, icon, menu and pointing device) interfaces. Ubiquitous computing implies that we can access the Internet from anywhere at any time, which we often do with laptops or smartphones. However, any computational device can take advantage of this anywhere/anytime access of information. With tangible interaction (Hornecker 2009; Shaer and Hornecker 2010), information is not just displayed on a screen but can be integrated into the real-world interaction. Leveraging the infinite variety found in nature for displaying and interacting with information is important. That is, the designers need to consider existing natural and artificial objects instead of adding yet another rectangular screen. Why is a classroom wall just a wall to hold paint and separate groups of learners? Why is everything in stores, museums, and office buildings labeled with static paper labels? To find innovative answers to such questions, UX designers need to consider the whole body of a person and also physical spaces, thus moving into realm of architecture (Alexander et al. 1977). The arts also need to be included when designing large public displays and, especially, ambient displays. Ambient displays show information in a non-intrusive way, allowing the user to perceive it pre-attentively with little cognitive load (Mankoff et al. 2003). This is quite different from the usual design elements in more traditional user interfaces and therefore, we cannot simply apply the same design and evaluation heuristics (Mankoff et al. 2003; Pousman and Stasko 2006). Ambient displays are sometimes used to change the behavior of the user

(Jafarinaimi et al. 2005), something that is often explicitly avoided in more traditional systems where the business process is to be supported, not disrupted.

For a long time, user interfaces have been rather restrictive: it is easy for the device to interpret a key press or a mouse click, however, it is not trivial for a user to translate some complex goal into a lengthy sequence of digital actions. As the computer become more and more invisible (Norman 1998), multimodal interaction will become more important, enabling design to become really user-centered for all users, no matter what their specific needs are, and in all social and physical contexts.

From Applications to Apps

With mobile computing, the traditional focus on large software applications with ever-expanding functionality has shifted to much smaller, highly focused apps. This move has a major impact on the design, development, and marketing of software.

Apps typically focus on a narrow, well-defined set of functions normally targeting an audience with similar goals. As a consequence, the interface can target the audience better and the conceptual model of an app can be more coherent. The functionality needs to be restricted and highly focused on the tasks targeted by the specific app (Wroblewski 2011). As a result, the relative simplicity of apps, as compared to the highly complex applications used on desktop and laptop computers, allows small teams, even individuals, to design, develop, and market a software product, potentially to a worldwide market.

Due to the narrow focus of apps, users need only buy the functionality they are interested in which is then reflected in a lower and more appropriate pricing model than when paying for lots of functionality that is of no interest to the user (Muh, Schmietendorf, and Neumann 2011). For instance, some text processors on the desktop contain every functionality imaginable plus the kitchen sink. On a tablet or smartphone, this functionality is separated out into specific apps providing either a dictionary, or an outliner, or a bibliography data base, to name a few. The new pricing model, where the user pays proportionately to use, is terribly disruptive to traditional design and pricing models. However, to sell an app, the interface needs to market itself within minutes or even seconds to the potential buyers as they frequently make a purchase decision not based on a long evaluation but based on word-of-mouth and a quick-and-dirty evaluation at purchase time. Thus, it is important for apps to be easy to use with a very flat learning curve supported transparently within the application. Learning is seamlessly embedded, similar to games, and the interaction is using gestures more or less based on physical interactions in the real world. However, such natural user interfaces are not necessarily the panacea for all mobile interactions, at least not in its current state (Norman and Nielsen 2010). Most gestures have to be learned and differ from culture to culture.

Games

Although computer games are as old as computers themselves, they have interesting characteristics not found, unfortunately, in many other computational user interfaces. Computer games used to be text-based but soon evolved into complex, sometimes massively multi-user games with highly interactive, graphical user interfaces. Today, games are everywhere, part of social networks, mobile platforms, but also in the physical world where the boundaries between physical and computation world start to blur.

A wide range of games are played on smart phones by people all over the world with many different socio-cultural backgrounds. Yet, most of these users do not seem to have serious problems learning to play these games, even though the interfaces are frequently rather complex. Although the learning curves may be just as steep as in other complex software, there seems to be a much better support of the user to overcome this obstacle. The immersive character of games often results in users trying harder at mastering the software application than when having to solve an un-authentic, imposed problem (Rooney 2007). Furthermore, in games users are typically scaffolded (Puntambekar and Hübscher 2005) with context-sensitive support built-in and not separate from using the software to accomplish a task (Wroblewski 2011).

When analyzing tasks supported by an interface, it is important to also understand the users' goals and why they want to complete that task. While the goals for playing games are often intrinsic, the ones for doing many work-related tasks are not. They are imposed from the outside and as a result, it may not be surprising that gamers may be more willing to spend some effort to learn a non-trivial user interface. Furthermore, the social interaction between the users is often characteristic in helping newcomers to get more proficient at playing. These observations should not be used as an excuse for missing support for novice users of a product, but as a suggestion of where to look for improved ways of helping the user to master an interface.

Although most UX designers do not design games, we should attempt to appropriately apply lessons learned within the game-design community to a broader class of interfaces. The mechanics-of-games guidelines (Sicart 2008) that drive an enjoyable game-playing experience can be adapted to the design of non-game user interaction (Zichermann and Cunningham 2011). Unlike most software that requires training or frequent trips to online documentation, games rarely require users to go through a tutorial. Support is seamlessly integrated as part of the game playing activities. Such scaffolding needs to be added to all non-trivial interfaces, not just educational ones. Furthermore, many educational applications are not very interactive and students rarely become as immersed in them as in games.

UX Theory and Practice: Looking forward

The pace of new technological developments and their integration in the lives of an increasingly diverse user community will continue to accelerate. User experience research and design must continue to evolve accordingly. Again, the need to change should not be viewed as a failure of past practice but rather seen favorably as a discipline's response to the ever-shifting demands of new technologies, enhanced interaction possibilities, and expanded user communities. This future produces challenges for the discipline and profession on a number of different levels as considered in this chapter:

- Address the needs of new technologies, user populations, and an expanded array of human behaviors in academic programs in human computer interaction, human factors, and user experience design.
- Expand the research agenda to address issues surrounding a more diverse user population and newly encountered behaviors. Most especially, this expansion should include the seamless integration of a more global research base, and the fundamental tenets of universal design.
- Appreciate the intersection of user experience with the larger business enterprise including, but not limited to marketing and competitive advantage in increasingly competitive markets.

- Understand more deeply how this strategic role shapes the research agenda moving forward and informs the practice.
- Expand the guiding research for new modes of interaction and their possible effects, both positive and negative, in the user experience. From a purely interaction design perspective, the interaction experience has finally realized its full multi-modal potential involving virtually all of the human senses. In practice, the UX profession must develop a systematic approach to optimizing the multi-modal interaction experience; delivering highest possible value with minimal negative consequences.
- Consider the profession's ethical role and responsibilities related to the consequences of the technologies they design. There is no easy or clear answer here; the important thing is that the profession continues to consider these issues and not blindly focus on the intended outcomes.

This agenda should not be viewed as negative or threatening to the past focus of the HCI discipline. Instead, this expanded view has provided exciting new research opportunities and increase recognition of the value the discipline offers the user as well as the product design organization.

In practice, a successful product or service must encompass each of the elements discussed in this chapter. User experience professionals must understand the relevance of market conditions, appreciate how those conditions shift over time and appropriately coordinate a response. They must recognize and leverage the implications of game-changing technologies, appreciate the expanding array of cognitive and perceptual factors associated with those technologies, weight these elements appropriately based on an actual user population, use context and value realized.

And finally, the UX professional must balance the human element against business, regulatory, marketing and technical requirements. Figure 3 frames a process that considers each of these elements.

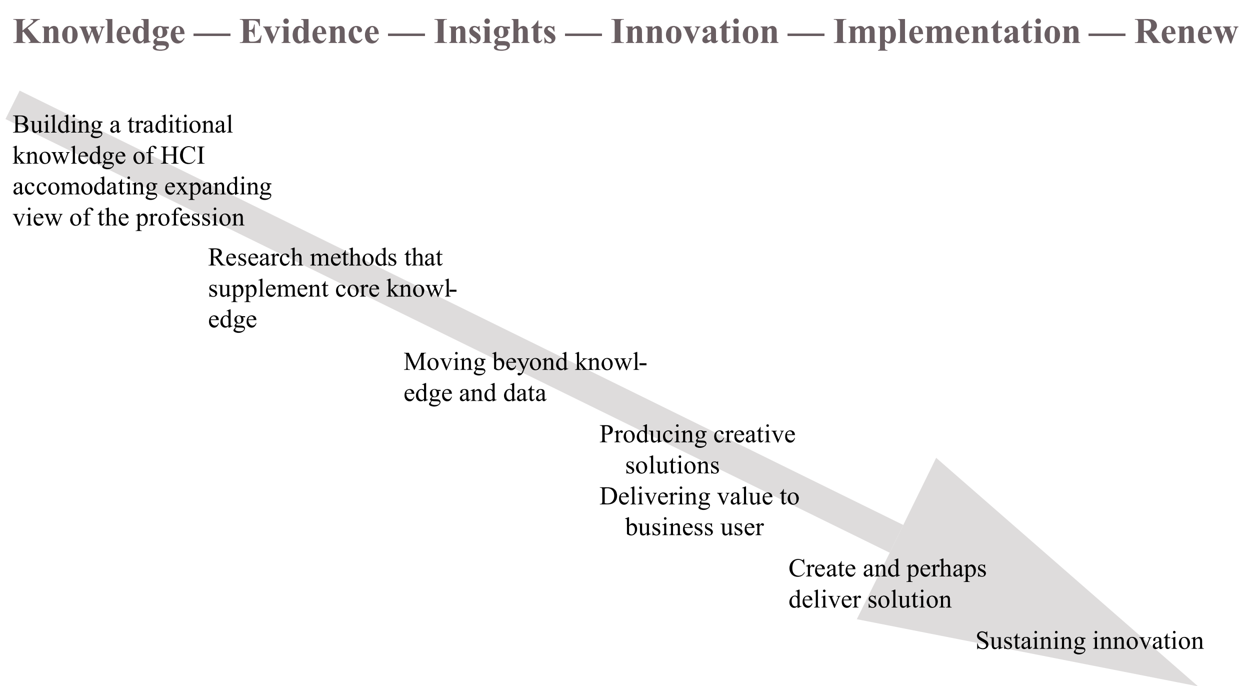

Figure 3: UX research and design process.

Beginning with a deep knowledge of human behavior and ability traditionally captured in HCI, the UX professional complements this knowledge with research gathered through user research identifying appropriate contextual factors. From this effort they glean insights that lead to design innovation and implementation. Finally, they anticipate and accommodate the changing demands of the marketplace through a deliberate and systematic focus on sustaining innovation.

In this model, UX is seen as an art, science and business. Through this model, the discipline will define their research agenda and professional practice moving forward. By deeply integrating and managing this process, they can avoid the narrow focus of the past. Instead, the discipline will greatly increase the probability of a carefully orchestrated user experience, ultimately delivering value to both user and business.

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