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User Experience Design: Beyond User Interface Design and Usability

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1. Introduction

This chapter first discusses major challenges faced by current user-centered design (UCD) practices. A user experience design (UXD) framework is then proposed to address these challenges, and three case studies are analyzed to illustrate the UXD approach and formalize the UXD processes. Finally, this chapter discusses future research needs.

2. Major challenges faced by UCD

User-centered design has been widely practiced by user experience (UX) professionals for many years, and a variety of methods have been used to facilitate UCD practices (Nielsen, 1993; see Chapter X of this book). *UX professionals* herein refers to the people who are practicing UCD, including human factors engineers, UX designers, human-computer interaction (HCI) specialists, usability specialists, and the like. The philosophy of UCD places emphasis on the end users when developing usable products (e.g., applications, services). It focuses on users by understanding the users, learning their environments and contexts of their usages, and realizing their needs in usable products.

Much progress has been made toward improving UCD practices and in increasing UCD influences on product development since its inception (Xu, 2001, 2003, 2005, 2007; Xu, Dainoff, & Mark, 1999). For instance, UX professionals now are involved in product development earlier than before; they contribute to definitions of product requirements, instead of just running ad-hoc usability testing of the user interface (UI) design; and they drive the design usability work by defining and tracking usability success metrics.

Overall, current UCD practices aim primarily at the usability of the product UI to achieve usability goals, such as ease of use, efficiency, reduced error, easy to remember, and user satisfaction (Nielsen, 1993). They identify user needs, conduct task analysis, define UI concepts, and conduct interactive prototyping and usability testing to optimize the UI design. The focus on UI design and usability has demonstrated UCD's contributions to the traditional approach to product development that focuses on system and product functionality. However, current UCD practices still prove challenging, which limits the

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potential to make greater contributions to product development. Major challenges are discussed below.

2.1 Challenge 1: Not effectively addressing total user experience

Norman (1999) coined the classic definition for *UX*: "all aspects of the user's interaction with the product: how it is perceived, learned, and used." Clearly, this definition suggests that UX is beyond UI design and usability. Norman's definition of UX is extended herein to a scope of total user experience (TUX) in a broader UX ecosystem context, as illustrated in Figure 1.

First, a clear understanding of the UX ecosystem clarifies the definition of UX in such a context. A UX ecosystem as defined herein is twofold. First, end users receive their UX from a product throughout a UX lifecycle across various stages, such as early product marketing (how it is perceived), use of the product (how easy it is to use), training and user help (how it is learned), support (how the user is supported), upgrade (how the user gets new versions), and so on.

Second, users receive their UX through all aspects (touch points) of their interactions with a product across all UX lifecycle stages, including anything related to the product, such as functionality, workflow, UI design and usability, online help, user manual, training, user support, service content, and the like. Multiple touch points may coexist in a single UX lifecycle stage of using a product. For instance, in the UX lifecycle stage, users may experience the product's functionality, UI design and usability, online help, and so on.

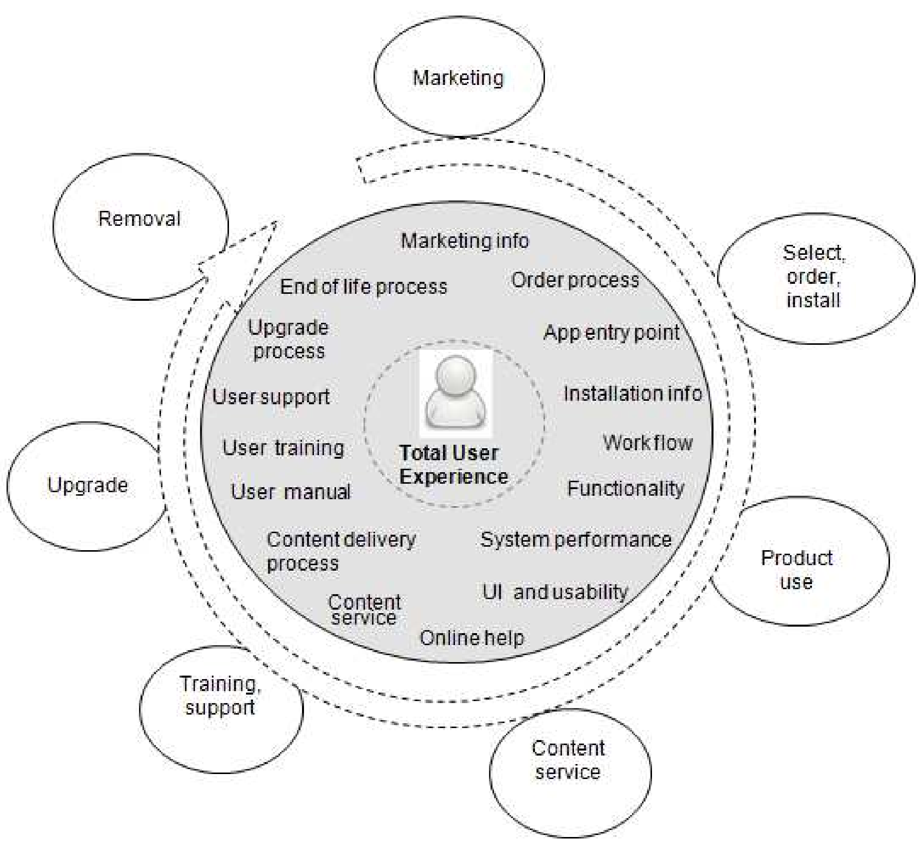

Fig. 1. The total user experience (TUX) concept in a UX ecosystem context.

User-experience ecosystems vary in terms of scale and nature across product domains. For instance, Apple Inc. has been building a macro UX ecosystem across a variety of product lines. In addition to its easy-to-use UI for individual products, Apple Inc. also focuses on TUX-related applications, content, service, and so forth. As part of TUX, its rich content (e.g., songs, apps) can be shared across different products, such as iPhone, iPad, and iPod, through its centralized iTunes service platform. In this case, the UX ecosystem spans from marketing and branding at the early stage, to purchasing, product use, post-buy support, updates, and then to the late stage of post-purchase content sharing across product lines. End users gain TUX not just from the UI of the individual products, but also from all touch points in such a macro UX ecosystem.

Also, individual products may have their own micro-UX ecosystems spanning from marketing and branding to post-sale services across all TUX touch points. For example, in a corporate IT setting, employees are often required to install enterprise applications. Employees may experience difficulties installing the application if multiple manual steps are required and the user manual is not usable, which may negatively affect employee productivity and result in support calls. Once installed, employees may experience ongoing difficulties without necessary self-help functionality, although the UI meets accepted design criteria. Thus, even if the application at some point allows employees to complete activities through its UI, other activities (such as the initial installation and ongoing support) can lead to an overall negative TUX.

Thus, from the perspective of a UX ecosystem, end users actually receive UX through an overall TUX, instead of through any single interaction touch point with a product. This implies that UX is a continuous involvement through various interaction touch points with a product across its UX lifecycle; any breakdown of these touch points would negatively impact TUX and cause a failure in delivering an optimal UX.

Obviously, UI design and usability are only one of the key interaction touch points within TUX. From a marketing competition perspective, the success of a product in today’s market no longer depends only on the UI design and usability; it actually depends on how well TUX is delivered to end users within its UX ecosystem. Apple Inc.’s success in the market is a good example. If we primarily focused on UI design and usability in the practices, we would not be able to deliver optimal TUX to end users.

In addition, there are no systematic approaches and methods that are available to guide current UCD practices to address TUX from a broad UX ecosystem perspective. There is also a lack of organizational culture that can effectively facilitate collaborations among various TUX stakeholders to address TUX. TUX stakeholders include various owners of these TUX touch points, such as professionals in UX, marketing, training, technology, and business. No single person in any of these individual areas could address all these TUX touch points, and optimal UX would not be achieved without joint efforts through collaborations among TUX stakeholders.

2.2 Challenge 2: Not predictively considering UX evolution to influence a product’s strategic direction

A technology or business capability roadmap is a common method that matches short-term and long-term goals with specific technology or business solutions to help meet those goals.

These capability roadmaps largely determine the UX of a final product that delivers to end users. However, in current practices, the development of these roadmaps has been driven mainly by technology people (e.g., architects) and business people (e.g., product line managers). When developing the roadmaps, they focus on business and technology based on customer requirements and technological trends, but UX (e.g., user gaps, needs) is not fully considered. In most cases, the customer requirements basically come from business stakeholders and owners who may not be the real end users of the product to be built, so those customer requirements may not truly represent end users' requirements. Thus, there is a gap in the process from the UX perspective (Wooding & Xu, 2011).

From the perspective of the UX ecosystem, UX dynamically evolves in terms of user needs and usages. User needs and usages for a product advance over time in a sequential order, which may be influenced by improvements in technology and people's living conditions. One user need or usage may have to be satisfied before subsequent user needs and usages while the products' initial UXs are maturing; otherwise, optimal UX will not be delivered. Also, UX is predictable because those user needs and usages can be analyzed and defined based on data collected from end users. These sequential and predictable UX data may potentially help UX professionals influence technology and business capability roadmaps so that the capabilities of a product can be delivered in a sequential order to match the optimal UX sequence and, eventually, optimal UX can be delivered over time, as needed.

In current UCD practices, UX professionals focus on the end users of products, and they collect UX data, such as end user needs and usage models, through various UCD activities. However, the challenge for UX professionals, in most cases, falls into one of the following three scenarios: 1) They did not proactively conduct user research to fully understand user needs and usages, either short-term or long-term; 2) they did not leverage the collected UX data to generate predictive UX data in terms of user needs and usages over time; or 3) they defined the predictive UX data, but they either did not leverage the predictive UX data or did not have an opportunity to influence technology and business capability roadmaps at the early product planning stage.

Figure 2 illustrates the gap in developing technology and business capability roadmaps in current practices (see the left side of Figure 2). That is, without considering UX, a delivered

Gap in current practices

An optimal solution resides in the balanced overlapping area across the three areas

Fig. 2. A concept that demonstrates how the intersection of business, technology, and UX would impact a delivered solution.

product may provide great technical capabilities that match a predefined business strategy, but it may not be the product or capabilities that end users want and is therefore unusable. As a result, the product may fail to achieve the business strategy and goals, such as market shares and return on investment. In reality, there are many cases where conflicting requirements may occur among technology, business, and UX over a product's evolution process; an optimal solution always resides in a balanced overlapping across all three areas (see the right side of Figure 2). The size of the overlapping area varies depending on the scale of conflicts, and a best effort should be made to maximize this overlap.

Current UCD practices therefore do not predictively consider the evolutionary nature of UX over time in a context of its ecosystem, and they lose the opportunity to influence the development of technology and business capability roadmaps. A gap may have already existed from the very beginning, when technology and business people defined the strategic direction for current (at the time) and future products when developing their roadmaps. Lack of such an influence would limit UX professionals' work in a passive and tactical work mode only within the predefined scope of a current project. Such a work mode would not only limit UX professionals' ability to deliver the best UX in current release (because user needs may not be sequentially optimized), but may also limit UX professionals' long-term influences on the strategic directions of products.

2.3 Challenge 3: Not proactively exploring emerging UX to identify new UX landing zones

New components always emerge over time in any ecosystem. The UX ecosystem is no exception. A variety of new user needs and usages may emerge daily as their UXs mature. Although premature, some are emerging as patterns with valid usages that represent a new UX landing zone. Such a new UX landing zone, which may have been previously unknown, creates a potential marketing opportunity for a new product that meets user needs and usages. In today's competitive market, whoever captures a new valid UX landing zone early enough and builds a product at the right time may win the market. There are several cases of such success in today's market, such as certain types of tablets, netbook computers, and smartphones.

However, current practices in identifying market opportunities for new products are primarily driven by current market methods. These market methods are limited in terms of understanding actual UX and user behaviours in end users' real-life settings, because the data collections are based mainly on user opinions or preferences gathered through such methods as surveys and focus group sessions. These methods do not fully explore users' behaviours and usages in their real-life settings. In many cases, the things users say may not truly represent their needs.

On the other hand, in current UCD practices there are many methods available that help UX professionals identify actual user needs and usage models in a social-tech environment through direct user behavioural studies, such as ethnography and contextual inquiry. These identified user needs and usage models may lead to the creation of a new UX landing zone in the very early stage; that is, even before a product development lifecycle starts. However, although UX professionals have tried to get involved in the early stages of a product's lifecycle and have made great progress, UX professionals with current UCD practices are not proactive enough to explore emerging UX. Therefore, their contributions to the process of identifying new market opportunities are limited, where UX is not fully considered.

Once a new marketing opportunity is defined, platform architecture design begins as part of the product's requirements. The platform architecture determines the foundation for the technical capabilities (both hardware and software) of a product, which determines the human-computer interaction functionality and the UI technology that can be developed in order to design a usable product. For instance, computing platform architecture consists of a CPU (central processing unit), chipset, and system hardware and software, all of which determine the functionality and UI technology for an end product (e.g., laptop, tablet) that will be built based on that platform.

However, in today's practices, a technology-centric approach is typically used in defining platform architecture capabilities. In the case of defining the platform architecture for CPU, people used to focus on system performance (e.g., CPU computing speed) and did not pay enough attention to user needs to foresee the UI capabilities to be used in the end products that are built on the CPU, such as wireless, touch-screen UI, 3-D graphics, instant boost, and multimedia. Without these types of capabilities built into the platform architecture, original equipment manufacturers (OEM) (e.g., Dell, HP) cannot use the CPU to build these UI capabilities into their end products to meet user needs.

Although UX professionals (e.g., Dell or HP UX professionals) may participate early enough in the development of their own products by following their UCD process, lack of these types of fundamental platform architecture capabilities will restrict these UX professionals from developing rich UX for end users through their UI. Therefore, if there is a lack of UX considerations in defining platform architecture capabilities in the very beginning, delivered UX of an end product will be greatly impacted. Again, in current UCD practices, UX professionals typically are not involved at such an early stage.

In summary, UX professionals in current UCD practices are not proactive enough to explore new emerging UX in its ecosystem. Without UX professionals' involvement from the very beginning, a UX gap may already exist when people defined market opportunities for new products and platform architecture capabilities. In this case, UX professionals who work on the end product will not be able to deliver good UX to meet end user needs, no matter how much effort they put into following UCD, because the end product may have been wrongly defined without a valid UX landing zone in the first place, and/or the platform architecture may not provide necessary capabilities that support user interactions on the UI.

3. A user experience design (UXD) framework

To address these challenges faced by current UCD practices, a conceptual user-experience design (UXD) framework is proposed herein (see Figure 3). The UXD framework has its roots in user-centered design (UCD), but beyond UCD that primarily focuses on UI design and usability. As shown in Figure 3, the UXD framework expands its boundaries far beyond UCD; it approaches UX in the context of a broad UX ecosystem, including various UX components from emerging UX in the beginning, all TUX touch points across a product UX lifecycle, and future UX evolution. Specifically, the UXD framework characterizes the UXD approach as follows.

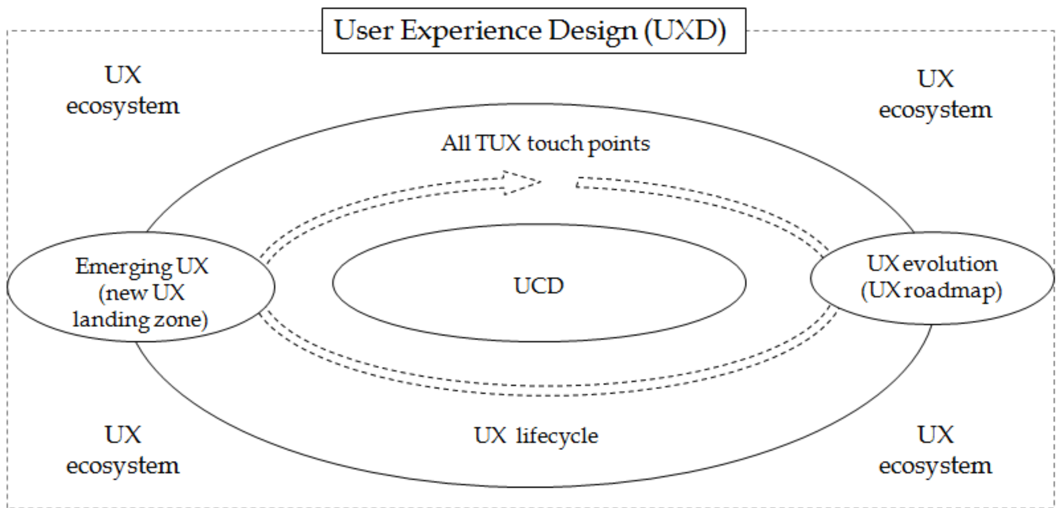

Fig. 3. The conceptual user experience design (UXD) framework in a UX ecosystem context.

- **It is a philosophy:** UXD addresses UX in the context of a broader UX ecosystem by emphasizing three aspects: (1) the emergence of new UX so that UX professionals may identify new UX landing zones in the very early stages of product development in order to influence market opportunities for new products and platform architecture definitions, instead of just executing UCD activities based on predefined products and predefined platform architecture with available UI technology in the UCD practices of the day; (2) the continuous nature of UX in terms of TUX; that is, continuous involvement through various TUX touch points with a product across all UX lifecycle stages, instead of focusing primarily on one single touch point at a single UX lifecycle stage, such as UI design and usability; and (3) the evolutionary nature of UX over time in terms of user needs and usages so that UX professionals can deliver predictable UX roadmaps to influence technology and business capability roadmaps in a long-term perspective, instead of a narrowed focus within the scope of a predefined current project for a near-term goal.
- **It is a process:** UXD leverages current UCD processes to deal with UX, such as a broader UX ecosystem. Beyond that, UXD requires additional processes to address all TUX touch points throughout a UX lifecycle, new emerging UX, and predictable UX. Overall, current UCD processes need to be enhanced to incorporate and facilitate some key UXD activities, such as UXD success scorecards and a tracking system. UXD requires much early involvement of UX professionals in the development lifecycle; it may ask UX professionals to execute activities beyond the scope of current individual projects. From a methodology perspective, UXD also continues to leverage current UCD methods with necessary enhancements. Besides, to be more user-centric and to support executions of the UXD approach, UXD requires the enhancement of conventional methods (e.g., training, marketing).
- **It requires great collaborations:** UXD requires great collaborations among UXD stakeholders who own each TUX touch point, such as people who own business processes, user training, user support desks, technology and business capability roadmaps, new marketing definitions, and platform architecture definitions. It is impossible for UX professionals to accomplish UXD goals without such collaborations. An organization culture should be established to facilitate such collaborations.

User-experience professionals at Intel and IBM, for example, have done some initial work that addressed the non–UI-related UX issues across UX lifecycle stages (Finstad et al., 2009; Swards, 2006; Vredenburg et al, 2001). The UXD framework presented here is intended to propose a formal framework in a more systematic way, and in a much broader context, from a UX ecosystem perspective. Besides, the label "UXD" has been used by others (e.g., Bowles & Bowles, 2010; Unger & Chandler, 2009). These versions of UXD vary slightly from one another, but all of these versions basically echo the current UCD approach that primarily focuses on UI design and usability. Therefore, these UXD approaches essentially do not differ from current UCD practices.

Thus, as compared to current UCD practices, the UXD approach intends to be: (1) more proactive by participating in much earlier stages of defining market opportunities and platform architecture; (2) broader through addressing the TUX in a UX ecosystem context; (3) more collaborative by partnering with various TUX owners; and (4) more predictive by developing UX roadmaps. Therefore, UX professionals can be more influential, creative, and strategic by practicing the UXD approach.

4. UXD practices and processes

This section discusses three case studies. Each one includes three parts. First, problem statements are described; second, details of the case study are discussed to illustrate how the problems have been addressed through a UXD solution in the practice; and finally, a UXD process is initially formalized.

4.1 Case Study 1: Effectively address total user experience

4.1.1 Problem statements

A few years ago, Intel planned to upgrade a large enterprise back-end database system. As a result, upgrades of some front-end, web-based applications were also required. The external vendor of the back-end system offered a front-end, web-based application suite at no cost. To save on costs during the economic downturn, as parts of the system upgrade program, the vendor's application suite was chosen to replace the existing web-based enterprise application suite (WEA 1). After WEA 1 was released, significant post-release issues were reported. Overall, end users perceived the upgrade as a step back, from a UX perspective. Two root causes were identified:

- **Vendor-side issues:** The application suite was the first-generation, web-based, front-end solution built by the vendor; the vendor had not done enough necessary UX work on it. As a result, the product was delivered with many UX issues across its UI design, business process, functionality, system integration, configuration capabilities, and user help materials, among others.
- **Enterprise-side issues:** As influenced by the overall cost policy used for the back-end system upgrade, a vanilla (i.e., no customization) approach was executed for the front-end application suite and UX work was not considered a high priority in the process.

To address the significant post-release issues, the phase 2 work (WEA2) kicked off. The human factors engineer (HFE) group was requested to provide support for WEA 2. A lead

HFE was assigned to the WEA 2 program. The HFE conducted a UX gap analysis based on WEA 1 post-release issues. The analysis clearly indicated that although there were many UI-related usability issues, UI usability issues only accounted for a small proportion (11%) of the total identified post-release issues. The overall identified issues were distributed across all aspects of TUX, including system and data integration, application functionality, business process, application configuration, system performance, online help, user support model, and marketing, among others. Obviously, if the project team just fixed all these UI usability issues, the team still would not be able to significantly enhance TUX.

4.1.2 The UXD solution

The HFE proposed a UXD solution for WEA 2, which was approved by program management. Three major steps were taken to facilitate the UXD process (Finstad et al., 2009).

- **Created a UXD team.** The HFE led the UXD team; members included representatives from such functional areas as across quality assurance, business process, transition change management (TCM), training, user support, and others. The HFE worked as facilitator of the team. Each of the UXD team members owned the planning and execution of the TUX component in his or her functional area.
- **Defined a TUX scorecard and a tracking process.** The TUX scorecard not only defined success criteria for usability as a typical UCD process (e.g., task completion, success rate), but also covered success criteria for other TUX aspects. Besides, various check points were defined across all these TUX touch points in alignment with the program lifecycle. Such a tracking process enabled the program management office (PMO) to closely monitor the progress of UXD and take necessary actions, if needed. This process also increased the overall awareness of a UXD culture within the program.
- **Included HFE as a member of the PMO.** This is different from conventional UCD practices, where UX professionals are typically embedded somewhere within a program as a project member. Becoming a PMO member helped promote UXD and increased the visibility of UXD work to the PMO.

Specifically, various UXD activities were executed as highlighted below:

- **Incorporated UXD into vendor selection:** During the selection of a new vendor for the application suite, UX requirements were incorporated into a vendor assessment scorecard and counted as 20% of the total score among the five components (i.e., business requirement fit, solution compliance, vendor viability, cost, and UX). A UX assessment template was defined to score various items across different TUX aspects, including UI usability, business process, training needs, online design, and others. The PMO made the final decision based on the total score among three candidate vendors. This ensured that UX was fully considered in the vendor selection process.
- **Leveraged UX data to optimize business processes:** The product from a new vendor was chosen, partially due to its flexible configuration capability of business processes as one of the advantages over others. In order to achieve the right balance between UX and business processes, four usability tests were conducted with various configured business processes. Eventually, an optimal business process was chosen based on a trade-off of decisions that achieved a streamlined business process with more intuitive

UI design, but without violating necessary business processes, such as legal requirements.

- **Collaborated with the vendor for major UI usability improvement:** Two critical usability issues were identified during the usability tests. The UXD team directly worked with the vendor and convinced them to fix the issues based on usability test data. This saved Intel substantial costs by avoiding customization coding work and helped other customers of the vendor.
- **Incorporated user-centric approach to conventional methods:** Influenced by the UXD approach, the training and user support teams shifted their focus from a conventional "quantity" approach (e.g., percentage of users trained) to a "quality" approach (e.g., effectiveness of the training delivered). The teams conducted training and support-need analysis across three target user segments and implemented effective training delivery methods based on the needs and priorities identified. Each training delivery (e.g., web-based training, in-classroom training) was tested through UX validations (e.g., surveys, usability tests) prior to release, according to the UX scorecard and the tracking process. Similarly, user support and escalation models were also optimized.
- **Validated user awareness and readiness:** Based on the UX scorecard, validation work of user awareness and readiness happened prior to WEA2 release. Communication materials were delivered (e.g., email) according to the TUX tracking process. Two surveys were conducted to check the progress of user awareness and readiness, and necessary actions were taken based on the feedback.
- **Conducted end-to-end TUX testing:** Unlike conventional usability testing, which mainly focuses on UI design, an integrated end-to-end TUX test was conducted with real end users across different job roles in a simulated environment that included call center desks (support scripts and agents), various help materials, and a back-end system support team. The end-to-end TUX test enabled the team to validate all the TUX touch points with real scenarios and various people who represented different roles in the business process. The test also gave the program one more chance to identify possible UX issues across all the TUX touch points prior to the release.

The WEA2 solution was released with great success. For instance, overall user satisfaction was increased from 43% (WEA1) to 78% (WEA2); the completion time for a major user task was shortened from >45 minutes to <20 minutes; the user-support call volume was decreased from 1.23 calls per 1,000 to 0.81 calls per 1,000. This case study demonstrates how the UXD solution was executed to address all TUX touch points through a streamlined business process, optimized UI design, enhanced user support model and training, and so on, resulting in an enhanced TUX.

4.1.3 Formalizing the UXD process

Figure 4 outlines the process of addressing TUX across a UX lifecycle. The overall process is highlighted below:

Step 1. Build a UXD team: The team consists of various TUX stakeholders who own individual TUX touch points, including people from UX professionals, training, communication, marketing, quality assurance, user support, and others. The team should report directly to the program management office.

Step 2. Conduct TUX gap and needs analysis: The TUX gap and needs analysis should reveal the TUX gaps in current use of products or services, not just in UI and usability but also from other TUX touch points. If there is no previous release, then the analysis should focus on user needs for current release. The analysis provides a foundation for defining UX requirements for subsequent UXD activities and the priority of efforts.

Step 3. Define a UXD scorecard and a tracking process: The UXD scorecard defines success criteria across all the TUX touch points, beyond conventional UI usability success criteria. A tracking process defines the time window to check the implementation of each TUX touch point and corresponding validation methods (e.g., surveys, usability tests).

Step 4. Execute and collaborate on UXD: The UXD team works together to execute the UXD process as planned, addresses issues around all TUX touch points, including business process, UI design, training, user help materials, user support model, communication, and marketing, among others. Take necessary actions based on the issues identified during each check, as defined in the tracking process.

Step 5. Conduct an integrated end-to-end TUX test: This test, unlike conventional usability tests that aim at UI design, checks all TUX touch points in a simulated environment where the real UX ecosystem is realistically presented as much as possible, including real end users, the product, user support desk, back-end tech support, and training materials, among others.

Step 6. Improve TUX and make end users ready for release: Based on the results of the end-to-end TUX test, the project team needs to make it a high priority to fix identified issues and ensure that end users are ready for the release.

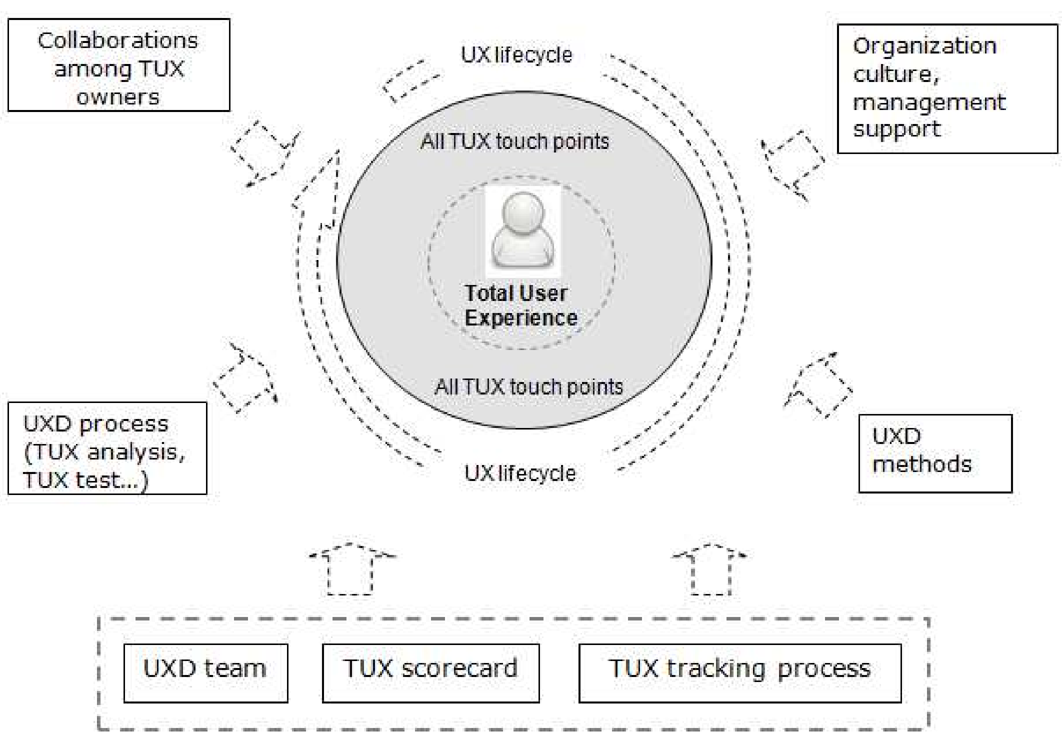

Fig. 4. The process framework of addressing TUX across a UX lifecycle.

Specifically, a UXD process is highlighted below in a specific UX ecosystem context of a corporation's IT setting, where typically off-the-shelf (OTS) products are purchased (Finstad et al., 2009; Sward, 2006). The overall UX ecosystem for an OTS product in this setting can be represented by five UX lifecycle stages as shown in Figure 5. Over the course of the UX lifecycle, end users interact with the product through all aspects of TUX. Relevant UX risks and key UX questions are outlined below for each of the UX lifecycle stages. Also, necessary UXD activities are suggested in order to address the corresponding UX risks and questions.

Stage 1. Marketing and user awareness: At this UX lifecycle stage, from a UXD perspective, the main goals are to clearly communicate the impending change and to set clear expectations to the end users so that they are aware of what is being delivered and what the impact will be. Questions for consideration: Is the end user aware of what is changing (and why)? Have expectations been set properly? Are communications targeted and timely? UX risk involves poor expectation management, confusion, and escalations. Possible UXD activities include surveying or interviewing end users to identify TUX issues in the previous release, if applicable, or their expectations and need for products with similar functionality, and conducting gap analysis by leveraging all available data (e.g., call center, email feedback) to identify UX gaps and needs. Thus, the project team can understand user needs for the upcoming release and better manage user expectations, and the users are ready to use the new product.

Stage 2. Order, delivery, and install: The main goal at this stage is to ensure that end users are able to successfully complete all tasks associated with initial usage of a solution without support. Questions for consideration include: Is the set-up process intuitive? Does the set up materials indicate whom to contact if help is needed? Risks include user frustration, inability to successfully complete a task, increased demand for support, escalations, and so on. Possible UXD activities include usability consulting, heuristic evaluation of the installation process, and usability testing of the materials. The project team also needs to ensure that the products to be purchased meet user needs and that they can be easily configured and installed. For OTS products, UX must be considered in the vendor selection process, including product TUX assessments and TUX scoring incorporated into the purchase decision-making matrix.

Stage 3. Product or service use: The main goal at this stage is to ensure that the product to be delivered is easy to use. Questions for consideration include: Is the product UI intuitive? Is the associated workflow easy to follow? Does the functionality meet business needs? Can the task be completed successfully with or without any help or support? Possible UXD activities include optimizing the business processes based on TUX data, optimizing product UI design through configuration changes if customization costs are significant, and collaborating with vendors to fix top UI usability issues, if identified.

Stage 4. User training and support: The main goal at this stage is to ensure that end users can easily and quickly receive support as needed. This is especially important to OTS products, where the UI design, the business process, and the configuration design may not be optimal for meeting corporate user needs. The product support can help mitigate potential UX risks left over from all other UXD activities. Questions for consideration include: Is the training effective for the user so minimal (if any) support will be required? Does support desk staff have documentation and training needed to support end-user needs? Are escalation and resolution paths clear? Possible UXD activities include collaborating with, training, and supporting business owners to jointly define a user-centric approach for delivering user- centric training and user support as needed.

Stage 5. Removal or End-of-Life: The main goals at this stage are to ensure that end users can successfully complete all tasks associated with EOL of a solution and/or seamless migration between an old solution and a new solution without support. Questions for consideration include: Does the shutdown or migration require additional support? Can the migration be completed with little to no manual intervention? Are instructions easy to follow? Do they indicate whom to contact if help is needed? Possible UXD activities include conducting an integrated end-to-end TUX test with real scenarios and actual end users in a simulated environment to test all TUX touch points, launching surveys to test user awareness and readiness, and launching effective communications based on the level of user awareness and readiness.

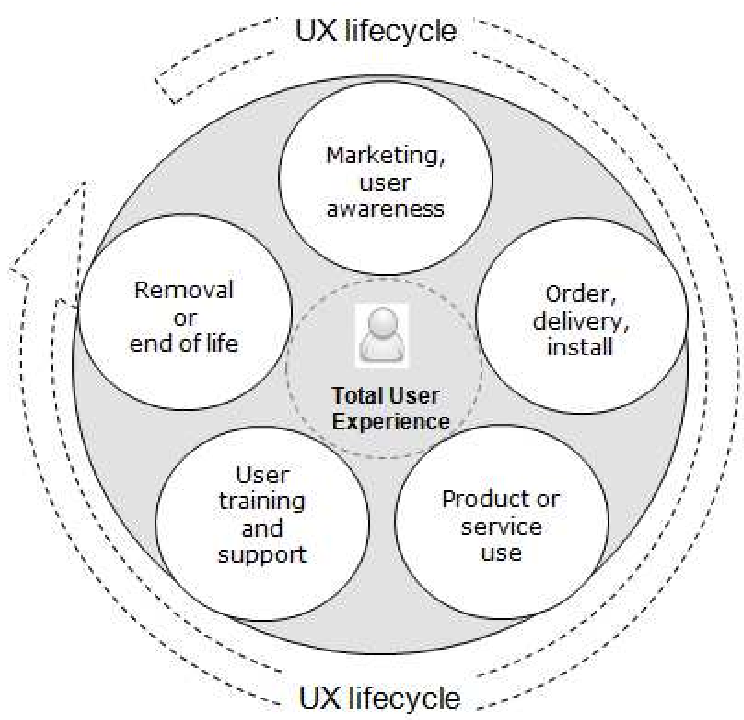

Fig. 5. The five UX lifecycle stages for an OTS product in a typical corporation IT setting.

4.2 Case study 2: Develop UX roadmaps to influence strategic directions of products

4.2.1 Problem statements

An internal business portal is a platform that provides corporate users with a collaborative, productive workspace by aggregating a variety of web content, applications, and reports. It allows users to access the content in a one-stop-shop approach based on their job roles with personalizable UX. Intel has been leveraging portals to enhance employee productivity. The UX problems in this case study come from two past projects. The first example has to do with a corporate business portal for internal financial users. The finance portal was released in the early 2000s with a personalization capability. The capability allowed users to turn some content on and off or move it around, similar to what iGoogle or myYahoo provide today. However, users felt frustrated when using the personalization functionality; they were not familiar with this type of capability, as there was no iGoogle or myYahoo at the time. The capability was eventually removed. This example shows that if a technology or business capability is ahead of UX and user readiness, it will not be accepted by end users and eventually will not deliver business values.

The second example has to do with an internal enterprise application. The product program was in the process of implementing a new version to replace the existing one. User research results indicated that users were not satisfied with the functionality provided by the new version (nor the existing one, for that matter). As compared with the UI design of a benchmark product with similar functionality on the market, the UI of the selected new version provided a lot of unnecessary data with less configuration flexibility. This would slow down the decision-making process. The program decided to add a customized UI presentation layer onto the new version of the application by using rich Internet application (RIA) technology, so that UX could be implemented that is similar to the benchmark product in today's market. This example shows that when technology or business capability lags behind user needs and UX, no one can deliver an optimal UX to end users.

The portal program had defined technology and business capability roadmaps for the next several years in order to enhance internal business portals to foster employee productivity. On the one hand, business and technology individuals are looking for predictable UX data to help guide their roadmaps to match the optimal UX sequence based on the lessons learned; on the other hand, the program had only the UX data that defined the current UX states (e.g., user needs, interaction models), which were typically delivered by a project HFE in terms of short-term user needs. There was no predictable UX data that could help the program optimize the proposed technology and business capability roadmaps.

4.2.2 The UXD solution

The business portal program requested that the human factors engineer (HFE) team to help identify UX gaps and needs, build the UX vision (near- and long-term), and define UI concepts for a next-generation business portal. While executing activities for these original goals, the team also leveraged the efforts to generate predictable UX data in terms of user needs and usages, so that the program could better plan its technology and business capability roadmaps accordingly, in order to deliver optimal UX over time, based on end user needs (Wooding & Xu, 2011).

The methods used in the study included: 1) industry best practice reviews (e.g., industry reports, external benchmarking), 2) information process mapping and observation sessions that allowed representative employees to map out the typical information and the workflow they use to support their daily jobs at Intel, 3) interviews with portal end users and observation sessions in their actual working environment to better understand their daily work patterns and usage models of the portal, and 4) a large-scale employee survey that collected their usage data on the portal and user needs for the portal from both near- and long-term perspectives.

The data analyses focused on identifying basic patterns and leveraging them to create larger patterns, and then looked for themes within themes; eventually the analyses led to the future UX vision, UX guiding principles, and user needs and the prioritized needs over time. Finally, a UX roadmap was created. Figure 6 illustrates the part of the UX roadmap concept that defines UX in terms of high-level usages in a subset area of the business portal domain.

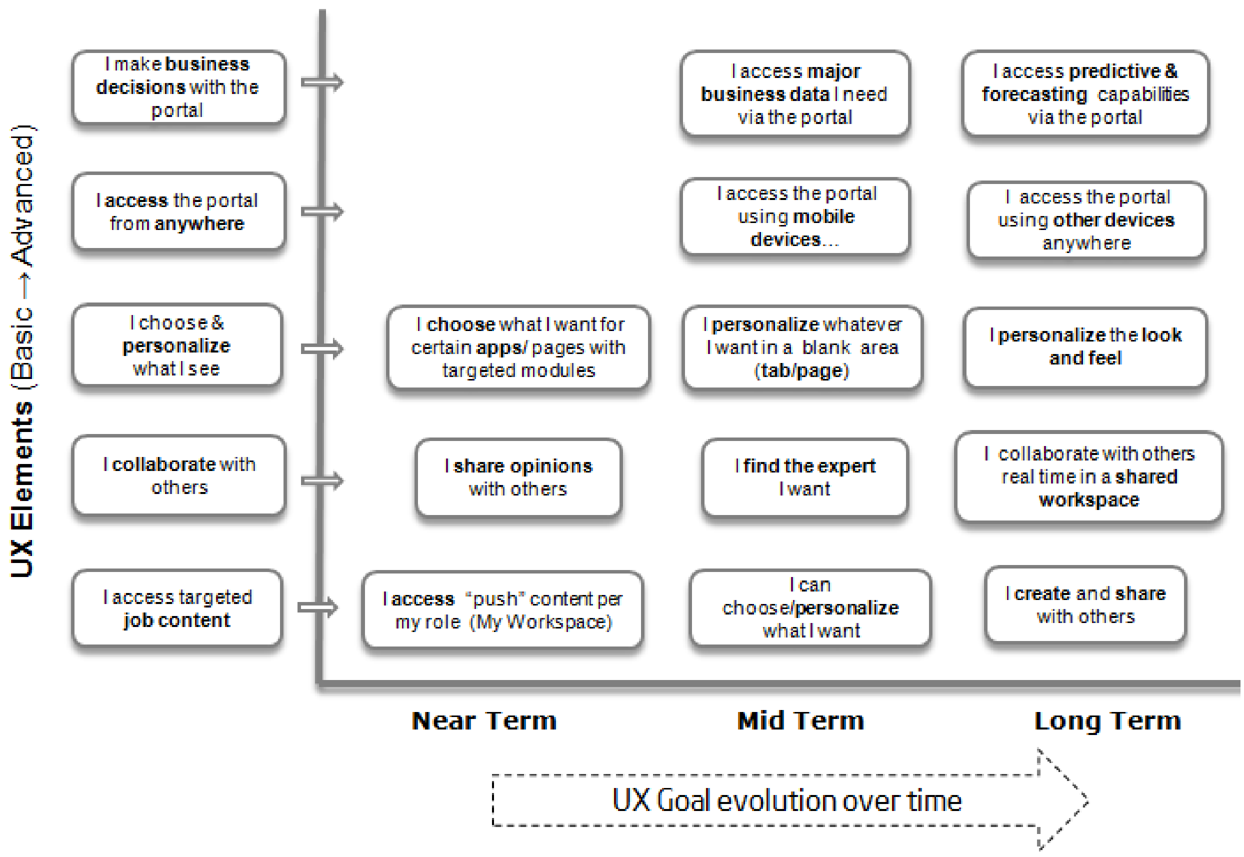

Fig. 6. Example of a UX roadmap for a business portal. Only high-level information is presented here for a subset area of the portal business domain.

Prior to creating the UX roadmap, HFE defined a UX vision and several UX guiding principles within the domain, based on the data collected. Overall, employees look for a business portal that not only provides information and news, but also provides more transactional data to help them take action and make business decisions. The collected data led to a UX vision; that is, employees can access information and do their work in one easy place with the portal. Following the UX vision, several UX guiding principles were defined. For instance, the portal should enable more collaboration, integration, and target content based on job roles; the portal content should be more relevant and personalizable. Put together, the UX vision and UX guiding principles helped shape the UX roadmap. Specific explanations for the UX roadmap follow:

- The vertical axis defines various UX elements in order, from basic to advanced. Basic user needs as defined by basic UX elements must be satisfied prior to advanced UX needs that will be satisfied later on. For instance, "I make business decisions with the portal" is the most advanced user need (UX element), but basic UX elements must be satisfied first, such as "I access targeted job content."

- The horizontal axis defines a sequence of sub-level UX goals over time, specifically for each of the UX elements. For instance, in order to achieve the "I access targeted job content" UX element, users need to access the "push" content per their job role first (i.e., the content is displayed to target users by default based on their job roles without user's touch); then to choose and personalize what they can access (a "pull" model). Eventually, the long-term goal, as defined by "I create or share content with others", will be achieved, which provides the capabilities for employees who want to do something beyond the push and pull models to facilitate collaborations with others.
- Figure 6 only presents a high-level view of the UX roadmap in terms of usages. A detailed view was also developed in terms of some near-term measurable UX goals. For instance, for the near-term UX goal of "I access 'push' content per my role," at the detailed level, UX goals were broken down into: 1) "I can access major job content by default with less than three clicks" for a project phase 1 deliverable, and 2) "I can access major job content by default with just one click" for a project phase 2 deliverable. Here, the measurable UX goals can be validated by project UX work during typical project-level UCD activities.
- Notice that no actual technology capabilities or product labels are defined in the UX roadmap above. A UX roadmap should only present user needs in a technical-agnostic way. Actual technology capabilities should be documented in a technology roadmap by mapping the UX roadmap and technology capability accordingly.

The proposed UX roadmap was presented to the product program with positive feedback. The program formed a team, including an HFE to further define the UX strategy for the program, and made adjustments of the existing technology capability roadmap by mapping both predictable UX data and technology capabilities accordingly (Chouhan et al., 2011). As a result, the sequence and the appropriate technology capabilities were optimized in a revised technology capability roadmap based on the optimal UX sequence, as defined in the UX roadmap. For instance, the implementation sequence of technology capabilities (e.g., corporate social media technology, enterprise workspaces technology) should be carefully defined in order to best satisfy user needs (i.e., "I collaborate with others") over time. In this case, some basic corporate social media capabilities must be implemented first (i.e., "Unified Employee Profiles"), and then additional capabilities (i.e., "Expert Finder") can be effectively utilized based on employee profiles. Eventually, the user need of "I find the expert I need" and then the user need for a shared workspace (i.e., "I collaborate with others in real time in a shared workspace") can be effectively satisfied in the long run.

This case study shows that a UX roadmap helped UX professionals document and communicate predictable UX data in a more influential way. Also, the UX roadmap helped technology and business people better understand UX and validate their roadmap; they were able to make necessary adjustments to ensure that both roadmaps were well aligned in order to deliver optimal UX over time.

4.2.3 Formalizing the UXD process

Figure 7 illustrates the process of developing a UX roadmap. The major steps are highlighted below:

Step 1. Gather data: Conduct user research to gather data on UX gaps and user needs in the relevant domain. The data may be documented in terms of usage scenarios, personas, etc. The data analyses should result in a better documentation of UX and user needs in terms of priority over time. The data gathered is the foundation for the development of a UX roadmap.

Step 2. **Understand existing technology and business capability roadmaps:** In many cases, existing business and technology roadmaps or strategies may be available. UX professionals should fully understand this information. The information provides great context for developing a UX roadmap. Also, an understanding of this information helps UX professionals effectively communicate with technology and business people.

Step 3. **Define a UX vision and UX guiding principles:** Analyze the collected UX data to generate a UX vision for the relevant domain. Collaborate with business and technology people to ensure that the UX vision is aligned with a long-term business strategy. Also, develop UX guiding principles based on the UX data; these principles will define the boundary and driving vectors for the UX roadmap.

Step 4. **Build a UX roadmap:** Draft the UX roadmap based on the data collected and roadmap conventions (see details in Section 3.2.2 of this chapter) with the guidance of the UX vision and UX guiding principles. Once drafted, review the proposed UX roadmap with business and technical partners (e.g., product manager, architect) to gather their input and revise it based on the feedback. This may be an iterative process.

Step 5. **Manage influence:** This is a key step in which UX professionals take opportunities to present the UX roadmap to various business and technical stakeholders, and work with them to develop or adjust (if already developed) their business and technology capability roadmap. There may be a lot of discussions and debates in this process. UXD professionals need to have UX data ready to support the discussions.

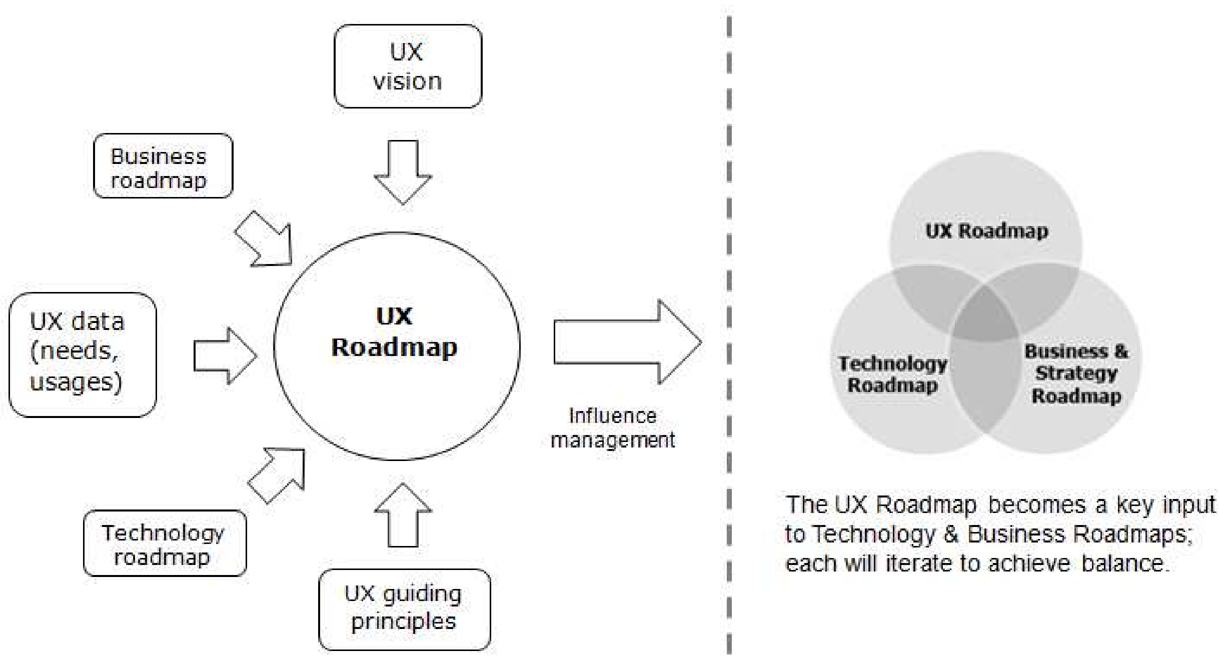

Fig. 7. The process of building a UX roadmap and influencing business and technology capability roadmaps, resulting in an optimal product roadmap that balances the needs across UX, technology, and business.

As a result, in order to achieve an optimal solution, one must consider the needs from all the three parts (technology capability, business capability, and UX). In reality, sometimes a trade-off decision may be needed. As Figure 7 shows (the right side of the figure), an optimal solution resides in the balanced, overlapping area across all three circles—technology, business, and UX. By doing this, an optimal product roadmap can be developed with balanced needs across UX, technology, and business.

4.3 Case study 3: Identify a new UX landing zone to influence the definitions of a new market opportunity and platform architecture capabilities

4.3.1 Problem statements

Popular TV technology failed to progress in the way other technologies had, leaving the living room with a comfortable void, since Internet experience, social networking, and contextual information are basically offered by other devices such as smartphones, netbooks, and laptops (Loi, 2011). Industry has been looking for new technological solutions and marketing opportunities for traditional TV technology. More specifically, the integration of Internet experience into traditional TV usage seems the most promising opportunity (Intel, 2011; Loi, 2011).

However, many UX-related questions remain open before a new UX landing zone can be validated (Intel, 2011): What kind of UX do consumers expect from the Internet access via a TV? How can one integrate the Internet experience while preserving the best of a TV medium which continues to inspire 1.3 billion households around the world? Will the worldwide reach of the Internet help link programming with an expanded pool of interested viewers? What is the best way to get content on viewers' radar screens? What type of interaction models do consumers expect? What are its implications to the TV screen design and user control UI design? What content do people want to watch and store? From a marketing perspective, what type of new market opportunity will this merge bring in if the new UX can be justified? In addition, what type of processing power and platform architecture capabilities are required to support the new TV experience and UI technology, based on desired interactions?

4.3.2 The UXD solution

To answer these questions, Intel UX professionals, along with other designers and technology people, has explored this new area in the last several years (Intel, 2011; Loi, 2009, 2011). As a result, a new TV experience and new market opportunity were defined; that is, the smart TV, which is called Google TV in the market. The smart TV allows users to access the Internet; to search online, personal content, and broadcast programming from a single TV interface; access downloadable apps; connect to social networks while watching favourite programs or movies; control TV with a unique new remote control or voice commands; and access an infinite amount of entertainment possibilities.

Related UXD activities are highlighted below to illustrate how these activities influenced the identification of the new market and the definition of the platform architecture capabilities (Intel, 2011; Loi, 2009, 2011).

- **Conducted early UXD activities:** In the past several years, Intel UX professionals, including anthologists and ethnographers, conducted a number of exploratory studies. They visited hundreds of people in their homes across India, the United Kingdom, the United States, China, and Indonesia to learn how they engaged with their TVs. These studies were aimed at various aspects of the TV experience and the social lives of television users. Unlike traditional user research (e.g., user groups, interviews), these studies intended to understand how people in various cultural settings touch the TV technology in their daily lives through direct observations and daily living with them. The UX professionals also conducted field studies on the retail floor (e.g., Best Buy) in America, where they talked with and listened to salespeople and consumers to understand what consumers needed from TV technology.
- **Identified user needs and modeled their usages:** The series of studies revealed overall user needs. For instance, they wanted to browse online while communicating and collaborating through social media while watching TV; they needed to access personal media on TV; they needed a way they could get whatever they wanted on demand. Furthermore, consumers wanted the UX quality of this new technology to be simple and interactive. Overall, a new usage model is clearly emerging: the intersection of television and the Internet.
- **Conceptualized the UX:** Based on the collected data and identified usage models, the UX professionals partnered with interaction designers, architects, and other technical people to define new UX concepts for various UX components through UI prototyping. These UX components include home media aggregation, TV widget (rich Internet apps), a 3-D UI, the ability to share/send personal content with/to others or to access/receive contextual information and recommendations, gesture-based navigation, and voice-based search.
- **Validated UI concepts:** Numerous usability tests were conducted to iteratively assess and improve these proposed interaction models and UI concepts through quantitative and qualitative UX assessment metrics. During the iterative process and interactive discussions among UX professionals, interaction designers, marketing people, and technical people, these concepts also deeply influenced people's thinking and the development approach.
- **Influenced platform architecture definitions:** The newly identified UX and usage models, along with the support data from both qualitative and quantitative UX data, helped open up new opportunities with internal stakeholders (e.g., architects, product owners) to conceptualize their technological frameworks. It eventually influenced the definitions of platform architecture. As a result, an Intel CPU was designed specifically for powering the smart TV (Intel, 2011). The CPU offers platform capabilities to help design a usable smart TV, such as home-theatre quality, audio/video performance, signal processing, surround sound, 3-D graphics, and etc.

In summary, the deliverables through these efforts met corporate strategic marketing needs and also provided a reference design for Intel when Google approached the company looking for hardware and platform solutions for Google TV. It opened a door for smart TV, which is not just a product but rather a completely new product category of TV (Lois, 2011). In addition, the UX professionals' early involvement in the first stages provided a UX foundation for the platform architecture capabilities, which enabled OEM (e.g., Google, Sony) to develop usable products to meet consumer needs.

4.3.3 Formalizing the UXD process

Figure 8 illustrates the process framework of the UXD solution. Major steps are highlighted as follows:

Step 1. **Gather UX data:** Conduct field user research with target users through methods such as ethnographic study and contextual inquiry. In contrast to conventional user studies, these types of studies should be conducted in a broad social-tech environment, and UX professionals may work or live with users to gain a deep understanding of their needs and usages of emerging technology.

Step 2. **Define usage models:** Analyze collected data to build usage models. Usage models define users' real needs, values, and the interaction environment by describing product usages and context. The usage models also tie several product development artefacts together around UX, including architecture, key features, requirements, and technologies. Eventually, the usage models help drive detailed UX definitions.

Step 3. **Identify new UX landing zones:** This is one of the key steps where UX professionals collaborate with other partners (e.g., architecture, marketing people, and business owners). A UX landing zone may be defined in a minimum, target, and outstanding format, which helps define a market opportunity for a new product by satisfying end user needs in terms of priority. Eventually, a UX landing zone, in alignment with market requirements, is created for influencing the definitions of product requirements and platform architecture capabilities. In this way, UX is well integrated and fully considered in the early strategic planning stage, even before a product development process officially kicks off.

Step 4. **Conceptualize future UX:** At this stage, detailed UX can be developed based on the previous work through methods such as use cases, workflow, and contextual diagrams, eventually leading to interaction models and UI design concepts. The efforts in this process provide visualized materials (e.g., UI concepts) to communicate and document future UX.

Step 5. **Validate concepts:** To validate the UX, usability testing should be conducted for the proposed UI concepts with novel scenarios and usages. The UI may include both software and hardware UI. This may require iterative tests and improvements of the proposed interaction models and UI.

Step 6. **Manage influence:** Influence management also is a key step and should actually be an ongoing effort throughout the whole UXD process. UX professionals need to collaborate with various stakeholders, including marketing, technology, and business people, to influence their capability roadmaps, platform architecture definitions, and marketing opportunity definitions.

5. Future research

As discussed above, although a common ground is shared between the UXD approach and current UCD practices at a high level, the UXD approach is beyond the UCD approach in terms of processes and methods. The UXD approach is still under development. Thus, more research is needed in order to make UXD more mature.

First of all, UXD involves great collaborations across a variety of TUX owners across all the TUX touch points in the context of a UX ecosystem. Conventional methods in some areas

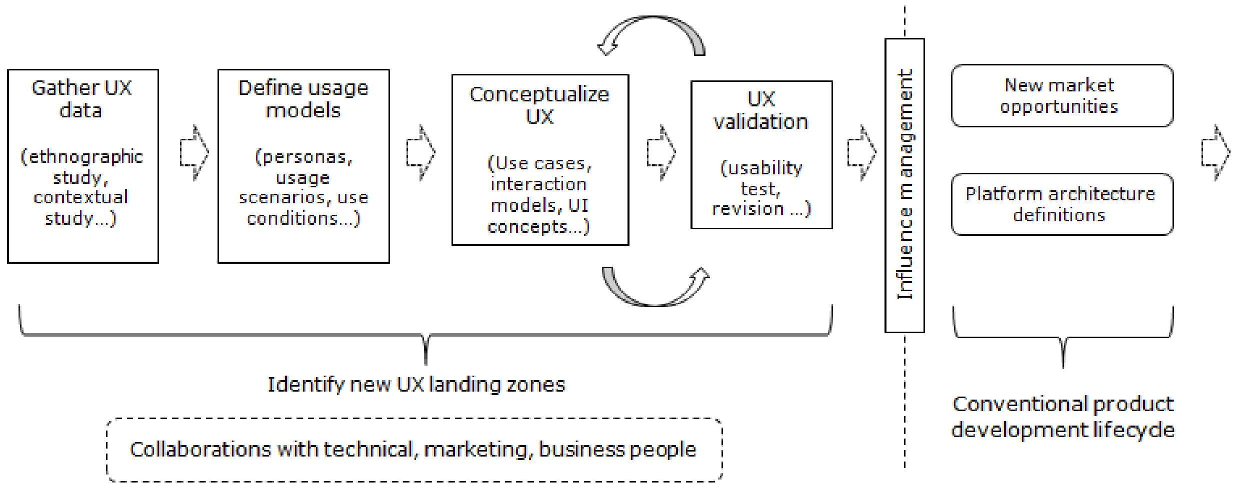

Fig. 8. The UXD process to identifying a new UX landing zone that influences the identification of a new product market and the definition of platform architecture capabilities.

(e.g., marketing, training, and business processes) need to be enhanced or integrated with UXD methods in order to support UXD activities more effectively, including more user-centric marketing and training methods, UXD success criteria definitions in these individual areas, and validation of success.

Secondly, more formalized and effective UXD methods need to be developed in order to support development of UX roadmaps, identifying emerging usage models and new UX landing zones in order for UX professionals to more effectively influence new market opportunity definitions and platform architecture definitions. For instance, methods for modelling usages of technology and modelling of UX in both quantitative and qualitative ways.

Also, a UXD process should be reasonably flexible to fit a variety of UX ecosystems in terms of scale and nature. New UX ecosystems are continuously emerging, and new components are being added to existing UX ecosystems, such as social computing and cloud computing. All of which make UX richer and more versatile. More best-known methods should be developed to help UX professionals address UX in a variety of UX ecosystems in today's dynamic and versatile social-tech environment.

Finally, UX is no longer an isolated experience within an individual platform, such as desktop computers, tablets, and smartphones. Computing technology is entering a "compute continuum" era, where computer resources (e.g., content, data, processes, and applications) are shared across different platforms. For instance, people want to access the same application across a smartphone, a tablet, and a desktop computer with seamless UX. This creates new needs and challenges to the continuum of TUX. The conventional consistent UI design principle is no longer feasible across platforms due to different platform UI conventions. The form factor between smartphones and desktop computers will definitely drive inconsistent UI. Here, achieving "UX continuum" with a consistent UX becomes a more important design goal, so that users can receive seamless UX across platforms without interruptions in different usage situations. This definitely expands the boundary of a UX ecosystem and drives new needs for UXD practices.

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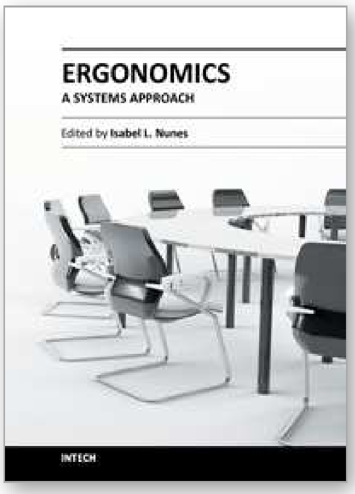

Ergonomics - A Systems Approach

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This book covers multiple topics of Ergonomics following a systems approach, analysing the relationships between workers and their work environment from different but complementary standpoints. The chapters focused on Physical Ergonomics address the topics upper and lower limbs as well as low back musculoskeletal disorders and some methodologies and tools that can be used to tackle them. The organizational aspects of work are the subject of a chapter that discusses how dynamic, flexible and reconfigurable assembly systems can adequately respond to changes in the market. The chapters focused on Human-Computer Interaction discuss the topics of Usability, User-Centred Design and User Experience Design presenting framework concepts for the usability engineering life cycle aiming to improve the user-system interaction, for instance of automated control systems. Cognitive Ergonomics is addressed in the book discussing the critical thinking skills and how people engage in cognitive work.

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