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Assessing the Quality of User Experience

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Index words: user experience assessment, UX, platform quality, consumer experience, perceptual quality

ABSTRACT

User Experience (UX) has become an increasingly important consideration in the design of technology. As part of a corporate wide strategic initiative focusing on creation of platforms, Intel has been steadily shifting toward a more holistic and user-centered approach to the design and development of technology. In essence, Intel's platform approach is about integration of technology ingredients, infrastructure, and service or content to ensure the creation of new end-user value [1].

The capability to deliver end-user value propositions requires the ability to set goals and measure the quality of end-user experience during the development process. Since perceived user experience and end-user value is psychological in nature, behavioral sciences researchers at Intel have made substantial inroads toward driving the creation and measurement of platform user experiences.

In this paper we describe the rationale behind setting User Experience Quality (UXQ) goals and measuring against these goals using experimental psychology, experience research, and human factors techniques. The assessment described here goes beyond traditional out-of-box or usability testing methodologies and toward a broader conception of user experience as is emerging in professional practice. Setting UXQ goals explicitly targets aspects of UX beyond usability that may be emotional, attitudinal, behavioral, and perceptual. Assessment of UX requires measurement at milestones placed throughout the development lifecycle and may be targeted at specific points of use or "moments of truth" in the users experience. In turn, the data about how the UXQ changes over time and compares to other products allows organizations to better target and control the quality of the UX.

Working definitions are proposed and three diverse examples of UXQ assessment methodologies are described: 1) a competitive benchmarking study, 2) a perceptual quality study, and 3) an in-home contextual study. Although these are only a few examples of user experience assessment methodologies used at Intel, the examples illustrate the diversity of the UXQ assessment approach. Implications of developing a user experience assessment capability beyond traditional usability testing are discussed.

Note: Intel works with other companies in delivering platform solutions. To maintain the confidentially of specific product data, the data in this paper have been modified and are deliberately not linked to specific Intel or partner products.

INTRODUCTION

As a semiconductor manufacturer, Intel's competitive edge has been based on technology design leadership combined with industry-leading manufacturing technology. Both the rapid evolution of technology and delivering high-quality products in large volumes are among Intel's primary strengths. Recently, the strategy for staying ahead of the competition has been evolving to become more closely tied to the creation of noticeable end-user value. Our traditional technology optimization goals of rapidly improving performance and power are necessary but not sufficient in the context of competitive pressures. A user-centered approach allows new growth opportunities through creation of platforms that support new consumer usages and ensure noticeable differences in the quality of User Experience (UX) for Intel® platforms. In this way, establishing platform credibility has extended beyond technology-based development processes to include planning and assessment of the UX itself.

The platform approach recognizes the importance of the end-user experience resulting from the combination of hardware, software, and services. These elements are often inextricable from a UX perspective and work in concert to enable end-user value propositions. For this reason, the platform approach emphasizes holistic solutions in Intel's product line planning strategies. These solutions involve hardware and software development, ecosystem enabling, and influencing industry standards.

Explicitly targeting UX and associated end-user value propositions requires a holistic understanding of how people interact with technology. This has presented new challenges and opportunities in setting User Experience Quality (UXQ) goals and ensuring proper validation against these goals.

Across the technology industry, assessing and improving the UX of products has become an increasingly sought-after objective. This is reflected in a greater number of conference topics on UX, and to a lesser extent, an increasing number of books and journal articles [2, 3] over the past ten years. This increase in attention reflects the fact that consumers have now come to expect products to be easy to use. As ease-of-use becomes more and more of a basic expectation, it is becoming more important for companies to differentiate on other aspects of UX [4].

Despite good intentions, there are often many barriers to designing and delivering good user experiences [5, 6]. Reasons include lack of understanding of users, poor usage model definitions, too many constraints on the technology, and inconsistency and/or inability to integrate the technology with other parts of the ecosystem. One of the overarching issues is a lack of a top-down approach to UX and an inability to systematically measure and communicate UX. Although UX is increasingly valued as an outcome tied to business objectives, in the past, it has often been thought of by decision makers as intangible or immeasurable. Traditional human factors engineering approaches have tended to focus on task-based efficiency and effectiveness at the moment of use [3] rather than emotional, attitudinal, and perceptual aspects; and across the stages of the usage lifecycle (including the "moments of truth" before, during, and after initial use of the product).

Over the past decade, a wider approach to UX has been taking hold in the fields of psychology, Human Computer Interaction (HCI), and the human factors disciplines [3, 4, 7]. As technology develops to the point where PCs have become more usable, people increasingly seek to satisfy higher-level needs including emotional needs. Recent examples highlighting the importance of emotion and attitudes in product design include *Emotional Design* [8], *Designing Pleasurable Products* [4], and *Funology: From Usability to Enjoyment* [9]. The trend in the literature toward recognizing the importance of a wider conception of UX reflects progress that has been made within private industry. Although these trends create new opportunities to educate and motivate stakeholders, there is still a need to better define these concepts and to explicitly distinguish them from related concepts and metrologies.

DEFINING TERMS

Although the term "user experience" (UX) has been used extensively in recent years, it has been associated with a wide range of meanings [10]. Commonly, however, the definition of UX goes beyond the traditional instrumental conception of usability common in the HCI literature [2, 3]. Unlike usability, UX tends to include wider human experience dimensions (such as pleasure, fun, and other emotions) and also may have a temporal or longitudinal component. While usability tends to be focused on task efficiency and effectiveness measures, UX includes emotional and perceptual components across time. UX involves a constant feedback loop repeated throughout the usage lifecycle including from initial discovery through purchase, out-of-box, usage, maintenance, upgrades, and disposal.

At a minimum, there are at least four components of UX. The components and a simplified relationship between these components are shown in Figure 1. The UX consists of perceptions that shape emotions, thoughts, and attitudes. The UX directly influences behavior that then continues the loop.

Components of UX

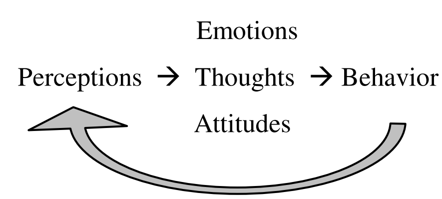

Figure 1: Components of User Experience

The following definitions are based on a literature review within psychology and HCI and have been developed to be relevant across different perspectives. The goal is to provide distinctions between key terms associated with UX. These distinctions are also relevant to potential UX goal setting and measurement.

- **User Experience (UX):** Emotions, attitudes, thoughts, and perceptions felt by users across the usage lifecycle.
- **User Experience Quality (UXQ):** (1) degree to which a system meets the target user's tacit and explicit expectations for experience or (2) the measured level of quality of a particular UX when compared to a specific target, using a specified metric and method or tool.

- **Perceptions:** The process of acquiring and interpreting sensory information. Focus is on the intake of information. Psycho-visual and psycho-acoustics studies assess human perceptual variables that can provide data to drive requirements and assess human perceptual aspects of interaction with technology such as video quality, audio quality, acoustical, and thermal performance.
- **Emotions:** Subjective states of consciousness that evoke positive or negative feelings. Emotions, both positive and negative, are critical to learning, trust, and assessment of what's desirable [7, 8, 11]. These, in turn, affect purchasing behavior, how much the technology is used, and what consumers say about their experiences. Despite the widely held impression that people make decisions logically, in fact, research shows that decisions are highly dependent on the emotional states of end users [12, 13].
- **Attitudes:** Judgments about a target, usually expressed as good or bad, helpful or harmful. Attitudes are a function of experience or anticipated experience with the target and include value judgments.
- **Thoughts:** Mental and cognitive processes that allow humans to model what they experience and plan behavior.
- **Behaviors:** Observable overt movement that includes verbal behavior as well as physical. Actions in response to our environment or experience.

Measurement of UX can be explicitly targeted to measure certain aspects of these constructs depending upon the product goals.

UXQ GOALS: SETTING MINIMUM REQUIREMENTS

Setting measurable UXQ goals is particularly relevant in companies undergoing transitions toward establishing user-centered processes. It increases emphasis and visibility of the key usage model being developed and sets targets for high-level UX outcomes to facilitate user-centered processes and accountability. UXQ goal-setting complements and may come well before detailed usability requirements and use-case development. The purpose of UXQ goal-setting is to set the level of UXQ that the final product should deliver with respect to perceptions, emotions, and thoughts, as well as attitudes that the product should elicit from the target market segments. These convey to stakeholders in management and the development process clear targets regarding how good the product must be.

We describe three broad steps in setting UXQ goals. Here is a brief outline. The first step in setting UXQ goals involves identification and prioritization of the relevant UX dimensions. For the purposes of this paper, it is assumed that market research and needs-finding processes (such as market segmentation, ethnographic research, and usage model definition) have already defined the nature of the product opportunity [14]. The first step in setting UXQ goals then is to rank order the high-level key features and usages that have already been defined. Particular attention should be given to the features and usages that are end-user noticeable, will be included in the marketing messaging, and differentiate the system from others that will be on the market. In addition, any usages involving perceptual quality (such as acoustics, video, or audio quality) can be called out as relevant according to the end-user value propositions being targeted.

The second step is targeting specific, measurable UX dimensions for each of the key usages and features. This involves assessing what emotions, attitudes, perceptions, and thoughts are being targeted for the planned end-user value propositions. Selecting the proper dimensions to target and how to best measure them is where a background in psychology and psychometrics is essential. The measures selected should be based on branding/marketing strategies as well as practical and experimental design considerations.

The third step is working with the UX owners to assign specific cutoffs for each of the key features with respect to the variables being measured. To do this, competitive analysis benchmarking data or prior baseline data can be used. If no prior UX data are available, then judgment based on experience with similar types of systems can be used to start with. The main objective is to set explicit goals for UXQ well in advance of product development so that these goals can serve as clear targets and bring appropriate attention to the UX throughout the development cycle. By highlighting what should be the UX outcomes to development teams and the accountable stakeholders, strategies and resources can be channeled to ensure user-centered design processes are prioritized appropriately with other business demands.

After goals have been set, measurements to assess the state of the UX can be planned for explicit milestones in the program. At these milestones, decision makers can now better weigh tradeoffs that may affect both the UX and other business outcomes.

Common questions that UXQ assessment can help answer include: How good is the UX for the target market? What levels of perceptual qualities will consumers notice and value? How does the end-user value proposition change when ecosystem partnerships or key functionality changes? How will the product be perceived if key features are implemented differently, delayed, or eliminated altogether? How do we know if a system is good enough to be released? These types of questions can be answered with UXQ studies.

UXQ Assessment Within Industry

Leading companies that consider UX to be a core part of their business have been using UXQ measures as checkpoints and quality gates in their development processes. Based on a series of informal benchmarking interviews, companies including IBM, Microsoft, British Telecom, Google, and Yahoo use some form of UXQ assessment data as part of ongoing assessments and go/no go decisions regarding product releases. These and other companies, including Philips, Ford Motor, and Proctor & Gamble have indicated that they routinely assess the UX of products during the development process. The methods used for assessing UX in these companies tend to be part of a larger user-centered innovation effort.

Integration into Organizational Processes

UXQ assessment can be geared to provide critical data about whether key aspects of the planned end-user value are being achieved. Since the complete UX is not typically under the exclusive control of any one project team (or even a single company), UXQ assessment provides a means to see, from the end-user perspective, how the value propositions are manifesting themselves in realistic usage scenarios.

When aggregated across targeted user segments, UXQ data indicate the extent to which the quality goals are being met. Results intersect at multiple points in the product lifecycle. Results can be quantifiable, such as in a classic summary dashboard format, or focus on richer description and story-photo-based reports. As such, study results can be tailored for executive reviews and become part of existing or new feedback processes that help UX stakeholders make good decisions affecting the UX. This type of information is particularly useful when tuning product requirements, refining marketing messages, negotiating with the ecosystem co-travelers, addressing existing issues, and helping to drive innovation for future systems.

The following sections describe three examples of UXQ studies illustrating some of the many distinct methodologies used in these assessments. Each was applied in assessing aspects of a digital home platform. The studies are real but the data shown are examples only and are not the actual data from the studies conducted to protect the proprietary interests of the parties involved.

Example 1: UXQ Benchmark Dashboard Study

A competitive benchmarking study was run to assess how the UXQ of a platform, based on Intel® technology, compared to similar usages on competitive platforms. This study was conducted during platform development to assess the current state of UX and set goals for the next version of the platform. Since a number of formative usability studies were conducted at earlier stages of planning and development, micro-level usability issues were known and not the focus of this study. This UX study was designed to answer the following research questions:

1) What delighted and frustrated consumers about the UX of the Intel platform?
2) How did the Intel platform compare to a prior version of the platform?
3) How did the Intel platform compare against non-Intel platform solutions?
4) To what extent did the Intel platform meet predefined UXQ goals?
5) How could product messaging be refined to reflect the actual UX?

There were 32 participants in this study carefully selected based on target market segments and additional demographic selection criteria. Each participant received $200 in exchange for about four hours of their time.

The study setting was a furnished apartment located in downtown Portland, Oregon. The apartment was divided into two similar sections with each section containing different platform solutions. The platform solutions each involved components that would be found in the den (PC, modem, wireless router) and living room (digital media, adapter, and a TV). On one side, a platform based on Intel technology was placed in boxes ready to be set up in the den and living room. On the other side was a similar configuration but with competitive solutions.

Before arrival, participants were randomly assigned an order in which they would be exposed to the platforms (Intel vs. competitor). Each condition started with participants learning about the technology according to the platform messaging provided by marketing. Participants were not aware that Intel was involved in the study until the debriefing at the end. As they learned about the platform value propositions through the marketing messaging, positive and negative comments showing participants reactions to the messaging were collected. Participants were encouraged to discuss their initial reactions to the purpose and value of the technology.

Next, participants were asked to set up and use the technology as they would normally do in their home if they had purchased the technology. High-level task guides were given to the participants that provided a minimal level of structure. The activities contained in the task guide were based on prior research so that it would reflect how people tend to go about the activities in actual home settings. The main goal from the participants' perspective was to be able to get media content (picture, music, and videos) stored on the PC to be viewed on the TV using new technology solutions. This involved unpacking the equipment, setting up a wireless network, connecting a digital media adapter to the TV, and finally building a media library on their PC. Exactly how participants did this and the order in which they did it was up to them.

Data collection involved structured interviews at natural breaking points in the set-up process. Rather than focusing on documenting micro-level usability issues (most of these were known from prior usability studies), the point of the UXQ assessment was to understand how the complete platform made people feel during set-up and initial use. To this end, three main types of data were collected. First, rating scales were developed to assess 1) level of satisfaction, 2) perceptions of being in control of the technology, 3) comparison with other similar experiences, and 4) value of the feature. Ratings consisted of Likert-type scales and semantic differentials embedded within a semi structured interview by a trained psychologist. Each of the rating scales was given at breaking points in the set-up process. The interviews were used to bring out more details of how participants were responding during their experience and to set an appropriate tone for participant introspection.

The second aspect of data collection was termed "user experience success." This was based on a professional assessment during participant observation. A pre-defined set of criteria included task times, number of user errors, and required assists. This and professional assessment was used to classify whether the participant had a positive (successful UX) or negative (failed UX) interaction with the platform. The UX success indicator is different than traditional usability-style success/failure rates in that, although participants may be able to complete the task, the main variable of interest in a UXQ study is maintaining a pleasurable experience during interaction with the platform. As a follow-up, exploratory semi-structured interviews were conducted by the psychologist to get an understanding of additional attitudes and emotions that were being experienced and which features participants were responding to.

The quantitative results were aggregated into a dashboard style UX summary. This summary highlighted differences between goals that were set early in development and the measured UX quality of the platform (see Figure 2). As this example illustrates, each of the key features and usages were assigned colors (green, yellow, or red) based on the degree to which they met criteria for the targeted UX dimensions. The particular UXQ dimensions assessed will vary depending upon the UXQ goals targeted (e.g., may include specific targeted emotions or perceptions). In this example the focus was on UX success, attitudes (composite of several attitudinal variables), comparisons to past experience, and the value the user indicated for the key feature.

	Sample Key Feature or Usage	Success	Attitude	Compare	Value
1	Easy set up Wireless Network	75%	5.0	5.3	6.4
2	Easy set up Add a Device	79%	5.7	5.6	6.6
3	Access Media Content	86%	5.2	4.7	6.4

A priori UXQ Goals

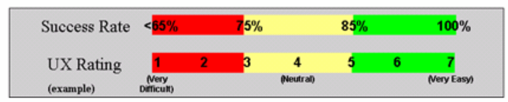

Figure 2: Sample UXQ dashboard against goals

Additional comparisons were made between the Intel platform and competitive usages (see Figure 3 for an example). Figure 3 shows how key features were compared with two competitive usages, C1 and C2. In order to facilitate future goal setting, an overall bar or individual UXQ goals can be set to explicitly consider comparative usages. In this example, the primary uses of these data was for immediate feedback to product developers, for helping to shape marketing messaging, and for setting clear goals (including targeting the right UX dimensions) for the next version of the platform.

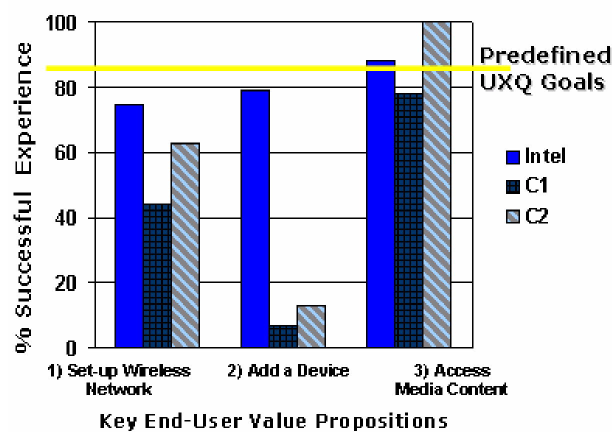

Figure 3: Sample comparison benchmarking data

Example 2: Streaming Video Quality Study

As previously mentioned, end-user perceptual experience is another vector of UX assessment. Perceptual quality is a key aspect of UX that lends itself to setting targets and measuring against these targets. Perceptual targets can be dynamic: the expectations of end-users change over time as technology delivers different levels of quality, and comparison points alter in response to those changes. For example, as the media community shifts from standard-definition to high-definition resolutions, the consumer anticipation of high picture quality increases and this must be reflected in perceptual requirements. There are many elements of human perception in the technology field; including areas of vision, hearing, and touch that can influence an end-user's experience of a given product. For the purposes of this case study the area of vision with respect to streaming video quality is discussed.

Streaming video is the process of sending video files from a server computer to a client computer so that they can be viewed in real time. Traditionally, streaming video has not been designed for use by the average consumer. However, recent advances in computer networking, combined with powerful computers and video technologies, have introduced the use of streaming video into the digital home infrastructure. Unfortunately, there are still limitations due to bandwidth constraints, which typically means that during a streaming session, video files are forced to be transcoded (format conversion) or transrated (bit rate conversion) to a more manageable size. The compression of the video leads to visual artifacts that are commonly displayed as blocking or loss of detail. These transformations tend to result in degraded video quality and overall degraded UX. Delivering excellent quality is a necessity in the highly competitive consumer electronics and PC market.

The following perceptual quality case study was conducted to find the lowest operational transrating level for streaming media associated with an acceptable UX. In addition, this work was intended to provide validation engineers with a calibrated objective tool to estimate the UX in a testing environment quickly, repeatedly, and reliably. In order to achieve these goals two questions were addressed.

1. What is the failure characteristic associated with reducing the bit rate used for MPEG-2 and the corresponding subjective assessments?
2. At what point on the failure characteristic curve do the results have no more return on investment or lowest operational point (what are the platform's video quality targets)?

The experimental design employed three measurement methods to determine the relationship between video quality and UX scores: 1) an expert assessment, 2) a non-expert assessment, and 3) an objective tool output. Video experts have prior knowledge of image compression, familiarity with video, and possess extensive training, practice, and experience in evaluating different technologies. Contrary to experts, non-expert participants are not directly concerned with video quality as part of their typical vocation [15]. The final method used was the Video Quality Metric (VQM), a tool that produces a numerical result that correlates to a set of non-experts' average perception known as a Mean Opinion Score (MOS) [16]. Since the VQM is a non-adaptive "black box" algorithm, the results need to be calibrated with every new format or platform under test.

For these three methods the independent variable was bit rate, defined by the amount of data transferred per second. In general, the higher the bit rate, the better the quality; DVD quality for a standard definition video has an average bit rate of 7Mb/s with a peak of around 10Mb/s. The dependant variable was the MOS value. The subjective assessments used a double stimulus impairment method in which participants were instructed to score their perception of a processed video clip (i.e., reduced bit rate) when shown a reference video clip (10Mb/s).

The study was designed using a standardized methodology verified by the International Telecommunications Union (ITU). A critical part of the experimental design was to properly choose the visual stimuli to be used for testing. For this experiment a standardized sequence of six clips was chosen that encompassed a wide range of video content created to stress the transrating stack for different video conditions. Source video was encoded using the transrating stack and written to the hard drive for playback. A controlled playback system called Video Clarity was attached to a calibrated (color temperature, brightness, and contrast) display [17]. Video Clarity was required for consistent evaluations, because it captures and outputs exactly what it records [18].

All evaluations took place in a semi-anechoic chamber with 50% grey walls, lighting measured to 10 lux, and participants were seated at a predetermined viewing distance to control viewing conditions.

All participants went through a vision acuity (Snellen Eye Chart) and color deficiency (Ishihara Testing Plates) screening [19, 20]. Participants were instructed on the double stimulus impairment method and the five point ordinal impairment rating scale that is typically used to determine failure characteristics [21]. A practice session was also given to familiarize the participants with the testing set-up. Once the evaluation began, the first five trials were discarded to address any learning issues and to stabilize the viewer's opinion [22]. Each session had a unique randomized order of presentation, so that opinions were balanced out.

The significant result is that we were able to differentiate between expert and non-expert when relevant, enabling validation and comparison of subjective results to an objective measure. Thus, we were better able to focus development efforts where they need to be focused, rather than over- or under-designing our platforms and missing the return on investment point.

There are many touch points in a product lifecycle at which performing video quality evaluations can benefit the design teams. One such place is during validation. At this phase, it is most efficient for the engineers involved to have an objective tool to accurately evaluate the video performance during the platform testing phase. This is crucial, since performing subjective assessments would be time consuming, expensive, and probably too late to impact product design prior to release. Using the VQM, validation engineers can get an estimated MOS value that is mapped back to end-users' perceptions.

However, as the subjective assessments have shown, this tool needs to be calibrated for every new video test because it only provides measurements for typical artifacts. If the engineers were to use the tool without calibration, the inflated results would indicate that transrating could go as low as 2Mb/s and be above the true target threshold. This would have created an unacceptable experience for the end consumer. As we've shown here, employing a holistic approach to assessments and drawing on the results of the expert and non-expert assessment, we were able to calibrate the video quality metric tool so that it would work for setting the appropriate performance threshold of the transrating stack. If we hadn't performed the two assessments, we may have passed (with the tool) video that was, in fact, unacceptable. Psychological assessment techniques thus play an important role throughout the development cycle.

This study not only determined the lowest operational level for a specific digital home platform, it also set target levels and changed the validation process by adding correction factors to an objective tool. Implications are clear for setting UXQ perceptual goals as part of larger UXQ assessment to drive end-user noticeable value propositions of platforms. The eventual goal is to roll-up relevant human perceptual data including areas of vision, hearing, and touch that can influence an end-user's experience of a product.

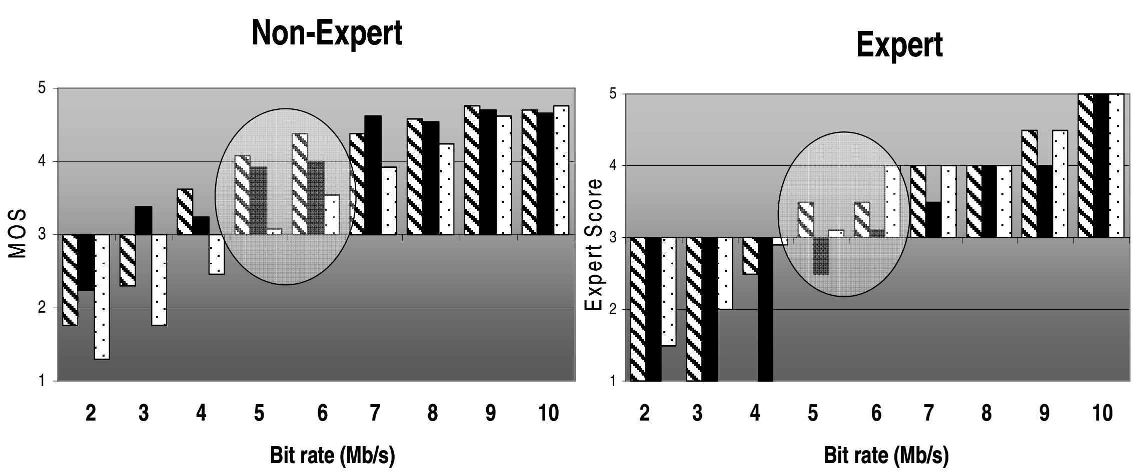

Figure 4: Non-expert versus expert ratings of visibility of impairment introduced with decreasing bit rate

Example 3: In-home Contextual Study

The final case study, a series of contextual in-home data gathering exercises provides an example of an exploratory and qualitative approach to UXQ assessment. Contextual studies provide useful data about how the platform integrates into real home settings. In this example, the main goal was to understand how the digital home platform and connected devices would be integrated into three home settings given the richness and complexity of target market households. We set out to gather anecdotes, photos, and rich information providing insight into the attitudes and emotional responses people have to the technology. The main research questions were these:

1) What are initial expectations and questions people have when they plan to set up the technology in their homes?

2) What are their attitudes and behaviors during set-up?

3) What are their reactions after the first several weeks of use, and how do they change from the initial and set-up reactions?

Three households were selected for participation in the study. Selection criteria were used so that each family would match at least one of the target market segments. Given only three families were used in this study, the results were not meant to be predictive or representative of the target consumer population but rather help identify integration issues with existing technology and other family members. Some characteristics of the three families are described in Figure 5.

Each family was asked to set up and use Intel platforms complete with all parts of the technology that made up the platform value propositions. Families were compensated approximately $300 for integrating the technology into their homes and participating in the study activities. The platform solution provided to participants allowed them to aggregate digital media (pictures, music, and videos) stored on PCs throughout their home for viewing on their TV, using a remote control. The equipment included a PC, monitor, input devices, a surround-sound speaker system, a digital media adapter, and a wireless router.

The procedure involved four main parts. The first was a home technology tour. Photos and notes were taken regarding the type of digital entertainment technology the families had, aesthetics themes, and how media were stored (pictures, music, videos) before introducing the new technology.

Second, in-person observations of the participants while they set up the equipment in their homes were conducted. Key areas of interest included the locations they thought made sense and evidence of the mental models participants had regarding how the technology could be integrated into their other PC and media-related technology. Observations of interaction with the technology in context started with the full "out-of-box-experience" assessment for each component of the equipment. The initial observations lasted about four hours for each household. Data were collected on any trouble the participants experienced, especially focusing on how good/bad the experience was for the participants. Semi-structured interviews, photographs, voice recordings and follow-up probes were used to collect data to understand attitudes and emotions associated with initial expectations and how these were resolved during this early phase of the usage lifecycle.

Figure 5: Participant profiles

UX data were collected across time as participants became more familiar with the platforms. This part of the in-home data collection involved email questions and follow-up telephone calls. Participants were left a series of activities to carry out at their own discretion, and they reported their success (or failure) and reactions via e-mail and telephone calls. The activities prompted participants to use certain aspects of the system and provide feedback. Participants were encouraged to explore all the key features of the platform and provide feedback as if they owned the system.

The final part of the data collection involved follow-up home visits. These were conducted after families had a chance to use the technology for several weeks. During these sessions, participants were asked to demonstrate how they used the systems and asked questions about the impact of the technology on their entertainment choices, daily routines, and social interactions. They discussed issues and what they saw as opportunities that came up along the way. The follow-up interview lasted approximately two hours for each household. As in the first home visits, semi-structured interviews, photographs, voice recordings and follow-up probes were used to collect data to understand attitudes and emotions associated with use of the platform.

Given these were case studies, the results of the home visits were presented to UX owners in the form of anecdotes of experience, photos, and selected clips from the voice recordings. Based on these results, two compelling potential drivers of attitudes to the brand were identified in addition to three potential liabilities. These converged with evidence from prior studies. Several examples of known areas where the user mental model did not match the conceptual design model were identified, and specific examples were described. Finally, evidence of clear gaps in features was used to help prioritize feature requests.

The findings were triangulated with the results of the other user studies to better understand and help "make real" to stakeholders some of the key UX issues with the technologies. Examples regarding key assets and liabilities to the brand messaging were presented, and as a result, changes were made to the platform messaging. Contradictions or gaps related to the users' mental models of the system were also addressed through modification of the messaging. Combined with quantitative dashboard data, the in-depth illustrations of problem areas helped to drive what would have been low-priority recommendations for future basic product functionality.

In-depth illustrations of problem areas, combined with quantitative dashboard data, created new directions for future basic product functionality out of what would otherwise have been low priority recommendations.

DISCUSSION

As consumers are faced with an increasing number of choices in the marketplace, UX has become a key differentiator. In this paper we described the UX assessment program at Intel that moves beyond the traditional technical validation and assessments of usability toward a multi-method approach to better understanding and managing key differentiators involving end-user value propositions.

Over the past five years, Intel has been developing internal expertise in the areas of social science including human factors, experimental psychology, and ethnography. One of the key results is an increased focus on the end-user value produced by a platform approach and a focus on understanding and advancing the user experience.

In this paper, one of Intel's approaches to UX assessment was outlined that highlights the roll of emotions, attitudes, thoughts, and perceptions across the usage lifecycle as well as product development lifecycle. A process was outlined to set measurable UX goals beyond technical validation or usability goals early. Setting explicit UX milestones at key gates in the development lifecycle allows the bigger picture UX to be assessed and checked against set goals, and provides useful visibility of the UX to key stakeholders. The data, both quantitative and qualitative in nature, are used to inform the development of platforms, guide future platforms, create demand, and provide answers to co-travelers regarding unique end-user benefits associated with the platform vision.

By increasing visibility through explicit UX goal setting and measurement across stages of development, not only is UX emphasized as an important organizational objective, but strategies and resources can be better channeled to ensure user-centered design processes are prioritized appropriately relative to other business demands.

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