The Total User Experience - How to make it Positive in Future Wireless Systems and Services

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Objectives (Abstract)

Good usability and user satisfaction are some of the main challenges in future wireless business from the terminal manufacturer and service provider point of view. Technological possibilities of wireless terminals and associated services increases and more emphasis must be put on finding and defining the right product features and feature sets for different customer segments. As this task deals increasingly with introduction of totally new product features and services, and user experiences build up of several components provided by different players, such as terminal manufacturer, network operator and value-added service provider, it is obvious that more traditional usability engineering practices focusing only on certain parts of the system become insufficient. In this paper, we focus on *the total user experience* that extends the goal of good usability to cover all the factors summarized by a user in her/his user experience. This means that all parts of *the experience chain* are recognised. **Our objective here is to help reaching the positive total user experience** by utilising early product and system simulations. We introduce the requirements for an advanced simulation platform for wireless systems and products. Then we describe an implementation alternative for these requirements, and summarise its results in terminal development. Finally, we explain our ongoing work with the simulation platform. Here, we focus on the future terminal features and wider experience chain under the terms ubiquitous computing and communication.

1 State of the art

Usability testing, usability engineering and user-centred design have received a lot of attention since the 1980's. There are several standards focusing both on design processes[1] and specific product areas [2] in this area. However, wireless terminals or applications are not specifically covered in these. Same lack of well-known references is seen also in research paper side. From these facts we can draw a conclusion that usability and user-centred design of wireless applications and devices is still in its early phases in research world.

Simulation and prototyping have been studied and referred a lot in the research world, in software (Boehm 1988, Smith 1991), electronics (Daehn and Müller-Schloer 1996) and mechanical engineering (Haug, et al. 1991). The problem, however, in this area has been that no real combination of these approaches has been implemented in order to reach an extensive simulation providing a realistic user experience for the user. Especially, there hardly exists such combinations to support usability testing and user experience simulation of wireless applications and devices.

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[1] E.g. ISO/DIS 13407 1997 Human-centred design processes for interactive systems, ISO/DIS 9241-11 1997 Guidance on Usability

[2] E.g. ISO CD 9241-9 1996 Requirements for non-keyboard input devices, ISO CD 14754 Common gestures for pen based systems, ISO/CD 9241-12 1996 Presentation of information

2 Backgrounds

Fast progress in wireless telecommunication technology, software, computer and electronics engineering has opened totally new possibilities for mobile terminal manufacturers and wireless service providers. In less than 10 years period mobile phones have faced outstanding improvements both in their features and technical capabilities. If the progress continues even with the half of the witnessed speed, we all can imagine the possibilities of coming wireless technologies in 5 to 10 years. Enabling technologies will offer tremendous possibilities for new product services!

However, when studying even the current business situation in mobile terminal industry, we can notice that the technology itself does not guarantee the success in the markets. As technological competition is very even, and often equalized by laws and standards, like by telecommunication standardization, companies' focus has shifted even more to user interface design, good usability and an appealing appearance. More emphasis is put on issues making product versions desirable and usable within customer candidates. In general, implementing a new product or product features as such may not be the problem anymore. Rather, the problem is often how to form an optimal product variation for different customer segments in international markets. User centred design and usability testing are used in order to tackle these issues, but there are still many aspects left without answers. To summarise, we claim that the demand for higher user satisfaction and good usability overall has an increasing role in present mobile phones business but increasingly so in the future.

3 Challenges of future terminals and services

In the future, the need for even more efficient usability engineering and concept testing practices and methods will become apparent as technology opens totally new product and product featurepossibilities. Some trends that have a clear impact for the development of future mobile terminals and their features in this context are:

- **New UI technologies.** Traditional input/output techniques are extended. Displays will be in colours, bigger and more accurate. However, they are still far away from normal computer screens, which makes them an interesting research topic for man-machine interface researcher (Holmquist 1999). Even light-weight head mounted displays are expected. In addition to these extensions, new technologies will be presented. Perceptual User Interface (PUI) relying on multimodal input and output (Turk 1998) is one of these. Multimodal solutions will use speech and gesture recognition, physiological stimulus, adaptive interfaces and many other techniques to give a user a more natural way to interface with his personal devices.
- **Context aware products:** Context awareness (CA) of the products can make them more clever and usable. In mobile terminals, CA means that terminals can become aware of their own status, user status or their surroundings. The utilisation of CA information opens many possibilities in new products.
- **Ubiquitous computing and communication:** This wide and maybe a little bit hype term will make different devices and systems work together in the future intelligent living environments. Ubiquitous communication means that heterogeneous communication links are used in connecting different entities together. Ubiquitous computing, on the other hand, distributes the intelligence for different computing units. These approaches, indeed, can extend the context aware solutions from single devices to wider environments and as such widen the role of personal wireless terminal to a common remote control device.
- **Value-added services**: The amount of services offered by 3rd party service providers will increase considerably in the future. The role of some service providers, even outside the main network operators, is expected to be so significant that their needs are recognised in terminal design[3]. This means that terminals will include new features designed especially for certain services. Likewise, the huge amount of 3rd party services in itself put pressure to terminal UI

[3] Cf. In Japan this is vice-versa, i.e., strong network operators define many of the features in mobile phones.

features. How to control services effectively? How to select only needed services? How to block out certain services?

In addition to previous trends, there are still some facts that affects considerably to the effective evaluation of the user satisfaction with mobile terminals and services. Firstly, the total user satisfaction is always a summary of elements provided by several contributors. In mobile phone this means that the experience of using a mobile phone is a summary of mobile phone, operator and possible service provider (Fig. 1). In practice, a negative experience may be misinterpreted as a mobile phone failure, even if it is a service provider problem, or vice versa. As the number of possible players in this experience chain increases, the problem of guaranteeing *the total quality* of the user experience will become even more difficult.

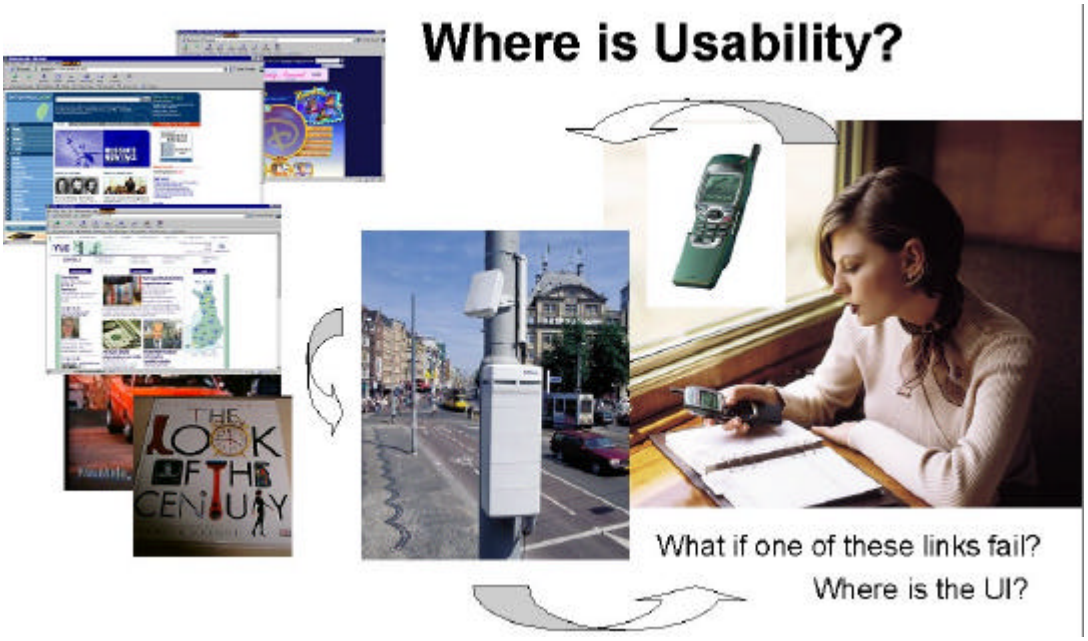

Figure 1. The experience chain of mobile services consisting of terminal properties, operator services and 3rd party value-added services.

Secondly, usability testing has been usually performed to address only certain part of the system. Typically in a way that a user has to complete a set of defined tasks using the given device and the usability is seen as the interaction between the device and the user. Even today there is a need to simplify and concretise these tasks in order to get comprehensive results. But what is usually left out, are the various other factors in the system that are coming more apparent in the future, especially in the case of ubiquitous computing. One reason for that is that there haven't been tools to include all these subsystems into one testing environment without custom made solutions for each case.

4 The challenge of creating "The Total User Experience"

Total user experience is a term that widens user experience. User experience has been seen more as the immediate or short-term implication of viewing at a particular single service or application. Basic idea behind total user experience is that the user is capable of doing what he needs and it is a pleasurable experience. But so, that the definition covers all other services and how they are viewed at the same time and how they are valued over time as well.

Achieving total user experience is a tedious task. Especially, when there are many factors to be taken into account. With mobile terminals product life cycles are getting shorter, more new services are converging into devices, devices themselves are becoming more intelligent and thus crowded, services are coming in from many directions, and software is written by many vendors. In other words there isn't one comprehensive view of the product. If creating one is a challenge, what does it mean for the user? After he has bought the device, how does he get support and help to suit his needs.

How do all the pieces work together? All individual parts have (hopefully) been tested, but the real user is the first person who really has to live with it all together as a system.

Is he happy? Is he happy now and is he happy with his device and all the services after some years? For him it is foremost a device to fill his needs, nevertheless who makes individual components. If the user is happy still after using the device for a long time and smiles out of pleasure every time he has to do something with it, total user experience has been accomplished. He knows what to do and how to do, he is the master of work. But even one glitch from help-desk or poor web support can affect this delicate balance. Total user experience is perhaps not the only goal, it should rather be designed into the whole chain than artificially added. How can this be achieved?

From the business point of view the challenges in reaching the total user experience are manifold. Already, in a more traditional usability testing and product definition phase several questions rise, when terminals are equipped with new technologies and feature possibilities:

- How to implement high-quality user tests with products including totally new features or components?
- How to implement high-quality user tests with products including features or technologies that do not exist yet, but are expected to be realisable soon?
- How to ensure the selection of right features, i.e. the positive acceptance of them, inside specific customer segments, especially, when the features include totally new technologies and solutions.

When extending the view to the total user experience, the challenges come even more demanding:

- How to implement the testing of total user experience provided by several contributors in the basic experience chain covering mobile terminal use with basic and value-added services?
- Is there any means to include also additional phases of the experience chain, like product marketing, user support, product service, etc., in the testing and verifying of total user experience?

5 Heterogeneous system simulation

As a solution for previous challenges we propose a complete product/system testing platform based on heterogeneous simulations, that integrates real and virtual product components to a fully functional product experience. Several simulation environments have been introduced for different applications, however, we have not recognised one taking into account the special characteristics of wireless application domain and focusing on usability testing and advanced user experience simulation. When considering the requirements for the simulation system following can be listed:

- **Extensive product simulation capabilities**: The target product, either single device, service or system, should be possible to simulate so realistically that the user or customer can examine the total quality of the target from the impression given by the simulation system. To reach this goal following features should be simulated:
  - **Visual appearance of the product**. The shape, texture, surface materials and colours of the target should resemble the original source.
  - **Audio properties**. Different sounds, tones, music and voices attached to the object or its functions should be able to be realised.
  - **Functionality of the user interface.** The user interface of the product including displays, lights and mechanical controls, like push buttons and sliders, should be possible to show.
  - **Functionality and behaviour of the product.** The logical and mechanical behaviour of the product should be realisable. Logical behaviour can contain both software and hardware implemented components and features.
  - **External functionality of the product:** External functionality includes connections to and from outside world, and stimulus and functions that are reacted or accessed though hardware or software, but not directly by the user. Examples are network access, value-added services, sensor interfaces, communication with external devices and systems.

- **Support for heterogeneous and distributed simulations:** Heterogeneous simulation means that real, existing product components and tools can be mixed to virtual product components to build executable simulation. Virtual components represent still non-existing or unfinished product components. Distributed simulations should be available to integrate real computing units to a heterogeneous simulation. With this arrangement, for example, a test case of ubiquitous application can take benefit of existing services, like a printer, in a room. In addition, tools should support different simulation approaches, i.e., software, electronics and mechanics, and be able to allow rapid and dynamic changes to the system parts, either in smaller or larger scale.
- **Expandable and open architecture** : Simulation system should be easy to modify for new tasks and cases. It should be easy to add new components to the simulation models. Rapid and easy modifications of product features should be supported. Likewise, components or sub-systems coming from different development environments and relying on different technology approaches should be linkable together with open-interface solutions provided by the system itself or by using standardized interfaces. All the previous requirements are needed in order to make the system adaptive to different applications and technologies.
- **Component based architecture** : The system should have a strong support for component based modelling. This means that different parts of the simulation should be reusable in new cases and between different simulation instances. Support for flexible componentisation provides clear cost saving as existing components can be used easily in new simulations.

5.1 Implementation and results

Nokia Mobile Phones and Cybelius Software have been researching the possibilities of heterogeneous system simulation in terminal business together with VTT Electronics, a part of the Technical Research Center of Finland, since 1997. A simulation system focusing on the requirements given in previous chapter has been implemented and tested in the selected areas of mobile terminal development. The main features of this Java-based tool platform are:

- *Component-based design support.* Different components, such as existing software and hardware components, UI components, external simulation systems and design tools, can be integrated within the environment.
- *Extensive UI simulation.* 2D or 3D presentations, VR-based simulations or physical hardware mock-ups can be used.
- *Heterogeneous and iterative simulations.* Both real product components and simulations can be used. Software simulation components can evolve towards real product components.
- *Expandable architecture*. New tools and features for new design tasks and areas can be easily added to the environment.
- *UI design support.* Both the Graphical User Interface (GUI) and the physical user interface components of the product can be created. With GUI components, the accuracy is equal to the real product components. For example, the resolution of a display can be defined, and the results as UI text, icons, animations can be used directly in real products.
- *Graphical product architecture and behaviour modelling.* Product architecture is modelled with a graphical design notation that describes instances of virtual components and their connections. Likewise, a product's behaviour is built with the hierarchical state machine formalism.
- *Simulation model execution and code generation.* The behaviour model of the product can be executed with different options. For example, the UI simulation type can be selected from the different alternatives given above. Finally, Java classes can be generated from the executable behaviour model.

Promising results have been achieved with the implementation. Some of these are the general support for usability testing and concept definition by executable product simulation, and the capability to

build an integrated product simulation that combines several engineering areas to a single executable simulation model (Kerttula and Tokkonen, 2001).

5.2 Future work and expected results

Currently, our research is expanding from traditional terminal context to new areas where futuristic terminal features are tested. We are also researching heterogeneous wireless environments under ubiquitous computing and communication. Most of the work here, at the time being, is focusing on implementation of the building blocks for various applications, i.e., different components for communication links, sensor interfaces, UI devices, database access, etc. that are needed when extensive simulations are implemented.

In fact, we have an infrastructure ready to incorporate also operator and 3rd party mobile services to a common simulation platform. With this arrangement we are ready to test the experience chain from value-added service providers to different terminal versions and features. This means that integrated pre-testing including device manufacturer, network operator and 3rd party services provider can be realised even in the very early development phases of new products and services.

In addition, we are also studying some of the post-phases of the experience chain. Mainly, this means that we are studying the utilisation of a simulation model coming from R&D to after sales operations. The purpose here is to find out how the same functional product models can be used in interactive user manuals and demonstrations, and as such avoid duplicated work and differences in R&D and marketing material.

Our work with the given issues is continuing, and the first public results are expected in 2nd quarter of 2002.

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