Toward Human Interface Engineering

ASAHI Toshiyuki

Abstract

Rapid progress in IT has steadily been increasing the social need for usability, particularly in the case of the technologies designed for the continual and systematic improvement of the human interface. For this purpose, it is necessary to develop and integrate various element technologies and to systematize them as an effective engineering methodology. This paper is intended to provide an overview of existing usability engineering techniques. It also introduces technical issues that need to be solved in order to construct a more effective methodology and discusses efforts being made by NEC toward this objective.

Keywords

usability, engineering, quantification, human-centered design, consulting

1. Introduction

If engineering can be defined as a technical methodology for creating items that can contribute to the improvement of human life, even when the modeling of the scientific principles and phenomena are not always precise, the human interface is a typical field in which such an engineering type approach is required. This is because, while the social needs for more functions, higher efficiency and more ease of use are becoming more desirable. The human interface therefore deals with what is hard to be modeled in an uncomplicated manner, such as the human senses and behavior patterns, which are deeply involved. It is now required to systematize the new element technologies into an engineering methodology that is capable of dealing with the significant advancements in the inherent snags and diversifications that are represented by "ubiquitous" systems. The knowledge and expertise accumulated through past research and standardization activities will be applied in the dissemination of the methodology in the fields of development as well as in the market.

In the following, we will outline the engineering approach to usability that we have taken up to the present time, the issues identified through it and the framework of "human interface engineering" that we have begun to deal with.

2. What Is Usability

"Usability" is the key concept when considering human interface (HI). Etymologically speaking usability means the "ability to use" but the meaning of the term is not strictly defined and it is often translated in Japanese as "TSUKAIYASUSA (ease of use)," "RIYOU-SEI (availability)," "KAYOU-SEI (capability of use)" or "SOUSA-SEI (operability)." The main reasons that topics related to HI often suggest ambiguity and tend to trouble managers and developers (and ultimately the users) are rooted in the ambiguity of the term "usability" and in the handling difficulties that are caused by it.

One of the definitions of "usability" that is currently being quoted most often is "a model of the attributes of system acceptability" proposed by Nielsen in his book called "Usability engineering" [1] . Here, usability is positioned as a set of attributes determining the usefulness of a system and these attributes are categorized into the five groups of "learnability (easy to learn)," "efficiency (efficient to use)," "memorability (easy to remember)," "errors (few errors)" and "satisfaction (subjectively pleasing)" (**Fig. 1**). The attractive feature of this definition is that in addition to its being arranged into five attributes, usability is positioned at the same level as

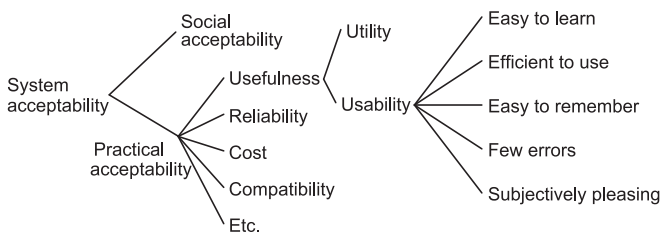

Fig. 1 Nielsen's definition of usability.

"functionality." This supports the claim that usability, which has been regarded as being important but subordinate, should be considered as of the same (or even higher) priority to functionality. This concept is now widely accepted, although some discussion is still current on the details of the model.

On the other hand, in the field of standardization, the most well known standard that deals with usability is ISO9241-11 [2] (JIS Z8521). This standard gives the following definitions.

- **Usability**

The extent to which a product can be used by specific users to achieve specified goals with effectiveness, efficiency and satisfaction.

- **Effectiveness**

Correctness and completeness of task goal achievement by users.

- **Efficiency**

Resources spent for the correctness and completeness of task goal achievement by users.

- **Satisfaction**

Absence of suspicion, a positive attitude to the use of a product.

- **Context of use**

User, task, device (hardware, software and materials) and the physical and social environment of use.

While Nielsen's definition assumes problems that may obstruct the use of the system, or "negative aspects" of the human interface, the ISO definition is wider than the Neilsen's definition and includes "positive aspects" such as effectiveness, efficiency and satisfaction in task goal achievement (Nielsen covers some of these aspects under "utility"). Today, the former definition is sometimes referred to as "Small Usability" and the latter as "Big Usability."

3. Usability Engineering

It is naturally meaningless to simply define usability the key is to improve its application in actual systems and services. The known methodology for this is "usability engineering" as proposed by Nielsen [1] . It is not only significant in that it compiles the per-element approach that has been taken as an experience-based or rather haphazard way under the concept of usability. Above all, it has demonstrated the "possibility and necessity of an engineering-based approach" to the usability issue that has hitherto been regarded as offering only ambiguous or fuzzy effects.

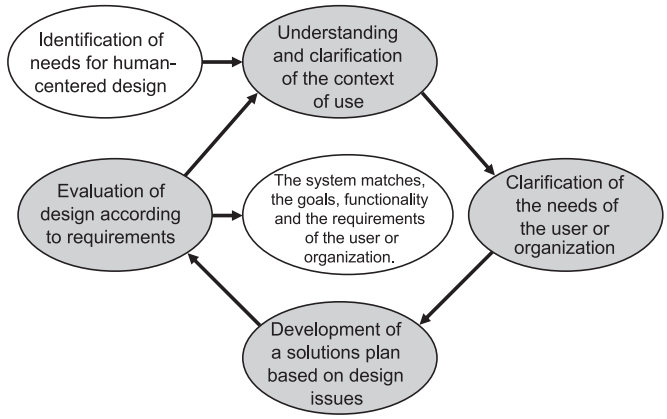

Fig. 2 Human-centered design processes defined by ISO13407.

However, since usability as defined here is the "Small Usability," which deals with the negative aspects of a system, the methodology was also focused on "improving problems." As a result, the "usability engineering" of Nielsen is focused on the introduction of evaluation and analysis techniques, the theoretical background and other development processes being handled only in outline.

On the other hand, ISO13407 "Human-centered design processes for interactive systems" [3] (JIS Z8530) inherits the definition of ISO9241-11 ("Big Usability") and indicates the methodology for constructing systems with higher added values, including those related to effectiveness and satisfaction. **Fig. 2** shows the concept of this standard, which emphasizes the importance of upstream development processes such as the understanding/clarification of the context of use and the clarification of the user/organizational requirements as well as the evaluation. The figure shows that the composition of this methodology is based on a wider range of coverage than that of Nielsen. Nevertheless, with regard to the actual development processes, it merely indicates an outline and does not offer theoretical or specific techniques.

4. Toward the Construction of HI Engineering

4.1 Technical Issues

Today, there is no manager who denies the importance of usability and many methodologies and standardized processes are already available. However, we still have to admit that the human-centered design (HCD) is not sufficiently dissemi-

nated among enterprises, particularly among those in Japan. Apart from the issues related to the management of organizations and human resources, one of the main reasons for this may be the fact that the HCD process is not fully established as an engineering technique. At NEC, we are tackling the establishment of HCD engineering methodology by linking the activities of the HI Center. These are composed of consultations and guideline settings based on assets accumulated through past research as well as by standardization and R&D activities. We believe that targets can be achieved by solving the following three issues.

1) Quantification of Usability

This measure is indispensable in positioning usability as an engineering issue and for improving it continually by involving it in the actual field. However, what is necessary is not an absolute quantification. What is important is to render the projects and development organizations (including design, quality control, design development and sales departments) suitable for sharing a specific image and the numerical targets of usability [4] .

It should not be a simple quantification, but a reliability and theoretical backup that can persuade all. It is also required to clarify the relationship between the quantification results and the impressions felt by the users.

2) Clarification and Detailing of the Product Development Processes

Since ISO13407 defines the processes for HCD, we apply these processes as a basis. However, this standard is a mere definition of the basic framework and concepts, and should be compiled into more detailed, specific processes so that it can be applied in actual development fields. Optimization of processes according to the system, project and customer should also be included.

3) Preparation of Techniques, Tools and Environments

It is necessary to prepare the practical techniques, tools and environments for solving issues 2). These include the usability evaluation techniques that are linked with the quantification of issue 1), common/individual guidelines and techniques for their construction, actual cases and component databases of user interface (UI), UI design/construction environment, and the methodology for systematic creation of advanced UI.

We set “HI engineering” as our research topic and are endeavoring to solve the related issues. In the following subsections, we describe the actual efforts that are being made and the approach that we are taking to systematization.

4.2 NEC’s Program

For issue 1), we are developing a checklist-based quantification technology and preparing a checklist of JIS and other guidelines for this purpose. The checklist distinguishes universal items and system-specific items clearly to enable flexibility of application to other systems. In addition, it applies the AHP (Analytic Hierarchy Process) technique to enable adjustment of the importance of each item according to the purpose of the evaluation. At present, we are verifying practicality on web systems and mobile terminals and also conducting a joint experiment with a university to see how far dependency on individuals may be reduced. For details, please read the paper “For Usability Quantification” on pages 33 to 37 in this special issue.

For issue 2), we have implemented the ideas of ISO13407 into a specific development procedure for the field of systems development (UI Design Guide) and are verifying its practicality and effectiveness by incorporating it in SystemDirector Enterprise, the SI standard of the NEC Group. We are also planning to refresh its content by reflecting field data and to expand its application to other systems. For details of these activities, please read the paper “SystemDirector Enterprise Development Methodology: a Human-Centered Design Process” on pages 12 to 16 in this special issue. In addition, we are also collecting the know-how for usability improvement and accumulating UI techniques and component data for use in the construction of UI environments for the future.

4.3 Research Approach

As discussed in 4.1 above, the true dissemination of the HCD process needs specific, detailed implementation as well as systematization as an engineering methodology. We believe that, for this purpose, it is necessary to develop and prepare adequate theoretical backup, basic models, HCD development processes and common guidelines as higher-level concepts (**Fig. 3**). The low-level concepts that are to a certain degree system-dependent are; individual guidelines and their construction technologies, the usability quantification method and its evaluation technology, appropriate tools, UI components and construction environment as well as a range of consultation expertise.

Systematization of the HCD methodology requires a mechanism for guaranteeing its legitimacy and validity and for improving its inherent reliability. This is because, even when

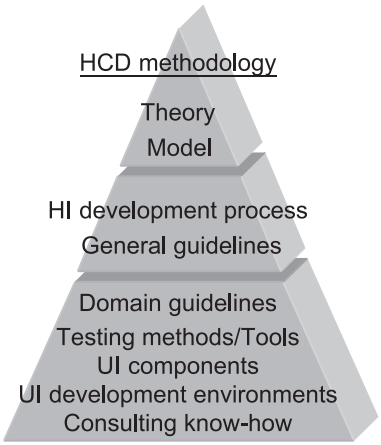

Fig. 3 Systematization of HCD methodology.

Table Approach for construction of HI engineering.

HCD methodology	Center activities (Consulting)	R&D	
		System aspect	Human aspect
Theory, Model		Framework construction, Basic model construction	Concept/basic model construction
HI construction process	Practice of HCD process	Systematization of HCD process	Related user behavior
Common guidelines, Individual guidelines	Guideline development	Automation of guideline construction	Model construction
Evaluation methods, Evaluation tools	Practice of evaluation, Demonstration of effectiveness	Quantification technique construction	Clarification of the psychological mechanisms of usability characteristics
HI construction support environments	UI components accumulation	Platform development for HI construction, Advanced UI construction	
Consulting know-how	Accumulation of know-how		Field study

it is capable of evaluating system usability and of quantitatively predicting the quality level and improvement effect achieved by it, it is hard to spend certain costs for applying the improvements proposed by it unless the developer or user cannot be confident of satisfactory effects. From the viewpoint of sales, the confidence is also required for sales engineers to explain the advantages and disadvantages of a system to customers.

We think that a complementary approach composed of both system and human aspects is effective for guaranteeing confidence (see **Table**). It may be for example that the psychological mechanism by which the user forms an impression via the use of a system can be clarified in the process of development of the quantitative evaluation technique. If this is so, we would be able to utilize the mechanism in verifying the validity of the evaluation method as well as in presenting the evaluation method in a persuasive way. Since it is expected that this kind of research necessitates cultural science-type research methodology and experiment techniques as well as study of the system aspect, we are planning to build an interdisciplinary, open joint research system.

5. Conclusion

In the above, we discussed advanced research issues of the engineering approach to human interfacing, the technical issues to be solved, and the "HI engineering" research activities recently began at NEC.

Although this field (including e.g. quantification of usability and definition of the HCD process) is not a particularly new one, the achievements of the past cannot be regarded as being disseminated sufficiently widely, possibly for the following reasons.

1) The effects were limited to the equipment or systems that were set as the research targets.
2) Practical techniques and tools were not fully available.
3) The basic theories and models were not available for backup.

At NEC, we are targeting the construction of a practical, universal and reliable engineering methodology by closely linking the research activities of the HI Center and by emphasizing the human aspects. We are eager to see that our achievements are disseminated widely throughout industry in order to enable all to use it freely.

References

1) J. Nielsen: "Usability Engineering GENRON (Principles of Usability Engineering) " translated and supervised by Toshikazu Shinohara, Toppan Printing, Co., Ltd., 1997
2) ISO9241-11: http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=16883
3) ISO13407: http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=21197
4) Hirasawa: "Software KAIHATSU NI OKERU Usability KOGAKU (Usability Engineering in Software Development)," Journal of IPSJ, Vol. 44, No. 2, pp.136-144, 2003.

Key Technologies

Toward Human Interface Engineering

Author's Profile

ASAHI Toshiyuki
Senior Principal Researcher,
Common Platform Software Research Laboratories,
NEC Corporation
Member of the IPSJ (Information Processing Society of Japan) and
HIS (Human Interface Society)