Mission of the ICT Design Center

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Abstract

This article reviews human-centered design and introduces the activities of the ICT Design Center (IDeC) of NTT Cyber Solutions Laboratories, which is striving to create user-friendly information and communications technology (ICT) services by utilizing various techniques of human-centered design and cognitive psychology.

1. Introduction

It is great to produce easy-to-read manuals that guide users without confusing them, applications that provide an enjoyable experience, and operating manuals that significantly minimize the possibility of human errors. How can we achieve these goals?

One of the criteria used for evaluating products and services is the quality of experience (QoE) [1]. Users have various feelings when they use products and services such as being happy or bored. When the feeling is positive, the QoE of the product or service is considered to be high. Two products with the same set of functions may have quite different sales volumes because of differences in their QoEs.

The QoE of a product or service is determined not only by the experience of using it but also by the purchasing process, packaging, and manual. In particular, user experience from opening a product's package to its first use (called the out-of-box experience) affects the QoE significantly. Making this experience smooth and pleasant increases the QoE and decreases user support costs [2].

Usability is the concept of how easy-to-use and user-friendly a product or service is. Nielsen, one of the masters of usability studies, defines the elements of usability as learnability, efficiency, memorability, errors, and satisfaction [3]. Steps needed to improve the QoE and usability include analyzing users' thoughts and behaviors, identifying problems and their causes (evaluation), and consequently improving the design (improvement).

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Network maintenance technicians use well-structured operation manuals that include a lot of know-how gleaned from a long history of consideration. The manuals help to reduce human error. To reduce the error even more, we can utilize knowledge discerned through cognitive science. For example, by measuring the cognitive load (number of items that a technician must take care of at the same time) in each step of the operation, we can identify operations that require too much attention. In this case, the two steps of evaluation and improvement, are important.

Human-centered design is a design philosophy focusing on human thinking and behavior [4], [5]. This concept can be applied to improve various business procedures as well as the usability and QoE of products and services.

The ICT Design Center (IDeC) of NTT Cyber Solutions Laboratories is striving to create user-friendly information and communications technology (ICT) services by utilizing various techniques of human-centered design and cognitive psychology. This article reviews human-centered design and briefly introduces IDeC's activities. More details of specific activities are given in the other Feature Articles on this theme.

2. Human-centered design

It is essential to know human characteristics in order to use the human-centered design process (**Table 1**). For example, knowing the user's behavior and the underlying psychology in depth is important in order to respond appropriately when a user claims that a service or product is hard to use.

The general procedure of human-centered design is

Table 1.   Human characteristics.

Human attributes	Explanation	Examples of problems in human interface
Perception	Sight, hearing, touch, etc.	Display is too small, bad audio quality, slippery knobs.
Cognition	Comprehending things, e.g., understanding that clicking a button on a web page loads and displays another page	A button on a web page may not be well recognized as a button if the design is done poorly.
Body	The structure and size of the human body, e.g., finger size	A button on a control panel is hard to press if it is too small compared with the size of the finger tip.
Emotion	Emotion from the experience of using a product or service: fun to use or not	The design of the product is unfriendly or unattractive.

shown in **Fig. 1**. The first step is to identify the problems in existing products and services or in early-phase prototypes. For this purpose, user behavior observations and interviews targeting usability are commonly performed. Once the problems have been identified, the designers think of solutions and a prototype is made. Next, the prototype is evaluated and it is determined whether or not the problems have been solved. If the results are unsatisfactory, the designers must return to the solution-creation step and make a new prototype (repeating the design cycle).

The choice of evaluation methods used in the problem-identification and prototype-evaluation phases is important. In human-centered design, it is fundamental to study and analyze user behaviors and the thoughts behind them precisely.

The human-centered design methodology has been developed most actively in the design areas of home appliances and office equipment. It can be applied to various work process improvements. For example, replacing "existing products and services" in Fig. 1 with "network troubleshooting procedure" yields the following process: first, observe a network technician trying to fix a problem with an existing operation manual; it is then possible to improve the identification of problems and points in the procedure, improve the manual, and improve the manual's evaluation. The important point is to trace the technician's thoughts step by step in order to identify what caused the problem.

3.   Methods for studying and analyzing human behaviors and thoughts

Many methods have been proposed for studying and analyzing the behaviors and thoughts of people using products and services. It is important to choose the one best suited to the purpose of the analysis [6], [7]. This section briefly introduces some of the meth-
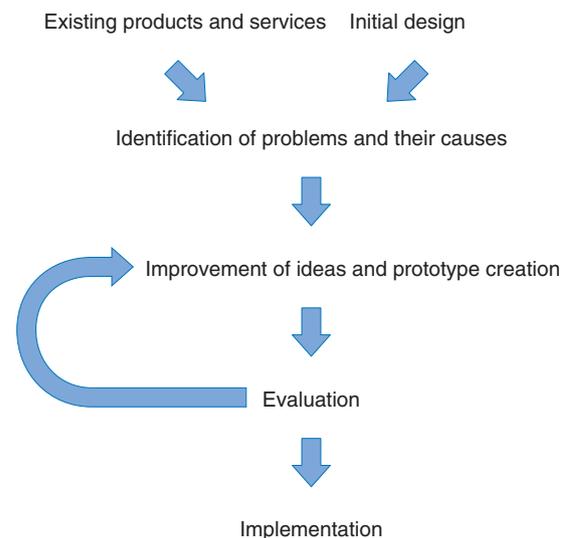
Existing products and services   Initial design

Identification of problems and their causes

Improvement of ideas and prototype creation

Evaluation

Implementation

Fig. 1.   Procedure of human-centered design.

ods. Note that the users who participate in the study and analysis are called *subjects* here.

3.1   Research and analysis methods for problem-identification phase

Imagine that you have a vague feeling that the QoE or usability of a product or service needs to be improved (perhaps on the basis of user feedback that it is hard to use), but you do not know what the real problems are or where they lie. In such cases, you first need to identify the real problems and their fundamental causes. This is called the problem-identification phase.

(1)   Observation

Observation is a powerful tool for finding the problems and causes of poor usability in products and services. If possible, you can record such scenes on video and analyze them in detail afterwards to get
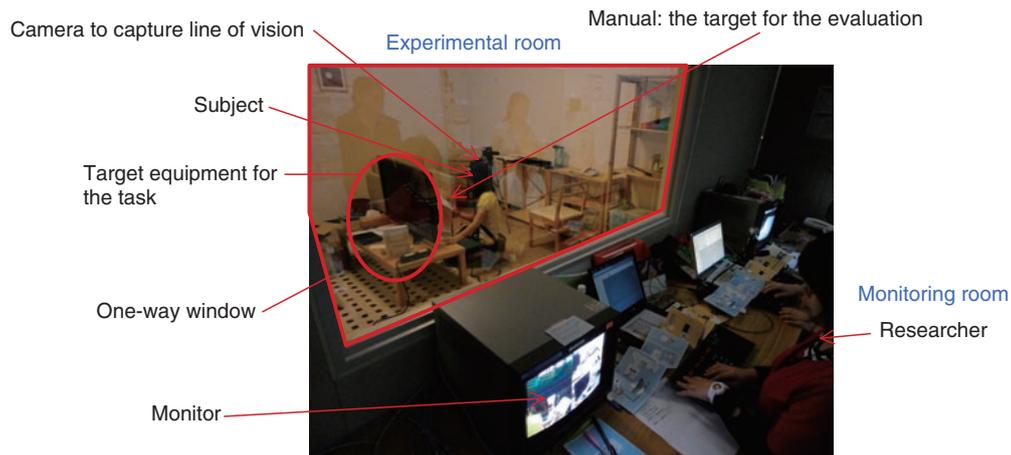
Fig. 2.   Configuration of usability lab.

better results. To analyze a subject's thoughts directly, we sometimes ask the subject to say what he or she is thinking at each moment (*speak aloud* method). Observation is done either at an actual place of use or in a usability lab. An example of a usability lab is shown in **Fig. 2**; here, the task was to evaluate the manual for setting up an IPTV (Internet protocol television). Observational methods allow us to find problems that are hidden in the subject's unconscious behavior.

(2)   Interviews and questionnaires

Interviews and questionnaires are commonly used in usability testing to identify problems and their causes. It is easy to find superficial problems by a simple analysis of the results. However, to find fundamental and hidden causes of the problems, it is necessary to analyze in depth the interview scripts and the free descriptions submitted as questionnaire results.

For example, using the grounded theory approach, we first break scripts down into sentences and words and then find the relationship among them. Thus, we can comprehend the transitions in the subjects' thoughts at a deep level and find the fundamental causes of the problems.

(3)   Evaluation by usability specialists

Usability specialists perform a heuristic evaluation using a checklist that consists of known and common causes of misunderstanding, misdirection, and misoperation. This method is mainly used in the early phase of prototyping to identify superficial problems with usability.

3.2   Research and analysis methods for evaluating prototypes

Once the problems have been identified and you come up with a solution, you then need to evaluate its effectiveness. When you have multiple solution candidates, you need to measure the effectiveness of each solution to choose the best one. In these cases, quantitative evaluation methods are used.

(1)   Subjective evaluation

Subjects grade the usability and performance using multiple levels (e.g., five) to grade characteristics such as response speed.

(2)   Objective evaluation

Subjects perform tasks using an improved target product or service. By measuring the task's success rate and the time taken to complete the task, we can quantitatively compare the effectiveness of different improvements. The quantitative data are processed by using statistical methods. For example, when we performed subjective tests on two interface design candidates, one candidate had a slightly higher average score than the other. To determine whether the former candidate is really better, we can use the t-test (a commonly used statistical method) to take into account the number of subjects and the dispersion of the data.

4.   IDeC activities

IDeC is studying the methodologies needed to implement the human-centered design concept and improve the QoE of the products and services of the NTT Group and to improve the group's work
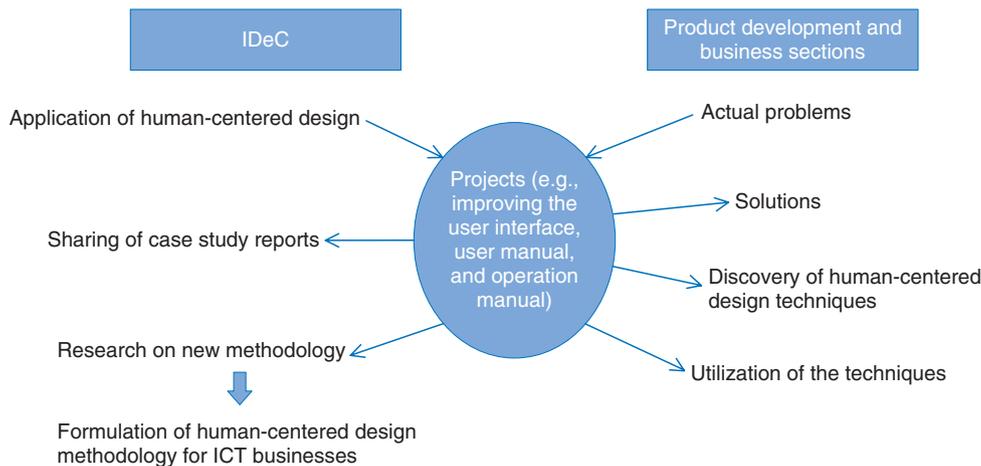
Fig. 3.   Activities of IDeC.

processes (**Fig. 3**). Its main activities are to provide solutions and support for common problems in the NTT Group and to provide consultation for specific problems in work places. For the former purpose, it studies common problems in the diverse areas covered by NTT and provides solutions. Some examples of such solutions are popularization through the use of universal design for web applications (web accessibility) and a tool for checking this and related consultation and producing design guidelines for various human-machine interfaces [9]. IDeC provides consultation to resolve specific QoE problems, improve usability, and reduce human error. For example, one project aimed to improve the user manual for home gateway replacement, as described in the third article in this set of Feature Articles [10].

5.   Concluding remarks

The Feature Articles on this first theme introduce the concept of human-centered design and the direction of NTT's research and describes four examples of the application of human-centered design. The authors hope that these examples will let readers better comprehend the human-centered design concept with a view to applying it to their own ongoing or future development projects.

The ultimate goal of IDeC is to reach a state where the human-centered design process and techniques are commonly used in every region of the ICT industry. In 1999, an international standard for human-centered design was established [11]. Unfortunately, the current human-centered design processes and tech-

niques are not very easy for beginners to utilize effectively and get desired results. In particular, there are few examples of their use in ICT.

IDeC continues to contribute by developing human-centered design methodologies suitable for ICT businesses and by expanding their deployment in the business sectors to support QoE enhancement activities.

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He received the B.S. and M.S. degrees in electrical engineering from Chiba University and the Ph.D. degree from the University of Tokyo in 1982, 1984, and 1994, respectively. Since joining Nippon Telegraph and Telephone Public Corporation (now NTT) in 1984, he has been working in R&D of videoconferencing systems. In the late 1980s, he actively contributed to ITU-T SG15 in making the H.261 video compression standard. In 2001, he started a web conference business called MeetingPlaza at NTT IT and led the business until 2007. From 2007 to 2011, he was the project director of the Human Interaction Project in NTT Cyber Solutions Laboratories, where he led research on human-centered design, video applications, IPTV applications, and digital signage. He currently leads the business of various video processing applications at NTT IT. His work "Exploring Edo", a computer graphics (CG) simulation of Edo on a shared three-dimensional virtual world platform called InterSpace, received a prize at Dream Centenary CG Grand Prix '99 in Aizu, Japan. He is a member of IEEE, the Institute of Electronics, Information and Communication Engineers (IEICE), and the Institute of Image Information and Television Engineers.

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