

# Research Trend of HCD in Fujitsu and Prospects for Innovation Design

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Fujitsu Design has consistently practiced Human-Centered Design (HCD), HCD methodology based on conducting user research and investigating requirements. As we are now in the age of cloud computing, we need to extend our domain into design activities that focus on society and the global environment. It is important that we consider why our products and services are needed, and whether or not they do any "good" for society. Therefore we will design them based on an evaluation of their benefits and influences on society. This paper first outlines the trend of research on HCD, practiced along with the development of information and communications technology (ICT), by presenting the methods and processes established up to now from four aspects: hardware-based HCD, software-based HCD, universal design and HCD, and ubiquitous computing and HCD. Then, it discusses Social-Centric Design (SCD) that studies designs from a social point of view, and describes new design processes integrating HCD and SCD.

## 1. Introduction

Since the advent of mainframe computers in the 1960s, information and communications technology (ICT) has made contributions to the improvement of productivity of enterprise activities by enhancing processing capacity on a daily basis mainly with large computers. In the 1990s, the Internet rapidly became widespread, which has allowed various information processes to be conducted via networks, resulting in bringing about innovation in business processes. Subsequently, dramatic technological innovation has continued and migration to cloud computing, which provides computing capability as a service, is accelerating now. The environment surrounding ICT is undergoing rapid change as exemplified by the start of a new service business that makes use of the big data collected in the cloud (**Figure 1**). Having gone through such technological change, Fujitsu is moving ahead with research and development of ICT in response to the demands of users and society with the aim of realizing a Human Centric Intelligent Society. After the experience of the Great East Japan Earthquake, activities toward a safe, secure and sustainable society have also accelerated and expectations seem to have been raised for handling of social issues that are increasingly

complicated on a global level such as disaster control, security measures and response to global environmental issues.

With this situation in the background, Fujitsu Design has consistently carried out activities for Human-Centered Design (HCD), which is human-oriented design development based on study of human factors. In the course of these activities, the scope of design objects has also increased to include "services" and "experiences" in addition to the initial "products." As a result, the content of studies, methods, and processes of HCD have also expanded and deepened. As we are now in the age of cloud computing, we regard it necessary to extend our domain into design activities that focus on society and the global environment.

This paper summarizes the past transition of HCD and discusses Social-Centric Design (SCD) that sees design from a social point of view. It goes on to describe new design processes integrating HCD and SCD.

## 2. Transition of HCD

In relation to HCD that Fujitsu has practiced up to now, this section recaps the activities carried out and the methods and processes established up to now from four aspects (**Figure 2**).

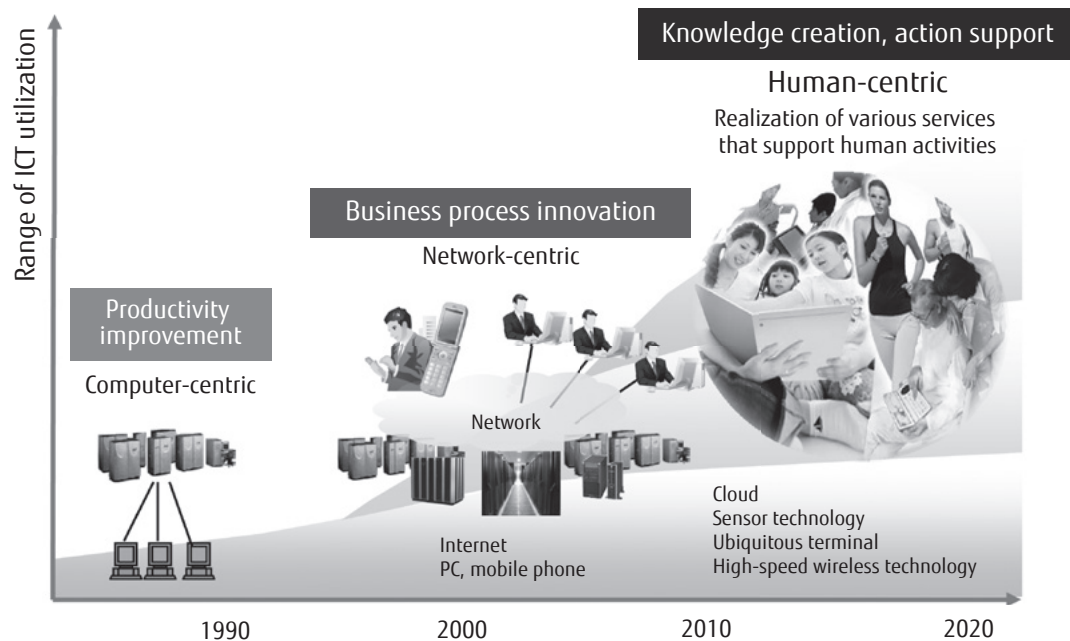


Figure 1  
Transition of ICT.

#### 2010 – HCD in age of cloud computing

- Age of cloud computing with remarkable ICT technological innovation
- Use of ICT promoted for realizing sustainable society in view of endurance of earth, safe and secure society and vigorous and affluent society
- Consideration must be given to people in developing countries as well as those in developed countries in future society
- For that purpose, "SCD integrated into HCD" is used to study ideal of ICT

#### 2002 – Ubiquitous computing with HCD

- Age of ubiquitous computing realizing information exchange "anytime, anywhere and with anybody"
- Consideration of ICT use from life and work perspective taking on importance in age of ubiquitous computing
- For that reason, ideal of ICT studied in "vision-oriented HCD process"

#### 1997 – Universal design with HCD

- Universal design of devices and environment seen as challenge with ICT accessibility posing social issue
- Development of laws progressed for correcting digital divide and encouraging universal design
- To that end, ICT design development promoted based on "HCD in consideration of universal design"

#### 1986 – Software-based HCD

- Devices black boxed and display screens provided for operation
- Ease of view of display indications and ease of understanding of operations became challenges
- HCD of user interface, GUI design, operation procedure, and such like pursued

#### 1980 – Hardware-based HCD

- Operation tools and systems designed based on human body measurements and work areas
- Comprehensive study conducted including operation and environment such as visual and acoustic environment and fatigue issue
- Promoting both the ergonomic study of VDT issues and ergonomic study of hardware

Figure 2  
Transition of HCD.

## 2.1 Hardware-based HCD

From the second half of the 1970s to the 1980s, we mainly conducted HCD research for hardware in ICT. Ergonomic pursuits and their application to products have been practiced. They include optimization of the dimensions and arrangements of computer devices and consoles based on human body measurements and human work areas. They also include improvement of shapes of operation tools, development and practical application of adjustment mechanisms for display devices based on the field of view and visual characteristics, and pursuit of visibility of display screens by reviewing the size and contrast of the on-screen text display. In the course of these practical activities, we have established an HCD methodology and processes that combine the pursuit of operability with the focus on human shapes, physical characteristics, visual characteristics and acoustic characteristics, and shapes and arrangements of hardware with an excellent aesthetic appearance of devices.

With the introduction of visual display terminals (VDTs) in various work sites including offices, in particular since the middle of the 1980s, we have conducted ergonomic studies on VDT work. In 1983, we established an organization dedicated to these studies and launched a systematic approach to improved operability of VDT devices and started handling customers in relation to VDT work. During these activities, we implemented research and development to address various environmental challenges such as issues with lighting and noise of offices and shops as part of the scope of HCD.

Through these practical activities, we have systematized factors related to ease of use and created HCD guidelines for the functional and aesthetic design of devices to work on the establishment of an HCD methodology for computer hardware.

## 2.2 Software-based HCD

From the second half of the 1980s to the 1990s, word processors and photocopiers became widespread in offices, a variety of automated machines (such as ticket machines at stations and ATMs at banks) were installed in life spaces, and devices equipped with displays and keyboards came to appear in various scenes of work and life. At the same time, software was integrated into all devices and intellectualization and black

boxing of ICT products progressed. As a result, software came to account for a very large part of the user interface between a device and a human.

For that reason, how to offer user-friendly user interfaces to general users without deep knowledge of software became a major challenge for HCD. Practical examples at the beginning of this effort include designing icons with improved visibility and recognizability, and having a screen design that supports understandability and operability of application software, the graphical user interface (GUI). In addition, design came to be conducted to achieve easier-to-understand interactions for software screen sequences by organizing the context of interactive screen information, simplifying the interaction steps, changing the overall interaction patterns, and sometimes designing interactions to given displayed information. Furthermore, recognizability and effect of sounds generated during user operation were also researched and analyzed, including musical scale composition, tone color and volume studies.

Based on these practical activities, we have established an HCD methodology and processes for designing easy-to-understand user interfaces realized by software to suit human visual, acoustic, and cognitive characteristics. In the process of pursuing ease of understanding, we also worked on applied research on cognitive science and peripheral sciences and studied protocol analysis and human mental models. The outcomes of this work have provided the basis for the establishment of a scientific evaluation technique for user interface design. With the development of the GUI design process, operation sequence design method, and evaluation technique, we have moved forward with the establishment of an HCD methodology for computer software. This research on user interface is still a core subject of HCD.

## 2.3 Universal design with HCD

In the second half of the 1990s, standardization of accessibility started mainly in the West. Until then, HCD had been conducted with the focus on able-bodied people but achieving HCD for disabled and elderly people became important as well. In the U.S., movements for creating an accessible society became active as shown in the enactment of the Section 508 Amendment to the Rehabilitation Act of 1973.<sup>1)</sup> As

if in concert with overseas movements, the e-Japan concept was announced by the Japanese government in 2000 and "correction of the digital divide"<sup>2),3)</sup> was set forth as one of the important policies. The IT Basic Act<sup>4)</sup> was enforced in 2001 and the Basic Programme for Persons with Disabilities was announced in 2002.<sup>5)</sup> At the same time, public institutions were instructed to select products in consideration of universal design when procuring fixtures and facilities, and criteria for that purpose were established. In 2004, the Basic Act for Disabled Persons<sup>6)</sup> was partially revised and, since 2004, the universal design standards<sup>7)</sup> for products and services have been established by the Japanese Industrial Standards (JIS).

In response to such movements in Japan and overseas, Fujitsu has come to pursue universal design of ICT. We have studied case examples relating to universal design in other fields and classified various types of disabilities based on the characteristic study to create guidelines for universal design and developed design methods. In addition, we sought the participation of persons with disabilities as development team members and engaged in actual design development together. We thereby carried out development that included having an essential understanding of the problems with the development and application of solution ideas and their evaluation in a user-oriented manner. Based on their outcomes, we have established the "problem-solving HCD process in Fujitsu," a design process in which user oriented design development is done together with users.

By systematizing these guidelines and study processes, we have established an HCD methodology for universal design. We also applied this methodology to product development and Website construction, including the universal design for Websites and development of evaluation tools for them, universal design for ATMs and the development of the Raku-Raku Phone. In this way, we have made contributions to business and improved the universal design presence of the Fujitsu brand.

## 2.4 Ubiquitous computing with HCD

In the 2000s, the concept of ubiquitous computing came into the spotlight along with the full-scale diffusion of the Internet, PCs, and mobile phones. Unlike the conventional computing world centered on

large computers, in the age of ubiquitous computing ICT has come to be present in various parts of society. It is a computing world in which information can be exchanged "anytime, anywhere, and with anybody" became a reality and the ICT paradigm underwent a sea change.

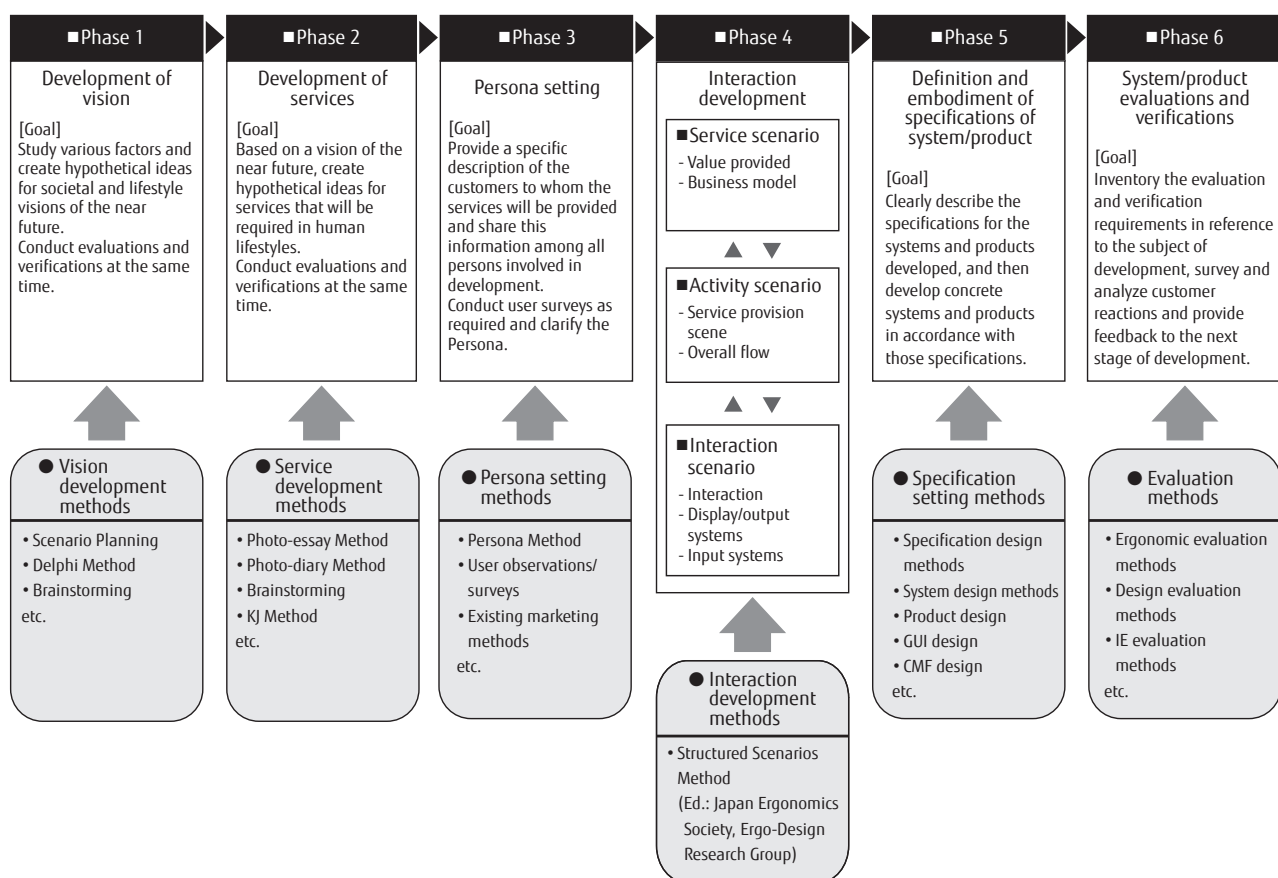
For that reason, HCD also significantly changed. It has become essential to create a vision of how to make use of ICT in various scenes of work and life. We decided that, rather than devising products and services from ICT, it would be important to have a "vision proposal-based" HCD development, in which developers consider how ICT can serve human life in a human-oriented way and in view of future human life, to visualize ICT services and products. Services and functions provided by ICT are visualized, the images of users who use them are defined, usage scenarios of the services and functions are set, human activities in the scenarios are visualized and the specifications of the interactions and products that embody the activities are conceived. This kind of Vision proposal-based design process should be adopted instead of conventional processes. As a new HCD methodology and process to that end, we proposed "service-oriented design process" (Figure 3) in 2008, and it has been used in various design development projects up to now.<sup>8)</sup> In 2010, we announced a specific HCD methodology for ubiquitous products (such as PCs and mobile phones) that are located at the front line of ICT and utilized by users on a daily basis.<sup>9)</sup> These HCD methodologies feature consideration of user value from a macro perspective for the development of ICT systems and products. In this way, we have successfully established HCD methodologies for embodying products and services intended for the next generation.

## 3. HCD in age of cloud computing

In the 2010s, ICT has made further advancement, sophisticated networks and data centers have been built and the age of "cloud computing," in which computing capability is offered as a service, has arrived. Meanwhile, with things coming to fill the life space of people, users' consumption awareness has shifted from things, and value is now sought in new experiences.

### 3.1 Provision of new experiences by ICT

In the cloud computing society that is well underway, it is important to utilize big data accumulated



**Figure 3**  
Service-oriented design processes.

in data centers to offer new values and experiences for work and life. Enterprises are obliged to propose new services and information processing systems that did not exist in the past. However, users have both a latent desire and a critical eye for utilization of ICT services, and tend to make a severe evaluation with the focus given to the value gained by services and value of experiences. For that reason, there is a risk that new services and systems proposed by enterprises may prove irritating. In order to offer experiences in which users find value, the key will be whether or not users' intrinsic desire can be accurately understood, and whether really useful services and information processing systems can be provided.

### 3.2 Sophistication and complication of problems to solve

In the cloud computing society, people are connected with each other in the digital world and

opinions come together, and these experiences are beginning to become powerful. Information gathered in the cloud across the borders of countries and regions has significant influence on the formation of trends and senses of value, and a dynamic age has arrived in which the slightest difference may bring about a significant change, as in chaos theory. Various phenomena in the world influence each other and have come to be interrelated, and this has made the problems to solve more sophisticated and complicated.

### 3.3 HCD challenges in cloud computing age

In this situation, we think that provision of highly satisfactory experiences and new values requires HCD methodologies to be expanded from the following viewpoints.

First, because of the increasing sophistication and complexity of problems to solve, human resources with a wide range of expertise must be gathered to form a

team with a variety of members, rather than creating new visions and solutions with a team composed only of designers, to work on design development.

The second point is that today's fierce enterprise competition demands high-speed development. The design and evaluation phases must be carried out rapidly for proposing services and experiences in a short time that are satisfactory to the users. For that purpose, the introduction of agile development processes into HCD development is necessary.

Third, design in view of sociality and impact on the global environment must be created. Utilization of ICT should no longer be directed only at pursuing economy or efficiency, but multilateral consideration of how ICT should be from a social point of view is important, and this may include the relationship with local communities, issue of ties and communication between people and maintenance of the future global environment.

As the fourth viewpoint, a service must be available in the same way to anybody who desires the service in the future society. However, users who receive services may be very diverse and their situations of use may vary. It will be important to offer user interfaces and products for the use of services, in a manner best suited to the characteristics of users and their situations when using the services. For that reason, we believe that future HCD will need to study "a system to provide ICT services with user interfaces that suit the users' characteristics and situations of use."

## 4. Construction of new design processes

Rapid creation of next-generation visions to address various challenges that are increasingly complicated on a global scale requires an approach that brings about innovation, not an approach that is an extension of the conventional technique. To that end, we think that the existing HCD must be expanded with new methods and processes.

### 4.1 Integration of SCD

We wish to realize an affluent life and a safe, secure, and vibrant society supported by ICT for people around the world to achieve a universal ICT society that transcends countries and regions, culture and experience, and disabilities and gender. To do so, we must carry out design activities for evaluating, studying and

gaining a real feeling of the impact of new ICT on society in advance. In addition, methods and processes for evaluating and verifying the significance of the created vision in society will be necessary. This activity is called Social-Centric Design (SCD) and integration of this SCD with HCD for design development will be important.

As described above, provision of ICT services and products with convincing essential usefulness will be important. For that purpose, we consider it necessary in the initial stage of creating a vision to clearly define the "goal" of a project and introduce methods and processes that allow thorough study of the target user's intrinsic demands.

### 4.2 Construction of new design processes

Based on the past study, we have constructed a "vision-oriented design process in Fujitsu" with the conventional "service-oriented design process" enhanced with four points:

- 1) For that purpose, a "co-creation process," in which thorough discussion is held with users and various stakeholders, is introduced in the upstream process of development. In addition, use of "Future Session" and "World Café" as a means for accelerating discussion and gaining more in-depth knowledge is under consideration. Furthermore, a suitable location for practicing vision development is necessary. We think that a space provided with a means for getting the participants in the best mental and physical condition for discussions while referring to past examples, is required.
- 2) A process of thoroughly assessing the value of the created scenario in advance is also necessary. Specifically, things such as whether the scenario really has value for users or provides enterprises with value that are worth doing business for should be evaluated. Methods and processes for complete evaluation of the value of a created vision must be introduced.
- 3) A process of evaluating the sociality of a created vision will also be necessary. That is, methods and processes for evaluating various aspects of sociality including the influence of the vision to be provided on society and user community, and impact on the global environment must be introduced as well.



- 4) In addition, for rapid execution of agile development and prompt implementation of accurate development, prototypes of the service or product created must be built in a short time to conduct user evaluation and give feedback to the development. In other words, we consider it necessary to introduce "evaluation and verification by prototype" in a timely manner for building a process that allows running of the development and evaluation PDCA cycle at a high speed.

## 5. Conclusion

This paper has described the background of the deployment of HCD in the ICT field and expansion of HCD methodologies that integrate SCD to accommodate the age to come. By expanding HCD methodologies in this way, customer value that provides the source of competition in the next generation can be identified, and user-friendly and sustainable products and ICT services can be developed. In addition, the development acceleration and cost reduction can be expected and, at the same time, ICT for the "social good" can be developed that revitalizes society and communities, and contributes to maintenance of the global environment. We believe that, by implementing such design development, we can bring innovation to enterprises. To ensure an active and affluent life of people in the future society with highly advanced ICT, HCD methodologies for research and development of "products" and "experiences," from the pursuit of human factors to a human-oriented way will be increasingly important. Furthermore, integration of SCD will allow manufacturing and ICT service development while considering why things and experiences offered by enterprises are necessary. Integration of SCD will also allow manufacturing

and ICT service development that considers whether those things and experiences do any "good" for society and they will be evaluated, tested and a real feeling of their benefits to and influence on society will be gained in advance. Carrying out design activities integrating HCD and SCD is important for realizing an affluent human society without creating a digital divide and for passing our rich abundant environment on to the next generation.

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