Approach of Applying Design Technology to System Development Process: From HCD to UX Design

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It is important that the practice of Human-Centered Design (HCD) is widely understood and used in sites of systems development, although it is mainly seen as an area for designers and specialists. An effective way to achieve this is to convey design know-how and technology to systems engineers (SEs) in an easy-to-understand way and make them easy to use by converting them into tools. Fujitsu Design has worked to apply design technology to systems development by building an HCD process into Solution-oriented system Development Engineering Methodology (SDEM), which is its standard system development process, developing and offering tools that can be used in the stage of user interface (UI) design and evaluation, and providing support for usability requirement definition and usability education. Recently, there has come to be a great need for product development that is aware of Rich Internet Application (RIA) and User Experience (UX) because of the popularity of smart devices. We are studying systems development cases and know-how, and continuously providing information to development sites amid this new shift from HCD to UX. This paper introduces HCD activities that have been developing as design technology mainly in the field of SI solutions.

1. Introduction

Since ISO 13407 was issued as guidance on design processes incorporating a user's viewpoint in the second half of the 1990s, Human-Centered Design (HCD) processes in systems development have gradually been disseminated and developed. Fujitsu also conducts development of products and services including hardware and software that incorporate an HCD process.[1]

This paper presents our activities for applying design technology from the perspectives of dissemination of an HCD process, user interface (UI) design evaluation and education on HCD with the focus on UI and usability, on which Fujitsu Design has worked in the field of systems development based on Fujitsu's solution business, and clarifies their effects and issues. It also gives a report on the new area of development with the focus on Rich Internet Application/User Experience (RIA/UX) for recent smart devices and the status of approaches to the development being conducted in cooperation with the systems integration technology unit of Fujitsu.

2. Role of design in systems development

In information systems development that supports the business infrastructure of various fields including finance, distribution, medical care, public service and social infrastructure, the role of design is important. Here design does not only include the colors and shapes of a product but also refers to an area mainly in relation to its usability including the psychological comfort and satisfaction of the users of a particular system and the effect and efficiency of the work itself achieved by using the system. Without satisfactory usability ensured, the system may eventually become unused, or with dissatisfaction even if used, or problems may result such as operating errors generated during use that lead to failure or loss.

From the perspective of human error, there are well-known cases such as a stock transaction system in which a wrong input of a value and a volume of transaction caused a tremendous loss, and a medical system in which mistaking one drug for another with a similar

name resulted in impairing a patient's consciousness. While issues include direct impacts such as induction of human error, there may be an impact on the development process itself in cases where, for example, lack of consideration of screen design or usability in the course of SI or systems development causes problems to be revealed in the later test phase, resulting in process delay or increased person-hours due to rework.

To reduce these issues, it is effective to apply an HCD process to systems development. An HCD process is intended to actively incorporate the user's perspective in the course of repeating four phases: clarification of assumed users and context of use of the target product or system (identification and understanding of the context of use), extraction of requirements, solution by design and evaluation of the proposed solution. In Japan, the Cabinet Secretariat Information Technology Policy Office released the e-Government Usability Guidelines in 2009.[2] These guidelines reflect the lessons learned from public service systems developed at a considerable cost that ended up not being widely used due to the low usability offered, resulting in failure to obtain a utilization rate that corresponds to the development cost. To raise the utilization rate of online application of e-Administration, the Guidelines provide for an HCD process that improves the usability of online application systems provided by different offices and ministries.

What is important about this concept of HCD process is that it is understood and used at the sites of systems development, and that systems engineers (SEs) and developers in the field can easily use design know-how and technology and acquire them as skills; this is effective in terms of raising the organizational capability. Fujitsu Design is promoting the use of design technology not only in the development and application of its own products but also in the development of systems to be widely offered to customers. The following sections outline our approaches from the perspectives of processes, tools and education.

3. Application of HCD to development process

SDEM,[note] which is Fujitsu's standard development process, gave a description about usability in 2007 in the form of a supplement on usability. SDEM is intended mainly for preventing omission of operations and managing projects efficiently and, as with general development processes, widely and systematically describing necessary operation items and deliverables in processes including planning, requirement definition, design, development, test and operation/maintenance.

The HCD process intended for usability improvement has been included in this SDEM since 2007, and it explains usability improvement activities. Specifically, the activities include: 1) incorporation into information systems strategy and 2) clarification of usability requirements in the planning process, 3) understanding of the context of use and recording of user attributes and environment in the requirement definition process, 4) design and development of usability in the development process, 5) evaluation of usability and 6) system introduction and operation/support activities in the operation test process and 7) planning and implementation of HCD process across the entire process (**Figure 1**).

This HCD process is discussed in more detail from the perspective of evaluation as the e-Government Usability Guidelines Information Provision Site published on Fujitsu's Intrasite. This site offers explanations about many actions provided for by the e-Government Usability Guidelines mentioned above. It describes what SEs and developers in the field should do in which process with the focus on the "process" to allow it to be incorporated and "documented" as a deliverable in the process. **Figure 2** shows the correspondence between the actions specified by the Guidelines and the processes of SDEM, which allows SEs and developers to overlook the actions in their everyday operations. The point is to evaluate usability in steps mainly of the development process for developing while checking to

note) A proper noun representing Fujitsu's standard process stipulating the basic concept of planning, development, operation/maintenance and quality assurance activities. SDEM was originally an acronym but now carries various meanings including software, system, solution, service, development, engineering, maintenance, management, methodology and mapping.
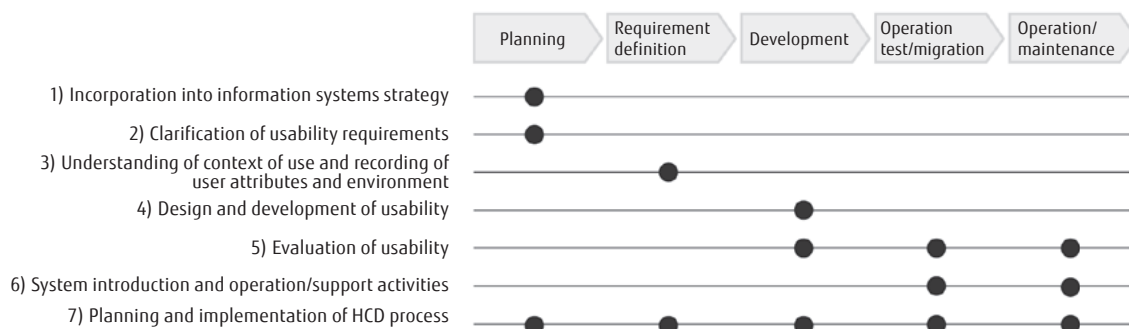
Figure 1
Usability improvement activities in SDEM.
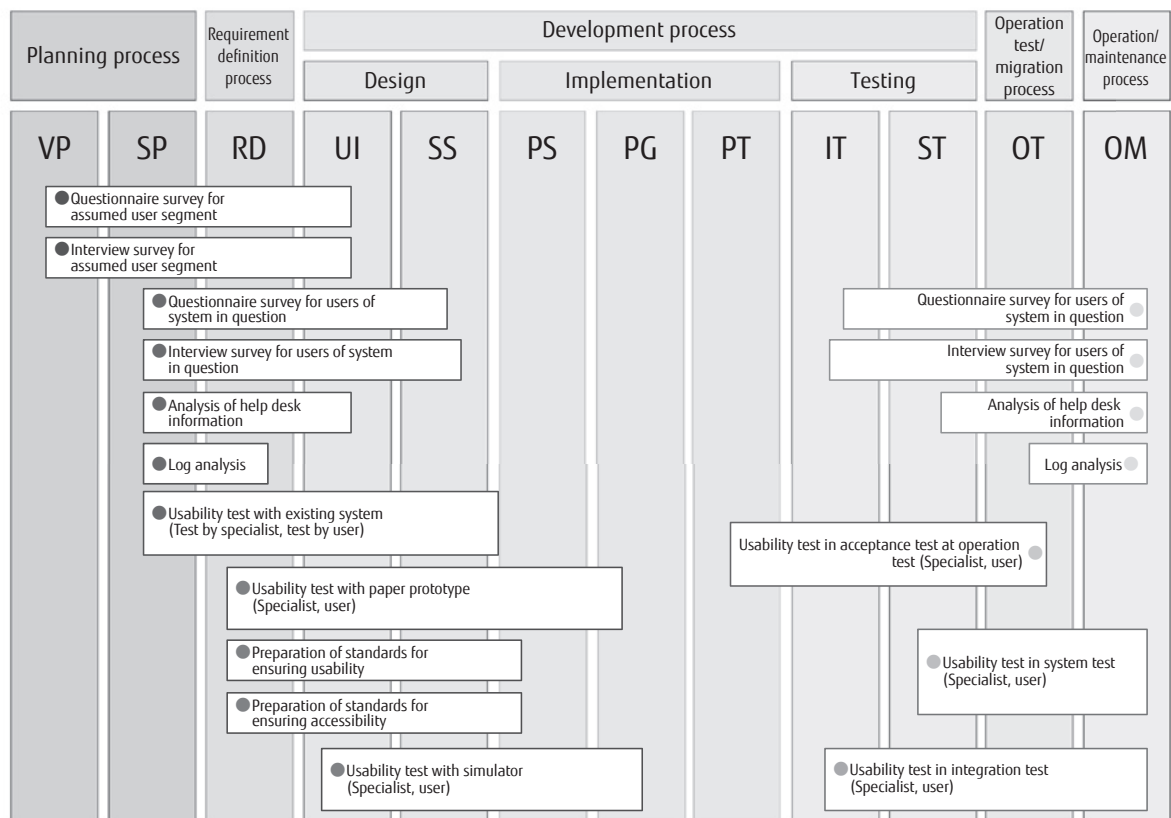
Figure 2
Correspondence between processes of SDEM and actions of e-Government Usability Guidelines.

see if usability that meets the target is ensured.

4. Tools usable in design and development processes

To apply design know-how such as screen layout and transition and color scheme based on a knowledge of ergonomics and cognitive psychology to the development process, there are on-site needs for tools that bring about a faster effect. Among the processes of SDEM including planning (VP/SP), requirement definition (RD), design (UI/SS), implementation (PS/PG/PT), test (IT/ST) and operation/maintenance (OT/OM), upstream processes such as "planning" and "requirement definition" are difficult to convert into tools. For

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"design" and "development," however, specific screens become subjects of development and tools such as templates can be made.

In terms of screen, many business applications can be broken down into typical and simple screen types and screen transitions. Specifically, a task performed by a user seen as a temporal flow of operations can be represented by templates of nine basic screens as described below (**Figure 3**).

The user first logs in to use the system [1) Login screen]. After logging in, the user usually goes to the screen that allows menu selection [2) Menu screen]. On the Menu screen, the operation (function) to be performed is selected. In a system that communicates with a database, after menu selection, a search function is prepared at the top of the respective function in most cases [3) Data retrieval screen]. The search is performed on that screen and a list of items to be processed by the user appears [4) Retrieval result list screen]. In some cases, the search criteria and results may be shown on one screen [5) Retrieval + result list screen]. From the list, one item is identified, on which processes such as edit, update and delete are performed [6) Input screen]. The same screen can be used to create new data. After new data are input or the existing data are updated, the input or update is confirmed [7) Confirmation screen] and the series of operations is complete.

From the perspective of screen template, on top of the seven screens described above, a sample of text on the Web browser [8) Text screen] and an auxiliary screen for inputting the date and other items [9) Input assistance screen] can be added, and they have been defined as the nine basic screens of Web business applications and made into templates.

To create the templates, we have optimized and standardized area segmentation for the header and footer based on the screen layout principles together with definition of the functions in the respective segments and layout of controls and buttons for realizing the respective screen functions. In addition, variations in relation to design taste such as colors have been made selectable from about 50 themes to meet the needs of diverse scenes of use. Consideration has been given to accessibility as well and text visibility has been adjusted for the optimum conditions (**Figure 4**). Furthermore, templates are created by using HTML and CSS conforming to Web standards, which allows simple and efficient customization.

Fujitsu Design has been offering these tools as the Fujitsu GUI Design Platform within the Fujitsu Group since 2007. As the template types, we started with HTML and have gradually prepared various types while incorporating the needs and requests from the sites of development to include others that support ASP.NET and Fujitsu's development platform, for
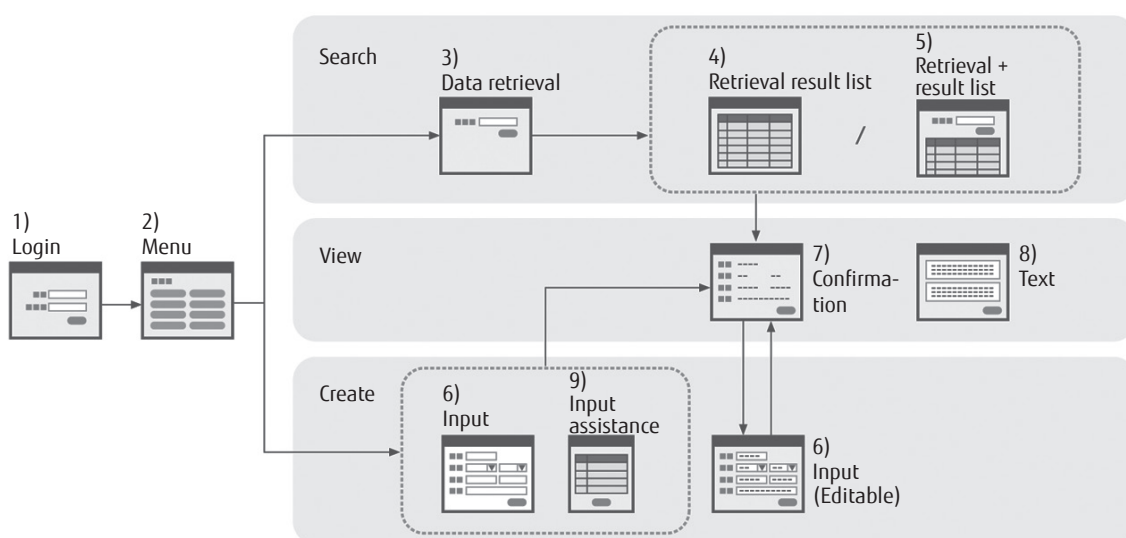
Figure 3
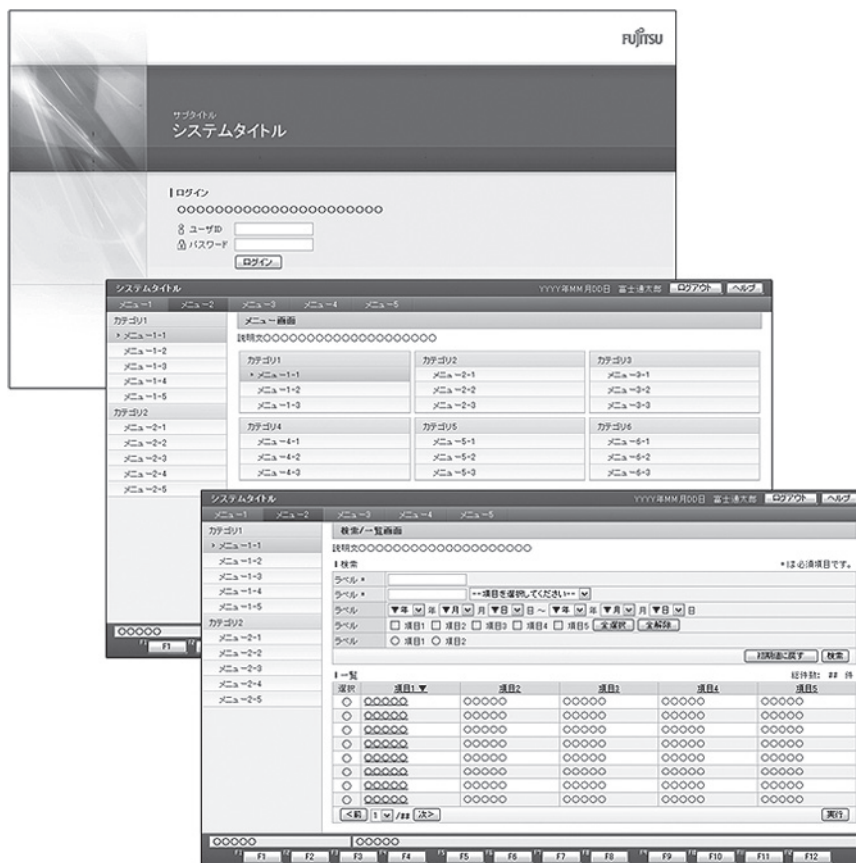Basic nine screen types and transition.

Figure 4
Screen template samples.

example. Developers can download for use a set of necessary templates and accompanying guidelines from the intranet download site. At present, about 2000 templates are downloaded annually, and they are continuously used for a wide range of purposes from tool development in the respective departments and business proposals to customers.[3]

5. Knowledge strengthening and education at sites of development

In addition to processes and tools, information enhancement and educational seminars on HCD are provided on an ongoing basis for promoting communication and cooperation between designers and developers on site.

5.1 Usability requirement definition

To practice HCD in the development process, dealing with usability as one "requirement" is desired. At Fujitsu, usability is positioned as one non-functional requirement. Generally, a requirement in requirement definition is regarded as "a request for the system representing what is expected of the system, or what the system should be provided with." The same applies to usability and carrying out activities including "derivation, analysis, documentation and confirmation of usability requirements" is called for. Meanwhile, as a result of interviews with the actual sites of development, we have found out that there are issues such as how to define usability itself as a requirement and whether it is possible at all. Accordingly, definition of usability as a development requirement including customers is known to be difficult.

The systems integration technology unit of Fujitsu internally provides the Guidelines for Writing Requirement Definitions for supporting field SEs with requirement definition including usability. The section on usability requirements in the Guidelines incorporates the concept of the Non-Functional Requirements Specification Definition Guideline[4] and the contents

are continuously updated. At present, five usability requirements including "understandability, learnability, operability, attractiveness and compliance" are specified and descriptions are added to allow designers to set quantitative goals. Conditions of achievement for requirements and specifics for its realization are also explained.

5.2 Dissemination and education on HCD

It is important to provide SEs and developers working at the sites of development with opportunities to get to know and learn the concept of HCD. Fujitsu Design has continued to provide usability education since 2009 as one of the technology workshops within the Fujitsu Group. Up to now, a total of 12 sessions of the workshop have been held with the participation of about 500 sales employees and SEs. The results of questionnaires taken after the sessions have shown favorable evaluations such as "The workshop helped me understand the technique for achieving a proper screen design, which tended to depend on personal sensitivity" and "The workshop provided me with a good reference about how to define screens, including quality, in the requirement definition and UI processes." The same contents are offered as e-Learning as well, allowing employees to participate from their own desks. These workshops are also offered to customers as requested, in addition to people within the Fujitsu Group, as a design service. Furthermore, HCD-related terms are included in the Fujitsu Group's information technology glossary published on the intranet not only to disseminate them in the Fujitsu Group but also to facilitate shared understanding so that we can prevent any difference in positioning and interpretation. One result of such dissemination and education efforts in the Group is that 16 persons in the entire Group hold the qualification of the Certified HCD Professional accredited by the Human-Centered Design Organization (HCD-Net).

6. Capability of development of new smart devices

As smart devices have been becoming widespread recently, the subjects of development are expanding from consumer products to business systems not just for ease of use but also for UX including the comfort and fun of use and satisfaction leading to a desire to use again. This section presents the background of UX improvement and approach in the Fujitsu Group.

RIAs were introduced in the beginning of the 2000s, along with the dissemination of the Internet, for the purpose of improving operability and expressiveness of the Web. Going beyond the framework of the Web, client applications that run by programs distributed on the Internet have now come to be referred to as RIAs. For intra-corporate business systems (inB systems), RIAs have become widespread. Their focus is on incorporating performance and operability equivalent to those of C/S systems into Web screens on PCs introduced for reducing the total cost of ownership (TCO). It can be said that, in business systems, usability improvement has been promoted mainly for improving the efficiency of operations.

B2C systems for consumer systems, on the other hand, the Web has become popular along with the diffusion of PCs and the Internet into ordinary homes. Operations ranging from information navigation and retrieval through online shopping to operations that have conventionally been conducted at counters including Internet banking and insurance contracting have come to take place on the Web. B2C systems, with which users in ordinary homes come into contact, make use of RIA technology to allow those unfamiliar with PCs to use them immediately. Designers place weight on consideration in terms of design by such means as using graphics and animations to realize high expressiveness and operability for intuitiveness and ease of understanding. They also take measures to improve the satisfaction of users and encourage them to revisit the companies' own Websites, and design in view of UX has been introduced from early on.

With the advent of the iPhone, a new hardware device, use of smartphones in the consumer field is becoming explosively widespread and use of smart devices in the business field has also begun. Users, who are used to operability and expressiveness of the smart devices they have been familiar with, have come to expect similar operability of business systems. For that reason, approaches to UX taken in systems development for the consumer market are beginning to be regarded as important in the business field as well. Furthermore, business systems on PCs are now required to go beyond usability to take UX into account on the assumption that they will be used on smart devices.

6.1 RIA study subcommittee

In the Fujitsu Group, Fujitsu Design has been carrying out design activities for ICT based on the policy of HCD. However, SEs who have mainly worked on the development of inB systems often, although they are well aware of the importance of design, lack consideration of design in terms of usability in the design and development processes. This is because of reasons including their unfamiliarity with technologies, methods and processes for improving UX. In order to avoid ending up in this situation, we are taking systematic approaches that go beyond the bounds of departments.

The RIA study subcommittee is engaged in the upgrading of design and development technologies for and exchange of information on RIAs mainly for smart devices, which urgently need technological upgrading. RIA technological upgrading activities, which were initially conducted by the systems integration technology unit, have been integrated into a subcommittee under the Ubiquitous Service Consortium, an internal consortium hosted by the ubiquitous service business department that provides smart devices. The activities now have the participation of a wide range of departments including Fujitsu's vertical SEs, SE companies, Fujitsu Design, middleware business department and Fujitsu Laboratories.

For design technology, the RIA design technology SWG mainly including experts has been established in the subcommittee to improve the UX guidelines.

6.2 UX guidelines

The UX guidelines describe the procedures of design and development for realizing "UI offering good UX" from the perspective of SEs with RIAs as a means of offering good UX. In upstream processes, in particular, UX design is positioned as "a spiral design technique based on HCD implemented at the timing of the planning and requirement definition processes" and the four activities of HCD, namely "identification and understanding of the context of use," "clarification of user requirements," "creation of solution by design" and "evaluation of the design for the requirements," are specified as a UX design process.

In addition, descriptions are given about how to incorporate the UX design process into SDEM and about a project organization including a new role responsible for UX design to allow SEs to move ahead with systems development offering good UX. Furthermore,

case examples of UI development including the results of the UX improvement measures taken by Fujitsu for fostering a better understanding of the UX guidelines have been gathered into a collection of case examples.

7. Conclusion

This paper has presented our approach to design application mainly in the solution business field. HCD and UX are increasingly demanded by the sites of development including customers, but putting them into practice is still considered as a cost to pay in many cases. This is partly because of a failure to clearly communicate design value but developers and designers including customers should be aware that the processes are required for better manufacturing and practice the HCD process according to the situation of the respective projects within a reasonable extent in incremental steps.

At the sites of development, new technologies and innovative devices are expected to continue to appear in the future but users who use them are humans and the human attributes will not significantly change. Accordingly, we believe that continuous development from the viewpoint of humans as users of them will support the foundation of manufacturing. The same applies to upstream service development in addition to systems development and good services are not generated without seeing design from the perspectives of both ICT and human use. We intend to broaden our vision from the conventional HCD to UX design with the focus of experience value and help to further improve customer value through development.

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