

Human-Centered Design in Medical Fields

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This paper introduces Fujitsu's human-centered design approaches to reduce human errors. The approaches are targeted at Fujitsu's Electronic Medical Record (EMR) systems: HOPE/EGMAIN-FX and HOPE/EGMAIN-GX. We aim to establish an easy-to-use, intuitive design with increased accessibility and convenience for users by focusing on the three improvements of design uniformity, operation uniformity and improved operability. These approaches contributed to restructure the conventional EMR systems those served as the foundation for the later EMR systems and induced an evaluation of human-friendly systems. The recent project on improving user interfaces (UIs) marked the first collaboration between the EMR development division and the Design Center. It offered an opportunity to recognize the importance of UI in promoting a design that reflects direct inputs from the development team and healthcare professionals, while giving consideration to the uniqueness of the tasks involved in the medical field.

1. Introduction

Fujitsu's history of developing Electronic Medical Record (EMR) systems in the domestic arena dates back to the 1980s (**Figure 1**). After the initial commercialization phase and popularization phase centered on national university hospitals, an order entry system was developed that enables physicians to enter medical orders such as laboratory tests, and information will then be sent to the related sections in the hospital. An electric medical record system including examination records accompanying the orders has been developed as a package since 1999 as an enhanced version of the previous systems. Meanwhile, Fujitsu has made various efforts to improve usability for customers, such as improving the product lineups covered by the package, increasing its functionality and supplying customers with know-how so they can make optimal use of the system. As a consequence, Fujitsu's EMR system has acquired the top share in the

domestic medical market. In July 2008, Fujitsu announced HOPE/EGMAIN-GX as a novel solution.

Reflecting the historic background, there was a change in the method of developing and applying the package. For about 20 years from HOPE/MCS to HOPE/EGMAIN-EX, each package has played an important role as a basic resource of system integration in each customer site. Meanwhile, the functional aspects of the package have evolved by integrating good practices. Since HOPE/EGMAIN-FX in 2003, a solution type of system that enables short-term adoption and stable starting of operations based on non-customization and on continuous addition of functionalities after the system's introduction has become the mainstream. This was because of changes in the market environment, including the need for frequent revisions of the EMR system accompanying the revision of the national healthcare system.

This paper summarizes and introduces Fujitsu's approaches for human-centered design (HCD) in HOPE/EGMAIN-FX and HOPE/EGMAIN-GX.

2. Current situation and challenges

As mentioned above, through about two-thirds of the system development period, Fujitsu's EMR system has evolved by enhancing the previous versions. While this method worked efficiently to bring this technology to the current status, the emphasis has inevitably been placed on functionality rather than design. To reconstitute this system into a ready-made type of package, we reviewed our system between 2005 and 2006, focusing on non-functional characteristics. As a result of this review, the system's design as well as response was improved while maintaining its

functionality.

In the design process, our approaches started from analyzing the current status of the conventional products (**Figure 2**). Usability experts carried out research on several existing products based on interviews and operations of a demonstration system. The usability of these systems was evaluated based on eight viewpoints of user interface (UI). These viewpoints are:

- 1) Consistency
- 2) Efficiency
- 3) Clarity of screen as a whole
- 4) Emphasis and simplification of display elements
- 5) Discriminability and identification of display elements
- 6) Legibility of display elements
- 7) Tolerance to human errors
- 8) Feeling of safety and satisfaction

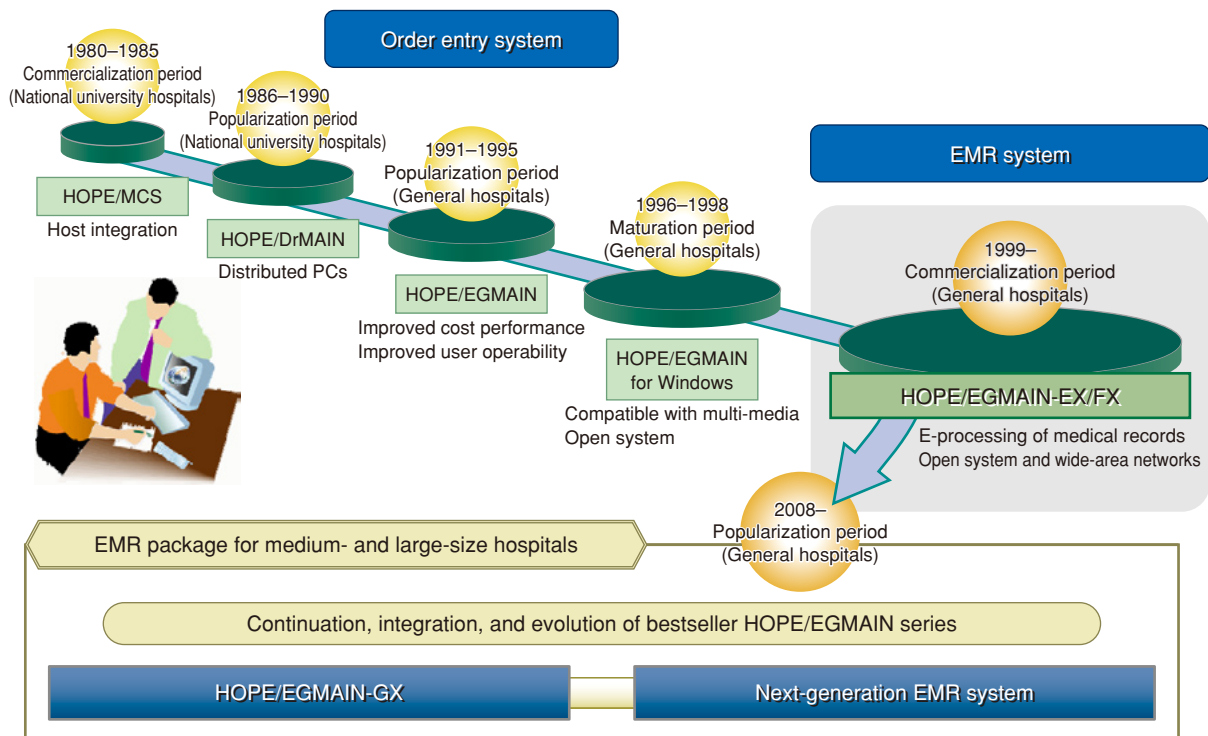


Figure 1
History of EMR system development in Fujitsu.

The evaluation results revealed that there was a significant difficulty from the aspect of consistency. Owing to the lack of consistency in the colors and layout used, as well as a lack of unified operation procedures and the meaning of each color, the screen concept was different from screen to screen even in the same product. The UI at that time had a high risk of inducing human errors. Based on the interview results, the cause of such inconsistency was attributable to (i) the various situations that existed during the development process, (ii) the local rules set by developers, and (iii) the history of trying to meet the requirements for specific additional functions. Further, one of the important causes of this inconsistency was the uniqueness of the system in the medical field, which is very different from systems used in the other fields.

3. Method and technology to cope with the challenges

As approaches in the area of graphical user interface (GUI), improvements were carried out in the following three areas: i) information design, ii) operation flow and navigation design, and iii) visual (Look & Feel) design. These ap-

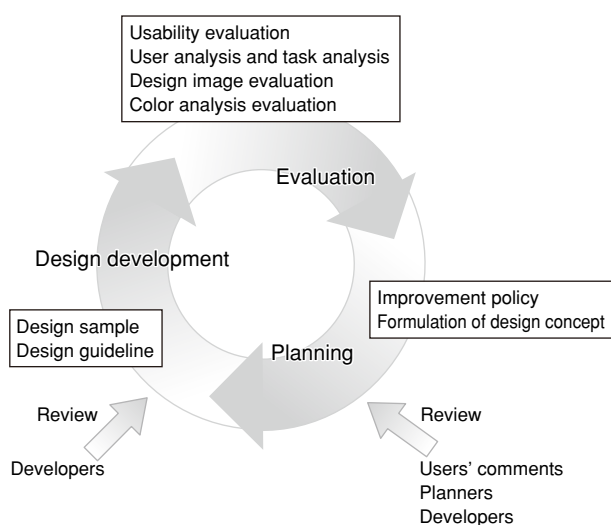


Figure 2
Design process.

proaches aimed to realize HCD by establishing an easy-to-use, intuitive design with increased accessibility and convenience for users. The design concept of the current system is “Improved quality to realize a convenient EMR system that can be used easily without any psychological barriers, and can be used with assured operation and easiness of learning”. Specific emphasis points for improvement were determined based on the evaluation and design concept. The possibility of errors should be strictly eliminated in the case of EMR, so we focused on the following three points as they were considered to be effective methods to prevent human errors:

1) Unified design

By using specific basic colors and unified layout formats, we strived to unify the total concept of the system.

2) Unified operation

A unified design and layout were applied to buttons that had similar functions. This made it easier for people to learn how to use and smoothly operate the system.

3) Improved operability

We have paid consideration to the line-of-sight of users so as to prevent operation errors and excessive tension. As a part of this effort, view areas and entry areas were designed based on the emphasis and simplification principle. However, in actual development, the order of priority was determined and implemented based on the feasibility and significance of the improvement. In reviewing the priority under the aforementioned rule, we took into account various job-related characteristics, including the order of data entry in clinical practice. Further, from the aspect of specific design expression, we formulated 15 screens as typical samples for prototypes of design improvement by particularly focusing on the rules and consistency in the following elements: screen size, areas framed by bold frame, background colors, identification colors, text, buttons and format. In formulating the rules for design unification, we gave adequate consideration to

the uniqueness of the tasks in this area including the use of a distinctive warning color code for each infection type. Using these prototype screens as a basis, we were able to establish fact-based rules for screen improvement. As a result, these improvements have been reflected in all of the several thousand screens used in this system.

4. Technologies and products generated from the improvements

We formulated a design guideline for the UI screen design in the EMR application as a tool for promoting the development of unified GUI screens on the basis of design prototypes. This guideline is comprised of the provisions mentioned in the previous section (**Figure 3**).

In conjunction with these efforts, the compliance with this GUI design manual was reviewed in the medical development group and a team responsible for design control was arranged as a

part of continuous approaches. By ensuring the review by this team at the UI process, we were able to reflect stipulated design rules in an appropriate manner, not only in the package in its final adjustment phase, but also in the functions that were added afterward. As a continuation of these approaches, the current design rules were reflected in HOPE/EGMAIN-FX when it was upgraded to version 3, launched in 2006. These approaches are also being integrated in the latest package HOPE/EGMAIN-GX on a continuous basis.

5. Effects achieved by new technologies and new products

There is a user network called “EMR user forum ‘Expert Users’” for HOPE/EGMAIN-FX, the first solution to which the aforementioned design rules have been applied. This user network was organized in 2004. As of February 2009, 141 healthcare institutes are participating in this

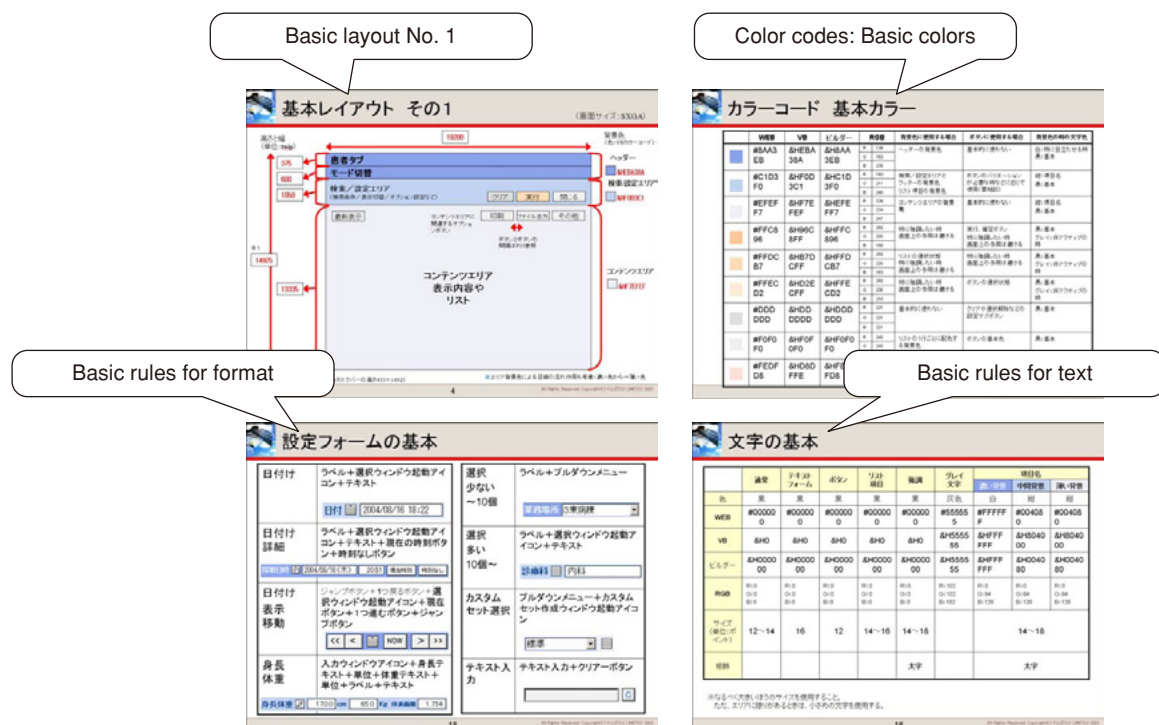


Figure 3
Example of screen design guideline.

network. The network is positively involved in realizing an improved system environment based on the premise that all participants use an identical system without customization. In this network, information, experiences and opinions such as the case studies on system introduction and know-how about the system, reuse and analysis of stored data, and the review of upgraded features after the system's deployment, are exchanged between the participants and also between the participants and Fujitsu.

In 2006, when these design rules were introduced, there were positive evaluations to our approaches in this network, suggesting that "these approaches are very important and contribute to the improvement of product quality in the recent trend of placing emphasis on ready-made EMR products as an essential tool. Quality improvement in these aspects has a great significance particularly in making it easier for physicians who have recently joined the organization to learn how to use the system, resulting in a shorter training period". Besides, some system users such as physicians as well as Fujitsu's in-house system engineers in development and in application groups, who tend to use the system for many hours a day, pointed out a change in the way they perceived the system after the design unification (they referred to their forming a sort of attachment to the system).

The current project on improving UI marked the first collaboration between the EMR development division and the Design Center. And the evaluations from users offered an opportunity for us to recognize the importance of UI and the significance of promoting a design that reflects direct inputs from the development team and healthcare professionals, while giving consideration to the uniqueness of the tasks involved in the medical field.

6. Results, analyses and discussions

Through the current improvement ap-

proaches, the inconsistency of screens was eliminated and a feeling of unification was achieved. An improved interface with increased operability and a feeling of safety means an increased level of user-friendliness for system users.

Because the systems used in clinical fields need to have special and unique characteristics, we, as participants in this project, felt there was a significant importance in having an evaluation and review by all three parties concerned (designers, system developers, and direct users). While unification of the colors and layout could be achieved in terms of visual design, further improvement of usability is necessary in terms of information design, operation flow and navigation design based on more detailed data. Moreover, in promoting the unification of the GUI, which should be consistent not only in individual products but also as a whole series, it is essential that designers should be involved in each phase of the development cycle on a continuous basis to address various day-to-day requests for features.

In recent years, EMR systems have reached the stage where applications are being offered as a package and the smooth starting of operation is a matter of course. Characteristics such as high profile, high performance, and high quality are considered as a part of the standard level of quality. Therefore, the current focus in evaluating the quality and value of a product is placed on the user-friendliness of its design and the considerations paid to usability from the users' standpoint. This focus goes beyond the points stipulated in a series of essential documents such as user manuals.

In the future, we need to reflect in our products the evaluation and analysis results for processes and tasks related to the lifestyles and work styles of the people who are directly or indirectly involved with our systems, including patients, patients' family members, physicians, nurses, laboratory technicians, pharmacists, office staff, and so on. This approach is considered effective in helping the system application evolve into higher

stages, where not only improved visual designs but also more sophisticated improvements for increased usability are realized. Such improvements consider the fatigue and stress level of users, as well as their psychological status. At the same time, we aim to offer comprehensive solutions that are assessable by any group of people. We will do this by proposing a design suitable for various communication situations related to clinical practices, including designs not only for software but also for hardware, facilities and clinical spaces.

Fujitsu needs to achieve a higher level of sophistication for HCD in the field of healthcare.

7. Challenges and future orientation

We expect EMR will further evolve from a system for registering clinical information into a system for supporting clinical practice. In fact, in a meeting of the aforementioned user network, some customers requested the development of a “second-generation EMR”. Some factors can also be seen that drive this evolution forward, such as the continuous growth of requests for additional features as well as the increased complexity and diversity of tasks that the system needs to perform.

To be specific, the following agenda have been raised: i) intuitive operation that allows users to use the system without barriers or without reading the manuals, ii) contribution to task standardization by deploying screens and features reflecting the task operation rules of the user facility, iii) support for determining patients’ behavior in multiple facilities, and iv) support for helping

physicians make decisions about what treatment to provide by allowing them to refer to appropriate past information. As a matter of course, it is essential that these agenda should be carried out as advanced features on the premise that a safe and secure system that helps to prevent human errors has been established.

This program also affects internal teams. It reinforces consolidation of internal staff members who are in charge of development, negotiation, and application of the package by emphasizing an in-depth awareness of design.

Based on the aforementioned observation results, we are determined to make efforts for further development of the system, as typically seen in the activities of the GUI team in the medical development group. To achieve this target, we will ensure smooth operation of PDCA cycles through the improvement of the structure and process of system development to continuously maintain usability and ensure the involvement of designers in these activities.

8. Conclusion

Based on the results of the project and the projected future orientation, Fujitsu is promoting its brand strategy for the HOPE series as an advanced stage of marketing with the collaboration of the EMR development division and the Design Center.

Fujitsu is committed to supporting our society through exploring HCD-oriented solutions with increased user-friendliness in the clinical field, while establishing safe and secure infrastructures.



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