# Human-Centered Design Activities in the Development of Smart Device Applications

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Abstract

In order that business styles may be changed and business productivity may be improved through the utilization of smart devices in business operations, the concept of user experience (UX) is important. Smart devices have to offer the value of the experience that makes a user in the field feel that he/she wants to use them even though they may change his/her familiar business style. After having taken notice of facility and equipment inspection as a promising area for the utilization of smart devices, we have developed applications through the practice of human-centered design (HCD) to ensure the effectiveness of smart devices. This paper discusses HCD in the development of smart device applications for facility and equipment inspection.

Keywords

smart device, human-centered design (HCD), user experience (UX), facility and equipment inspection, agile

## 1. Introduction

In recent years, there have been many cases of reforming business styles and improving business productivity by utilizing smart devices such as smartphones and tablets in business operations. The concept of user experience (UX) will help new business styles to be established and encourage a successful outcome. It offers the value of an experience exciting enough for people in the field to feel that they would like to use these devices even though this would involve changes in their existing accustomed business styles.

We have brought our attention to facility and equipment inspection, an area in which full utilization of smart devices is expected. In order to enable smart devices to be effectively used in facility and equipment inspection, we have developed supporting applications for facility and equipment inspection by applying human-centered design (HCD), which is designing and improving processes that bring the experiences of users into focus.

This paper first discusses NEC Group's smart device solutions and then introduces the development of smart device applications based on Human-Centered Design.

## 2. NEC Group's Smart Device Solutions

In comparison with PCs, smart devices feature more intuitive operation by touch screen, superior portability and increased readiness as they are always powered on. At NEC Group, we offer a wide range of solutions that take advantage of these features.

These features make it possible for IT to be used for places, occasions and users to which it has conventionally been difficult to apply PCs, e.g. "sales support," with which store instructors can collect information outside the office and send in reports without going back to the office, and "teaching support," with which elementary school students can practice arithmetic drills while enjoying themselves outside.

Facility and equipment inspection, which we have focused on in this project, is a service of a highly social nature. It ensures safety of buildings and facilities by confirming their condition, which leads to repairs so that accidents can be prevented. Those facilities include factories, tunnels, railways and data centers, as shown in **Fig. 1**, which are indispensable for people's lives. The introduction of smart devices to facility and equipment inspection is expected to achieve new operational styles, such as carrying a large volume of manuals and draw-

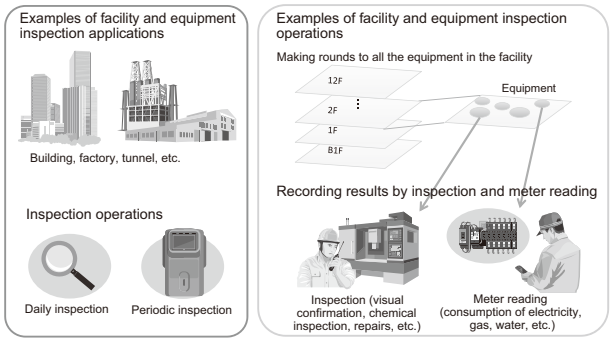


Fig. 1 Schematic of facility and equipment inspection operations.

ings to the site and easily converting the inspection results into electronic data.

## 3. Development of Smart Device Applications Based on HCD

This project has adopted Human-Centered Design from the viewpoints of operators to develop applications that will make the operators feel that they want to use them. The Human-Centered Design process adopted in this project is explained below, in accordance with the four processes specified in ISO 9241-210, which are to understand and specify the context of use, to specify user requirements, to produce design solutions that meet user requirements and to evaluate the designs against requirements.

### 3.1 To Understand and Specify the Context of Use

We conducted fieldwork as well as interviewed operators to investigate the actual conditions of facility and equipment inspection. The investigations were performed from three viewpoints, as follows:

**(1) Characteristics of operators**

We conducted our investigation with an emphasis on the need for expert know-how with a view to clarifying the expert nature of the operation supported by the applications.

As a result of interviews with operators, for instance, we found that user characteristics of both experienced and novice operators were required, from statements saying that there were both experienced and novice operators in many cases. We also discovered that experience and know-how were required to implement operations, from statements saying that workers with 2-3 years' experience were still beginners. Confirmation of such operators' characteristics helped us minimize the risk of making applications that would be difficult to use for novice operators who lacked knowledge in operations, even if they would be easy to use for experienced operators who had sufficient knowledge in operations.

**(2) Characteristics of operating environments**

Matters which operators took for granted would be difficult to discover from interviews, so we investigated operating environments such as workplaces, inspection objects and physical conditions while placing an emphasis on on-site work.

For example, there were many large-scale machines at the work sites that looked unfamiliar to us. There were very few facilities that would reveal their names from their appearances alone. This helped us to discover the problem that novice workers were likely to get lost because they could not find the inspection objects. Additionally, some of the inspection objects of voltage and current measurement did not show any reference values. This helped us to detect the problem that a malfunction could be overlooked without the reference values unless the inspector was aware of past measurement values. The confirmation of these problems enabled us to acquire information that novice workers needed.

**(3) Characteristics of operations**

We also held interviews focusing on contrivances made in the field and problems generated frequently in order to further understand the characteristics of operations which had not been made obvious and their potential needs.

For example, the interviews revealed the following: basic operational facts such as that about 30 kinds of inspection operations were performed and that each inspection operation included about 10 kinds of facilities and a total of more than 60 kinds of inspection items; contrivances such as that the most efficient order of inspection was thought out and the inspection records were made according to that order; and problems such as that an inspection could not be performed due to the personal circumstances of the facility user, causing it to be forgotten while it was kept on hold.

Clarification of these made it possible to eliminate factors that prevented operators from performing inspection efficiently, such as the inability to change the order of inspection or postpone the inspection.

### 3.2 To Specify the User Requirements

The requirements for work in the field were clarified and classified according to the problems found in the field and contrivances to be introduced, as well as the characteristics of operators, operating environments and the operations themselves which had been detected in our fieldwork. As typical examples, there were two requirements: one to improve efficiency and reduce errors and the other to support novice workers.

The requirement to improve efficiency and reduce errors takes effect when operators wish to improve the efficiency of inspection operations and reduce careless mistakes. For

example, contrivances such as that the most efficient order of inspection is thought out and the inspection records are made according to that order are efforts to reduce chances of moving of equipment and minimize waiting time while taking careful consideration to avoid inspection mistakes. In the meantime, problems such as an inspection being forgotten while it is kept on hold are mistakes that cannot be prevented by skills and can happen to anyone. It is clear from these examples that supports for efficient and accurate operations are necessary no matter what the experience of the operators, whether they are beginners or highly experienced.

The requirement to support novice workers is to supplement their knowledge of the work. This is because some problems are caused by a lack of knowledge of the work. For example, problems such as novice workers getting lost because they cannot find the inspection objects and malfunctions being overlooked without reference values unless the inspector knows past measurement values. This makes it clear that it is necessary to support novice workers in making decisions so that they can choose appropriate inspection orders and correctly judge normality and abnormality.

### 3.3 To Produce Design Solutions that Meet User Requirements

After an analysis of problems and requirements, we reached the decision that the improvement of efficiency and accuracy of operations is the priority issue in this project. Therefore, we have adopted a user interface (UI) that help facilitate efficient operations regardless of the level of operator skill and also prevent data entry mistakes and omissions.

In the first place, a large number of items - more than 60 kinds in one inspection operation - need to be inspected in this project. To support operational knowledge, it is also necessary to display information such as the external appearance of the facility or equipment and the past results of inspection for each inspection item.

In order to achieve these UI requirements, one of typical assumed design is displaying the inspection items on screens after changing the view by pagination, tab switching and scrolling. If all 60+ kinds of inspection items are displayed, however, a large number of pagination, tab-switching and scrolling operations must be carried out, resulting not only in a deterioration of browsing efficiency but also in the likelihood of overlooking inspection items on hold, making it impossible to meet the need to improve efficiency and reduce errors.

We have now adopted a UI that automatically slides to display the inspection item that needs to be worked on next, in accordance with the inspection operations (**Fig. 2**). This UI makes it possible to group the instructions for each inspection item together with information such as the input results and the external appearance of the facility or equipment. Then, it displays them all together, as well as to display the next

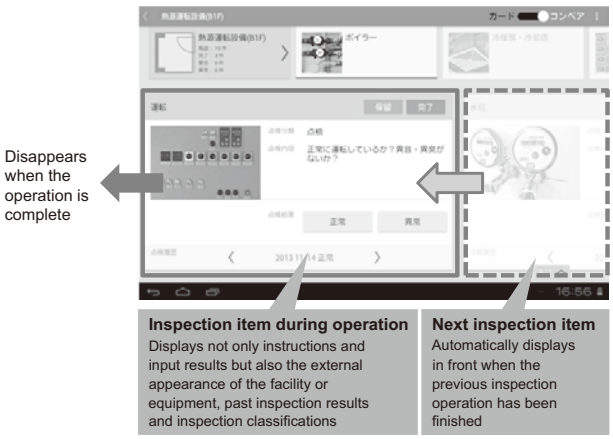


Fig. 2 Example of a UI for inspection operations.

inspection item without the need to scroll after the input has been finished. Thereby it achieves both the display of a large volume of information and the improved efficiency of operations. A system is also incorporated to prevent an inspection item on hold from being forgotten by redisplaying the item on hold when the other inspection items have been finished.

### 3.4 To Evaluate the Designs against Requirements

In order to provide UIs with the usability and pleasantness that will satisfy the operators, reviews were held repeatedly over a short period of time. The reviews were held in a "full-participation style" that all participants in the review make comments on the developed results. We also have employed some of agile software development methods.

Full-participation reviews were conducted from the viewpoints of efficiency and accuracy, while application prototypes were operated by the project leaders and designers who investigated the application specifications and the developers who were in charge of implementation. As for the problems found in these reviews, the participating project members could take advantage of their expertise to make in-depth investigations into the causes from the viewpoints of both users and developers. This enabled them to come up with feasible solutions for efficient improvement.

**Fig. 3** shows an example of the improvement efforts for the problem of an operational mistake in which the user tapped the same button again and again. In this example, the designer analyzed the cause from the user's point of view, supposing that the waiting time until the animation would start was so long that it was unclear whether or not the button had been tapped. On the other hand, the developer analyzed the causes in terms of the implementation, concluding that it took too much time for the animation to start because the animation did not start until the entire screen had been displayed. The investigations

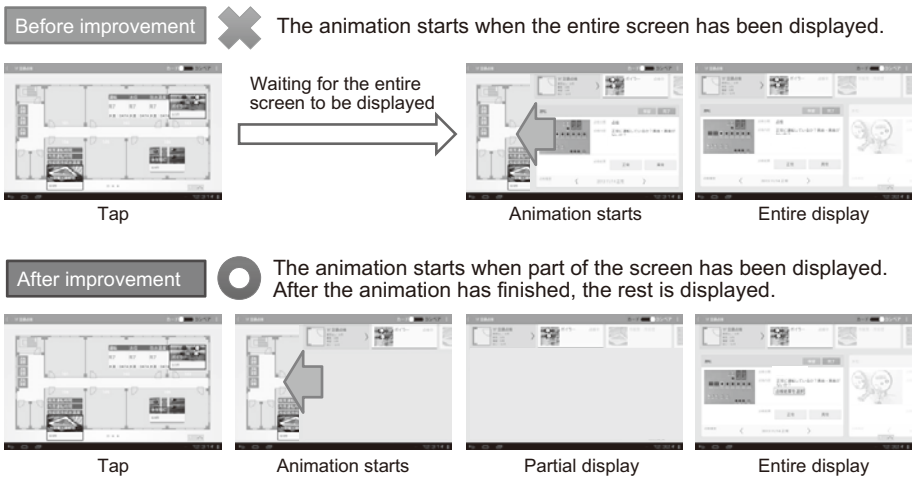


Fig. 3 Example of UI response improvement.

made in the reviews also included countermeasures through which the operational mistake could be prevented by starting the animation as soon as the screen header was displayed, then displaying the rest later, because doing so would increase the user's perceived speed. Through the repetition of these investigations, the developers became aware of the importance of the outward attractiveness of operations to users, which virtually eliminated similar questions in subsequent investigations and enabled the developers to execute implementation operations more efficiently.

## 4. Conclusion

When we asked our customers for their opinions of these applications, one of them said that the ability to display a large volume of information made his work easier to perform because his job was a confirmation operation at a data center which required high accuracy, while another said that these applications looked very useful because his production management operation demanded high speed, etc.

We at NEC continue to contribute to society by providing products and services that will satisfy our customers by comprehensively achieving better operability and more attractive quality in our customers' systems through the utilization of UX, while maintaining our commitment to activities in the on-site utilization of smart devices.

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