Operator Panel Design for Mobile Genset

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Abstract

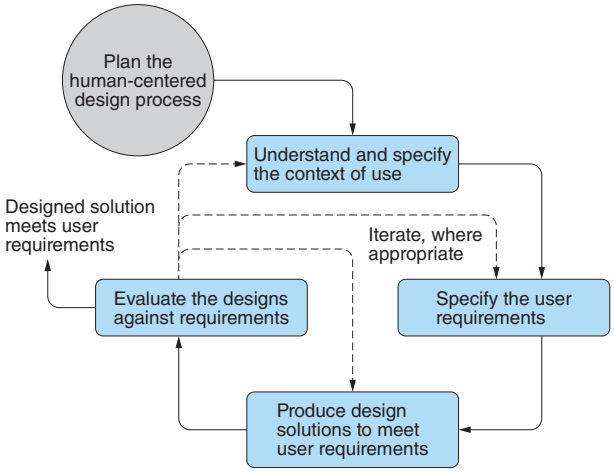
In recent years, there has been a shortage of highly skilled workers at sites where mobile power gensets are used. It is, therefore, difficult to pass on skills and expertise to unskilled workers. To solve this problem, we introduced a development process to make a product easier to use, and developed a control device for the mobile genset. This device is easy to operate. The operation screen is an interactive User Interface (UI) that displays only the instructions that should be done paced in real time. This makes it possible for even an unskilled worker to operate.

1 Preface

Mobile gensets are being used in various places, as power distribution line construction, an emergency power supply in the event of a disaster, mobile power supply equipment, or an emergency power supply unit. In the field where mobile genset is used, there is a shortage of skilled workers due to the recent decline in the labor force population in Japan. Along with this, the percentage of workers who lack experience and are inexperienced in technology is increasing. For this reason, there is a problem that it is difficult to pass on the skills and know-hows to the unskilled workers. To solve this problem, we introduced a development process that uses the user's point of view, and designs the optimal method to achieve the purposed action. We also developed a control device for the mobile genset. This device can be operated by unskilled workers without any confusion. This paper introduces the Human Centered Design (HCD) process that was put into practice when developing software for touch panels in the control device for the mobile genset.

2 HCD Process

The HCD process defined in the International Standard ISO 9241-210 was applied. Fig. 1 shows the HCD process. This process consists of four steps: "Understand and specify the context of use", "Specify the user requirements", "Produce design solutions to meet user requirements", and "Evaluate the designs against requirements". It returns to the appropriate step until the evaluation result meets the requirements, and then repeats[1][2]. The details of the four steps are shown below.



Note: The design was made based on the HCD process defined by the International Standard ISO 9241-210:2019.

Fig. 1 HCD Process

The HCD Process consists of 4 steps: investigation, analysis, design, and evaluation. Until the result of evaluation meets the requirements, the current process is returned to an adequate step and necessary actions are repeatedly taken.

2.1 Understand and Specify the Context of Use

Our design-related departments wanted to improve the operability and visibility of the touch

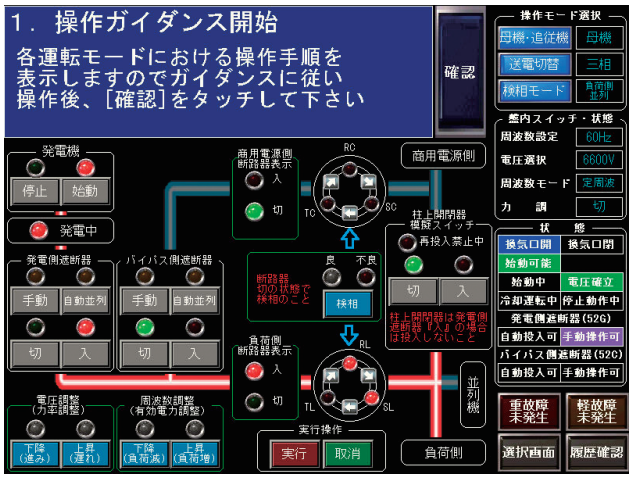


Fig. 2 Conventional Touch Panel Screen

The conventional screen reproduces the actual image of operation panel with the illuminated pushbutton switch.

panel in the control device of the mobile genset. First, we interviewed the design engineer in charge to understand the current situation. We asked about usage and basic operation method. Next, we conducted a semi-structured interview using a prepared questionnaire to delve further with questions according to the answers provided. Fig. 2 shows a conventional touch panel screen. In the conventional screen, the image of the operation panel using the push button switch was reproduced as it was on the screen. Originally, we should have investigated the touch panel usage status of the workers to understand potential challenges, but this time the project-related design engineer and sales engineer had already discussed these with the customers and the problem was clarified. As such, this investigation was not conducted. Two goals of this development project were set according to their inputs. The first was to make the operation method easy for unskilled workers to understand, and the second was to improve the visibility of the screen in the outdoors.

2.2 Specify the User Requirements

In order to analyze the obtained information and clarify the required requirements, we examined what were the difficult points of the operation method. The operation procedure was grasped and organized from the operation manual and the guidance message on the conventional screen. The operation procedure is somewhat different depending on the specifications, but the whole is classified into “arrival at the site”, “preparation for power supply”, “start of power supply”, “stop of power supply”, and “cleanup process”. The procedures in each classification are arranged for each of the steps so that we can get the overall picture of the matter. As a result, it became clear that there is a large amount of information to be remembered at the time of work such as each work specifics and its confirmation items. In order for an unskilled worker to conduct work, it is necessary to either memorize work information or proceed while simultaneously checking the operation manual, which we expect is a burden. As a countermeasure, it was assumed that it was “easy to understand” to display and support the necessary work information.

The mechanism for encouraging workers to operate has already been implemented as the guidance function on the conventional screen. We, therefore, examined a more effective method of transmitting information. We devised a screen configuration in which photographic images are placed in the main screen and supplemented with text information. This proposal was discussed with the person in charge of design and technology. From this idea, we concluded that the User Interface (UI) in the wizard format, which guides the operation interactively, was appropriate as an operation method suitable for unskilled workers.

The most influential factor in the second goal, “improving the visibility of the screen outdoors”, is the display performance of the Liquid Crystal Display (LCD) monitor on the touch panel. When the LCD monitor is used outdoors, the visibility varies greatly depending on the performance of the monitor. In this development project, a high-brightness type touch panel display was adopted in consideration of the usage environment, and the problem of the performance of the LCD monitor was solved. There were two possible design points to improve the visibility of the screen. The first was to use a color scheme with a large contrast in brightness so that the difference can be clearly viewed, and the second was to adjust the character size with respect to the viewing distance to improve readability. We drafted and studied a screen design plan that took these factors into consideration.

2.3 Produce Design Solutions to Meet User Requirements

We created a paper prototype for us to clearly convey what the wizard format is and what effect it had. Fig. 3 shows an example of the screen. A

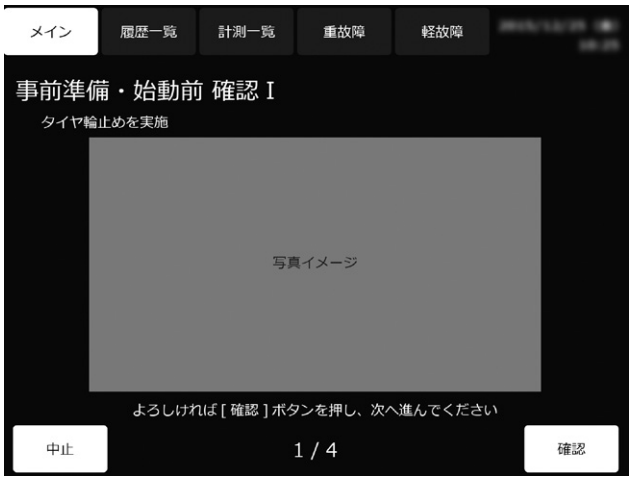


Fig. 3 Example Screen of Paper Prototype

Display element in the screen is expressed in monochromatic mode. Screen configuration and transition are examined in a simplified manner.

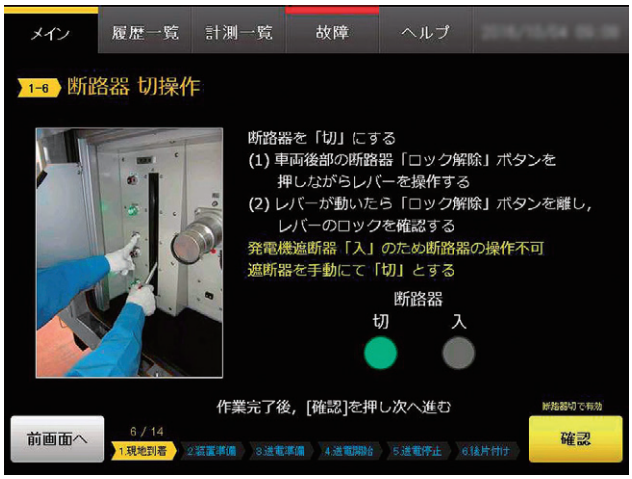


Fig. 4 Designed Touch Panel Screen

We designed the interactive UI that only shows what needs to be done and progresses by checking and executing.

paper prototype is a simple screen configuration plan aimed at confirming screen display elements and screen transitions. The display elements on the screen are expressed in monochrome. First, considering the ease of deployment from among the power supply methods, we created a paper prototype of the “Power supply method from mobile genset to the stop section”. The screen configuration is to display a picture and explanation of one work detail per screen, and show only the information on the work to be done at that moment. This paper prototype was shared with the parties concerned. Regarding the displayed contents, we examined and adjusted the specific operation procedure, such as those that are easier to work with by displaying several tasks together and the one that should be disassembled and explained in an easy-to-understand manner. A team consisting of a design engineer, a sales engineer, and a sales representative made a presentation to the customer using the modified paper prototype. As a result, a wizard-style operation method was adopted. After that, other power supply methods were also considered in this paper prototyping.

In parallel with paper prototyping, we also proceeded with screen design work. **Fig. 4** shows the designed touch panel screen. A menu button to switch functions was placed at the top of the screen, and was always displayed to clarify the function. Since the operation is performed by directly touching the screen, the operation buttons on the screen are three-dimensionally expressed by the gradation so that the worker can clearly distinguish them with a color scheme that is highly visible. In addition, the operation buttons are fixed in position so that workers do not get lost during operation. Frequently used buttons such as confirmation buttons are placed at the bottom of the screen so that the information is not hidden by the operating hand. If the required operating conditions are not met, the button becomes inoperable and the next step cannot proceed. The work process is displayed in the center of the lower part of the screen so that one can check the total number of steps in the current process and the step number one is currently in. The size of the button is such that it does not interfere with operation even when wearing work gloves. The language on the button should avoid technical terms as much as possible so that anyone can understand its meaning.

As for the size of the characters in the operation explanation, we set the minimum character

Fig. 5 State of Visibility Examination Using Touch Panel Display

Under indoor and outdoor conditions, the screens were displayed at a touch panel display and the ease of visibility was examined.

height to 5 mm so that it can be read without any problem at a position where the touch panel display can be reached, and it can be read even within a viewing distance of 1 m. The content of the explanation was expressed simply, and one sentence was limited to 50 characters or less. In order to determine the color scheme, we examined it with the actual touch panel display to be used. Fig. 5 shows a state of visibility examination using a touch panel display. Two design proposals with a light background color and a dark background color were displayed on the screen, and the visibility was verified by the parties concerned. We examined each of them from a position that can be reached outdoors and in the indoor (viewing distance 400 mm) and a position slightly away (viewing distance 1000 mm), and decided on black as the background color because the explanation was easier to read and highly visible.

When the operation method and screen design were settled, the designer created a UI prototype. This prototype can be actually operated, and we can experience the operation of the touch panel, screen transitions, and the visibility of the displayed information.

2.4 Evaluate the Designs against Requirements

In the early stages of development, the paper prototype was evaluated twice by the customer and internal project members.

We evaluated whether the display information such as work procedure, work explanation, work explanation image, button language, and numerical display was appropriate for the actual work, and whether the wording and operation method are consistent in the system. At this stage, the parties concerned adjusted the perception of the overall operation flow so that no major rework would occur in the future.

After deciding the operation flow, the customer and internal project members evaluated the UI prototype four times. The items to be evaluated are the screen transition, tactile operation, feedback information, information display content, and display timing. At this stage, we evaluated whether the screen transition and UI were appropriate in the movement while operating the prototype. At the same time, the wording such as work explanations, work explanation images, and buttons were adjusted each time. By using the prototype in this way and repeating the design and evaluation while verifying how to use it, the quality of use of the touch panel was improved.

During the development process, we asked field workers about the touch panel screen and confirmed the ease of understanding of the work explanation image. Furthermore, after the product was delivered, we were able to hear valuable input from skilled workers that would lead to the next development.

3 Postscript

We introduced the HCD process that was applied during the software development of the touch panel display for the mobile genset's control device. By incorporating the HCD process, we contributed to the development of products that meet the requirements of our customers. We will continue to utilize this HCD process to develop products that contribute to solving customers' issues.

《References》

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