A development of user interface on a new model of automatic washing-drying machine

Keiko Ishihara
School of Psychological Science
Hiroshima International University, Japan
k-ishiha@he.hirokoku-u.ac.jp

Ryo Nakagawa
School of Psychological Science
Hiroshima International University, Japan

Shigekazu Ishiahra
School of Psychological Science
Hiroshima International University, Japan

Yoshihisa Fujiwara
Hirofumi Sako
Masahiro Naito
Sanyo Electric, Co. Ltd.

Abstract

Purpose – About one third of all automatic washing machines sold in Japan in 2007 had built-in dryers. The operation of the machines can be difficult because of the many functions it offers. The aim of this study was to improve the usability of a new model of washing machine.

Methodology/Approach – The authors conducted usability experiments in both the planning and preproduction phases of the new Sanyo AWD-AQ3000 prototype, comparing it to the conventional model. The subjects were asked to set the machine to perform the designated washing tasks using the two simulator and preproduction panels. The time and the sequence of steps to complete each task were recorded along with a subjective 5-point irritation score for each subject. All operations were recorded on video tape. The hierarchical task analysis was used to determine the incorrect steps. The new model using the improvements based on the results was released in February 2008.

Findings – Based on the results of the analysis at the planning phase, we decided to use the control knob to alleviate the operational steps and irritation score, and isolate the mode-selection buttons from the others. The locations of the start button and the control knob were also changed. The rotation of the control knob was consistently related with curved arrows pointed both ways on the horizontal display of LCD. Based on the results at the preproduction phase, in particular, changing the layout and adding the control knob was found to improve the results for the waterless function

(disinfects and deodorizes using ozone instead of water) task, the average completion time of which was 34.5% that of the conventional model. Small problems noted in the experimental stage were fixed on the final production model.
Originality/Value of paper – The practical case example of usability improvement for the commercial product development, from the planning phase to the release was described.

Keywords *Usability, Automatic washing-drying machine, Hierarchical task analysis, Quantitative analysis*

Paper type *Research paper*

1. INTRODUCTION

About one third of all automatic washing machines sold in Japan in 2007 had built-in dryers [1]. Factors such as the increase in working parents and pollen allergy measures have contributed to the increase in sales of automatic washing-drying machines.

The operation of such machines becomes more complex and difficult as they offer more and more functions. Manufacturers provide more functions on automatic washing machines according to changes in family structure or customers' ideas of personal hygiene. For example, futons and blankets, which are rarely sent to the dry-cleaner, are usually washed at home using the heavy- or wool-washing programs of washing machines. Residents of apartment buildings often use a quiet-wash or time-delay program.

In addition, Sanyo Electric has added a new waterless cleaning program for disinfecting and deodorizing items such as leather-goods and stuffed toy animals, which have always been difficult to maintain at home.

As the number of functions increases, the users require simpler operating methods. The user interface must enable a wide variety of users to find the functions they need among the many available, and select the settings that are appropriate to their immediate washing requirements.

2. SIMULATED USABILITY EXPERIMENT

The usability of the control panel was a consideration right from the planning stages of the new washing machine.

2.1 Settings

This study examined the control panels of the conventional AWD-AQ2000 model and the proposed AWD-AQ3000 prototype, which incorporated a new control knob in a modified layout. Both panels were replicated in simulations using touch screens.

Seven women participated in the experiment. They were all over 30 years old and had used automatic washing machines before.

The experiment required the performance of 7 tasks: turning on the power, selecting either the wash or wash-dry mode, selecting the wash program, selecting the wash settings, setting the timer, setting the water-saving mode, and setting the "air-

washing" (waterless) function. The instructions given to the participants were, for example, "wash the wool sweater without drying it" or "deodorize the leather shoes".

The subjects were asked to set the machine to perform the designated washing tasks using the two simulator panels. The time and the sequence of steps to complete each task were recorded along with a subjective 5-point irritation score for each

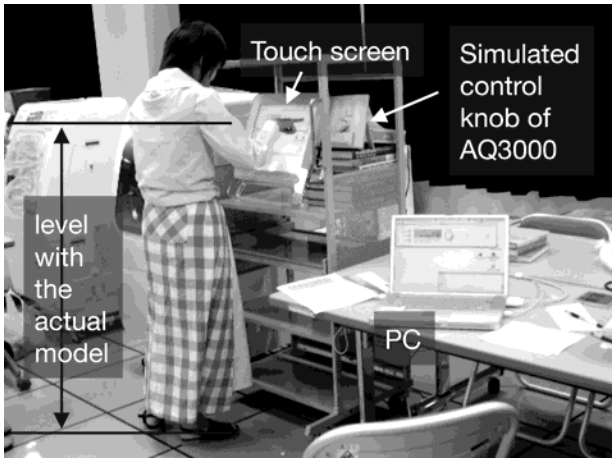

Figure 1. A snapshot of usability experiment on the simulators.

subject. All operations were recorded on video tape.

2.2 Results

The total irritation score for all participants and tasks was found to be significantly less for the new prototype than for the conventional model ($df = 1$, $F = 9.0645$, $p = 0.0032$). The task completion times showed no significant differences. The number of operations was reduced using the control knob. The subjects liked this since they had fewer buttons to push.

The hierarchical task analysis [2] shown in Figure 2 was used to determine the incorrect steps. The current choices were laid out horizontally and the subjects' sequence of operations were listed vertically. The points at which subjects got lost were found by comparing the results with the correct operating sequence.

Based on these results, we decided to use the control knob and isolate the mode-selection buttons from the others. The locations of the start button and the control knob were also changed.

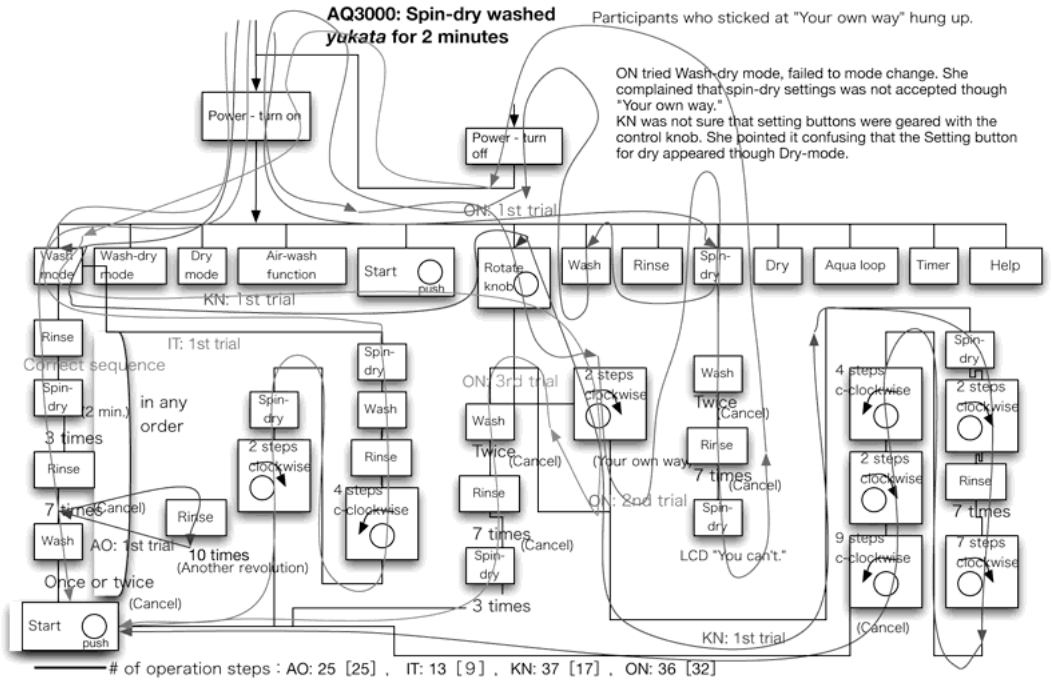

Figure 2. An example diagram of hierarchical task analysis for the task "to spin-dry washed *yukata* (Japanese summer kimono) for two minutes." The procedure starts with "turning on power" drawn on the top of the diagram. Choice buttons and control knobs are drawn as connected boxes. The designed procedure and the participant's actually performed sequences were traced as lines with arrowheads.

3. RELATIONSHIP BETWEEN CONTROL KNOB AND DISPLAY

A general procedure was used to select the main flower, determine the final shape of the arrangement, and then to choose other flowers with suitable colors and shapes.

3.1 Settings and results

Before starting the usability experiments, we conducted a study of the relationship between the operation of the control knob and the display on the liquid-crystal display (LCD). The participants, 120 university students and teachers aged 20–61, were asked which program they expected to be indicated on the display when they turned the knob clockwise. Their responses were recorded for three types of display. The display types and number of responses are shown in Table 1. Display type A had two triangles pointing right and left, similar to railway station signs. Curved arrows on Type B also pointed both ways. Curved arrows on the Type C display were associated with the rotation of the knob. We adopted the Type B display since it got the most identical responses from participants, while the responses to Type C display were divided in almost half.

3.2 Comparison to other rotary controls

The suitability of the relationship between a rotating control and a quantitative display is one of the classic problems described in [3]. Wheel-type controls have recently been used on new devices such as the Apple iPod and the Sony HandyCam for choosing one item from a list. In those two devices, the association is completely rotated clockwise in 90 degrees; the displayed items are listed in a column and the

pointer moves up or down when the user rotates the control wheel counter-clockwise or clockwise, respectively. The size and shape of our control panel were constrained by the hardware, so a new association between the control and display in a row had to be developed.

Table 1. Compatibility between display and the rotary control knob.
Question given to the participants: The course "標準 (*hyoujun*; standard washing)" displayed at the center of LCD is now focused. When turning the control knob a division clockwise, which course do you expect to be focused next, "カビガード (*kabi-gaado*; keeping mold out)" or "おいそぎ (*oisogi*; quick washing)"?


Control knob

Shape of arrows	Display on LCD	
Type A	カビガード ◀ 標準 ▶ おいそぎ	N.A.
Number of answers	21 (17.5 %)	96 (80.0 %)	3
Type B	カビガード ◤ 標準 ◥ おいそぎ	N.A.
Number of answers	13 (10.8 %)	105 (87.5 %)	2
Type C	カビガード ◤ 標準 ◥ おいそぎ	N.A.
Number of answers	61 (50.8 %)	56 (46.7 %)	3

4. USABILITY EXPERIMENT ON THE TEST MODELS

4.1 Settings

Fifteen male and female washing-machine users 30–61 years old, and 25 others approximately 20 years old, participated in the usability experiment. As shown in Fig. 3, they were asked to use actual models of the conventional washing machine and the improved prototype for the six specified washing tasks of the first experiment, excluding the use of the water-saving mode. The time, the sequence of operating steps, and the irritation measure were recorded.

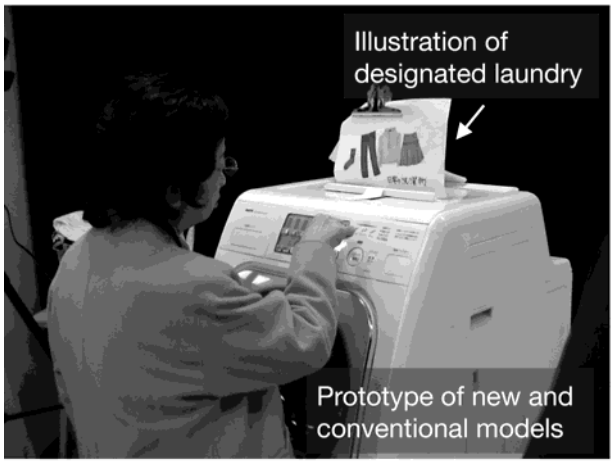

Figure 3. A snapshot of usability experiment on the prototype models.

4.2 Results

The results for all six tasks on the new model were better than on the conventional machine. The overall performances for each measurement, for all participants and all tasks, are shown in Table 2. There was no significant difference in the total completion time between the two models, while total number of steps and the total irritation score were significantly reduced for the new model. We tested the difference in the measurements for the two models by the Wilcoxon matched-pair signed-rank test because we recognized that all of the distributions were not normal.

We then focused on the performance of the participants 30 years and older because they were the most like our target customers. We found that all measurements were significantly reduced for the new model.

In particular, changing the layout and adding the control knob was found to improve the results for the waterless function (disinfects and deodorizes using ozone instead of water) task, the average completion time of which was 34.5% that of the conventional model.

The results of the hierarchical task analysis for 15 participants aged 30 years or more showed there were still a few problems with selecting the correct washing program on the test model. Six participants missed setting the wash/dry mode first, even though this was better than in the case of the conventional model.

Some participants almost pushed the power button instead of the start button. The participants who discovered how to rotate the control knob for selecting the washing program and settings performed those tasks smoothly.

Table 2. Comparison between new and conventional models with average measures over all tasks for all 40 participants.

Measures / Models	Average completion time	Average steps**	Average irritating measure*
AQ3000 (new prototype)	28.3 sec	11.8	1.9
AQ2000 (conventional)	31.1 sec	16.4	2.0

(*$p < 0.05$, **$p < 0.01$)

Table 3. Comparison between new and conventional models with average measures over all tasks for 15 participants who were 30-61 years old.

Measures / Models	Average completion time **	Average steps**	Average irritating measure**
AQ3000 (new prototype)	26.3 sec	11.2	1.8
AQ2000 (conventional)	34.9 sec	18.2	2.2

(*$p < 0.05$, **$p < 0.01$)

Table 4. Comparison between new and conventional models on the task of the appealing function "Air-wash." The measures were averaged over 15 participants who were 30-61 years old.

Measures / Models	Average completion time **	Average steps**	Average irritating measure*
AQ3000 (new prototype)	12.5 sec	3.6	1.3
AQ2000 (conventional)	36.2 sec	11.5	2.3

(*$p < 0.05$, **$p < 0.01$)

5. ADDITIONAL IMPROVEMENT

Small problems noted in the experimental stage were fixed on the final production model. The colored line on the start button was changed so that it should be easily distinguished from the power button. Rounded squares were added to the menu illustration on the control panel to indicate that the user should rotate the control knob. The final design is shown in Figure 4. The new model using these improvements was released in February 2008.

(a) Body of the new model.

(b) Improved operation panel and the printings.

Figure 4. Released model of SANYO AQUA AWD-AQ3000.

REFERENCES

Sanyo Electric, Co. Ltd., News release on January 21, 2008. http://www.sanyo.co.jp/koho/hypertext4/0801news-j/0121-1.html

Stanton A and Young MS. A Guide To Methodology In Ergonomics. Taylor & Francis: London 1999.

Sanders, MS and McCormick EJ. Human Factors in Engineering and Design Seventh Edition. McGraw-Hill: New York 1993.