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The Usability of Respiratory Protective Device on Instruction with Images

Sakol Teeravarunyou and Pongsak Kitirojpan***
School of Architecture and Design,
King Mongkut's University of Technology Thonburi,
126 Pracha-utid Road, Bangmod, Toongkru, Bangkok, Thailand
*E-mail: *sakol.tee@kmutt.ac.th, **pongsak.kit@kmutt.ac.th*

Abstract

Respiratory protective device (RPD) for the fire escape requires a safety instruction to guide the way to use it. The printing instruction was placed on the package so users can read the instruction without training. Similar to the safety instruction on airplane, the instruction is mainly image rather than word. The more understandable images, the more chances for users to escape from the fire. The objective of this study is to find out how the printing images can assist the usability of the product. The comparison of the image elements are arrow guided action vs. non-arrow indicator, holistic view vs. close up view, and full-detail vs. ignoring parts. Six subjects were assigned to view random images with eye tracking device.

Keywords: Instruction, Printing Images, Attention

Introduction

Most of new safety product requires users to read or see the demonstration how to use the product. For example, the flight instruction requires air hostess to demonstrate how to use the safety life jacket. In the same way, the respiratory protective device is another type of safety equipment that is used for fire escape. Currently, the international standard such as DIN EN 137 requires a training instruction before use [1]. Such this kind of product was used in office and hotel, it is impossible to give a demonstration for a dynamic change of users. As a result, the printing instruction is crucial for this type of product. The instruction should convey the meaning clearly and fast in reading speed.

Most of an existing flight instruction is a printing image more than text, since it is good for international passengers in terms of the language and communication. To make the printing images more usable, the study of cognitive performance is the key issue. From the review of instruction design, Chandler et al. studied about the cognitive load theory and the format of instruction. He tested the instruction with separated notes versus the instruction with notes on the diagram [2].

Basic of eye movements were made in the context of research on reading. The eye movement can reveal the visual attention and visual scan. For this research, the visual fixation is the maintaining of the visual gaze on a single location. Reading involves fixating on a successive locations across the page or screen. The fixation may consist of a number of view positions. If there are five view positions in a circle with a radius of 7 mm. It counts as 1 fixation. A fixation must have a minimum duration of 200 ms [3].

Experimental

The example of instruction is extracted from Fire-Pak, a fire escape respiratory protective device, which contains 6 donning steps. There are three sets of experiment in this study.

Experiment 1 – Arrow and Non-arrow Indicator

Figure 1. Non-arrow versus Arrow

The first set of experiment is a comparison between arrow and non-arrow indicators on the images (see two example in Figure 1). In order to avoid the transitive learning of the same image, they were flipped and random presented. The arrows represent the direction of action and function. For example, the pulling string action has two arrows beside the hands.

Experiment 2 – Holistic and Close-up View

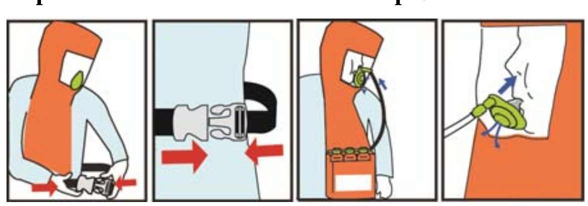

Figure 2. Holistic versus Close-up View

The second set of experiment is the holistic image comparing with the close-up image. The holistic image is a view that illustrates the whole picture, for example, a whole body of man wears the belt. The close-up image contains only a view that would like to present only, for example, the image of belt on waist.

Experiment 3 – Full Detail and Ignoring Part

Figure 3. Detail versus ignoring part

The third set of experiment is the design of different levels of details. The instruction which contains full-detail objects and the instruction which has the rough details on irrelevant object and facial expression are compared.

Three sets of experiment are displayed on a computer screen, each image appears on the screen for 6 seconds. Six subjects are assigned to view the images – 4 females and 2 males. Before the first image appears, the countdown title will prompt the subjects' readiness. The subject is asked to watch each set of instruction while wearing an eye tracking device. The eye tracking device, head mount type "IVIEW X HED" from SensoMotoric Instrument (SMI) is being used in this experiment. All recorded data is sent to IVIEW software to be analyzed. Before each testing session, the calibration process is prepared in order to synchronize the eye position to the watching area.

After finishing the eye tracking, the subject needs to complete a questionnaire while watching all images in each set. The questionnaire was set to test the subject's interpretation of each image meaning and the subject was asked for the better image which conveys such meaning. For the first experiment with arrow, the subject was requested to rate how the arrows assist the donning process more understandable. In order to understand how the subjects have a focus attention on the image, the Area of Interest (AOI) was defined based on the components of objects on images such as hood, cab, face, belt and others. The footage video from eye movement was recorded. Then, all footages are analyzed by Begaze software, the AOI is drawn to divide the instruction image into different portions and measured in terms of fixation.

Results and Discussion

Experiment 1 – Arrow and Non-arrow Indicator

The assumption of this experiment is that the arrows assist subject in terms of highlighting the action and image interpretation. From the experiment, the subjects spent most of the fixation time on the arrow for 'Press valve', 'Pull hood', 'Wear hood', 'Breath-in & out','Pull neck rope' and 'Fasten belt' images respectively. The reason that the last three images have less fixation time(761, 459 and 140 ms.), since there are more than one arrow indicator.

Table 1 Average time spending for arrows in six images .

Images	Pull hood	Wear hood	Fasten belt	Pull neck rope	Press valve	Breath in & Out
Average time(ms.)	1058	1041	140	459	2373	761

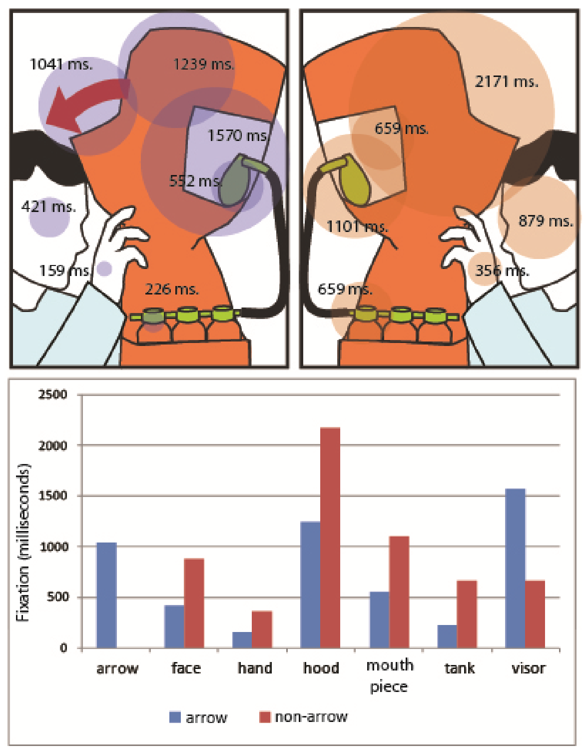

Figure 4. Highlights average number of eye fixation time(above) on 'Wearing hood' image

Figure 4 (above) is an example of size of circle which represents the fixation time. When having the arrow, subjects will move their eyes to the arrow part around 1,041 ms. When looking at the average time of six subjects on Figure 4 (below), some objects have more fixation time such as visor, while some have less such as hood. From the testing of six subjects found that five of six subjects look at the arrow. Only one subject did not pay attention on the arrow. The reason is that he understands how the arrow functions already and does not spend time to look at it.

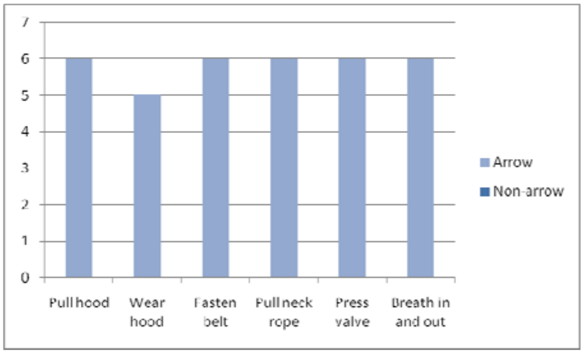

Figure 5. Ratio between arrow and non-arrow selection

The result from the questionnaire shows that subjects preferred to have an arrow instead of non-arrow nearly 100% (see Figure 5). Nevertheless, some of the images can understandable without arrow such as 'Pull hood', 'Tight the rope' and 'Fasten belt'. The subject can guess the action without arrow. On the other hand, the subject interpreted the wrong meaning on non-arrow image such as 'Breath in and out'. The arrows of these images indicate the direction of action clearly, for example, the arrow heading to the nose is "breath in" and arrow that comes out from the mouth is "breath out". Another function of the arrow is used to indicate the direction. For example, 'Press valve', the arrow indicates the location of finger press.

Experiment 2 – Holistic and Close-up View

The assumption of the second experiment is that the focus image is better than the holistic image in term of eye movement and interpretation.

Figure 6 shows that most subjects' fixation time is on the belt around 3,452 ms in the close-up view, while the fixation time in the holistic view is only 1,231 ms. As a result, the fixation time between the holistic and the close-up view has a significant difference. On the other hand, the interview reveals that the subjects preferred the holistic view than the close-up view. It is quite contradict between what subjects saw and what they preferred. They said that they would like to see the location of the belt including the whole human body.

Figure 7 is another example of study that includes inward and outward arrows which represent how to breathe in and out. The result shows that the subject spent most of the time in AOI of breath-in and mouth piece. From the interview, the result supports the outcome from eye tracking by selecting the close-up view more than the holistic view.

From the interview, the subjects must select the choice between the holistic and close-up views (see Figure 8). Some subjects did not select both images since they are not clear to them. The subjects select the images based on the context and their interpretations. Half of the subjects select the holistic view and another half selects the close-up view.

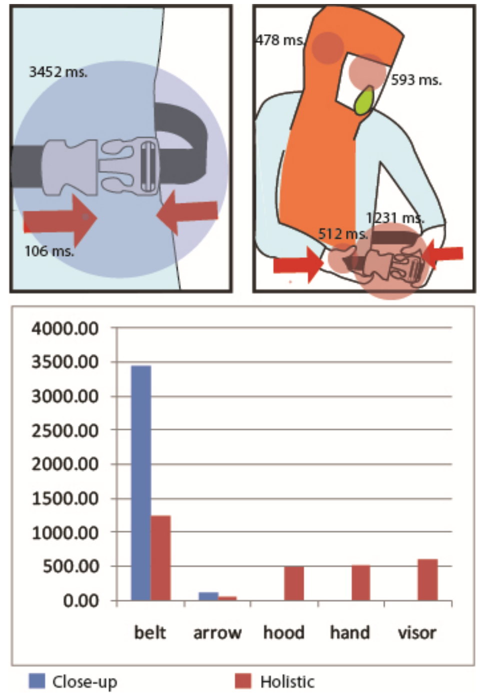

Figure 6. Highlights average number of eye fixation time(above) on 'Fastening Belt' image.

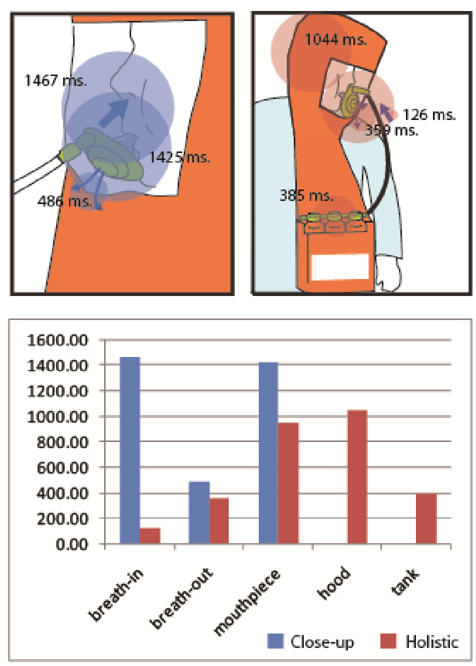

Figure 7 Highlights average number of eye fixation time(above) on 'Fastening Belt' images.

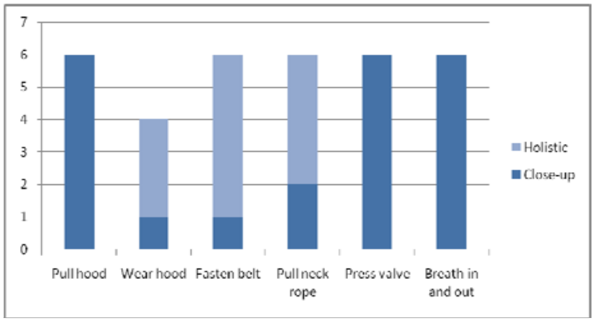

Figure 8. Ratio between holistic and close-up views.

The holistic view images are ‘Wear hood’, ‘Fasten belt’, Pull neck rope’. These kinds of images require the human as a way to locate where the action happens. On the other hand, ‘Pull hood’, ‘Press valve’ and ‘Breath in and out’ are more likely to be the close-up image to understand the function in details.

Experiment 3 – Full Detail and Ignoring Part

The assumption of the third experiment is that it is not necessary to have all details in the images. There is no significant difference of the fixation time of AOI between full-detail and ignoring part. The subjects can save their time of reading on the detail and still interpreting the right meaning.

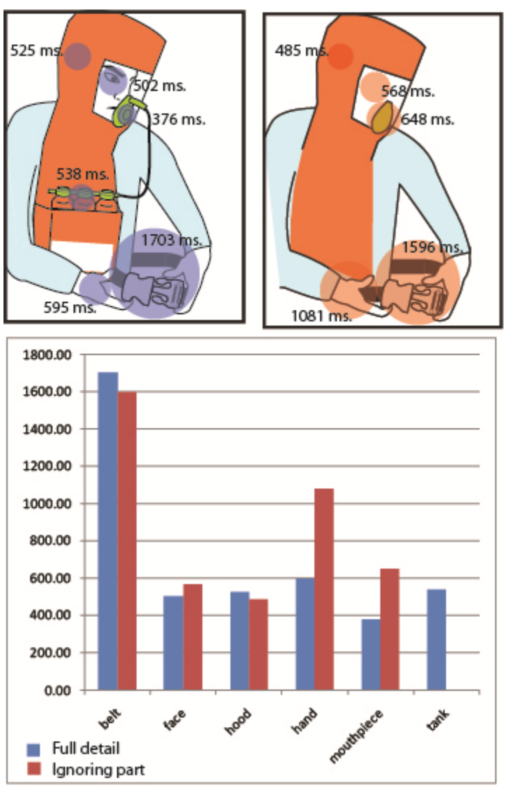

Figure 9. Highlights average number of eye fixation time(above) on ‘Fastening Belt’ images.

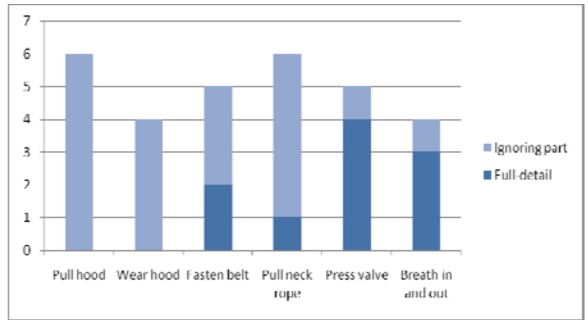

Figure 10. Highlights average number of eye fixation time(above) and graph of AOI

Figure 9 is an example of full-detail and ignoring part. In the experiment, the details such as face, canister and tube are added into the images. The result shows that the average fixation time of both images is not so much difference. Subject still spent time to look at the image in the same location. From the observation found that subjects do not pay attention much on the detail that is not related to the main action. As a result, ignoring the detail is effective and delivery the similar outcome as full-detail.

From the interview, subjects preferred to use both ignoring part and full-detail. They select the most detail of the image of ‘Press valve’, since the rough detail cannot tell how the product functions. As a result, the full-detail is appropriated in the context of product function. The full-detail is quite closed to the video demonstration or photography of image that can describe the function clearly. On the other hand, the ignoring part image is a simplify version of the reality. It is easily to understand and use less time for reading.

Conclusion

For experiment 1, arrow is crucial element to be used in instruction design. It shows how the product works including the direction of action. Many subjects spent time to see the arrow as one of the major element. The fixation time on arrows ranges from 140 to 2,373 ms.

Experiment 2 shows that the guideline to use holistic and close-up view depends on the context of presentation. The close-up image reveals that the fixation time increases when the image is enlarge. Nevertheless, subject selected the images based on the context and their interpretation.

The third experiment shows that the fixation time of full-detail and ignoring parts is not so much different. Only some images require full-detail that needs to show how to use product cautiously such as ‘Breath in an out’ and ‘Press valve’ images.

From the study, the eye tracking could be used to reveal the user’s attention on image based on fixation time. Nevertheless, the interpretation of images is crucial to understand the users’ perspective. The study of an instruction with image is not only benefit to the industry but it also increases the safety of product.

References

1. DIN EN 137 Respiratory protective devices – Self-contained open-circuit compressed air breathing apparatus with full face mark – Requirements, testing, marking (2007).
2. Chandler, Pual and Sweller, John: Cognitive Load Theory and the Format of Instruction, Cognition and Instruction: 8(4) 1991, 293-332.
3. Zwerina, H. Erkennung von Sehzeichen in unterschiedlichen Strukturen auf dem Bildschirm. Doctoral dissertation, University of Karlsruhe. John Doe (1992).

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Biography

Asst. Prof. Dr. Sakol Teeravarunyou received his B.Arch. degree in Industrial Design from King Mongkut's Institute of Technology Ladkrabagn in 1995, Master degree in Interface Design from the Ohio State University in 1997, and a Ph.D. in Design Methods from Illinois Institute of Technology in 2001. Since 2001 he has worked in King Mongkut's University of Technology. His work has primarily focused on the usability testing, including human perception, eye tracking and image usability issues. He is a member of the Ergonomics Society of Thailand.

Mr. Pongsak Kitirojpan received his B.Arch. degree in Interior Architecture in 2003, and Master degree in Building Technology program from King Mongkut's University of Technology Thonburi in 2008. Currently he has worked in King Mongkut's University of Technology as a researcher. His work has primarily focused on lighting, energy and wind simulation.