THE EFFECTIVE COMPARISON OF FEEDFORWARD TRAINING OF VISUAL DEFECT INSPECTION PATTERNS IN WELDING

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ABSTRACT

Welding inspection is a vital element in ensuring safety and quality of the welding. The human inspector performing visual inspection of welds is the gist of welds inspection process. Training is an effective strategy for improving inspection performance of inspectors. Training strategies for visual inspection have presentations of feedforward information are widely used forms of training. Feedforward information can be useful for novice inspectors, which may not be have knowledge of the visual search method in welds inspection. This study compares the performance of three feedforward training from visual defect inspection patterns in welds on visual inspection performance, consist of the mean search time of defect search and the percentage of defects detected. A random search pattern, vertical search pattern and horizontal search pattern were used to feedforward information on visual search strategy. 15 students attending at Production Technology Education Department, King Mongkut's University of Technology Thonburi were initially enrolled in the study. The completely randomized design (CRD) were applied in the experiment. The analysis of variance on the mean search time of defect search and the percentage of defects detected was not show a significant treatment effect ($F=1.342$, $P>0.05$), ($F=3.072$, $P>0.05$). Based on the results of this study, feedforward training from the vertical search pattern had the most percentage of defects detected and feedforward training from the random search pattern has the least average time in defect search.

1. INTRODUCTION

Inspection is a major quality control component for many industrial tasks, such as food industry, aircraft maintenance, printed circuit assemblies and welding. The criticality of inspection in manufacturing and production becomes evident when the potential consequences of missed defects are examined. In some cases, defect causing damage to the workpiece. Visual inspection provides the basic element for evaluation of structures or components being fabricated and maintained. Welding inspection is a vital element in ensuring safety and quality of the welding. It constitutes an important aspect of practicable quality control for weldments with joints that may require testing. Visual Inspection is a very effective inspection method, and it should be the primary method included in effective inspection and quality control. Visual Inspection it has been shown "Visual inspection, conducted by properly trained inspectors, results in the discovery of the vast majority of those defects which would only be discovered later by some more expensive non destructive test method" (Ted, 1997). Thus, the human inspector performing visual inspection of welds is the gist of welds inspection process.

Visual search and decision making are the two primary components that are important to visual inspection tasks (Drury, 1978; Sinclair, 1984). Visual search and decision making can be defined as the process of locating a defect within the area of interest and deciding whether the defect is acceptable or not (Deepthi, 2006). Visual search strategy is as a way of looking for defects and is reflected by the movement of the eyes, can be broadly classified into two types: random search and systematic search. Random search is search process in which each fixation is equally likely to occur anywhere in the search area (Bloomfield, 1975). Thus, the same area may be inspected multiple times. Systematic search is good search process because the same area is never inspected more than once or repetitive inspection (Williams, 1966). Performance of visual search can be measured by speed and defect detection accuracy (Performance measures) and used process measures derived from eye movements to evaluate visual search (Process measure) (Megaw and Richardson, 1979).

Training improves an inspector's task performance such as providing information or presentation of feedforward and feedback information (e.g., Drury and Gramopadhye, 1990) has been shown that training was indeed effective in improving inspection performance (e.g., Czaja and Drury, 1981) and (Gramopadhye, et al., 1993) has been shown to be an effective technique by which human factors engineers have sought to improve reliability in inspection. Feedforward training provided prior information such as basic information for inspection, rules to the inspector concepts and goals in the form of physical guidance, verbal guidance, or demonstration before the inspectors performs the inspection tasks. Therefore, the procedure for giving knowledge and training the inspectors so that the efficiency of visual inspectors in detecting the defects increase and the mistake in inspection decreases is an approach in developing the efficiency of visual inspectors. As a result, there should be a training or method, which could provide information to visual inspectors along with modern technology. This study objective is to compares the performance of three feedforward training from visual defect inspection patterns in welds on visual inspection performance.

2. EXPERIMENT

2.1 Experimental Apparatus

The tasks for visual inspection defects in welding is a simulation of a welds for a defects with shield metal arc welding process (SMAW), horizontal T – Joint. The welding material is steel size 100mm long 50mm wide and 5mm thick. Include 5 defects types: undercut, incomplete fusion, spatter, porosity and crack.

The computer program for visual inspection was designed and developed according scope and conditions of the program to inspect defect in welding. It is equipment that was used to record the visual inspection performance of inspectors (Fig. 1-3), implemented on a personal computer with Microsoft Windows operating system, color monitor 40 inch, Standard keyboard and Laser mouse.

Fig. 1 The screen to log in the computer program for visual inspection.

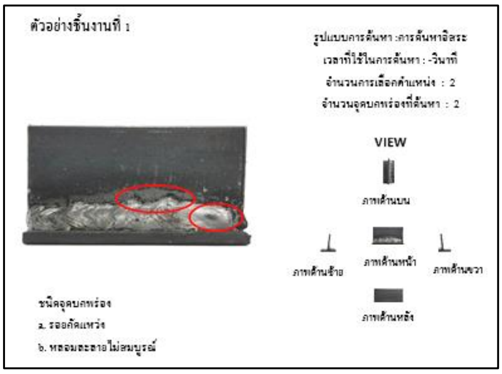

Fig. 2 Operating screen of the computer program for visual inspection.

Fig. 3 Data processing screen of the computer program for visual inspection.

2.2 Methodology

2.2.1 Participants. According to the test on their ability to detect the basic defects with the sampling group of 60 persons at Department of Production Technology Education, Faculty of Industrial Education and Technology, King Mongkut's University of Technology Thonburi between the ages of 18 and 20 years. We gained the sampling group of 33 persons who has the ability to correctly detect at least 50% and had a visual acuity of 20/20. This study utilized 15 subjects who were randomly assigned to one of the three groups so that each group had an equal number participants. The criteria for participation in the study were color vision, color vision was tested using ISHIHALA"S TESTS (Deepthi, 2006). 20/20 vision was tested using a Snellen's chart and the ability to correctly detect at least 50% (Watanpa, Kaewkuekool and Suksakulchai, 2011) of the defects presented to them in the familiarization phase of the study.

2.2.2 Variables. Independent variables were data derived from the training with feedforward data. Participants get information about defect search patterns: random search, vertical search and horizontal search. Dependent variable was the efficiency of visual inspectors measured by the mean search time for each defect search patterns and the percentage of defects detected.

2.2.3 Familiarization phase. Initially, all the subjects were to familiarize with the computer, a demonstration program was presented to the subjects, provided with a graphic and verbal description of the defect types and the inspection task before performing the experiment. The inspection task was consisted of inspecting 10 simulated (Deepthi, 2006), each workpiece have zero, one or two defect. In the familiarization phase data were collected on the mean search time for defect search. To guide the selection of a standard search time and subjects for the experimental, randomly assigned to one of the three groups so that each group had an equal number of participants.

2.2.4 Experimental design. A completely randomized design (CRD) was used for this experiment. The 15 subjects selected were randomly assigned to 3 groups along independent variables were data derived from the training with feedforward data.

Table 1 Table of experimental sequences design.

Feedforward Training	Experimental sequences				
Random search	s1	s2	s8	s9	s10
Vertical search	s3	s4	s7	s11	s14
Horizontal search	s5	s6	s12	s13	s15

s1-s15: experimental sequences (randomly assigned)

2.2.5 Training procedure. An overview of the experiment was presented to the subjects. First group received random search feedforward training (RFT), the subjects were also shown the tasks to be inspected and provided with a graphical, verbal description of the defect and random searching process. Second group received vertical search feedforward training (VFT), the subjects were also shown the tasks to be inspected and provided with a graphical, verbal description of the defect and vertical searching process and third group received horizontal search feedforward training (HFT), the subjects were also shown the tasks to be inspected and provided with a graphical, verbal description of the defect and horizontal searching process.

2.3 Procedure

Initially, all the subjects were to familiarize with the computer and the inspection task before receive feedforward training in experiment, the inspection task was consisted of inspecting 10 simulated. The 15 subjects were randomly assigned to 3 groups (Random search, Vertical search and Horizontal search), subjects underwent feedforward training under condition according to the group to which they were assigned. On completion of training, the subjects performed the inspection task from the computer program for visual inspection was designed at each of the 3 different feedforward training. The inspection task was consisted of inspecting 20 simulated.

Table 2 Table of experimental design.

Group	Familiarization phase	Treatment	Post-Test
Treatment Group (randomly assigned)	Familiarization	Feedforward random search training	Inspection task
		Feedforward vertical search training	Inspection task
		Feedforward horizontal search training	Inspection task

2.4 Data collection

Data was collected using the computer program for visual inspection was designed software's in-built data capture module from performance of visual search, mean search time and the percentage of defects detected for each defect search patterns (Dependent variable).

3. ANALYSIS

3.1 Results

Each of this data was used to analyze for normality test in order to verify that data collect from subjects was normal. Then, data to be analyzed by a one-way analysis of variance (One-Way ANOVA) was used to analyze and compare inspector's performance based on feedforward training methods, conducted on each of the dependent variable. The One-Way ANOVA result was shown in table 3 and table 4.

Table 3 The statistical analysis of one-way ANOVA for mean search time.

Source	SS	df	MS	F	P
Treatment	256.485	2	128.243	1.342	0.302
Error	1162.684	12	96.890	-	-
Total	1419.169	14	-	-	-

Table 4 The statistical analysis of one-way ANOVA for percentage of defects detected.

Source	SS	df	MS	F	P
Treatment	207.258	2	103.629	3.072	0.084
Error	404.855	12	33.738	-	-
Total	612.113	14	-	-	-

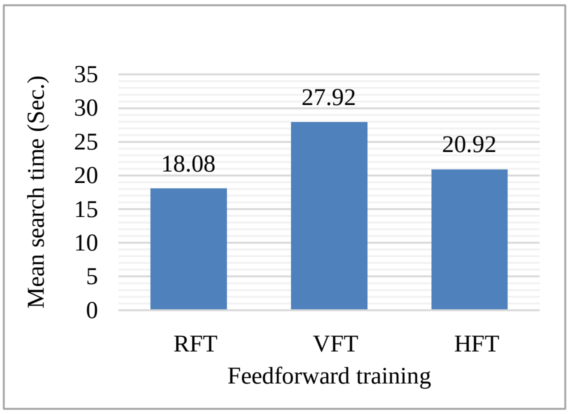

Fig. 4 The graph shows the mean search time of each search feedforward training.

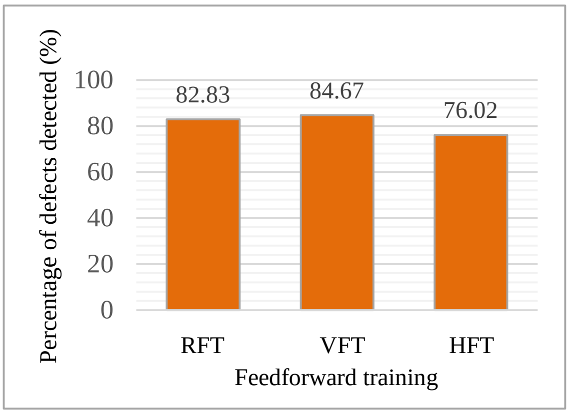

Fig. 5 The graph shows the percentage of defects detected of each search feedforward training.

The performance of visual inspection of mean search time and percentage of defects detected for the random search feedforward training, vertical search feedforward training and horizontal search feedforward training respectively was 18.08 sec., 27.92 sec. and 20.92 sec. (Fig. 4), 82.83%, 84.67% and 76.02% (Fig. 5). The One-Way ANOVA result was shown from table 3 and table 4 respectively, the statistic for mean search time of defect search and the percentage of defects detected was not show a significant treatment effect ($F=1.342$, $P>0.05$) (Table 3), ($F=3.072$, $P>0.05$) (Table 4).

4. CONCLUSION

The objective of this research was to compares the performance of three feedforward training from visual defect inspection patterns in welds on visual inspection performance. This study evaluated the effect of different search feedforward training on visual search performance. The conclusions of this study can be summarized as follows.

Based on the results of this study, it can be concluded that the effect of three feedforward training on mean search time and percentage of defects detected performance was not significantly different, feedforward training from the vertical search pattern had the most percentage of defects detected and feedforward training from the random search pattern has the least average time in defect search. This indicates that if inspectors want to have minimum mean search time, they should give inspectors to receive on the random search feedforward training, that if inspectors want to have maximum percentage of defects detected they should give inspectors to receive on the vertical search feedforward training. Feedforward information can be useful for novice inspectors, which may not be have knowledge of the visual search method in welds inspection.

Future applications of feedforward training are potentially numerous, generally related to improvement novice performance. Increase movement of the eyes of the inspectors to be more systematic.

5. REFERENCES

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