A Study of Inspector's Behavior for Increment Stopping Strategies

S. KAEWKUEKOOL[1], S. KONGSUWAN[2], S. SANGMUN[3]
[1]Department of Production Technology Education
King Mongkut's University of Technology Thonburi
126 Pracautit Rd. Bangmod Thongku, Bangkok 10140
THAILAND
http://www.kmutt.ac.th

[2]Computer and Information Technology Division
King Mongkut's University of Technology Thonburi
126 Pracautit Rd. Bangmod Thongku, Bangkok 10140
THAILAND
http://www.kmutt.ac.th

[3]Department of System Management Engineering
Inje University
607, Obang-dong, Gimhae, Gyeongnam 621-749
SOUTH KOREA

Abstract: The purpose of this paper was to study inspector's behavior for increment stopping strategies as multiple-target search. Visual task was simulated using program search task, which indicated X character as defect. The simulation task was contained of background characters A, K, M, N, V, W, Y and Z, which were filled up to 50% of searching area in each screen. Ten subjects were randomly chosen from undergraduate students at King Mongkut's University of Technology Thonburi (KMUTT) and had to be tested for 20/20. The experiment was consisted of one, two, three and four defects, which were totally equal to 100 points. Preliminary information was provided to subjects before running the experiment. The subjects were asked to perform the experiment by searching and detecting the defects without time limits. The result was shown that the inspector's behaviors had been affected by the pattern of which they were spent time in searching and stopping. Moreover, result was indicated that inspector's behavior was significantly affected by the number of defects in each screen at the level of 0.05.

Key-Words: Visual Inspection / Inspector's Behavior / Stopping Strategies

1 Introduction

At the present, there are many competitive to the market to keep customer's satisfactions. This would enforce company to have successful inspection on products. The best way to do this is inspection to detect defects on product before reaching and quality assurance to customer [1]. In this situation, how do human observers decide the stopping time? These questions are important in research issues related to visual search performance. However, visual inspection has been composed of two primary functions: visual search and decision making [2]. Visual search is inspector looked for defect and interested in the decision mechanism for determining a stopping time. Therefore, this would be indicated that if inspector does not have the experience, the bad product could be passed to external customers. This would be indicated that inspection is important in manufacturing industries [3]. Product inspection is one dimension of a comprehensive quality assurance program. While there are many forms of inspection, visual inspection is predominant. Humans are regularly assigned to visual inspection tasks even though it has long been established that their performance is not entirely satisfactory [4]. These functions are the main determinants of inspection performance and must be executed reliably for inspection to be successful.

This is largely due to the fact that human visual search behavior tends to be less multiple, which leads to incomplete visual coverage. However, the superior decision making ability of humans, along with their inherent flexibility, make them desirable inspectors. Thus, due to these and other shortcomings of automation [5, 6], methods to improve the search behavior of human inspectors are sought and interested in the decision mechanism for determining the increment stopping time.

However, those models were limited to the visual search task for finding one target. In this study, the optimal stopping time model of the one-target search is extended to that of a multiple-target search. Additionally the visual search program experiment was performed in order to investigate which optimal stopping time usage strategy is most effective.

2 Methodology

2.1 Visual Task

Visual inspection task was simulated search tasks indicated that X character was the defect. The simulation task was contained of background characters A, K, M, N, V, W, Y and Z, which were filled up to 50% of searching area in each search screen.

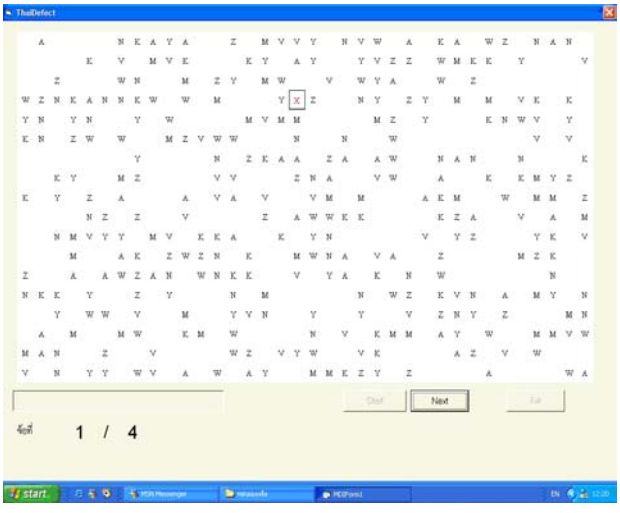

Fig. 1. Examples of visual inspection task for one defect.

2.2 Stimulus Material

The experiment was run by using computer Pentium IV, 1.5 GHz ram 512 MB with 17 inch monitor and using mouse to click for defect. The example of screen capture was showed in Figure 1. Figure 2 was showed the administrator display for creating visual inspection task.

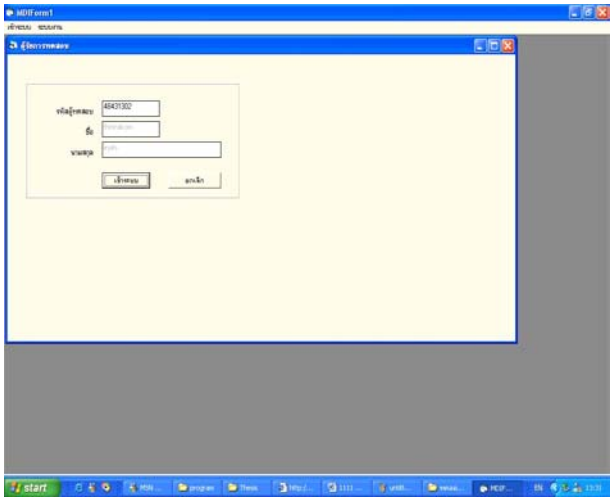

Fig. 2. Sample of administrator display for creating visual inspection task

2.3 Subject

Ten subjects were randomly selected from undergraduate students at King Mongkut's University of Technology Thonburi and were tested for 20/20. All these subjects were tested for 20 trials of pilot study and passed at least 60 percent of total defects detected.

2.4 Experimental Design

The experiment was consisted of one, two, three and four defects, which each defect was equal to one point and was totally equal to 100 points. All subjects were asked to perform test for 40 trials as showed in Table 1.

Table 1 Experiment design

Pattern	Number of defect	Trials of task	Percent of background	Total defects
1	1	10	50	10
2	2	10	50	20
3	3	10	50	30
4	4	10	50	40
Total	-	40	-	100

2.5 Procedure

All ten subjects who took part in visual inspection tasks for the experiment were provided preliminary information before running the experiment. They were asked to perform the experiment by searching and detecting the defects without time limit. There were 40 trials in the experiment, which were randomly presented to the inspectors.

2.6 Data Collection

Data was collected on performance measure, which is mean search time, mean stopping time and percent defects detected of inspector to computer based programming.

3 Results

3.1 Mean Search Time

The results on mean search time of one defect, two defects, three defects and four defects were showed significantly different at the level of 0.05 as shown in Table 2. The comparison on least significant different analysis of mean search time for defect types was indicated that one defect type was significant different from two, three, and four defects at the level of 0.05. One defect type was showed mean search time for 27.10 second, which spent more time to look for defect than any defect types as shown in Figure 3.

Table 2 Analysis of variance on mean search time.

Source	df.	SS	MS	F	p-value
Factor	3	400.2	133.4	2.92	0.047
Error	36	1643.6	45.7		
Total	39	2043.8			

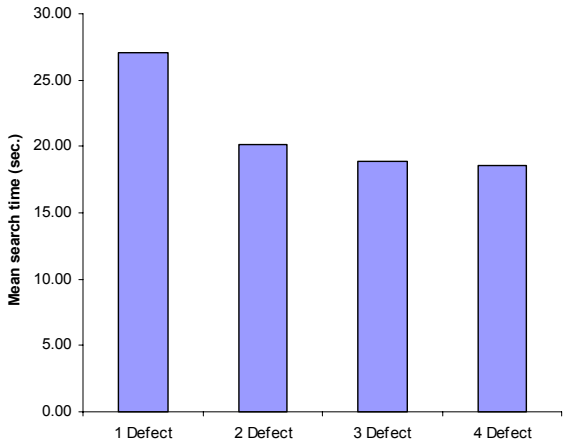

Fig. 3. Comparison of mean search time for one, two, three, and four defects

3.2 Mean Stopping Time

The results on mean stopping time of one defect, two defects, three defects and four defects were showed significantly different at the level of 0.01 as shown in Table 3. The comparison on least significant different analysis of mean stopping time for defect types was indicated that one defect type was significant different from two, three, and four defects, and two defects was significant different from three defects at the level of 0.05. One defect type was showed mean stopping time for 66.97 second, which spent more time to stop for searching defects than any defect types as shown in Figure 4.

Table 3 Analysis of variance on mean stopping time.

Source	df.	SS	MS	F	p-value
Factor	3	5217.0	1739.0	20.79	0.00
Error	36	3010.7	83.6		
Total	39	8227.7			

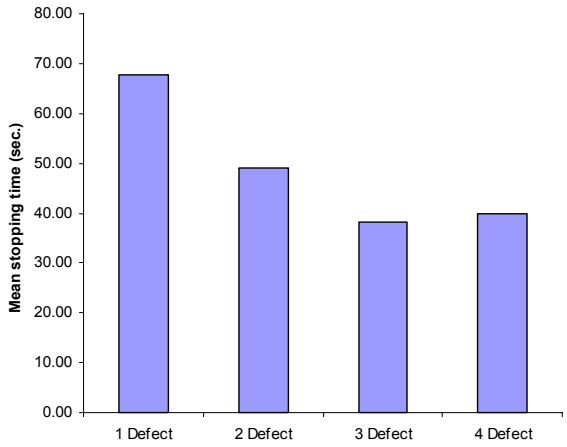

Fig. 4. Comparison of mean stopping time for one, two, three, and four defects

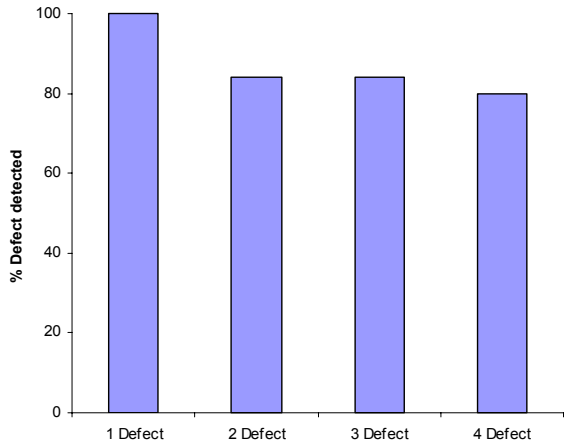

Fig. 5. Comparison of percent defect detected for one, two, three, and four defects

3.3 Percent Defect Detected

The results on percent defect detected of one defect, two defects, three defects and four defects were showed significantly different at the level of 0.01 as shown in Table 4. The comparison on least significant different analysis of percent defect detected for defect types was indicated that one defect type was significant different from two, three, and four defects at the level of 0.05. One defect type was showed 100 percent defect detected, which was better than any defect types as shown in Figure 5.

Table 4 Analysis of variance on percent defect detected

Source	df.	SS	MS	F	p-value
Factor	3	2451.3	817.1	15.83	0.000
Error	36	1858.7	51.6		
Total	39	4310.0			

4. Discussion and Conclusion

As the results, they were shown that inspector's behavior has been affected by type of defect, which was one defect type for this study. One type of defect was spent on mean search time and mean stopping time significantly different at the level of 0.05 and 0.01, respectively more than any types of defect. Moreover, this type of defect, inspector could be able to detect for 100 percent defect detected. These results were supported by the study of human stopping strategies in multiple-target search of Seung-Kweon Hong [7]. It revealed that the performance of the self-stopping strategy was performance inspectors higher, but performance search time it low.

5. Acknowledgments

We would like to thank to King Mongkut's University of Technology Thonburi, Bangkok, Thailand for funding us to study on this research.

6. Refference

[1] George M. Nickles, Brian J. Melloyb and Anand K. Gramopadhye, 2003, "A comparison of three levels of training designed to promote systematic search behavior in visual inspection", International Journal of Industrial Ergonomics, Vol. 32, pp. 331-339.

[2] Drury, C.G., 1978, "Integrating Human Factors in Statistical Quality Control", Human Factors, Vol. 20, No. 5, pp. 501-570.

[3] Moll, R.A., 1980, Product Liability: A Look at The Law, Engine Education, 66, pp. 326-331
[4] Juran, J., 1935, Inspector's error in quality control, Mechanical Engineering, Vol. 57 (1), pp. 643–645.
[5] Bainbridge, L., 1983, "Ironies of automation", Automatica, Vol. 19 (6), pp. 775–779.
[6] Parasuraman, R., 1997. "Humans and automation: Use, misuse, disuse", abuse. Human Factors, Vol. 39 (2), pp. 230–253.
[7] Seung-Kweon Hong, 2005, "Human stopping strategies in multiple-target search", International Journal of Industrial Ergonomics, Vol. 35, pp. 1-12.