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# A Comparative Study of the Effectiveness of Trained Inspectors in Different Workloads between Feed Forward and Feedback Training

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***Abstract*****—** Objective of this study was to study and compare the effectiveness of inspectors who had different workloads for feed forward and feedback training. The visual search task was simulated to search for specified alphabets called defects. These defects were included of four alphabets in Thai and English such as **ก, ถ,** X, and V with different background. These defects were combined in the specified alphabets and were given the different three backgrounds i.e., Thai, English, and mixed English and Thai alphabets. Sixty students were chosen as a sample in this study and test for final selection subject. Finally, five subjects were taken into testing process. They were asked to search for defects after they were provided basic information. Experiment design was used factorial design and subjects were trained for feed forward and the feedback training. The results show that both trainings were affected on mean search time. It was also found that the feedback training can increase the effectiveness of visual inspectors rather than the feed forward training significantly different at the level of .05

***Keywords*****—**visual search**,** feed forward, feedback training.

## I. Introduction

AT present the competition is increasing in education, economics or industrial sectors. There is also a higher rate of competition, resulting in the products or goods out of factory with the best quality. That is to say, there should be no waste until the products reach the customers or consumers. This is the way; the customers will rely on and become satisfied with the products [1]. In general, the industrial factories need to examine the quality of their products by sampling in order to reduce the cost in manufacturing the products. Nevertheless, the problem of products without quality or products which do not meet the requirements still exists and gets in to the hand of the customers. Such problem is the cause of lack in efficiency in examining the quality done by inspectors as well as the process of giving knowledge to inspectors, especially visual inspection. 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. A computer application was then developed to be used in training visual inspectors in order to reduce the time and the cost of inspection. Moreover, it also increases the efficiency of the inspectors in a short time. Therefore, the objectives of this study were:

To study the efficiency of visual inspectors from training between feed forward and feedback data on a different job basis by using computer application for visual inspectors, and

To compare the efficiency of visual inspectors between feed forward and feedback data on a different job basis.

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## II. Methodology

### A. Computer Application for Visual Inspection

The computer application for visual inspection was designed and developed to inspect Thai and English alphabets. In this case, they represented defect and background only.

### B. Variables Used in This Study

1. Independent variables were data derived from the training with feed forward data and feedback data. They were the number and the percentage of defect occurrences in each screen area, mean search time, the number and the percentage of defects detected as well as defect missed in each screen area.

2. Dependent variable was the efficiency of visual inspectors measured by the mean search time for each screen and the number of screens where defects were detected.

### C. Population and Sampling Group

1. Population consisted of the persons interested in visual inspection or the persons making a visual inspection in the production industry.

2. Sampling group consisted of 60 undergraduate students from the Department of Production Technology Education, Faculty of Industrial Education and Technology, King Mongkut's University of Technology Thonburi. They were chosen by purposive sampling method.

### D. Research Tools

1. Computers to be used with the sampling group.

2. The computer application for visual inspection. The program was used in order to test defect detection. Models

were specified with defects in the form of Thai and English letters: ถ ,ภ ,X and V. The computer program was written in Visual Basic as shown in Figure 1.

3. The document asking for the data of visual inspectors in order to be used a way to select the sampling group and measure the standard time spent to detect the defects for each screen. This was for the pilot study.

4. The document asking for the data of visual inspectors from the training with feed forward data and feedback data. This was for the real test.

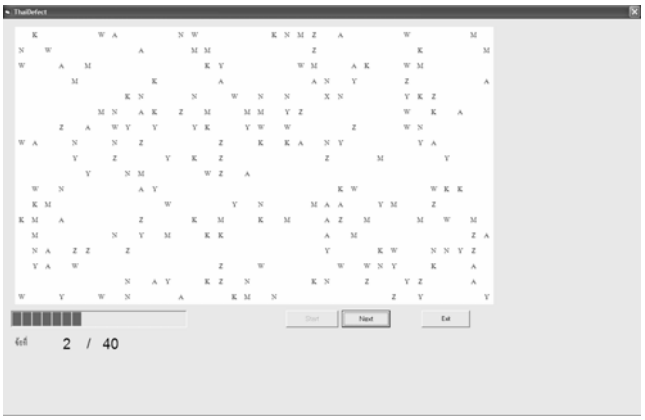


Fig.1. Sample of simulated task.

## III. Procedure

The test was conducted with 60 persons (the sampling group) to test their ability to detect the defects and then the persons with over 50 % of correctness in detecting the defects from all screens with a visual acuity of 20/20 were selected. Afterwards, the first pilot study was conducted to select the group of 5 persons who could detect the defects with over 80 % of correctness from all screens and spent the least time. This way, we gained the sampling group with the best efficiency and the best ability to detect the defects. The second pilot study was conducted to find out the mean search time for each screen to measure the standard time spent in detecting the defects for each screen. From this pilot study, we gained the sampling group of 5 persons who represented the whole sampling group. They were considered as the sampling group with the best efficiency and the best ability to detect the defects. In the real test, after given the basic data used to detect the defects, the sampling group of 5 persons had to detect the defects from 40 screens. Then, feed forward data were given to find out the errors done in the first and the second times. Each time the feed forward data were given to the sampling group, the sampling group needed to detect the defects on 40 screens all at once. Afterwards, feedback data were given from the errors done in the last time. Then, the sampling group was asked to detect the defects for the first and the second times. Each time the feedback data were given to the sampling group, the sampling group needed to detect the defects on 40 screens. After that, the data were collected to analyze the results

## IV. Results

### A. Pilot Study Result

According to the test on their ability to detect the basic defects with the sampling group of 60 persons, we gained the sampling group of 25 persons who could detect the defects with over 50 % of correctness from all screens and had a visual acuity of 20/20. After the second pilot study, we gained the sampling group of 5 persons with the best efficiency and the best ability to detect the defects. The standard time to detect the defects for each screen which was to be used in the real test was 20 seconds as shown in Table I.

TABLE I
PILOT STUDY FOR MEAN SEARCH TIME TO DETECT DEFECT FOR EACH SUBJECT

| **Result** | **Time used to sear for defect for each subject** | | | | |
|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** |
| Mean | 19.38 | 20.58 | 30.25 | 33.00 | 21.21 |
| Overall mean | 24.88 | | | | |
| Standard error (S.E.) | 2.80 | | | | |
| $\overline{X} - (2S.E.)$ | 19.28 | | | | |

### B. Results in Overall Mean Search Time

In the experiment, the subjects were asked to search for defects in different task basis and training methods to analyze for their performance. Results in overall mean search time for each background and different types of training were shown in table II. Each of this data was used to analyze for normality test in order to verify that data collect from subjects was normal. After normality analysis was show that data was normal for overall mean search time to search for defect. Then, analysis of variance (ANOVA) was used to analyze and compare inspector's performance based on different tasks and training methods. The ANOVA result was shown in Table III. Results in Table III were indicated that only main factors effects in trainings and task backgrounds both significantly different at the level of .01

TABLE II
INDICATED THE OVERALL MEAN TO SEARCH FOR DEFECT IN EACH SCREEN FOLLOW BACKGROUNDS AND TRAINING METHODS

| **Back-ground** | **Mean Search Time (sec.)** | | | | | $\overline{X}$ | S.E |
|---|---|---|---|---|---|---|---|
| | **Basic Data** | **F.F. Data1** | **F.F. Data2** | **F.B. Data1** | **F.B. Data2** | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Thai** | 13.06 | 10.48 | 9.94 | 9.44 | 9.26 | 10.4 | 0.7 |
| **English** | 15.54 | 15.16 | 13.32 | 11.88 | 11.72 | 13.5 | 0.8 |
| **Thai & English** | 15.16 | 13.91 | 11.59 | 12.07 | 10.95 | 12.7 | 0.8 |
| Mean $\overline{X}_{TT}$ | 14.59 | 12.40 | | 10.89 | | - | - |
| S.E. | 0.77 | 0.84 | | 0.51 | | - | - |

*Remark*

F.F. Data 1 means Feed forward Data (for the first time)
F.F. Data 2 means Feed forward Data (for the second time)
F.B. Data 1 means Feedback Data (for the first time)
F.B. Data 2 means Feedback Data (for the second time)

TABLE III
ANOVA RESULTS OF OVERALL MEAN SEARCH TIME TO SEARCH FOR DEFECT

| Source | SS | Df. | MS | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 55.007(a) | 8 | 6.876 | 7.955 | .010 |
| Intercept | 2151.584 | 1 | 2151.584 | 2489.299 | .000 |
| Training | 27.662 | 2 | 13.831 | 16.002 | .004 |
| Background | 21.865 | 2 | 10.932 | 12.648 | .007 |
| Training * Background | 1.600 | 4 | .400 | .463 | .762 |
| Error | 5.186 | 6 | .864 | - | - |
| Total | 2304.520 | 15 | - | - | - |

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### C. Comparison of Overall Mean for Mean Search time

Since main factors of background and training were shown significantly difference, the comparison of least significant difference (LSD) was applied to indicate which factors were different. Table IV and figure 2 were shown the comparison difference of mean search time for background while Table V and figure 3 were shown the comparison difference of mean search time for Training.

TABLE IV
COMPARING RESULTS OF THE MEAN SEARCH TIME FOR BACKGROUND FACTORS.

| Background | Thai | English | Thai & English |
|---|---|---|---|
| **Thai** | - | * | * |
| **English** | - | - | .229 |
| **Thai & English** | - | - | - |

* Significantly different at the level .01

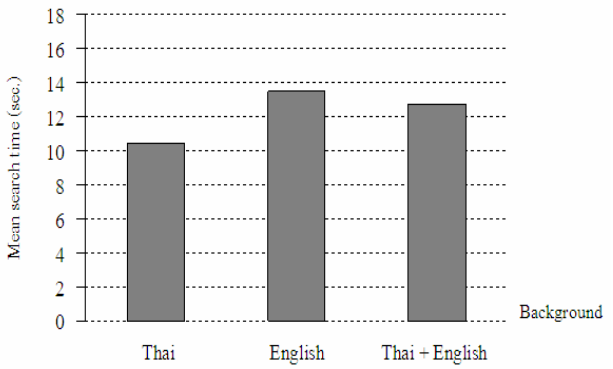


Fig. 2. Graph showing a comparison of the overall mean search times spent in detecting the defects for background factors.

TABLE V
COMPARING RESULTS OF THE MEAN SEARCH TIME FOR TRAINING FACTORS

| Data Type | Basic | Feed forward | Feedback |
|---|---|---|---|
| **Basic** | - | ** | * |
| **Feed forward** | - | - | ** |
| **Feedback** | - | - | - |

* Significantly different at the level .01
** Significantly different at the level .05

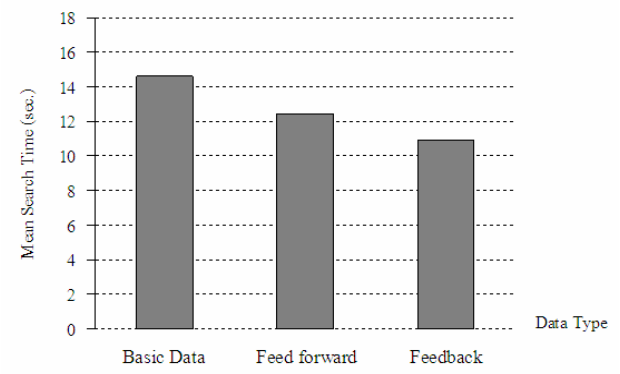


Fig. 3. Graph showing a comparison of the overall mean search times spent in detecting the defects for training factors.

As shown in Table IV, results were indicated that there were different between Thai and English, and Thai and Thai & English backgrounds. However, it was indicated that there was not different between English and Thai & English backgrounds. As shown in Table V, results were indicated that there were different for all types of training method.

### *D. Results in Percent Defect Detected*

ANOVA was used to analyze percent defect detected. Results in Table VI were indicated that only main factors effects in trainings and task backgrounds both significantly different at the level of .01

TABLE VI
ANOVA RESULTS OF PERCENT DEFECT DETECTED

| Source | SS | Df. | MS | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 1804.73(a) | 8 | 225.59 | 5.96 | .02 |
| Intercept | 61206.00 | 1 | 61206.00 | 1617.78 | .00 |
| Training | 845.40 | 2 | 422.70 | 11.17 | .00 |
| Background | 829.00 | 2 | 414.50 | 10.95 | .01 |
| Training * Background | 44.80 | 4 | 11.20 | .29 | .87 |
| Error | 227.00 | 6 | 37.83 | - | - |
| Total | 74555.00 | 15 | - | - | - |

### *E. Comparison of Mean Percent Defect Detected*

Since main factors of background and training were shown significantly difference, the comparison of least significant difference (LSD) was applied to indicate which factors were different. Table VII and figure 4 were shown the comparison difference of percent defect detected for background while Table VIII and figure 5 were shown the comparison difference of percent defect detected for Training.

TABLE VII
COMPARING RESULTS OF PERCENT DEFECT DETECTED FOR BACKGROUND FACTORS

| Background | Thai | English | Thai & English |
|---|---|---|---|
| **Thai** | - | * | * |
| **English** | - | - | .416 |
| **Thai & English** | - | - | - |

* Significantly different at the level .01

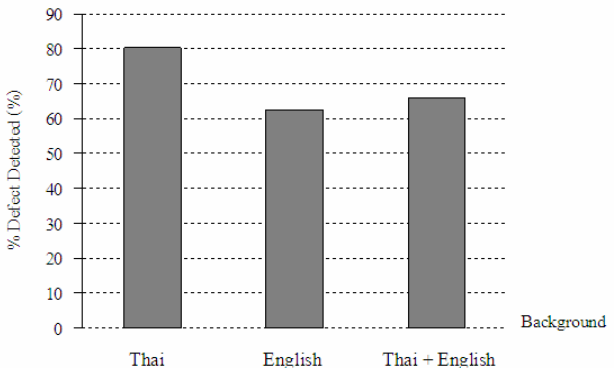


Fig. 4. Graph showing a comparison of percent defect detected for background factors

TABLE VIII
COMPARING RESULTS OF PERCENT DEFECT DETECTED FOR TRAINING FACTORS

| Data Type | Basic | Feed forward | Feedback |
|---|---|---|---|
| **Basic** | - | ** | * |
| **Feed forward** | - | - | .065 |
| **Feedback** | - | - | - |

* Significantly different at the level .01
** Significantly different at the level .05

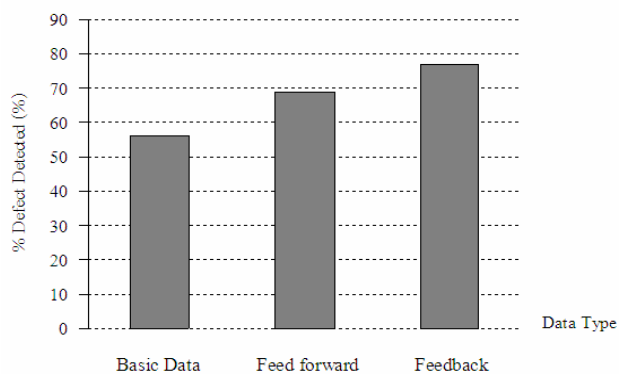


Fig. 5. Graph showing a comparison of percent defect detected for background factors

## V. Discussion and Conclusion

### A. Discussion

According to the research objectives, the results revealed that different backgrounds to detect defects or different jobs had an effect on the efficiency of the visual inspectors as calculated by the speed and the correctness in detecting the defects of the visual inspectors. When faced with different jobs or more jobs, the visual inspectors had to spend more time in detecting the defects and their correctness in detecting the defects decreased. English background or job made the visual inspectors spend the highest mean search time in detecting the defects on the screen due to the fact that the visual inspectors were not familiar with the English alphabet. Therefore, the detection between letters specified as background and letters specified as defects took more time, resulting in higher mean search time. The inspectors were not familiar with the job, resulting in more brain tasks to increase the working efficiency. This complies with the research entitled "Task Complexity in Visual Inspection" conducted by Gallawey T.J., Drury C.G., [2] which studies the efficiency of visual inspectors for different job and visual complexity. Their results were that the different characteristics and the different numbers of defects were considered as different job and they affected the efficiency of quality inspectors. This also complies with the research entitled "The effects of per-lot and per-item pacing on inspection performance" done by Sandra K. Garrett, Brian J. Melloy, and Gramopadhye, A.K., [3], which studies the speed and the inflexibility of per-lot and per-item inspection. The result was that the speed of defect detection affected the correctness in detection.

As for the comparison of the efficiency of the visual inspectors from 2 training methods, it was found that both training methods increased the efficiency of the visual inspectors. The feedback data method increased higher efficiency in detecting defects than the feed forward data method. This was because the visual inspectors had already detected the defects and feedback data which was given right after fast searching could help the visual inspectors remember their errors and find a way to correct the mistakes in the next time. It was different from the training with feed forward data in that although the visual inspectors knew the data before searching, they could neither remember nor apply the given information in detecting the defects. Hence, the efficiency in detecting the defects increased to a slight extent. Still, it could account for a training to improve the efficiency in visual inspection. This complies with the research entitled "A comparison of three levels of training designed to promote systematic search behavior in visual inspection" conducted by George M. Nickles, Brian J. Melloy and Gramopadhye, A.K. [4], which was aimed at comparing the differences among the 3 following training systems: Verbal instruction, a static diagram and a dynamic diagram. The result was that all 3 training methods increased the efficiency in visual inspection. This also complies with Skinner [5] in that feedback acts as reinforcement. Giving feedback immediately will increase the efficiency in learning or working. In comparison, giving feedback after the visual inspectors had detected the defects could reduce the search time and increase correctness.

### B. Conclusion

The efficiency of visual inspectors after training with feed forward data and feedback data increased. This was measured by the mean search time for each screen and the mean percentage of defects detected. After the visual inspectors had been trained with both methods, their mean search time for each screen decreased and their mean percentage of defects detected increased when compared to the mean search time and the mean percentage of defects detected by giving basic data method. The comparison of the efficiency of visual inspectors from training between feed forward data and feedback data on a different job basis revealed that the efficiency from both trainings was different in that feedback data method increased higher efficiency for visual inspectors when compared to feed forward data method. This was calculated by the mean search time for each screen and the mean percentage of defects detected. Different backgrounds were considered as different jobs and they affected the efficiency of visual inspectors in terms of the mean search time for each screen and the mean percentage of defects detected. The visual inspectors spent the highest mean search time for English background and gained the highest mean percentage of defects detected in Thai background.

## References

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