

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The aim of this study is to investigate responses of workers who perform an inspection task throughout a working day. The study is done to assess mental fatigue between two shifts, morning and night shift, and paced-condition with two types of rest allowances. Intensity of mental fatigue was determined from the measurements of critical flicker fusion frequency (CFF), reaction time and self-scaling questionnaire. Work output was also recorded as an indicator for inspection performance, and sleeping hours on the day before testing as an external stress. Fuzzy set theory is applied to determine the significant effects of the contributing factors to mental fatigue levels. In addition, the technique of electromyography and heart rate are used to identify cumulative physical and mental fatigue due to prolonged working hour.

The conclusions drawn from this study can be summarized as followed:

1. Workers' responses, i.e. CFF and reaction time, show a sign of increased mental fatigue and decreased inspection performance, i.e. work output. This is particularly true because mental fatigue will induce work performance.

Results from EMG measurements, as an indicator of physical fatigue, correspond to other studies (Åstrand and Rodahl, 1986; Baidya and Stevenson, 1988). That is, high EMG signal results from high work load (many defects or many corrections).

2. By comparing mental fatigue of workers between two shifts and two types of rest allowances, the trend of mental fatigue for morning shift is lower than night shift and that for existing allowance (R1) is higher than the rearranged one (R2). Moreover, the work output in morning shift and R2 are higher than that in night shift and R1.

Similar results of shift are demonstrated by Chaiyos Kunanusonthi et al (1989, quoted in Chartchai Usadomsak, 1993) that working in night shift lowered working efficiency due to the need of regular cycles of sleep

contrasting with the unnatural working time. In contrast, Chartchai Usadornsak (1993) reported that night shift work had lower fatigue level than morning shift because of the flexibility of work control and work speed that led to the lower work output.

The result of rest allowance is supported by a study of Dul, Douwes and Smitt (1991) on a work-rest-model for static posture. They formulated some general model predictions from computer simulations and mathematical derivations. The model predicted that for a given number of variable work-rest-cycles it was better to arrange cycles with long work times at the beginning of working.

Since a worker's daily output is always more than the daily target set by the management, the introduction of the new device was, therefore, not encouraging. Based on the psychology theory (McCormick and Tiffin, 1974; Konz, 1983), people will resist to changes. To change people's attitude, time is a determining factor. This study has a limited time. It is recommended that a separate study with regard to paced work should be initiated.

3. The results from fuzzy analysis shows the priority of the effects as: 1) rest allowances, 2) shift, 3) work output, 4) sleep hours on the day before testing, respectively. The results comply with those of Chartchai Usadornsak (1993) that factors affected to workers in sanitary ware factory were tasks, shift, work output, age, body weight, environmental temperature and sleep hours before testing day, respectively. This finding will help the management to ameliorate working conditions by considering the most effective factors as the first priority.

4. Technique of EMG and heart rate illustrate a development of fatigue through long working period, though there is some recovery after holiday. Moreover, EMG shows reduced muscle efficiency through the work period (4 weeks of observation).

5. CFF and reaction time, as appears in hypothesis test of fatigue appearance, can be postulated to be due to mental fatigue. But then, in comparison test of fatigue on each factors, the statistical analysis is not clear because of limits of sample size. This research studies mental fatigue of an inspection task which is a cognitive task requiring a high vigilance. Therefore, it is recommended that CFF, which reflects activity of visual system from

receptors to cortex, is the most effective criterion for mental fatigue evaluation in this work situation.

In principle, CFF on before- and after- work measurement can drop lower than 1 Hz. Consequently, it is necessary to obtain a value of tenths. Thus, an oscilloscope was connected to the CFF apparatus in order to get that value.

Recommendations for Future Research

1. Work output could be increased by suitably rearranging rest allowance. Longer work cycle at the beginning of the work shift is recommended. Industrial engineering technique should be introduced to improve productivity. This is because, from the study, fatigue level of the worker is still manageable .

2. The further study of machine-paced system is worthwhile to be taken over as a separate study. Particularly in the case when quantity of errors could be detected or improved before arriving at the final inspection, or the correction activity could be done in other place than the inspection.

3. The result shows very interesting conclusion, the number of subject in measuring EMG and heart rate was very small, i.e. only one subject, due to technical and organizational problem. Therefore, statistical inference cannot be concluded in a meaningful way (Table 4.8a, 4.8b and 4.9). Thus, more research is needed to see whether the significance will change in a relevant direction if more subjects are tested.

4. The application of fuzzy set theory is able to analyze such complex ergonomics system, therefore more experiment researches should be carried out to explore the application in the analysis of this field.

5. CFF, reaction time and subjective rating should be measured as frequently as possible to understand pattern of the evolution of mental fatigue throughout working day.

6. The subjective rating should be measured every hour or so in parallel to EMG and heart rate for confirmation in the experimental results.