# APTIV: ERGONOMIC ANALYSIS OF A FUSE INSERTION, PRESS-FIT AND TEST WORKSTATION BY THE E.W.A. METHOD - ERGONOMIC WORKPLACE ANALYSIS

Bastos, Nuno; Gomez, Adriana; Mesquita, Catarina; Oliveira, Maria; Pacheco, Tiago; Pinheiro, Ivo; Rodrigues, Beatriz; Serra, Cláudia; Silva, Ana; Sobral, Nuno
SPOSHO Edições, Guimarães, Portugal

ABSTRACT: In recent times, more and more focus has been placed on workers' well-being, as they are an integral part of an organization. This study was made in a automobile company APTIV, where a workstation, in the Built-in System Interface (BSI) area, was evaluated through the Ergonomic Workspace Analysis method. The objective of this study was to evaluate the working conditions of the workers, in order to be able to indicate which factors are the most probable causes of discomfort. This method considers the perspective of the analyst, obtained by systematic observations on the workstation and the perspective of the workers achieved through questionnaires made to four workers. For the application of the method, it was necessary to collect quantitative data regarding the items Lighting, Thermal environment and Noise. After applying the method, the authors analysed the results and concluded that there are 3 factors that stand out from the others, these being the repetitiveness of work, lighting and thermal environment. In order to evaluate the severity of the critical items identified, it is proposed to apply other more specific analysis tools for the study, since the method is a generalist ergonomic analysis that allows a first evaluation of all the factors that can affect the employees but does not encompass further improvements for the problems encountered.

**Keywords:** Ergonomics, Industrial Engineering, EWA, Lighting

**Presentation Preference:** Poster

## 1. INTRODUCTION

As industries keep the pace, there has been a greater focus on workers' well-being so that they can do their jobs more productively and have major sense of responsibilities. Many studies have pointed to the role of both ergonomic and psychosocial environments in the development of various health problems in workers. One of the main issues encountered in the workplace are musculoskeletal disorders, which if not removed can lead to cumulative trauma disorders (González-Muñoz and Chaurand, 2015). The fact that a worker is performing under non-ideal situations will have a negative impact on his performance, thus reinforcing the importance of improvements in the design of the workplace to enhance workers' satisfaction, job performance, safety and health. If ignored, Work-related Musculoskeletal disorders (WMSDs) can create a significant financial burden to both employer and employee that includes the cost of treatment and lost work time (Sharan, 2012). There are numerous factors that can influence the working environment: noise, vibration, light, heat and cold, among others.

In this case study, a workstation at an automobile component factory was evaluated through the EWA method (Ergonomic Workspace Analysis), developed by the Finnish Institute of Occupational Health (FIOH). The EWA method has been highlighted by its success in several areas, for example in occupational health (Hakkarainen, Ketola and Nevala, 2011), bus driving (Querido et al., 2012) and aircraft pilots (Monteiro et al., 2012). The application of this method, which aims to make a preliminary analysis to identify the possible factors that have a negative impact on the well-being of workers, is central to any organization because it allows a general analysis of the problem taking into account the opinion of the workers, hence the fact that it was selected for this case study.

The objective of this visual ergonomics intervention study is to evaluate the working conditions of the workers, through the EWA method, in order to be able to indicate which factors are the most probable to their discomfort.

## 2. MATERIALS AND METHODS

### 2.1 *Workstation*

This study was carried out in an automobile parts company APTIV. Its main activity in the factory of Braga is the area of Infotainment, User Experience and Connectivity and Security. The area that has been evaluated is located in building two and named BSI (Built-in System Interface). The focus of this study was on the workstation one (Figure 1).

Figure 1 - Computer rendering, by the authors, of workstation 1.

This workstation is made up of five female workers. The first four workers place fuses on a power board (Figure 2). While the fifth worker places the board in the press-fit machine, which presses the fuses in, and then transfers it to the test machine to verify that the fuses have been placed correctly.

Figure 2 - Workstation 1: (a) place fuses on the board; (b) press-fit and test.

The application of the EWA method will be performed for the first four workers, because it is a repetitive work and requires some visual acuity from them, thus carrying greater risk.

### 2.2 *EWA Method*

For Silva, Bormio and Pacolla (2009) the emergence of the Ergonomic Workplace Analysis method, developed by the Finnish Institute of Occupational Health (FIOH), occurred due to the context of a great increase of occupational diseases in Finland, where the government once used, mobilized and putting into effect occupational hygiene laws in order to reduce the trend. With this emerged the need for a method that could diagnose faults and problems of workstations regarding various aspects, thus generating a diagnosis and supporting engineers, architects and designers performing modifications and improvements to existing workstations or projects.

EWA is a method used to identify ergonomic and psychophysical risks of the workstation, tools and interpersonal relationships. Its main foundations are biomechanics, work physiology, work organization and psychological aspects in the prevention of occupational diseases (Pacolla, Bormio and Silva, 2008; Shida and Bento, 2012).

This method considers two perspectives, of those that observe and of those that execute the task, so it is necessary to make questionnaires to the workers and systematic observations on the workstation.

The fact that two different perspectives are evaluated, reduces the possibility of errors because the worker has the experience of performing the task and the analyst has the technical knowledge about the ergonomics.

According to Costa (2004) there are 14 evaluation factors in the EWA method.

In this evaluation, the workers give their opinion about each item using a scale: good (+ +), reasonable (+), bad (-) or very bad (- -). To collect their opinion about the performed task, it was developed a questionnaire by the authors. The analyst evaluates each item using a scale of 1 to 5 or 1 to 4 in some cases, where ratings above 3 indicate that the working conditions are inadequate or even dangerous for the health of the worker, requiring special attention to that factor. If the evaluation of employees differs greatly from the

classification of analysts, the situations should be analyzed in greater depth.

This method requires the collection of quantitative data to be compared to the parameters defined by the method in order to be able to assign an evaluation regarding the items Lighting, Thermal environment and Noise.

In the evaluation of the lighting, since the task requires normal visual acuity, the measurement was made in the workplace using a Delta OHM HD 9221 lux meter (Figure 3) and taking into consideration the recommended illuminance values of the Chemicals, plastics and rubber industry section of the norm ISO 8995:2002 as well as two internal documents:

- DELPHI - ESGP 4-4 ME 09 EN - Visual Inspection of Cosmetic Aspects of Decorative ComponentsVDA 6.3;
- VDA 16 - Decorative surfaces of external fittings and functional parts in the internal and external areas of automobiles.

Figure 3 - Delta OHM HD 9221 lux meter.

For the thermal environment item, since the workers perform their tasks in the seated position, the measurement of the air temperature and speed in the workplace was performed at head and ankle height, through the use of the VelociCheck TSI thermo-anemometer and of the globe thermometer. Finally, for the measurement of the noise was used Quest Technologies Model 2800 sound level meter.

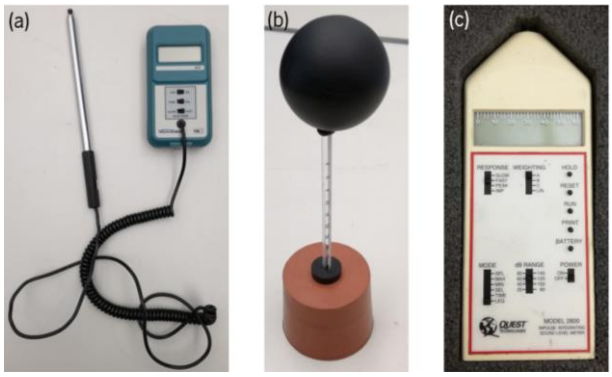


Figure 4 - Equipment for quantitative measurements for thermal environment classification: (a) VelociCheck TSI thermo-anemometer (b) Globe thermometer (c) Sound Equipment Quest Technologies Model 2800.

## 3. RESULTS AND DISCUSSION

In the following table shows the final results, sorted into the two perspectives mentioned previously, gathered from two observers and four employees. In the development of the table, the worst evaluation of the workers, as well as the observers, was considered, aiming at the protection of all the workers, allowing to prioritize the items in which to intervene.

Table 1 - Results obtained by the application of EWA method.

| | Analyst's rating | Worker's rating |
|---|---|---|
| 1.Workplace | | |
| 1.1.Horizontal work area | 1 | + |
| 1.2.Work plane height | 1 | + |
| 1.3.Vision | 1 | + |
| 1.4.Legroom | 2 | + |
| 1.5.Seat | 2 | - |
| 1.6.Hand tools | 1 | + |
| 1.7.Other equipment | 2 | + |
| Global appreciation of the workspace | 2 | + |
| 2.General physical activity | 2 | + |
| 3.Lifting tasks | N/A | N/A |
| 4.Postures and movements | 2 | + |
| 5.Risk of accident | 1 | + + |
| 6.Work content | 3 | + |
| 7.Work restrictiveness | 3 | + |
| 8.Worker communication | 2 | + + |
| 9.Difficulty in making decisions | 1 | + |
| 10.Repetitiveness of work | 5 | + |
| 11.Required attention | 3 | + + |
| 12.Lighting | 3 | - - |
| 13.Thermal environment | 2 | - |
| 14.Noise | 2 | + |

According to the results obtained, was highlighted the Repetitiveness of work, due to the fact that the analysts gave a high score. This high score is due to the specification of the method, that for a cycle time inferior to thirty seconds, a score of 5 is given. In the opinion of the workers, it was determined that, although the cycle time is very small, they prefer this task over other tasks, since it is the only one that allows them to be seated, hence their good evaluation of this item.

The most problematic item is Lighting, since it presents a negative evaluation from both perspectives. In the analysis performed it was necessary to measure the illuminance at various points of the workstation with the aid of a lux meter. The values obtained are shown in Figure 5.

According to the standards mentioned previously, the illuminance at this workstation should be between 1000 and 1500 lux, however as it is possible to verify in the figure, the upper limit is exceeded in the two intermediate worktables. For the application of

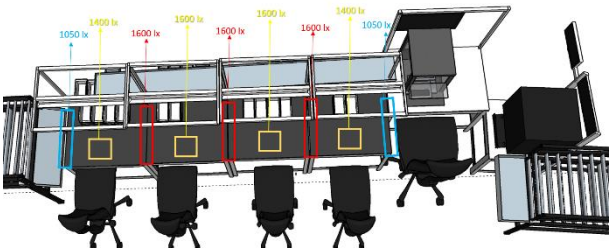


Figure 5 - Illuminance values at the workstation.

the EWA method for jobs requiring normal visual acuity, it was necessary to calculate the percentage of measured illuminance relative to the recommended value and the level of glare.

$$\text{Percentage of illuminance} = \\ = \frac{1600}{1500} \times 100 \approx 107\% \qquad (1)$$

Since the percentage was greater than 100%, a score of 1 was obtained for illuminance. With regard to the glare, through the in situ observations, it was concluded that there is some glare, which presents a score of 3. Finally, the scores obtained were compared, and the score that represents the weakest evaluation (highest number) was attributed to the item under study.

According to the workers perspective, the intensity of the light causes glare (Figure 6) which interferes with the efficiency of the worker and they also complain about headaches.

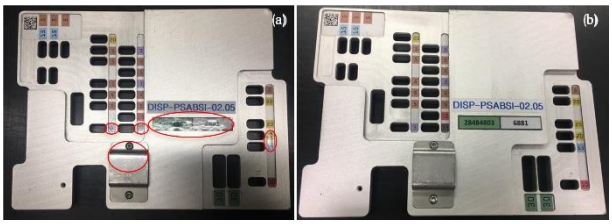


Figure 6 - Images of the mask used for helping the allocation of the fuses: (a) with combined lighting on; (b) with just general lighting on.

Finally, the thermal environment is an item with a bad evaluation by the workers, justified by the complains about the variability of the temperature throughout the week. Taking into account the methodology necessary to the

analyst evaluate this item, the dry air temperature ($t_a$) was measured and the metabolism calculated.

$$t_a = 22{,}9°C \quad (2)$$

$$\text{Metabolism} = 40 + 10 + 85 = 135\ W/m^2 \quad (3)$$

These two quantities, allowed the analyst to use the EWA method for this item, reaching a score of 2.

## 4. CONCLUSIONS

The EWA method is a generalist ergonomic analysis that allows a first evaluation of all the factors that can affect the employees. However, it does not comprise possible improvements for problems encountered.

After the EWA analysis, it was verified that there are 3 factors that stand out from the others, these being the repetitiveness of work, lighting and thermal environment. Both the repetitiveness of work and the thermal environment are highlighted by the divergence of opinions between analysts and workers.

In the case of repetitiveness, this divergence stems from the fact that the method takes into account short cycle times to determine the repetitiveness of a task, while the operations state that they don't require a high concentration compared to other operations with similar cycle times.

The thermal environment is regulated in order to maintain a low relative humidity to avoid electrical discharges in the electronic components. The tasks at the workstation are repetitive and have short cycle time. This leads to the increase of the workers' metabolism, causing thermal stress.

The lighting stands out due to the fact that both parties agree on the evaluation of this item, prioritizing the study of this factor.

For future work, it is proposed, primarily, the application of a lighting method that allows verifying and analyzing the problem of this item. In addition, it would also be relevant to study luminance, since both analysts and workers have identified glare related problems. Finally, in order to evaluate the severity of the remaining critical items identified, it is proposed to apply other more specific analysis tools for the study of the thermal environment and the repetitiveness of the work.

## ACKNOWLEDGMENTS

The authors would like to acknowledge the APTIV collaborators for enabling this study in the BSI area, as well as for the sharing of information. A special thanks to the workers who have made themselves available to answer the questionnaire. We couldn't forget to thank our professors, Paula Carneiro and Ana Colim, for the readiness to help and for providing the measuring devices.

## REFERENCES

Costa, L. G. da. (2004) 'Análise Ergonómica de Postos de Trabalho', *Universidade do Minho*. Available at: http://www.crpg.pt/empresas/recursos/kitergonomia/Documents/EWA_Português_2004.pdf.

González-Muñoz, E. L. and Chaurand, R. Á. (2015) 'Analysis of the Role of Job Stress in the Presence of Musculoskeletal Symptoms, Related with Ergonomic Factors', *Procedia Manufacturing*. doi: 10.1016/j.promfg.2015.07.642.

Hakkarainen, P., Ketola, R. and Nevala, N. (2011) 'Reliability and usability of the ergonomic workplace method for assessing working environments', *Theoretical Issues in Ergonomics Science*. doi: 10.1080/14639221003736339.

Monteiro, T. P. *et al.* (2012) 'Ergonomic work analysis of airbus pilots job in Brazil', in *Work*. doi: 10.3233/WOR-2012-0987-5905.

Pacolla, S. A. de O., Bormio, M. F. and Silva, J. C. P. da (2008) 'A contribuição do método EWA para o design ergonômico de carteira escolar', *Design Arte e Tecnologia*, 4. Available at: https://www.researchgate.net/profile/Mariana_Bormio/publication/282049628_A_CONTRIBUICAO_DO_METODO_EWA_PARA_O_DESIGN_ERGONOMICO_DE_CARTEIRA_ESCOLAR/links/5603e68c08ae4accfbb8d29e/A-CONTRIBUICAO-DO-METODO-EWA-

PARA-O-DESIGN-ERGONOMICO-DE-CARTEIRA-ESCOLAR.pd.

Querido, A. *et al*. (2012) 'Ergonomic work analysis of urban bus drivers in Rio de Janeiro city', in *Work*. doi: 10.3233/WOR-2012-0993-5956.

Sharan, D. (2012) 'Ergonomic workplace analysis (EWA)', in *Work*. doi: 10.3233/WOR-2012-0821-5366.

Shida, G. J. and Bento, P. E. G. (2012) 'MÉTODOS E FERRAMENTAS ERGONÔMICAS QUE AUXILIAM NA ANÁLISE DE SITUAÇÕES DE TRABALHO', *VIII Congresso de Excelência em Gestão*. Available at: http://www.inovarse.org/sites/default/files/T12_0496_3097.pdf.

Silva, J. C. P. d., Bormio, M. F. and Pacolla, S. A. de O. (2009) 'The interface between user - school environment: employment EWA in studies of the methodology developed in the Graduate Program in Industrial Design FAAC / UNESP Industrial FAAC/UNESP', *Arcos Design 4*, 4. Available at: https://www.scribd.com/document/288590881/Aplicacao-Do-EWA.