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ERGONOMIC WORK ANALYSIS OF THE TIG WELDING PROCESS IN A RESEARCH LABORATORY

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Summary: The text addresses the importance of ergonomics in the interaction between people and machines, highlighting its role in improving systems performance and minimizing ergonomic risks. It focuses on Ergonomic Work Analysis (AET), which aims to understand and identify the ergonomic risks that workers are exposed to, especially in welding environments.

A study carried out in a TIG welding research laboratory is presented, where the ergonomic risks associated with welding activities were analyzed. Using various analysis tools, such as the Ocra Checklist, TLV HAL, OWAS Checklist and RULA Method, postural and repetitive problems that affect the health of operators were identified.

Based on the results of the analysis, ergonomic recommendations are proposed, including replacing furniture, adjusting chair and table heights, and using appropriate PPE. Improvements to the work environment are also suggested, such as increased lighting.

It is concluded that, despite the low workload in the laboratory, ergonomic risks are significant and must be continuously monitored. It is recommended that the proposed measures be implemented and that constant monitoring be carried out to assess their impact on workers' long-term health.

Keywords: TIG welding; Ergonomic Work Analysis; Laboratory.

Introduction

Ergonomics is the study of the interaction between people and machines and the factors that affect such interaction (BRIDGER, 2003). Its objective is to improve the performance of systems, improving human-machine interaction, through interventions that allow changes in the interface of these systems, in the occupational environment or even in the organization of work.

Ergonomic Work Analysis (AET) allows the understanding of the work system in a systematic way, allowing the analysis of the activities carried out by the operator during his working day and how the environment interferes with the worker's performance. Through AET, the ergonomic risks to which the worker is exposed can be identified, leading to solutions to eliminate or minimize the effects of such risks (ABRAHÃO et al., 2009).

Professionals who work in the welding process, due to the nature of their role, are commonly exposed to musculoskeletal disorders; breathing problems; effects of UV radiation; burns from sparks and splashes; noise; vibration; accidents; vision, (SILVA, 2003). The ergonomic vision for the activities carried out by welders allows the potential risks arising from such activities to be identified so that control measures can be implemented in order to eliminate or minimize them.

The welding process is widely used to join metals, due to its affordable costs and the versatility of the process. For Magrini (1996), welding is a process of joining materials, providing continuity and maintaining their mechanical and chemical properties. It can be carried out by fusing parts, or by fusing adding another material. TIG (Tungsten Inert Gas) welding is commonly used for welding thinner parts and when seeking to ensure higher quality. An electric arc is formed between a tungsten electrode and the part, which is responsible for melting the material, and if used, the filler material, and effectively joining the parts (MACHADO, 1996).

Due to the need for precision linked to the TIG welding process, ergonomic risks related to static sitting posture and the repetitiveness of the welding process are common during the workday. In view of the above, the objective of this work was to carry out an Ergonomic Analysis of TIG welding work in a research laboratory, to identify the risks related to this activity, and subsequently recommend improvements for the workstation in question. Aiming to reduce worker exposure to identified risks and improve performance in the position. The position analyzed belongs to LABSOLDA, a welding laboratory linked to the Federal University of Santa Catarina (UFSC).

Development

The methodological approach adopted in this research follows the five stages of the Ergonomic Work Analysis (GUÉRIN et al, 2001), as shown in Figure 1.

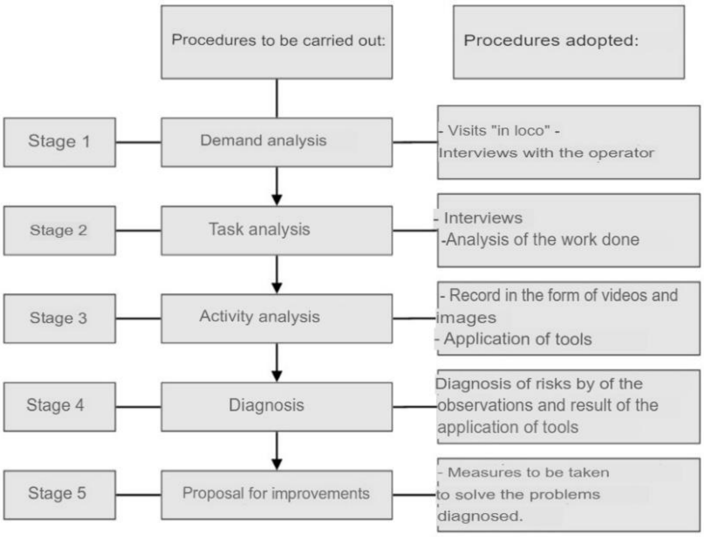


Figure 1 - Methodological procedures adopted in this research.

The activity analyzed was TIG welding of small steel parts for subsequent analysis and study of weld quality, due to ergonomic risks related to static sitting posture, and repetitiveness. The TIG process uses an electric arc between the tungsten electrode and the part, surrounded by a protective gas.

To analyze the task, a semi-structured questionnaire was applied to the operator, containing questions about the conditions to which the worker is exposed during work in the laboratory, as well as questions aimed at identifying physical, cognitive and organizational ergonomic demands. The mapping of ergonomic risks was carried out during the demand analysis with the help of the semi-quantitative tool for failure mode and effect analysis or FMEA (in English, Failure Mode and Effect Analysis) (SANTOS, 2010; PEREIRA, 2012). The determination of indices and levels of risk factors was based on the approach proposed by Santos (2010).

The Ocra Checklist, Threshold Limit Value for Hand Activity Level (TLV HAL), OWAS Checklist and RULA Method were the ergonomic analysis tools used to investigate the demands raised, the analyzes were carried out with the help of the demo version of the Ergolândia software.

The Ocra Checklist was used to measure the risk of biomechanical overload in the upper limbs, considering the distribution of breaks during the workday and evaluating the risks for the left and right sides of the body, separately (OCCHIPINTI; COLOMBINI, 1996). The TLV HAL method aimed to evaluate the risk factor related to repetitiveness in the work environment, more specifically for hand activity (LATKO, 1997). The Owas Checklist, developed by Karhu, et al. 1977, makes use of recording the operator's typical postures during work, as well as the frequency and time in which the operator remains in these postures, determining the resulting effect on the musculoskeletal system. The RULA Method, or Rapid Upper Limb Assessment, made it possible to evaluate the posture, strength and movements of the upper limbs, in order to verify risks to the operator's health.

Results

Demand Analysis

The operator, during most of his time at the workstation, is in a static sitting posture, performing repetitive precision activities with his arms and wrist. There is no history of absences due to repetitive strain injury (RSI), however there are complaints regarding the table and chair. The ergonomic mapping carried out with the help of FMEA allowed identifying and prioritizing the potential ergonomic risks to which the worker is exposed, Figure 2.

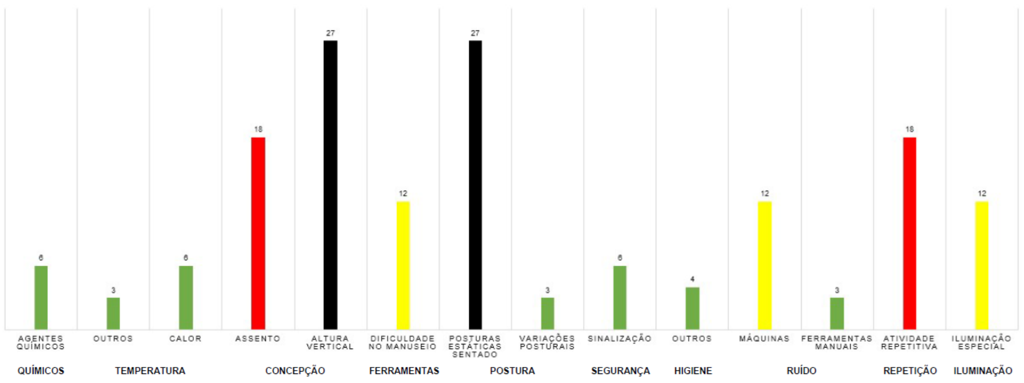


Figure 2 – Mapping of ergonomic risks

In red there are substantial risks and in black there are intolerable risks, to which the worker is exposed. Which are subsequently investigated during AET.

Task Analysis

The processes of defining welding parameters on the TIG welding machine, transporting the parts to be welded to the welding bench, cleaning the parts, checking the need for sharpening or replacing the tungsten electrode, and finally, welding the parts characterize the operator's duties during his workday. Given this scope, the intervention region is limited to the space used during these processes, as well as the way in which the operator uses this space.

The machines used during the process are a TIG welding machine and a grinder for sharpening the welding electrode. The process inputs are: small steel parts; product for cleaning the part (alcohol or paint stripper for stainless steel); tungsten electrodes; filler material; argon gas; electricity. The outputs are: welded part; argon gas; heat; gases from the use of paint strippers; radiation.

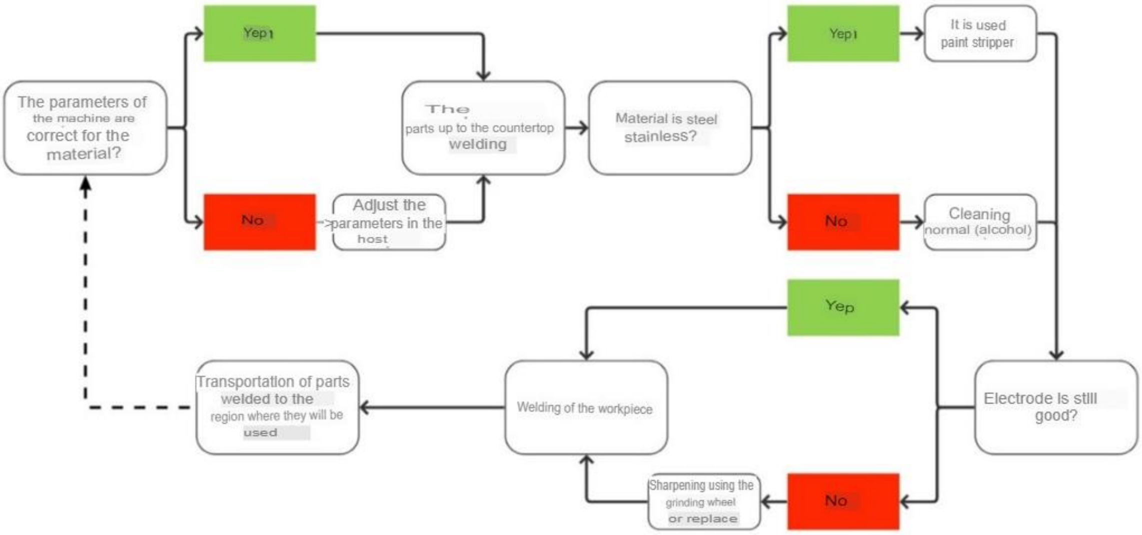
The general characteristics of this job are: working in a closed location with regular hours, in which the operator does not spend an entire shift welding, both due to breaks required during the process and due to variation in demand. There is almost no loading effort made at this station. The analysis carried out considered the volume of critical service: two batches of ten specimens. Through an interview with the operator, the technical, organizational and environmental conditions were assessed. There were no reports of cognitive or organizational problems on the part of the operator.

Activity Analysis

The analysis of the activity was carried out by recording videos and photos, however, it was not possible to record or take photos during the welding operation, due to the intensity of the light emitted by the arc, which affects the quality of the image. Therefore, a welding simulation without turning on the arc, in order to take measurements and analyze the operator's posture, was carried out, Figure 3.

Figure 3 - Operator at the workstation performing a welding simulation.

The flow of activities performed by the operator is shown in Figure 4.



The flow of activities performed by the operator is shown in Figure 4.

The total time to complete the welding of the ten specimens was approximately 2 hours. During this period, it is necessary to change the machine parameters and change an electrode, taking about 2 minutes. The total time spent cleaning the parts is about 10 minutes, and the welding process takes about 10 minutes per part. After welding, there is a break of at least one hour before the operator returns to welding.

During activities, the operator uses PPE for protection during the process: welding coat; welding gloves; auto-darkening solder mask; covered footwear and low-flammable material; if pickling is carried out, respirator.

Using the OWAS checklist, it was found that the back is inclined for 89% (Figure 5) of the work time carried out at the station, and it was the most critical point highlighted by the checklist, presenting category 3, “corrections are necessary as soon as possible".

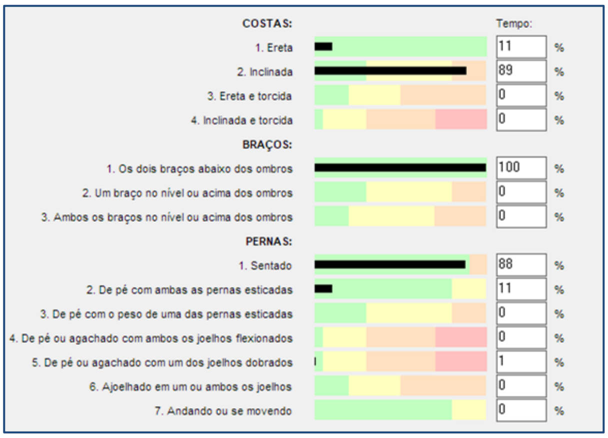


Figure 5 - Result of the OWAS checklist.

The results of the OCRA checklist indicate that work carried out on the operator's left side, the side that holds the welding torch, presented a medium potential for illness, due to the worse posture of the torch arm, which needs to be positioned in order to maintain the quality of work. welding throughout the process. Using the TLV HAL method, it was found that the high level of activity of the hands, especially the hand responsible for the torch, makes changes to the workstation necessary as it presents an action level of 0.56 and a limit value of 0.78, for the left hand.

The RULA method, responsible for evaluating efforts related to the upper part of the body, was applied to the welding activity, and reached a final score of 7, a result related to the highest possible risk, requiring immediate changes. This is largely due to the operator's posture during welding: back inclined with the torso and neck slightly twisted, with arms without support and wrist slightly inclined to access the welding region. Furthermore, the operator performs work sitting without adequate foot support.

Environmental comfort was evaluated in two areas: acoustic and lighting. To take measurements, a lux meter and a sound level meter were used, used during a break in the welding activity. The results are described in Table 1.

	Noise	**Lighting**
Result obtained	91 dB connected machines	75,64 lux
Required by standard	Max 85 dB	Min 500 lux, class B

Table 1 - Measured noise and lighting results.

Ergonomic diagnosis

Based on the results presented, it was identified that the main postural problems found in the workplace are: static sitting posture with excessive back and neck inclination and for a long period of time, in addition to the lack of adequate support for the feet, and repetitive activity of the left hand with inadequate wrist tilt.

Although the height of the chair and table is in the appropriate range for the operator, fine adjustment of the height is necessary, in addition to the table angle, in order to improve arm support and reduce the tilt of the back and neck. . Regarding environmental comfort variables, although the noise level only exceeds the standard limit when all machines are turned on, in which case this occurs infrequently, preventive measures are necessary to avoid operator discomfort. To control the welding quality, a greater amount of lighting is required on the workbench.

Ergonomic recommendations

Based on the ergonomic diagnosis, it is recommended that the current model of chair be replaced with a model with height adjustment and a lower inclination of the back support, which in the current model is unusable. For your feet, you must acquire adequate support. It is also necessary to replace the welding table with a model with height adjustment, and preferably with angle adjustment and slots to facilitate the fitting of the parts to be welded. Both the table and the chair need to be made of non-flammable material. For the evaluated operator, it is recommended that the table height be around 820 mm, recommended height for high precision tasks (GRANDJEAN, 1998) and the chair height be around 440 mm.

When all machines are turned on, it is recommended that the operator wear hearing protection. As the use of a welding mask may interfere with the use of the earcup protector, the use of an in-ear model is recommended. To increase the lighting on the bench, we suggest installing an adjustable lamp attached to the table, with enough light intensity to reach 500 lux.

Conclusions

Despite the low welding load in a laboratory, the nature of the activity and ergonomic risks involved are the same as those seen in medium to large companies. Even if the suggested ergonomic recommendations are implemented to reduce the identified risks, problems related to static sitting posture and repetitive activity must be monitored by the laboratory to monitor their long-term impacts on worker health. If the need for further interventions is determined, it is recommended that a subsequent study be carried out considering the frequency and duration of post-welding pauses.

Bibliographic references

ABRAHÃO, J. et al. **Introdução à Ergonomia: da prática a teoria**. São Paulo: Edgar Blucher, 2009.

BRIDGER, R.S. **Introduction to ergonomics**. 2ª edição, Londres, Taylor & Francis, 2003.

GRANDJEAN, E. **Manual de Ergonomia: Adaptando o Trabalho ao Homem**. 4 ed. Porto Alegre: Bookman, 1998.

GUÉRIN, F. **Compreender o trabalho para transformá-lo: a prática da ergonomia.** São Paulo: Blucher: Fundação Vanzolini, 2001.

KARHU, O. et al. **Correcting working postures in industry: A practical method for analysis**. Applied Ergonomics, 1977.

LATKO, W. A. et al. **Development and evaluation of an observational method for assessing repetition in hand tasks**. American Industrial Hygiene Association Journal, v.58, n.4, 1997.

MACHADO; GUERRA, I. **Soldagem & Técnicas Conexas: Processos**. Porto Alegre: Machado, 1996.

MAGRINI; OLIVEIRA, R. **Segurança do Trabalho na Soldagem Oxiacetilênica**. 2.ed. São Paulo: FUNDACENTRO, 1999.

OCCHIPINTI, E.; COLOMBINI, D. **Proposal of a concise index for the evaluation of the exposure to repetitive moviments off the upper extremist (OCRA Index)**. Med Lav, 1996.

VIDAL, M. C. R. **Guia para Análise Ergonômica do trabalho (AET) na empresa: uma metodologia, ordenada e sistematizada.** 2ª ed. Rio de Janeiro: Virtual Científica, 2012.

SANTOS JÚNIOR, R. L. de F. **Processo perceptivo humano e a fadiga cognitiva nas empresas de vigilância privada**. Tese (Programa de Pós-Graduação em Engenharia de Produção), Universidade Federal de Santa Catarina, Centro Tecnológico., 2010.

SILVA, S. A. **Análise ergonômica do trabalho do soldador: contribuição para projetação ergonômica**. Porto Alegre, Universidade Federal do Rio Grande do Sul, 2003.