38 - ERGONOMICS AND THERMOGRAPHY INSIDE THE ASSEMBLY LINE

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1. INTRODUCTION

Ergonomics is a relationship based on a set of science and technology, aimed at achieving the mutual adjustment between human beings and their working environment, providing comfort and safe productivity, seeking to adapt the work to man (COUTO, 2011 p.7).

During the Second World War, the ergonomics of man-machine interface or occupational ergonomics was developed, concerned with the problems of science and technology and practice of physical issues and awareness for products, equipment and jobs. After World War II, the lean production system in order to reach the Western automotive industry came to increasing productivity and reducing costs (IIDA, 2005, p.5-13).

Currently, the ergonomics has a greater relevance and the coverage area is larger yet. For better productivity, the worker must be satisfied and this, studies are needed processes to avoid discomfort, monotony, fatigue, avoidances and accident (IIDA, 2005, p.12-14).

In a broader view of the human being, it can be said that it is not only a being biomechanical or physiological characteristics and also has a whole complex psychosocial and this has also been approached by ergonomics (COUTO, 1995 p.15- 22).

In this context, there are no explicit recommendations about the choice of methods and techniques more adapted to each case. Ergonomics can be understood as part of the larger effort to the development of production engineering in Brazil (IIDA, 2005, p.25-29).

This work objective is to apply conventional ergonomic analysis tools (OWAS - Ovako Working Posture Analysing System, New Checklist Couto and RULA - Rapid Upper Limb Assessment) and correlate their results with the capture of thermal imaging (thermography) for the purpose to validate the method as a new ergonomic tool.

2. LITERATURE REVIEW

2.1. Ergonomics

According to Fundacentro (1981, p.423) ergonomics is quite coincident with occupational hygiene and its objective is to achieve the ideal mutual adjustment between the man and his work, and the results are measured in terms of human efficiency and wellbeing in job.

According Grandjean (1998, p.7), ergonomics comes from the Greek: "ergon" meaning work and "nomos" which means law standards. The objective of ergonomics is to develop scientific basis for the adjustment of working conditions to the capabilities and realities of the working person.

2.2. The heat production in the human body

According to Saliba (2004, p.208), metabolism is the heat generated by the resulting BMR worker physical activity. Thus, the greater the physical activity, the greater the heat produced by metabolism.

2.3. Thermographic technology

According Brioschi (2011, p.28) infrared thermography is a method of image diagnostic which by means of a coupled sensor and a computing system measures the distance and the infrared radiation emitted by the surface of an object without physical contact.

According to Flir (2016) the application of infrared radiation or thermography is done by using an infrared camera to measure the heat that is emitted by any object or material existing in nature. Thermal or infrared energy is not visible light, since its wavelength is too long to be detected by the human eye.

According to Tecnolass (2013, p.5) infrared image is the technique of transforming an invisible infrared radiation into a visible image. The infrared camera detects the energy emitted by an object, modify this energy and shows the infrared image.

2.4. Method RULA – Rapid Upper Limb Assessment

According to Osmond (2016) the RULA is a research method developed for use in ergonomic investigations in workplaces where disturbances work-related upper limb are reported. It is a screening tool that assesses the biomechanics and postural load throughout the body, with particular attention to the neck, trunk and upper limbs.

2.5. Method OWAS - Ovako Working Analysing System

According to FIOH (2016) OWAS the method is to identify the primary working postures most common back, arms, legs and handling loads by assigning values and then comparing them with a rating where there are recommendations.

2.6. Method the New Checklist of Couto - Risk for upper limbs

According to Couto (2012, p.71-72) method consists of observing the activity and assignment of default values to later realize the sum of these values and the Interpretation by legend on the checklist itself.

3. METHODOLOGY

This study was applied to a Brazilian assembler in a specific area of assembly and soldering of components for the manufacture of cabins, more specifically a piece called the “left-side” where three workers perform the activity daily in turn relay being mounted sixteen pieces per shift work regime of forty hours per week.

The activity involves removing parts of a cart, mount them on the device for welding, apply adhesive in some parts

using a specific pneumatic device and then perform a soldering process to the point. After the subassemblies are transported to the next station not included in this study.

The function was analyzed the operator due to the qualitative characteristics of greater efforts to implement the activity.

Data were collected on a typical working day, at the beginning of the work journey in the morning, with the worker's consent activity was filmed for later application of ergonomic analysis tools and thermographic images were obtained to prove the method.

For the development of ergonomic analysis, the following tools were used:

a) OWAS – Ovako Working Analysing System;

b) Method the New Checklist of Couto - Risk for upper limbs;

c) RULA – Rapid Upper Limb Assessment;

d) Thermography.

This analysis aims to evaluate the upper limbs, verify the possible situations that may cause discomforts until injuries to employees of a welding activity in a Brazilian automaker using traditional ergonomic analysis tools and in the end, apply a thermal imaging process.

These tools were selected, having the common objective, analyzing upper limb, and the OWAS aims to identify an elementary analysis of the prevalence or absence of situations to be studied in upper or lower limbs.

The New checklist of Couto has been applied is an initial version (25/06/2012), but allows a very reliable analysis of the risk of disturbances and injuries to members.

The RULA is specific, being considered as a complementary tool for upper limbs and details of the possible points of injury. This form is found on the website of Osmond Ergonomics, whose filling should be done electronically after collecting field data and finally, the results are displayed.

The last step was understood by the capture of the thermographic images to validate the items listed in other ergonomic analysis tools during the course of normal work activities.

4. RESULTS

4.1. Method OWAS

In applying OWAS noted that the positions of back and arms, may cause discomfort or pain depending on the time kept in these positions due to the inclined trunk and an arm above the shoulder line.

The posture of legs indicated that the worker is standing, with the legs stretched, and consequently with the weight resting on this, a condition that can result in discomfort and pain as a function of time held in this position.

In item effort, not more than ten kilograms load is manipulated, which may be favorable for the activity taking into account the trunk effort and legs, but if there is effort arms, this can be a factor that will cause discomfort or pain to the self-employed time maintained.

Assigning the percentage of time kept at thirty percent activity for laying back and forty percent for arms, we obtained the result that corrections are needed in the near future.

For legs, the value of thirty percent is they are not necessary corrective measures, ie it is very likely that there are no problems in this activity that may compromise lower limb, however, as to the upper limbs, the diagnosis indicates correction needs.

4.2. Method the New Checklist of Couto

Analyzing the application of the New Checklist of Couto to upper limb basically observed the requirement of activity emphasizing the use of high intensity strength in the hands and upper limbs in time greater than fifty percent of the cycle, cargo handling in posture bad (even with the handling of the welding equipment to the point aided by balancin), crisp postural deviation of wrist and shoulder, static efforts with the body kept out of vertical and inclined neck axis.

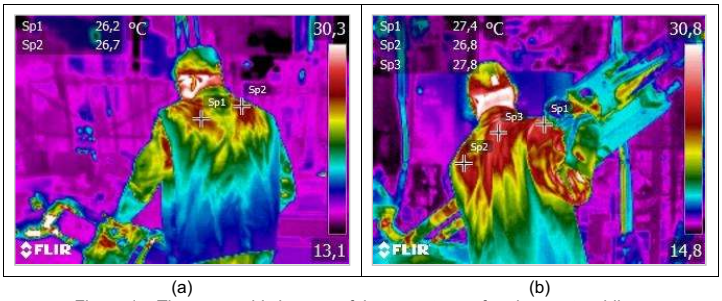
It was also observed that there are alternating muscle groups and the fatigue recovery time can meet the job requirements. The result of the data obtained in implementing the checklist was four points as indicating position consistent with DDF - Discomfort, Difficulty or Fatigue and with little likelihood of lesions in the upper limbs.

4.3. Method RULA – Rapid Upper Limb Assessment

According to the analysis and the results presented, the score was equal to seven (data generated by Osmond software after inserting the data) indicating that an investigation and changes are required immediately due to high demand of the muscles of the upper limbs.

4.4. Thermograph method

Applying the thermographic method in parts of the body (back and shoulders) in which other methods of ergonomic analysis (OWAS, New Checklist of Couto and RULA) indicated greater potential for discomfort or pain, it was observed that can be identified by analysis of thermal images, points with higher temperature even on the garments, as demonstrated in Figure 1.



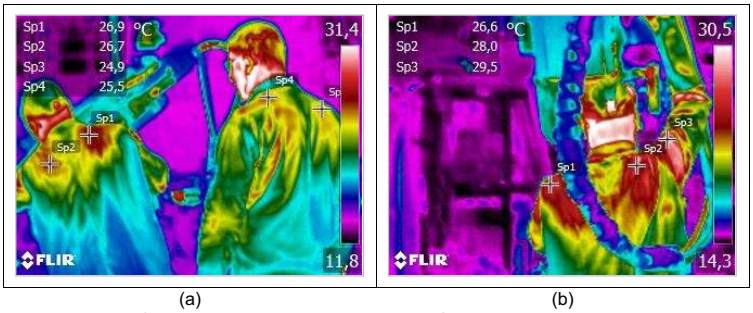
(a) (b)

Figure 1 – Thermographic images of the operator performing spot welding.

The points indicated in Figure 1 refer to increased blood flow and thus temperature rise due to the increased muscle demand at those points.

Figure 2a can be seen a comparison between the operator running its welding activities to the point and an observer,

where temperatures called Sp1 (26.9ºC) and Sp2 (26.7ºC) show higher temperature compared to Sp3 points (24.9°C) and Sp4 (25.5°C).

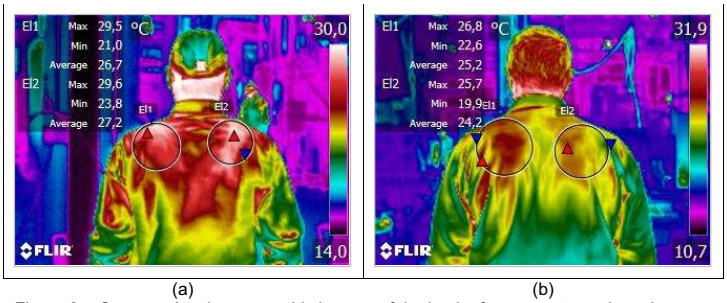


(a) (b)

Figure 2 – Comparative thermographic images of the operator and another person at rest

In Figure 2b, there is the operator with the arm above the shoulder line and the temperature points called Sp1 (26.6°C), Sp2 (28.0°C) and Sp3 (29.5°C) show an increase in temperature greater effort in worker region muscles (right shoulder and back).

It is observed in figure 3, a comparison of the back of an operator (Figure 3a) of the captured spot welding equipment after one hour and twenty-six minutes of work on a typical day and an observer (Figure 3b) after a time administrative work.



(a) (b)

Figure 3 – Comparative thermographic images of the back of an operator and an observer

It is possible to identify in Figure 3a, the measurement values of temperatures known as E1 and E2, are superior to measured values of Figure 3b.

The most likely cause of this temperature increase in the upper limbs is muscle requirement of the activity (in this case the operation of point-welding equipment), further emphasizing the right side of the body and more specifically the trapezius and shoulder, possibly because of the need the lifting arm above the shoulder line and load support.

4.5. Comparative analysis of the methods

In the analysis of traditional ergonomic evaluation tools used, there was some diference.

The OWAS method determines that corrections are needed in the near future to upper limbs. Already the New Checklist of Couto indicates the discomfort compatibility, difficulty or fatigue with little likelihood of lesions in the upper limbs.

Thus, comparing the OWAS with New Check-list of Couto, you can see that the OWAS is a simpler and less specific method, since it aims only to direct and not delves into the problem, when it comes to members higher.

The RULA showed unfavorable working conditions resulting in the need to investigate and change immediately.

It was observed that the RULA is more accurate for upper limbs than the other two methods and the results showed the need for immediate changes in the assessed job.

The thermographic analysis complemented and validated the appointments of the other methods. As can be seen, the traditional methods of ergonomic analysis is more qualitative and depend heavily on the perception and experience of those who evaluate for better efficiency.

It understood that thermography is relevant to the ergonomic study and prevention of injuries and illnesses at work.

5. CONCLUSION

This work was of fundamental importance to the further knowledge of traditional ergonomic analysis tools (OWAS, New Checklist of Couto and RULA). These tools were applied and compared to each other and subsequently validated with a thermographic technology not routinely used in the occupational environment.

The ergonomic analysis with traditional methods highlighted the divergence between them and the more qualitative and less accurate and dependent on difficult to control variables such as perception and experience of the evaluator.

The application of thermography in ergonomic analysis enabled the breakdown of employment paradigm method only for industrial diagnostics and innovated concept of using this technology little explored in the occupational environment to prevent injury and illness. The thermography demonstrated that muscle demand can be measured points.

Based on the results it is recommended the application of thermography as a supplement in ergonomic studies for validation of traditional tools notes.

Improvement in the study of thermal technology for use in occupational purposes, analytical methods and specific parameters, development and control of existing variables is recommended.

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ABSTRACT

This research was developed in a Brazilian assembler and discusses the use of infrared imaging technology called thermography in the occupational environment is still very incipient condition. Presents a comparative approach to traditional ergonomic analysis tools, OWAS, New Checklist of Couto and RULA, applied to upper limbs and infrared imaging method. Discusses the generation of heat in the human body due to static or dynamic postural requirements, specifically in the muscles as an object for study thermography. Explanations are given on the thermographic technology and their physical settings, as well as the methodology applied and the characteristics and parameters of the equipment used. Traditional ergonomic tools used in this research are detailed the method and setting are described. Complemented by field research, the study found that traditional ergonomic analysis methods differ from each other, even when it comes exclusively from the upper limbs, making it difficult to apply in isolation, that is, the survey revealed that should apply more than a tool to get success and above all, depend on the knowledge and experience of the evaluator. Therefore, the thermographic method is recommended as quantitative complementary tool for the validation of information from other traditional methods.

Keywords: Ergonomics, Safety, Thermography.

ERGONOMIE ET THERMOGRAPHIE DANS L'ENSEMBLE DE LIGNE

RÉSUMÉ

Cette recherche a été développé dans un assembleur brésilien et discute de l'utilisation de la technologie d'imagerie infrarouge appelée thermographie dans l'environnement de travail est toujours un état très naissant. Présente une approche comparative des outils traditionnels d'analyse ergonomique, OWAS, Nouvelle Liste de Couto et RULA, appliqués aux membres supérieurs et de la méthode d'imagerie infrarouge. Discute la production de chaleur dans le corps humain en raison des exigences posturales statiques ou dynamiques, en particulier dans les muscles comme un objet d'étude thermographie. Des explications sont données sur la technologie thermographique et leurs paramètres physiques, ainsi que la méthodologie appliquée et les caractéristiques et les paramètres de l'équipement utilisé. Les outils traditionnels ergonomiques utilisés dans cette recherche sont détaillées la méthode et le réglage sont décrits. Complété par la recherche sur le terrain, l'étude a révélé que les méthodes traditionnelles d'analyse ergonomiques diffèrent les uns des autres, même quand il provient exclusivement des membres supérieurs, ce qui rend difficile à appliquer dans l'isolement, qui est, l'enquête a révélé qu'il devrait appliquer plus d'un outil pour obtenir le succès et surtout, dépendent de la connaissance et de l'expérience de l'évaluateur. Par conséquent, le procédé thermographique est recommandé comme quantitative outil complémentaire pour la validation des informations provenant d'autres méthodes traditionnelles. Mots-clés: Ergonomie, Sécurité, Thermographie.

LA ERGONOMÍA Y LA TERMOGRAFÍA EN UNA PLANTA DE ENSAMBLAJE

RESUMEN

Esta investigación se ha desarrollado en una planta de ensamblaje de Brasil y discute el uso de la tecnología de imagen infrarroja llamada termografía en el entorno laboral sigue siendo condición muy incipiente. Presenta un enfoque comparativo de las herramientas tradicionales de análisis ergonómicos, OWAS, Nueva Lista de Control de Couto y RULA, aplicadas a las extremidades superiores y el método de formación de imágenes de infrarrojos. Discute la generación de calor en el cuerpo humano debido a los requisitos posturales estáticas o dinámicas, específicamente en los músculos como un objeto para la termografía estudio. Se dan explicaciones sobre la tecnología termográfica y su configuración física, así como la metodología utilizada y las características y parámetros de los equipos utilizados. herramientas ergonómicas tradicionales utilizados en esta investigación son detallada, el método y el ajuste se describen. Complementada por la investigación de campo, el estudio encontró que los métodos tradicionales de análisis ergonómicos difieren entre sí, incluso cuando se trata exclusivamente de los miembros superiores, por lo que es difícil de aplicar en forma aislada, es decir, la encuesta reveló que debería aplicarse más de una herramienta para conseguir el éxito y, sobre todo, dependerá de los conocimientos y experiencia del evaluador. Por lo tanto, se recomienda el método de termografía como herramienta complementaria para la validación cuantitativa de la información de otros métodos tradicionales.

Palabras-clave: Ergonomía, Seguridad, Termografía.

ERGONOMIA E TERMOGRAFIA DENTRO DE UMA MONTADORA

RESUMO

Esta pesquisa foi desenvolvida em uma montadora brasileira e discute a utilização da tecnologia de captação de imagens infravermelhas denominada de termografia que no meio ocupacional é uma condição ainda bastante incipiente. Apresenta uma abordagem comparativa em relação às ferramentas de análise ergonômica tradicionais, OWAS, Novo Check-list de Couto e RULA, aplicadas a membros superiores e o método de captação de imagens infravermelhas. Aborda a geração de calor no corpo humano em função de exigências posturais estáticas ou dinâmicas, mais especificamente nos músculos como objeto para o estudo termográfico. São apresentadas explanações sobre a tecnologia termográfica e suas definições físicas, bem como, a metodologia aplicada e as características e parâmetros do equipamento utilizado. As ferramentas ergonômicas tradicionais utilizadas nesta pesquisa são detalhadas, o método e cenário são descritos. Complementado pela pesquisa de campo, o estudo verificou que os métodos de análise ergonômica tradicionais divergem entre si, mesmo em se tratando exclusivamente de membros superiores, dificultando sua aplicação isoladamente, ou seja, a pesquisa revelou que se deve aplicar mais que uma ferramenta para se obter o êxito e sobretudo, são dependentes do conhecimento e experiência do avaliador. Portanto, o método termográfico é recomendado como instrumento complementar quantitativo para a validação da informação dos demais métodos tradicionais.

Palavras-chave: Ergonomia, Segurança do Trabalho, Termografia.