BIOMECHANICAL ANALYSIS ON THE OPERATION OF MANUAL VALVES IN A CHEMICAL INDUSTRY

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SUMMARY
Occupational Biomechanics concerned with the physical interactions of the employee with its job, machine, tools and materials, to reduce the risks of disturbances muscle-skeletal disorders. Through concepts of physics, of Anthropometry and Anatomy, biomechanics examines the forces and moments in the parts of the human body during an activity. This work used the tools of biomechanics studies to analyze the activity of valves manual operation in a chemical industry. Often this activity is carried out in adverse conditions, in postures, with realized with raised upper limbs. We used the following ergonomic tools: 3D SSPP (3D Static Strength Prediction Program) and RULA (Rapid Upper limb assessment). Ergonomic high risk was observed and that the most affected articulations in postures derived during the manual valve operation activity are those of the shoulder, elbow and wrist.

INTRODUCTION
The manual valve operation is a common activity in different industries. The valves are operated to lock or release the product flow inside pipes.

Valve adjustment activity has potential risk factors to induce shoulder injuries. These factors are related to the force used and the postures [1].

Shoulder disorders are influenced by biomechanical factors related to work, such as abduction or flexion of the shoulder for prolonged time, vibration, static posture or with load on the upper limb [2].

Thus, this study aims to evaluate, through ergonomic tools using biomechanical concepts, postures typical of manual valve operation in a chemical industry.

METHODS
Through observation of the operators of a chemical industry, critical stances were selected for opening and closing the hand control valves. These postures were evaluated biomechanically through Software 3D SSPP (3D Static Strength Prediction Program) and RULA method (Rapid Upper limb assessment-).

3D SSPP is the result of more than 35 years of research center of Ergonomics at the University of Michigan on the Biomechanics and the capabilities of the strength of the employee in relation to the physical demands of the work environment [3].

The software simulates static strength requirements for tasks such as elevations, crunches, push and pull. The program provides a rough simulation of work and includes data from the posture, the parameters of strength and male and female anthropometric data. In addition, it includes the forces of spinal compression and data comparisons with NIOSH guidelines. The analysis is aided by a feature of automatic generation of graphical illustrations and three-dimensional human posture [3].

The RULA method (Rapid Upper limb assessment) is an agile and fast tool that allows to obtain an assessment of upper limb Biomechanics and overload of the neck in an occupational task [4]. This method is proposed to be determined, with regard to postures assumed during the work, the properties of intervention or the need for further investigations by experts and ergonomists [5].

Through a score for different postures of: 1) arms and wrists; 2) forearms; 3) position and turn the handle, 4) neck, trunk and legs; added to a score of force/load, it is obtained a final score, ranging from 1 to 7. If achieved the score 1 or 2, the posture is considered acceptable, to score 3 or 4, you should investigate, to score 5 or 6, you must investigate and change soon, to score 7, must investigate and change immediately. The worksheet used to RULA method is shown in Figure 1.

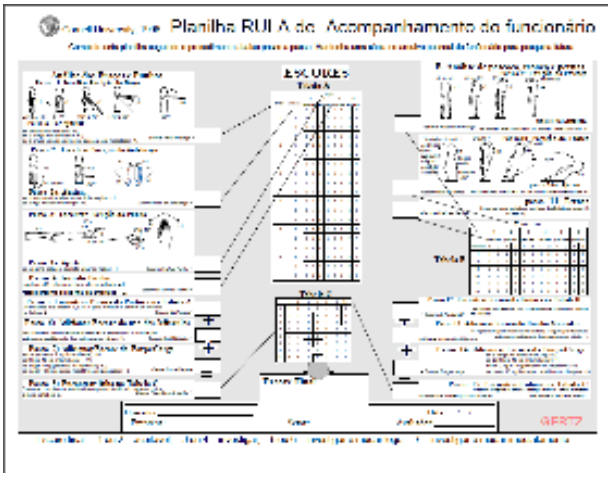
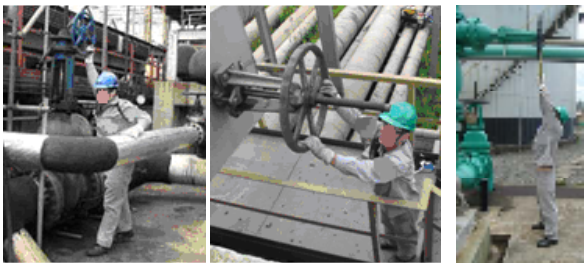


Figure 1: Worksheet for RULA method

RESULTS AND DISCUSSION

Technical operation of a chemical industry was accompanied during the activity of operation of manual valves. The following images were obtained during this monitoring and represent some postures assumed during the operation of manual valves.



Posture 1 Posture 2 Posture 3

Figure 2: Postures assumed during the operation of manual valves in chemical industry

The force used to open a 6 inches horizontal valve is 66 pounds (30 kg). To close, this force increases to 103 pounds (47 kilograms). These parameters were used for the simulations in 3D software SSPP [1].

Through the analysis with the software 3D SSPP has been evident high strength requirement in the articulations of the wrist, elbow and shoulder. Only in posture 3, with the status of valve opening, no joint force requirement demand unacceptable.

For posture 1 and 2, for valve opening, there are unacceptable requirement in the shoulder joint. When the power in the hands is intensified, in the situation of closing the valve, there is requirement of force unacceptable in the elbow joint in all simulated postures. For this situation, it is maintained for the 1 and 2 requirement poses unacceptable in the shoulder joint, which is further intensified. In addition, it was found unacceptable in the articulation of the requirement to handle the position 2 and next unacceptable to posture 1.

The evaluation through RULA method has generated final score 7 to the 3 postures, with a higher score (6 and 7) to the analysis of arms and fists. The analyzed postures are characterized by arms at an angle greater than 90° (around 180°), shoulders high and in position 2, the arms away from the body.

CONCLUSIONS

Through simulation with 3D SSPP software and application of method it was possible to verify RULA ergonomic risk, requiring research and immediate change; and requirement of force unacceptable articulations of shoulder, elbow and wrist postures observed in a chemical industry during the operation of manual valves.

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REFERENCES

1. Yoonton S., The Ergonomic Analysis of Valve Adjustment Tasks for Refinery Unit Operators At Koch Petroleum Group, St. Paul, Minnesota. Master of Science with a Major in Risk Control. University of Wisconsin-Stout, USA, 1999.
2. Mendonça HP, Assunção AA, Association between shoulder diseases and work: a brief review. Braz Rev. epidemiology 8 (2): 167-176, 2005
3. The University of Michigan Center for Ergonomics. Available in: < http://www.engin.umich.edu/dept/ioe/3DSSPP/index.html>. Access 16/09/2011.
4. Pavani RA, Quelhas OLG, A avaliação dos riscos ergonômicos como ferramenta gerencial em saúde ocupacional. In: XIII SIMPEP – Bauru, SP, Brasil, 06 a 08 de novembro de 2006.
5. Colombini D, et al. Il método ocra per l´analisi e la prevenzione del rischio da movimenti ripetuti. Milão: FrancoAngeli, 2005.