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THE USE OF *OWAS* IN FOREST OPERATIONS POSTURAL ASSESSMENT: ADVANTAGES AND LIMITATIONS

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Abstract: *It is widely accepted that forest operations are both difficult and hazardous activities. During their activity, forest workers are required to take uncomfortable postures, exposing themselves to risks of musculoskeletal injuries and disorders. Hence, evaluations are needed to improve their operational behaviour and ergonomics. One way to assess the work postures consists in implementing the Ovako Working posture Assessment System (OWAS) that has the advance of a rapid yet full body postural assessment. However, in forest operations, one may deal with some specific situations that should be carefully analyzed. This paper describes the advantages and limitations that the use of such a system may have, through a series of case studies, based on snapshots extracted from video files, as this particular approach may be specific to forest operations.*

Key words: *posture analysis, assessment, OWAS, forest operations.*

1. Introduction

Forest work is particularly important in many economies across the world, because it contributes substantially to GDPs by sequentially adding value to timber products through specific forest operations. On the other hand, forest operations are prone to occupational accidents [4], [5], [26], [30], [32], [33], [36] that are related to the used tools and tasks, frequently resulting in fatalities [18], [30], as well as into several types of disorders [1], [34], because people are required to work frequently in difficult conditions and sometimes they disobey the prescribed procedures in their work tasks [4], [5]. Work conditions refer to characteristics of the natural environment that may be related to the accident rates [29], as well as to the used equipment [11]. Firstly, the workers have to carry on their duties outdoors, frequently in sloped terrains and under the clear sky, being exposed to adverse weather (cold, heat, rain, snow etc.). Secondly, they are required to carry

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personal protective equipment and tools [23] that represent additional burdens during their work. The used tools and equipment may expose the forest workers to technology-related stressors. Noise and vibration [10], [22], [25], [34] as well as dust emissions [14] and exhaust gases are among the most important ones. Some exposure levels depend on the used tools and equipment, as well as on the particular characteristics of the work object, such as the tree species [27]. It is known that an increased level of mechanization may lead to decrements of the physical work, hence to some decreasing rates of the occupational accidents [3] but, for most of the currently used equipment, ergonomic improvements are still needed [12], [15]. Furthermore, the mechanized forest work leads to higher mental demands [20]. In addition, forest workers have to be well trained in health and safety issues, possibly by a participatory approach [31], since in some countries or regions, this kind of training is not provided to all the workers [19] and, even if differently between State and private companies, the forest workers take unnecessary risks [4-5], [16].

Given the aforementioned, forest work is considered to be very difficult and risky. As the risk of work accidents depends also on the worker's fatigue, it is also very important to assess the factors that contribute to fatigue development because, besides the risk of exposure to musculoskeletal injuries or disorders [2], the work posture in given tasks may contribute to the worker's fatigue. This is quite obvious in forest operations where the workers are required to take uncomfortable postures when carrying on their tasks. Nevertheless, in order to evaluate the difficulty of their work, hence to take improvement measures, it would be required to assess somehow their work postures.

Several methods for body postural assessment are known and very well described in different textbooks [13], [28]. The rapid assessment of the entire body may be carried out using the Ovako Working Posture Assessment System (OWAS) that has the advantage to be quite easy to implement. As it has a lot of potential to be used in the evaluation of body posture in forest operations, in this paper, some of the issues that a researcher may deal with, when using this system, are described.

2. The Ovako Working Posture Assessment System

The Ovako Working Posture Assessment System (OWAS) was developed in Finland in a steel industry company - Ovako Oy – In 1973, to describe the workload in the overhauling of iron smelting ovens [17]. The system was originally developed for use in manufacturing industries, where the workstations were static and the job tasks were repetitive and predictable in nature [37]. OWAS can be used to identify the most common work postures for the back (4 postures), arms (3 postures), legs (7 postures), as well as for the weight being handled (3 categories). The general (whole body) work posture is further described by a four digit-code (Fig. 1), resulting in 252 possible body postures that are further classified into four action categories indicating the needs for ergonomic change (Fig. 1).

Methodologically, the observations are being made as *snapshots*, while the sampling is being made at constant time intervals. Used this way, OWAS can lead to full body posture assessment, as well as to the evaluation of load (force exertion). However, it cannot measure the movement frequency and duration, physiological recovery, vibration etc. [7]. Nevertheless, this system has been widely used to evaluate the workload in various industries including forestry and forest related operations [6].

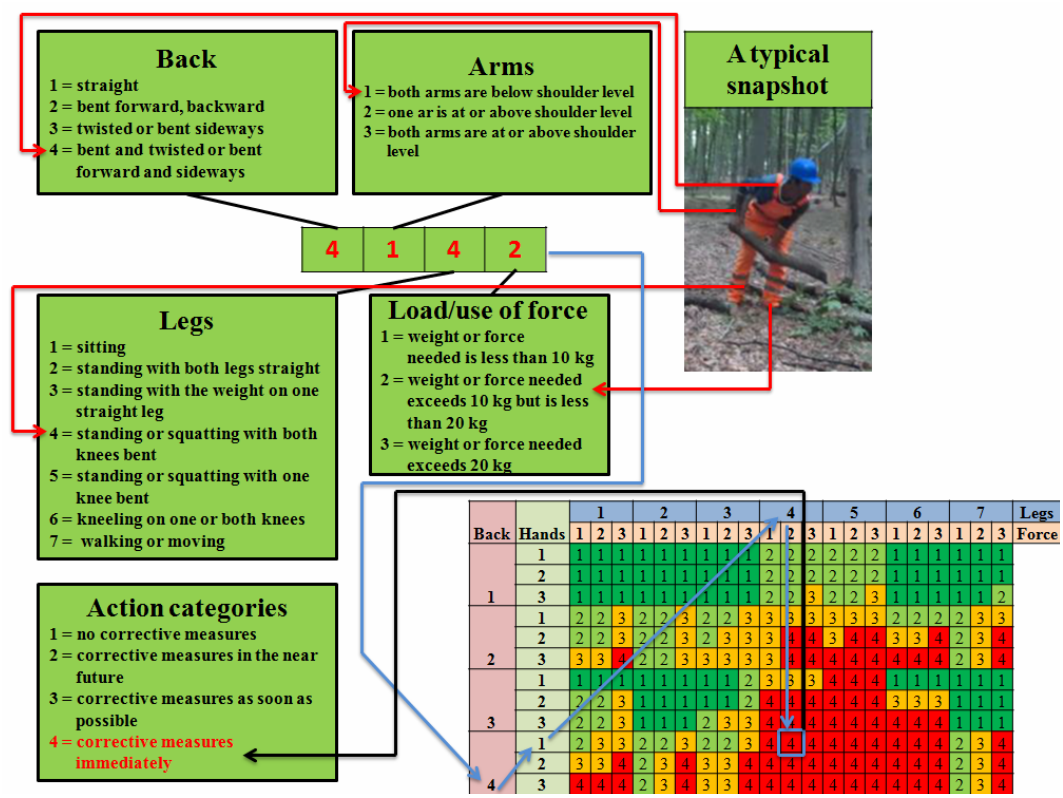

Fig. 1. *The concept behind Ovako Working posture Analysis System. Source: adapted from the original of Helander (2006)*

As the evaluation tasks require important time resources, several automation tools for data processing have been developed in time. In particular, their functionalities include the possibility to generate a string (four or more digits code) that is further used to choose a given ergonomic action category (Fig. 1). Basically, uncomfortable or very uncomfortable postures are classified in ergonomic categories that require immediately or as soon as possible, ergonomic actions to be taken. Such postures resemble significant (potentially harmful) deviations from the normal (natural) human body postures. It is always very important to assess the body posture in relation to a given task. This approach may lead to additional digits [35] to be processed in a given software tool, representing a particular elemental task that could be separated from the general task taken into study.

3. Possibilities to use OWAS in forest operations postural assessment

There are several particularities of forest operations that may actually influence the use of traditional OWAS (either visual snapshots taken in the field or office processed images extracted from video files). One issue is that of very short duration elemental work tasks that may affect the accuracy of in-situ sampling, giving this way sufficient reasons to capture the necessary data, using video recording devices. Figure 2 shows what can happen in relation to the timeframe, in case of a regular manual work of grouping short logs for further extraction. Figure 2 has been prepared by extracting each third frame from a video file recorded at about 24 frames per second. As shown, in less than one second both legs and back posture may change. As a matter of fact, the back posture evolved in less than one second in three distinguishable postures as defined in OWAS: straight (1), twisted sideways (2) respectively bent and twisted (4).

Therefore it would be necessary to use very detailed data when conducting postural assessment in some of the forest operations. In case of video recording, this means that the resulted video data should be broken into a large number of frames, therefore the analysis and assessment effort will increase.

Fig. 2. *Posture change relative to a very short period of time in a particular task (Photo: SA Borz)*

Fig. 3. *Force exertion in a typical work task (Photo: SA Borz)*

It is typical for many industries and workers to use given tools for assistance in their work tasks, as different tools improve their capability. This is also true in forest operations, where a worker may use, for instance, a motor chainsaw to fell and process the tress. In such cases, one can frequently and easily approximate the load and (or) force exertion, based on the tool weight. However, there are many instances in which this approach would be rather difficult in forest operations. As an argument, there is an example enclosed in Figure 3. Here, one can use some known variables to estimate the weight of a small log and this approach would be very useful when the full weight is actually supported by the worker's hands and body. However, one may deal with particular situations in which the log is partially supported by the hands and ground respectively. Hence, it would be more difficult to approximate the load that is actually carried. Then, when throwing the log, the same problem may occur. Another example of force exertion estimation problems is given in Figure 4.

Fig. 4. *Cable pulling in typical winching operations (Photo: SA Borz)*

Here, a worker pulls a cable to attach a log. Unless the cable length is known in each of the recorded or analyzed postures, it would be difficult to estimate the force exertion. Furthermore, the estimations should be also calibrated by considering the constructive characteristics of the cable and winch respectively, because it is known that different cable types may under- or overload the worker [21], [24]. Other typical examples are those of using hookaroons to roll-over or slide the logs, the use of different kind of levers to fell the trees, and so on.

Essentially, OWAS was designed for ground-work, meaning that the legs position is very important to evaluate the whole body posture. However, in forestry, people are often required to work at considerable heights as being specific to cable yarder rigging operations (Fig. 5). Regardless of the used approach, when recording data, this particular situation has at least two implications.

Fig. 5. *A typical example of cable yarder rigging operations (Photo: SA Borz)*

Firstly, if dealing with very large trees and the need to climb at considerable heights, as the worker advances on the tree, the ground observer may have difficulties in understanding right a given work posture. Then, when the body is sustained by both the legs and the climbing harness, it would be difficult to correctly classify, in the spirit of OWAS, the legs posture, since part of the body weight is not sustained by the legs. Similar problems may arise even when observing ground operations. Given the forest ground conditions as well as the safety concerns, in some cases, an observer may or may not accurately capture the entire body position due to the safety distance reasons and the presence of harvesting slash or other obstacles on the ground (Fig. 6).

Fig. 6. *A typical example of how some obstacles may influence the accuracy of data capturing (Photo: SA Borz)*

Also, due to the ground roughness, it is possible for the observer to miss some of the worker's actions when video recording. As in the example of cable rigging operations presented above, some information will be lost. In this respect, the observer is called to compromise the observation distance and the data capturing accuracy. On the other hand, when possible, the fully front, back or sideway data capturing should be avoided, due to the reduced extent to which a work posture from a given screenshot may be recognized at the office. An example of recording the posture from a full back position is shown in Figure 7. As shown, beside the fact that it is difficult to appreciate the arms position relative to the shoulder level, it is impossible to assess the force exertion.

Fig. 7. *An example of taking incorrect snapshots (Photo: SA Borz)*

One of the most important features of OWAS is that, based on the way of doing work (in terms of work postures), one can propose certain ergonomic measures, often consisting of work posture improvement. Of course, this is congruent with the fact that some work postures are actually avoidable. However, in forest operations, even if avoidable from one point of view, some work postures are rather forced due to many reasons such as the safety concerns, local environment (topography) and operational reasons. Therefore, some of the work postures cannot be avoided even if they are potentially harmful.

Fig. 8. *An example of forced posture in forest operations (Photo: SA Borz)*

A typical example is shown in Figure 8 where a worker has to hook a log (winching operations) using a cable engaging himself in a work posture that, according to OWAS, will be translated in a digit code (4141) corresponding to a category in which the corrective actions should be taken immediately. Unless the local ground configuration allows him to stand, he will be required to bend his back for each cable setting he performs and the same would be true when he detaches the cable. Other typical examples are those of making the cuts to fell a tree, using a motor chainsaw, when the worker is required either to bend his back or to kneel, in order to manipulate the saw at the required level of cut making, as well as when it is required for a worker to stay on one sitting leg on a cross-slope.

While the OWAS cannot evaluate the static versus dynamic work, some information in this direction would be quite important in correctly evaluating a given work posture, based on images extracted from video files. In this respect, movement or walking can be inferred from the general position of the legs relative to the position of a given work object (Fig. 9).

Fig. 9. *Inferring the movement from legs and the work object position (Photo: SA Borz)*

Blurred parts of a given image, as well as the position of the work object may suggest to a researcher whether a posture involves dynamic work (Fig. 10). In some cases, this approach may be also very helpful in understanding and correctly assessing the force exertion. Therefore, the dynamic work can be assessed also from the context of given images, as shown in Figures 9 and 10. This approach is very useful when there are doubts about the particular posture of a given body part.

Fig. 10. *A blurred part (the log) indicating that dynamic work just has been carried out (Photo: SA Borz)*

4. Conclusions

This paper has intended to describe some conditions as being specific to forest operations in which the OWAS may have more or less applicability. The techniques used for data collection should be chosen very carefully and they should be also balanced with the particularities of the tasks taken into study. In adequate conditions related to data capturing, as well as in the conditions of data processing automation, video recording has a lot of potential in the assessment of the body posture, including here the possibility of evaluating the time spent in different postures, as well as of evaluating the dynamic work. For such a purpose, data automation is very important and the used tools should enable both the possibility of analyzing great amounts of data (images extracted from video frames) and the possibility of describing or calculating other factors (elemental tasks, dynamic work, automation of time calculation).

Nevertheless, we conclude that OWAS has a lot of potential in assessing the physical workload in forest operations.

References

1. Alexandru V., 1997. Ergonomics. Basic Elements (in Romanian). Lux Libris Press, Brasov, 316 p.
2. Ashby L., Bentley T., Parker R., 2001. Musculoskeletal disorders in silviculture and logging 1995 – 1999. Centre of Human Factors and Ergonomics (COHFE) Report. Volume 2, n. 3.
3. Bell J.L., 2001. Changes in logging injury rates associated with use of feller-bunchers in West Virginia. In: The International Mountain Logging and 11th Pacific Northwest Skyline Symposium 2001, Seattle, Washington, Schiess P. & Krogstad F. (eds.), pp. 28–36.
4. Borz S.A., Ignea G., Vasilescu M.M., 2014. Small gains in wood recovery rate when disobeying the recommended motor-manual tree felling procedures: Another reason to use the proper technical descriptions. In: Bioresources, vol. 9(4), pp. 6938–6949.
5. Brachetti Montorselli N., Lombardini C., Magagnotti N., et al., 2010. Relating safety, productivity and company type for motor-manual logging operations in the Italian Alps. In: Accident Analysis and Prevention, vol. 42(6), pp. 2013–2017.
6. Calvo A., 2009. Musculoskeletal disorders (MSD) Risks in forestry. A case study to suggest an ergonomic analysis. Agricultural Engineering International: the CIGR Ejournal. Manuscript MES 1149, vol. XI, April, 2009, pp. 1–9.
7. David G.C., 2005. Ergonomic methods for assessing exposure to risk factors for work-related musculoskeletal disorders. In: Occupational Medicine, vol. 55, pp. 190–199.
8. Enez K., Topbas M., Acar H.H., 2014. An evaluation of occupational accidents among logging workers within the boundaries of Trabzon Forestry Directorate, Turkey. In: International Journal of Industrial Ergonomics, vol. 44(5), pp. 621–628.
9. Eurostat, 2010. Health and safety at work in Europe 1999–2007. Available at: http://ec.europa.eu/eurostat/documents /3217494/5718905/KS-31-09-290-EN.PDF/88eef9f7-c229-40de-b1cd-43126bc4a946. Accessed: 18.11.2015.
10. Fonseca A., Aghazadeh F., de Hoop C. et al., 2015. Effect of noise emitted by forestry equipment on workers' hearing capacity. In: Journal of Industrial Ergonomics, vol. 46, pp. 105–112.
11. Gandaseca S., Yoshimura T., 2001. Occupational safety, health and living conditions of forestry workers in Indonesia. In. Journal of Forest Research, vol. 6(1), pp. 281–285.
12. Gerasimov Y., Sokolov A., 2009. Ergonomic characterization of harvesting work in Karelia. In: Croatian Journal of Forest Engineering, vol. 30(2), pp. 159–170.
13. Helander M., 2006. A guide to human factors and ergonomics. Second Edition, CRC Press.

14. Horvat D., Calvlovic A., Zecic Z. et al., 2005. Research of fir-wood dust concentration in the working environment of cutters. In: Croatian Journal of Forest Engineering, vol. 26(2), pp. 85–90.
15. Inoue K., Kobayashi H., 1996. Operator's physical strain in operating the high proficient forestry machines. In: Journal of Forest Engineering, vol. 1(3), pp. 111–115.
16. Inoue K., Gotoh E., Ishigaki I. et al., 1999. Factor analysis of risk-taking behaviour in forest work. In: Journal of Forest Engineering, vol. 4, pp. 201–206.
17. Karhu O., Kansi P., Kuorinka I, 1977. Correcting working postures in industry: A practical method for analysis. In: Applied Ergonomics, vol. 8(4), pp. 199–201.
18. Klun J., Medved M., 2007. Fatal accidents in forestry in some European countries. In: Croatian Journal of Forest Engineering, vol. 28(1), pp. 55–62.
19. Korkut D.S., Gedik T., 2010. A research of occupational safety in forest products industry in Turkey. In: Africa Journal of Business Management, vol. 4(7), pp. 1423–1430.
20. Landekic M., Martinic I., Bakaric M., et al., 2013. Work ability index of forestry machine operators and some ergonomic aspects of their work. In: Croatian Journal of Forest Engineering, vol. 34(2), pp. 241–254.
21. Magagnotti N., Spinelli R., 2012. Replacing steel cable with synthetic rope to reduce operator workload during log winching operations. Small-scale Forestry, vol. 11(2), pp. 223–236.
22. Nietzel R., Yost M., 2002. Task-based assessment of occupational vibration and noise exposures in forestry workers. In: AIHA Journal, vol. 63(5), pp. 617–627.
23. Oprea I., 2008. Timber Harvesting Technology (In Romanian). Transilvania University Press, Brasov, Romania, 273 p.
24. Ottaviani G., Talbot B., Nitteberg M. et al., 2011. Workload benefits of using a synthetic rope strawline in cable yarder rigging in Norway. In: Croatian Journal of Forest Engineering, vol. 32(2), pp. 561–569.
25. Poje A., Spinelli R., Magagnotti N. et al., 2015. Exposure to noise in wood chipping operations under the conditions of agro-forestry. In: International Journal of Industrial Ergonomics, vol. 50, pp. 151–157.
26. Potocnik I., Pentek T., Poje A., 2009. Severity analysis of accidents in forest operations. In: Croatian Journal of Forest Engineering, vol. 30(2), pp. 171–184.
27. Rottensteiner C., Tsioras P., Stampfer K., 2012. Wood density impact on hand-arm vibration. In: Croatian Journal of Forest Engineering, vol. 33(2), pp. 303–312.
28. Stanton N., Hedge A., Brookhuis K., et al., 2004. Handbook of human factors and ergonomics methods. CRC Press.
29. Suchomel J., Belanova K., 2009. Influence of selected meteorological phenomena on work injury frequency in timber harvesting process. In: Croatian Journal of Forest Engineering, vol. 30(2), pp. 185–191.
30. Suchomel J., Belanova K., Vlckova M., 2013. Analysis of work accidents in selected activities in Slovakia, Czech Republic and Austria. In: Croatian Journal of Forest Engineering, vol. 34(2), pp. 311–320.
31. Tsioras P., 2012. Promotion of safety in forest operations. Advanced Research in Scientific Areas, December 3-7, pp. 1395–1399.
32. Tsioras P., Rottensteiner C., Stampfer K., 2011. Analysis of accidents during

cable yarding operations in Austria 1998 – 2008. In: Croatian Journal of Forest Engineering, vol. 32(2), pp. 549–560.

33. Tsioras P., Rottensteiner C., Stampfer K., 2014. Wood harvesting accidents in the Austrian State Forest Enterprise 2000 2009. In: Safety Science, vol. 62, pp. 400–408.
34. Tunay M., Melemez K., 2008. Noise induced hearing loss of forest workers in Turkey. In: Pakistan Journal of Biological Sciences, vol. 11(17), pp. 2144–2148.
35. Wilson J.R., Corlett N. (eds.) 2005. Evaluation of human work. Third Edition. Taylor&Francis.
36. Yoshimura T., Acar H.H., 2004. Occupational safety and health conditions of forestry workers in Turkey. In: Journal of Forest Research, vol. 9, pp. 225–232.
37. Vujica Herzog N., Vujica Beharic R., Beharic A. et al., 2005. Ergonomic analysis of ophthalmic nurse workplace using 3D simulation. In: International Journal of Simulation Modelling (IJSIMM), vol. 13(4), pp. 409–418.