Alexander Höldrich and Hans Hartmann, Straubing

Work Intensity Measurements in Firewood Production

A measuring campaign was carried out to evaluate work intensity during firewood processing. Through video analysis of the working person´s posture during all phases of the production processes, the relevant data were generated and evaluated according to the OWAS method. The partial process steps "thinning", "wood retrieval", and "manual wood stacking" proved to be the most stressful phases within the process chain. In contrast, wood splitting has become considerably easier due to the use of hydraulic splitters or sawing and splitting automats nowadays.

Dr. Hans Hartmann is director of the Department of Biogenous Solid Fuels in the Centre of Technology and Promotion of the Competence Centre for Renewable Raw Materials, where Alexander Höldrich works as well. Address: Technologie- und Förderzentrum (TFZ) Straubing, Schulgasse 18, D-94315 Straubing; e-mail: *Hans.Hartmann@tfz-bayern.de*

Keywords

Wood fuel, wood logs, work intensity, OWAS

During the measurement of physical strain at the work place, the test person should be exposed to as little influence as possible. In order to meet this requirement, a method developed for the steel industry, the so-called basis-OWAS method (Ovako Working Posture Analysing System), was adapted for the present study. During these examinations, an index is developed based on observations of the kind and frequency of certain body postures of workers, which allows the different work processes to be compared with regard to physical strain. This method is based on the multi-moment technique, during which an observer assesses the body posture of the test person directly in regular intervals. Here, this classic approach was altered by evaluating images from video recordings which covered several hours. Based on 14 basic postures, the recorded postures were divided into three groups: four back postures, three arm postures, and seven leg postures (*Fig. 1*). Within one group, each posture can be described using a characteristic number so that the posture can be characterized with the aid of an evaluation code comprising a total of three digits. Thus, the 14 basic postures first lead to 84 different combinations ("digit codes"), which describe the posture of the back as well as arm- and leg posture. If objects whose weight is known are moved during work, a fourth digit is added (up to 10 kg: number 1, > 10 up to 20 kg: number 2, > 20 kg: number 3).

In the OWAS method, every digit code is assigned to a so-called "measure class":

- Measure class 1: Body posture is normal. Measures of work design are not necessary.
- Measure class 2: Body posture causes strain. Measures which lead to better working posture must be taken soon.
- Measure class 3: Body posture causes significant strain. Measures which lead to better working posture must be taken as quickly as possible.
- Measure class 4: Body posture causes

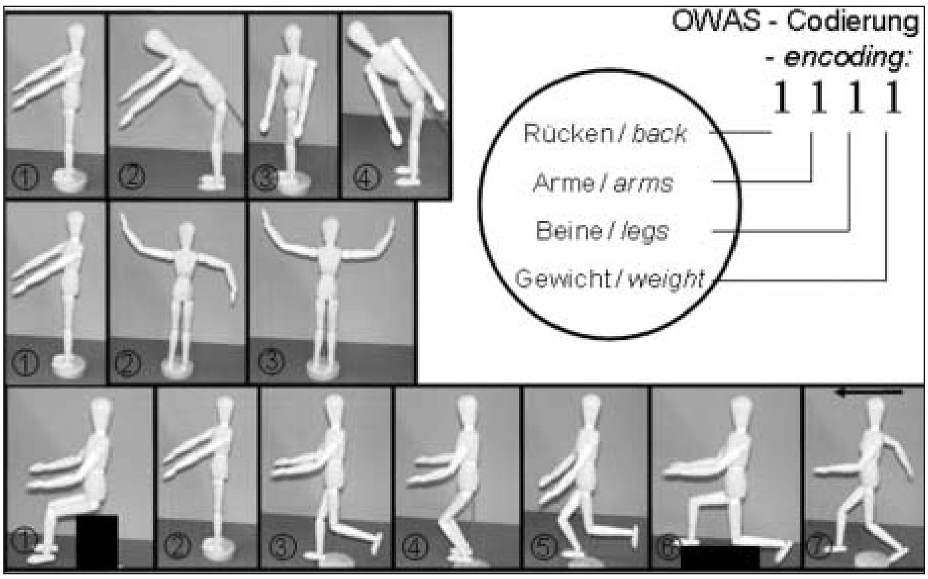

Fig. 1: Basic working postures and the respective digits for the evaluation code of work intensity measurement according to OWAS

Fig. 2: Examples of code allocation for body postures according to OWAS; example 1 (left): code 1111; example 2 (right): code 2151

heavy strain. Measures which lead to better working posture must be taken immediately.

A posture which is described using code 111, for example, and in which a wood mass of up to 10 kg is handled would be assigned to OWAS measure class 1. The posture shown in the instantaneous photo in *Figure 2* is given code 2151. This code belongs to measure class 3. Classification can be carried out with the aid of the software "WinOwas".

The work processes recorded using a digital camera were evaluated in 30-second intervals. Thus, a two-hour study provides 240 individual photos. Nine different work steps (wood harvest, large splitter, small splitter, horizontal splitter, vertical splitter, disc saw, axe splitting, bundling help, and retrieval) were examined with the aid of 16 different test persons. All in all, 4213 individual pictures from almost 38 hours of film material were coded and classified. In the next step, the percentage of each of the four measure classes (MC) was determined. Based on these percentage figures (MC 1 to MC 4), a strain index L (according to Lundqvist) was calculated:

$$L = (1 \cdot MK1) + (2 \cdot MK2) + (3 \cdot MK3) + (4 \cdot MK4)$$

Theoretical bandwidth for the strain index ranges from 100 to 400. This index is the actual result of work intensity measurements according to OWAS. It enables different work methods and process steps as well as work in different branches of industry to be compared.

Results

Work strain indices for "thinning", "axe splitting", "retrieval", and "stacking" are relatively high (L = 159 to L = 186) (*Fig. 3*). For the process steps "fire wood disc saw", "vertical splitter", and "bundling help", they are in the medium range (approximately L = 140), while the values for the process steps "horizontal splitter" and "automatic splitting machine" were low (L = 109 to 118), as expected. In certain phases (e.g. during machine loading), values of more than 200 may occur. Since more phases of rest and recovery are required during these work processes, the average value did not exceed the mark of L = 200. The index range of L = 100 to 200 thus represents almost the entire range of strain from "virtually no strain" to "heavy strain". In a parallel survey, the majority of the test persons evaluated the examined process steps identically.

The results allow the conclusion to be drawn that improved mechanization (in particular with sawing and splitting automats) enables work-related strain, which is sometimes relatively heavy during fire wood production, to be reduced. This becomes particularly obvious when the OWAS results from the process steps are aggregated and evaluated as part of a model examination of differently mechanized process chains. For this purpose, the OWAS values were weighted according to time shares [1].

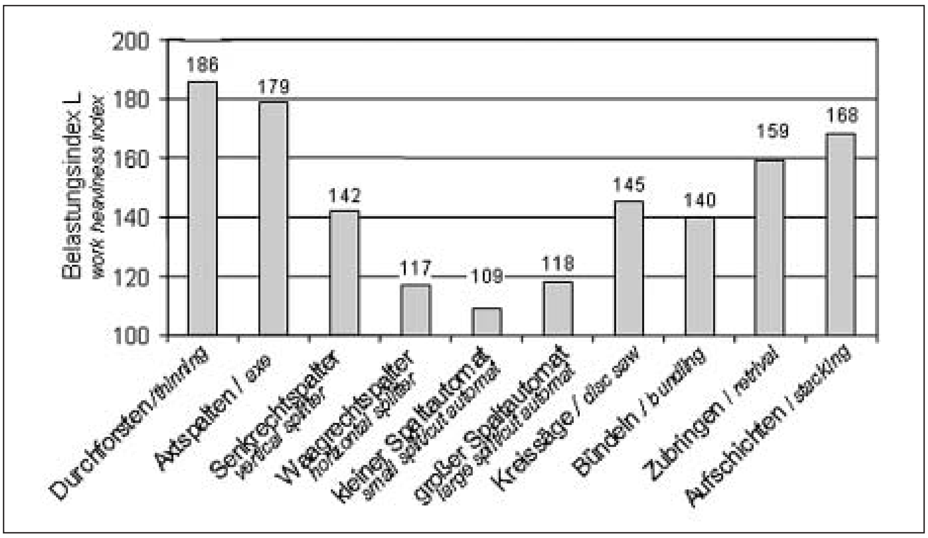

Fig. 3: Work intensity index L for the different possible work steps

Promotion

These studies were promoted by the Bavarian State Ministry of Agriculture and Forestry.

Literature

[1] *Höldrich, A., H. Hartmann, T. Decker, K. Reisinger, M. Schardt, W. Sommer, S. Wittkopf und G. Ohrner*: Rationelle Scheitholzbereitstellungsverfahren. Berichte aus dem TFZ, Nr. 11, Technologie- und Förderzentrum (TFZ), Selbstverlag, Straubing, 2006, 274 S.; Download: *www.tfz.bayern.de*