International Journal of Industrial Ergonomics 30 (2002) 135–148

International Journal of
Industrial Ergonomics

www.elsevier.com/locate/ergon

MTM-based ergonomic workload analysis

J. Laring[a], M. Forsman[b,*], R. Kadefors[a,b], R Örtengren[a]

[a] Department of Human Factors Engineering, Chalmers University of Technology, Göteborg, Sweden
[b] National Institute for Working Life, P.O. Box 8850, S-402 72 Göteborg, Sweden

Received 30 November 2000; accepted 17 January 2002

Abstract

Production engineers are urged to take ergonomic considerations into account when planning for production. However, the means to do so are often inadequate with respect to training as well as support. There is a lack of methods to predict, at a reasonable cost, biomechanical load on an operator performing a task not yet observable on a product and in a workplace not yet existing. The purpose of this study was to develop an ergonomic complement to a modern MTM system called SAM that gives the production engineer a first insight into the future ergonomic quality of a planned production. A method was developed that requests the engineer to supply two additional pieces of information to the analysis: the zone relative to the operator's body in which the movement takes place or ends, and the weight or force involved in the operation. As method of comparison for validation purposes was selected the operator self-evaluation method VIDAR. The method was tested at the Torslanda final assembly plant of Volvo Car Corporation and at the ITT Flygt plant for large submersible pumps at three different balances and compared with two different methods of assessing biomechanical load. The results show that the method identifies the events causing high biomechanical load on the operator so that they can be redesigned. The suggested method has proven to be a useful tool and is being introduced at Volvo Car Corporation.

Relevance to industry

Under the concept of concurrent engineering the production engineer will have less time for experimenting with new production layouts. Given access to early design drawings of the product she or he must be able to decide on the future layout. There is a need for a tool giving the possibility to estimate simultaneously the consumption of time in the envisaged production, and the biomechanical load inherent in the planned tasks.

Keywords: MTM; SAM; Production planning; Workplace design; Biomechanical load; Ergonomics

1. Introduction

1.1. MTM in industry

Work analysis methods were taken into use in the industrialized countries on a larger scale in the 1930s. A number of predetermined time systems (PTS) were developed, of which the method time

*Corresponding author. Tel.: +46-31-501659; fax: +46-31-501610.

E-mail address: mikael.forsman@niwl.se (M. Forsman).

PII: S0169-8141(02)00091-4

measurement (MTM) method was developed by Maynard in the United States (Maynard et al., 1948). One reason why the MTM system became the one most widespread is probably due to the fact that it was made publicly available with no economical or judicial claims on behalf of the inventor. The MTM Association for Standards and Research was founded in the United States in 1951. The managing director of the Volvo Car Corporation, took the responsibility of introducing MTM in Sweden, and the first installation of MTM was made at the Volvo engine factory in Skövde in 1950. The work lead to the foundation of the Swedish MTM Society in 1955 as a result of an initiative from a sub-committee of the Swedish Academy of Engineering Sciences (IVA). The strong interest in the MTM system may be explained by the potential it holds in rationalization of work and the possibility for employers and unions to negotiate and agree on piecework contracts (Luthman et al., 1990).

In Sweden, IVA decided to exclude physical workload from the agenda of all its work study sub-committees and consequently the research on production technology and work physiology was separated. During the late 1960s and early 1970s the MTM system was criticized and associated with Taylorism. Production technology was no longer in focus in an industry that was being more oriented towards market and product development. The piece-rate system was commonly replaced by time-rates. In the middle of the 1970s the Swedish MTM Society was dissolved and the previous general interest for MTM was often turned to its opposite (Luthman et al., 1990). However, in practice the MTM system and its modern versions are in widespread use in many companies and is used to calculate production times for line balancing, line pace setting and in calculation of business tenders.

1.2. SAM

An analysis using the basic level of MTM, MTM-1, is a very time-consuming task. This led already during the 1950s to initiatives to combine MTM data in order to simplify and thus decrease time needed for analysis. The Swedish MTM-society took the initiative to a work that led to the development of MTM-2 that in 1965 was accepted by the International MTM Federation as an international standard. The work continued with the creation of MTM-3 that, however, never was widely accepted. During the 1970s a project was therefore carried out that resulted in the SAM system in order to shorten the time needed for analysis but eliminate the defects found in the MTM-3. SAM groups several MTM-1 movements into one SAM movement and excludes many special cases. The analysis is simplified resulting in shorter times both to learn how to use the system and to carry out an analysis, and the loss of precision is not discouraging (SAM-2 Kompendium, 1995). Similar systems have been developed elsewhere for much the same reason, such as MOST and MTM-UAS. Many of the modern developments of MTM derivatives have also been computerized (for a review, see Karger and Bayha, 1987).

1.3. MTM as base for ergonomic evaluation

Studies to use the information received from MTM for ergonomic evaluations have been carried out in Germany since the early 1980s. Calculation of the distribution of the work task over the different body regions, giving the possibility to detect an uneven balance between load on the right and left hands during work by means of MTM-1, was done by Kühn and Laurig (1990). They concluded that the most appropriate is a "pragmatic ergonomic approach" and that this approach has a problematic process of validation but is acceptable because of its reproducibility.

In the computer program ErgoMOST (H.B. Maynard and Company, Inc.) the methodology of MOST is used as an ergonomic survey tool. It is a special program, separated from the corresponding MOST software, in which it is possible to define e.g. joint angles, grip type, external forces and repetition in order to get an assessment of biomechanical load during a work sequence. However, the level of detail and thus the time needed to analyze a work sequence may be