Chapter 28
Combined Methods for Physical and Mental Workload:
Fatigue Evaluation – A Systematic Literature Review

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ABSTRACT

This chapter presents information about the methods that combine physical and mental workload/fatigue during ergonomic evaluation. The methods were identified through a systematic literature review. The search criteria were done through a literature search in databases like SciFinder, SciELO, ScienceDirect, etc. As result, the following methods are described: Global Load Scale, Multivariate Workload Assessment, Subjective Fatigue Symptoms Test, Fatigue Assessment Scale, Scale of Recovery for Exhaustion of Occupational Fatigue, Scale of Estimated Fatigue-Energy Points, Swedish Occupational Fatigue Inventory, NASA-TLX, Combined Cognitive and Physical Assessment, Laboratory Method of Economics and Sociology of Work, OWL Method, Ergonomic Checklist Method, RENAULT Method, Joyce Method, NERPA Method, ARBAN Method, and MAPFRE Method. As a conclusion, it is possible to affirm that there are some evaluation methods that provide better elements for an accurate evaluation, and others lack basic elements, which causes an incomplete/not accurate evaluation.

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INTRODUCTION

The changes in job processes and work design happened in the last decades were, predominantly, demographic, economic, political, and technological (Bailey & Iqbal, 2008). These changes have caused that the current work must be performed developing physical and mental efforts in a combined and/or simultaneous way (Gil-Monte, 2012). Currently, modern technology has involved new changes in industrial work, especially in decision-making involving high levels of mental load (Demands & De, 2018). As a result, the mental workload is one of the most researched concepts in ergonomics and human factors and represents an issue of increasing importance (Ayaz, 2012). In work environments, more and more cognitive demands are imposed on operators, while physical demands decrease in tasks, understanding how the mental workload affects performance is increasingly critical (Hernandez Arellano, Serratos Perez, Alcaraz, & Maldonado Macias, 2018; Young, Brookhuis, Wickens, & Hancock, 2015).

Due to high levels of mental load, levels of stress and fatigue are being generated and affecting the worker's performance, organizational productivity as well as health problems (Arce & Silvia, 2012). Stress is shown in the physiological plane altering indexes such as the reactivity of the heart rate and the increase in blood pressure. In the behavioral level, the effects of stress are revealed in problems of smoking, alcoholism, drug abuse, antisocial, and aggressive acts, which leads to a possible tendency to accidents and errors, as well as problems of relationships at work (González Muñoz & Gutiérrez Martinez, 2006).

The physical workload is the set of physical requirements that the person required during his working day (Moreno, 2015). A physical job occurs when the type of activity required by the task is primarily physical or muscular. On the contrary, the mental workload is the amount of deliberate mental effort that must be made to achieve a specific result, and it is linked to the need for information processing and decision making for the execution of the task (O'Donnell & Eggemeier, 1986).

The mental workload is used in tasks involving mainly cognitive processes, information processing and affective aspects (Arquer de, 1999). All jobs require a certain level of physical load and mental load. However, the working conditions can affect the mental load of the people (Ceballos Vásquez, Paravic Klijn, Moreno, & Barriga, 2014). For example, in work on production lines (application of adhesives, sewing, welding of electronic parts, insertion of components, etc.), transport of materials (manual or automated), and manual assembly lines (assembly of harnesses, automobiles, components electronic, etc.), are some of the jobs where there are high levels of physical and/or mental load. To assess the workload, both physical and mental aspects must be evaluated, so there are different techniques for evaluation. Similarly, physiological, behavioral and subjective changes should be considered. Some physiological measures evaluate the effect of the increase or decrease of the workload, examples of these are heart rate, heart rate variability, eye movement and brain activity (Stanton, Hedge, Brookhuis, Salas, & Hendrick, 2005). However, the number of methods that combined both kinds of efforts are limited in contrast to the great number of methods, tools, and techniques to evaluate physical or mental factors during an occupational task.

Ergonomic Evaluation

Over time, ergonomic studies have been carried out on the workload, theoretical discussions, and reviews of past investigations (Hart & Staveland, 1988; Lysaght, Ouellette-Kuntz, & Lin, 2012). A growing number of different approaches and techniques for measuring workloads have been discussed, devel-