

## **ACHIEVING WORKPLACE INCLUSIVENESS BY USING ERGONOMICS RISK ASSESSMENT**

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### **ABSTRACT**

Traditional manufacturing work practices do not consider human variability issues during the design process. However, most manual assembly activities demand high levels of repetition and speed without compromising product quality and work productivity. Individual factors including age, gender, skill, experience and anthropometry cause variations in task strategies that lead to variations in individual and organizational work performance. The ergonomics-based risk assessment methods OWAS, REBA and RULA have been used to evaluate risk levels associated with working methods. This paper discusses the need for these methods to understand and highlight the key issues generated by these variations with the objective of minimizing these variations. Methods that can be used to promote working strategies that minimize the level of risk are described. The proposed research method potentially reduces work-related musculoskeletal disorders, injuries, pain, and promotes safe, healthy, productive and more inclusive working strategies suitable for a diverse working population.

**Keywords:** Ergonomics Risk Assessment, Human Variability, Inclusive Design.

### **1 INTRODUCTION**

Humans are different in many ways. These differences influence human behaviours at work that eventually result in variations in working strategies. These variations might be because of differences in age, level of skill, background, experience, gender and lifestyle, and affect task performing strategies and working procedures. Many differences might be due to variations in the task performing capabilities that directly affect working strategies and procedures. This paper highlights the need to understand these variations, their causes and potential impacts on work performance. A special focus is placed on using ergonomics risk assessment methods for exploring the effects of human variations on workplace safety and productivity, and how these variations can be minimized so that more inclusive, safe and productive work practices can be promoted.

### **2 INDIVIDUAL FACTORS AND RISK EXPOSURE**

The meanings of individual factors can be interpreted differently. However, the National Research Council and the Institute of Medicine (NRC/IOM 2001) stated that these are the factors that affect individual or personal responses to workplace exposure and can be thought of as physiological and psychological attributes. Individual factors like age, gender, level of skill, education, cultural background and nationality play a vital role in the selection of different working strategies for similar kinds of tasks, where these differences lead to varying levels of risk. For example, Punnett and Herbert (2000) found a relationship between work-related musculoskeletal disorders and gender, and that upper extremity disorders are more significant in women as compared with men. Usually, tasks with repetitive movements, lower physical demands and higher work pace are assigned to women. It is important to note that in the UK nearly 0.6M workers had accidents at work in 2010/11, and this

resulted approximately two million lost working days (H.S.E. 2011). The National Research Council and Institute of Medicine (2001) concluded that work-related musculoskeletal disorders of low back and upper extremities are the most costly health problem faced by workers and put a huge economic burden on organizations, in the form of lost wages, compensation costs and lost productivity.

Many psychosocial factors like job dissatisfaction, high job stress, inadequate work support, high mental pressure, perception of insufficient safety climate and lack of job control are also associated with work-related musculoskeletal disorders (Sobeih et al. 2008, Simon et al. 2008, Hofmann and Mark 2006, Stone et al. 2007). Similarly, age is also considered a contributing factor to work-related musculoskeletal disorders. Although older workers are more likely to work on jobs with low workload and lower physical demands, head-neck-shoulder symptoms still occur more frequently in older workers (Landau et al. 2008). Ilmarinen (2002) further mentioned that prevalence of musculoskeletal disorders between the age of 51 and 62 may increase up to 15% and this can have more serious implications for those who are exposed to repetitive and physically demanding work. In spite of the fact that physical work capacity of older workers decreases with age, still a significant proportion of older workers (aged 45 or more) are exposed to handling of heavy loads along with harmful working postures (Paoli 1997).

Differences in working techniques and procedures also play a key role in exposing workers to risk factors. Different workers perform their work in different ways, especially if they have an option to adopt a method of their own choice. Variations in working techniques lead to the adoption of different body postures, and these differences are more prominent in women as compared with men. Moreover, women are exposed to risk factors more frequently as the working methods adopted by them are more stressful. For example, they adopt strategies that acquire the use of hands at or above shoulder level and this is considered as a risk factor for neck and shoulder disorders (Keyserling et al. 2010, Dahlberg et al. 2004). Type of work is also an important factor to consider. For example, workers using Visual Display Units during work are exposed differently to risk factors because of the variations in their working techniques. Workers with poor techniques face the higher level of risk exposure in the forearm, shoulder and wrist (Karlqvist et al. 1998, Palmerud et al. 2012). Similarly, the importance of work style in terms of the level of risk exposure when using computers due to variations in working style and it has been concluded that wrist postures, speed of movements and applied forces while keying are the main variables in work style (Feuerstein et al. 1997; Haufler et al. 2000).

There are other individual factors like personality, past history, social issues and anthropometry, that might have a significant effect on performance at work. Factors such as physical, physiological and cognitive capabilities that are linked with age, culture and background also have a strong relationship with work performance of individuals. Unlike younger workers, the physical capabilities of older workers are lower and working strategies adopted by older workers might be significantly different because of this decline. Similarly, reaction time increases with age and this might be of great importance for those tasks where quick, accurate and simultaneous movements are required. It can be said that a number of individual factors like age, gender, skill, experience along with physical, physiological and cognitive capabilities play highly important roles in determining workplace safety and organizational productivity. Because of these individual factors, workers respond differently in the same situation. Existence of these human variability issues has been mentioned in the literature but very little has been proposed about how to solve these issues.

The next section describes the usefulness of ergonomics risk assessment methods for addressing workplace safety issues and how these methods have been used in highlighting risk factors and avoiding bad practices along with the promotion of safe and productive working techniques.

### **3 ERGONOMIC RISK ASSESSMENT**

As concluded in the previous section, individual factors significantly affect working behaviours of workers, and variations caused due to these factors influence the level of risk exposure attached with any adopted working strategy. Work-related musculoskeletal disorders constitute an important occupational problem that has serious economic and social implications for individuals, organizations and society. It is extremely important to prevent these disorders by exploring major factors involved and by defining such strategies and methods that might assure safe and productive workplaces.

The assessment of discomfort and postural stress caused by different body postures is divided into two main techniques, known as observational and instrument based techniques. In the observational techniques, observers assess the angular deviation of a body segment from its neutral position. In the instrument based techniques a device is attached to the body and a continuous recording is carried out. Observational techniques are more commonly used in industry because of their low cost, ease of use and lack of interference with the job (Genaidy et al. 1994). OWAS, RULA and REBA are widely used in a variety of applications in different workplace conditions. As these techniques have been developed for different purposes, each technique has its own postural classification scheme which differs from the others (Kilbom 1994). Usefulness of these techniques has been discussed in several occupational settings. This paper describes the postural classification schemes and the effective use of OWAS and REBA for multiple applications.

The OWAS method (Ovako Working Posture Analysis System) describes a working posture by capturing and defining positions of three body parts; the back, arms, legs. The load handled (force applied) is also assessed and the three body part postures are further classified into different categories. Postures of the back are classified into four further categories, arms into three, legs into seven and three for force applied. In this way, 252 (4 x 3 x 7 x 3) posture and load combinations are presented in the form of four digit codes. These codes define the level of risk attached with any adopted posture and then the level of action category is defined. Posture combinations with higher risk of musculoskeletal disorders belong to higher action categories.

Table 1: The OWAS action categories (Karhu et al. 1977, 1981 and Karwowski and Marras 2003)

Action Category	Explanation
1	Normal and natural posture with no harmful effect on the musculoskeletal system - No action required
2	Posture with some harmful effect on the musculoskeletal system – Corrective actions required in the near future
3	Postures have a harmful effect on the musculoskeletal system – Corrective actions should be done as soon as possible
4	The load caused by these postures has a very harmful effect on the musculoskeletal system – Corrective actions for improvement required immediately

The usefulness of the OWAS postural assessment technique has been validated in several occupational settings, including construction, automotive, agriculture, nursing and the poultry industry. This method is able to detect the level of discomfort and risk involved in any working strategy and provides suitable recommendations for the improvement of working strategy and workplace design to minimize or prevent work-related musculoskeletal disorders (Karhu et al. 1977, Mattila et al. 1993, Nevala-Puranen 1995).

Like OWAS, REBA (Rapid Entire Body Assessment) is also a postural assessment system to assess the severity of musculoskeletal risk involved in working postures. Postural classification is based on scores for upper arms, lower arms, wrist, trunk, neck and legs; along with the external forces/loads applied, muscular activity caused by static and dynamic, rapidly changing or unstable postures and coupling effects. As a result of REBA scores shown in Table 2, five levels of action are recommended keeping in view the level of risk involved with postures. Action level 4 has a very high level of risk and action is necessary immediately whereas action level 0 has negligible or no risk (Table 2). The usefulness of the REBA method has also been described in the literature (Hignett and McAtamney 2000, Janowitz et al. 2006).

From the above discussion, it can be said that observational techniques are useful in assessing postural loads for a wide range of occupational settings. Furthermore, a detailed overview of results also provides an opportunity to highlight major causes of risks attached with any specific occupational setting. This study focuses on exploring the effect of the level of skill and experience attached on musculoskeletal disorders based on the differences in working strategies. The next section describes a

method in detail where these observational risk assessment techniques can be used to address human variability issues caused due to the varying level of skill and experience.

Table 2: REBA action levels

Action level	REBA score	Risk level	Action (including further assessment)
0	1	Negligible	None necessary
1	2-3	Low	May be necessary
2	4-7	Medium	Necessary
3	8-10	High	Necessary soon
4	11-15	Very high	Necessary now

#### ACHIEVING WORKPLACE INCLUSIVENESS: A PROPOSED METHOD

As discussed earlier, individual factors influence work performance as they are linked with human variations and these variations further lead to a varying level of exposure to risk factors at work. Ergonomics risk assessment methods have been found useful in highlighting the underlying causes of risks involved at work. This article proposes a systematic method of investigating human variations, their relationship with the level of risk attached, finding major causes and then achieving such inclusive working strategies that are healthy, safe, productive and equally acceptable for workers, in spite of their existing differences. For this study, workers with different levels of skills have been selected to explore whether or not the level of skill affects human work performance in terms of productivity and the level of risk involved at work, because of the differences in working strategies caused due to varying level of skill and experience.

After selecting appropriate tasks and workers the next step is to observe the differences in working strategies, which can be recorded using simple video recording methods. Different workers of varying levels of skill can be captured while working on different workstations performing similar kinds of activities. Here in this study, specialized, multi-skilled and semi-skilled workers (3 in each category) have been recorded on four different workstations on a sofa assembly line at a furniture manufacturing company. Data collection was carried out by simple video recording methods, where workers were recorded on each workstation at least 4 times while performing the same activity, so that workers attitude towards their work in terms of differences in working strategies can be observed and captured in detail. These differences can be quantified through the above mentioned ergonomics risk assessment techniques, like OWAS and REBA methods. This analysis can provide a detailed analysis about the differences in working strategies and their potential impact on workplace safety by quantifying the severity of the risk factors associated with different working strategies. In this way a comprehensive analysis can be carried out provides information about different things; for example, how skill influences working methods in terms of postural comfort, what are the most significant body movements that are responsible for risk at work, and which strategy is the best one in terms of productivity and safety.

All this information will lead towards evidence-based conclusions and recommendations can be developed for the promotion of more inclusive, friendly, safe and productive working strategies that can assure minimal effects from human variations. Furthermore, acquired results can be used for the training of relatively less skilled workers so that they can proactively develop their skills based on the optimal working methods.

#### 4 THE WAY FORWARD: FUTURE RESEARCH

Future research will be carried out by the systematic and step-by-step implementation of the above mentioned research method. For this purpose, a case study at a furniture manufacturing industry is ongoing, where data collection through video recordings have been carried out. Workers with varying levels of skill and experience were recorded carrying out similar activities, so that the effects of skill and experience on task-performing strategies can be observed and analysed. The initial findings clearly show that skill and experience have a significant influence on working strategies. It has been found that object handling strategies are greatly affected by the level of skill, and this directly affects the productivity of workers in terms of effective time utilization. Moreover, the way an object is handled (a sofa in this case) influences body postures. Figure 1 shows two different workers handling

the object in different ways, where orientation of the object and adopted postures are the main causes of this difference. Further research will focus on the quantification of the level of risk attached to any strategy by using OWAS and REBA methods and this will be achieved by taking snap shots from the recorded videos and comparing the results for different workers. This will provide an opportunity to find major causes of risk at work and how these can be removed by providing appropriate training for the workers. Further to this, capturing different workers performing the same activity in different ways, also provides an opportunity to select the optimal and risk free working strategy from a larger pool of options.

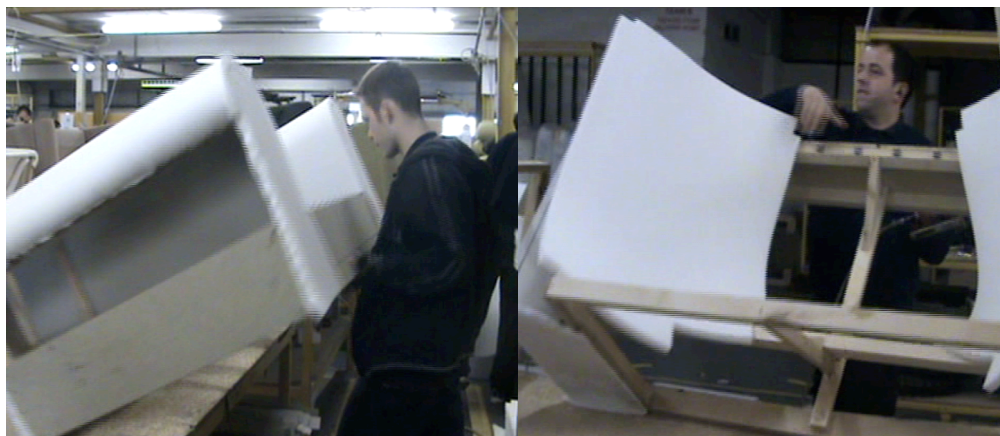


Figure 1: Different object handling strategies of two different workers at the same workstation

## 5 CONCLUSIONS

Individual factors influence work performing strategies that have a direct relationship with risk factors that cause musculoskeletal disorders and injuries at work. Ergonomics risk assessment methods can be used to address human variability issues by exploring the risk factors influenced by these individual factors. Workplace inclusiveness can be achieved by promoting such working strategies that are easier to learn, more safe and equally productive for all workers in spite of their existing differences. The proposed method, which is based on observational ergonomic risk assessment techniques, can be used to quantify the level of risk attached to any working method. Future research will focus on further exploring the underlying effects of individual factors on the level of risk and work productivity, and developing guideline methodologies that might be used to minimize the influence of individual factors. Research findings can be used to develop and implement training procedures so that the variations at work can be minimized.

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