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PROJECTING OF WORKING ACTIVITY BY USE OF TECHNOMATIC JACK

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Abstract: Projecting of workplace and working activity by use of simulation enables flexible adjustment to new conditions and simultaneously implementation of ergonomic principles in the phase of proposal. In the article is given the analysis of working activity by use of tools of program Technomatix Jack and also the creation of the model of workplace as well as simulation of analysed working activity in the given program. By proposal of simple measures, repeated simulation and calculations it points at the possibility of solution of the analysed problem. An advantage of using Computer Aided - CA systems is that all changes in real system may be first simulated with a goal to predict their influence on behaviour and running of the system.

1 Introduction

For solution of problems in working system human – machine – environment are used computer systems which enable simulation of human factor in 3D environment. Big software systems are focused on full vital cycle of the product, superstructures of systems solve partial tasks from the area of ergonomics, independent software applications for complex solution of ergonomics are focused on certain areas, e.g. interior of the car and by help of small software applications are solved specific problems e.g. loading of the backbone of human during lifting burdens, etc.

2 Use of software application Technomatix Jack at projecting of working activity

For study of behaviour of human being during work with possibility of simulation and optimisation of working environment and also simulation and evaluation of influence of working activity and workplace on the human being is used the software application Technomatix Jack. This application is determined for study of human behaviour during work. Simultaneously it simulates mutual bonds in the system human – machine – environment with regard to ergonomics, effectivity of work and physical load of the worker [6], [7]. The result is a workplace which considers the abilities and possibilities of worker and enables more effective, more productive and safer production [2].

An advantage of using Computer Aided - CA systems is that all changes in real system may be first simulated with a goal to predict their influence on behaviour and running of the system. The simulation model is a dynamic system where occur events and states as in the investigated system and in the same order however in the majority of cases in various time moments [5].

2.1 Tools of task analysis in program Technomatix Jack

The system of tools of Task Analysis in software Jack includes tools for ergonomic analysis by help of which it is possible to propose tasks in production with optimal safety and productivity [3]. Individual tools and their characteristics are given in table 1 processed according to [10].

Table 1 Tools of task analysis

Tools	Charakteristics
Low Back Analysis	Evaluation of forces influencing the hip area of the backbone of virtual figure in the given position and with the given load.
Niosh Lifting Analysis	Determination of weight of the burden with which it is possible to manipulate safely in long term.
Manual Handling Limits	Determination of maximal acceptable weight for manual working acts.
Working Posture Analysis	OWAS – simple and fast check of comfort during work and determination of measures.
Static Strength Prediction	Determination of % of workers who manage to perform a certain task on the basis of determined position, effort and anthropometric parameters.
Predetermined Time Analysis	Estimation of time necessary for performance of work on the basis of movements, by help of system of measurement (MTM-1).
Fatigue/Recovery Time Analysis	Enables proposal of manual working activities with minimal risk of fatigue of the worker.

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Metabolic Energy Expenditure	Estimation of demands for energetic output during certain work by help of characteristics of worker and description of tasks.
Rapid Upper Limb Assessment	Evaluation of risk of injury of upper limbs on the basis of position, involvement of muscles etc.

3 Analysis of working activity

Projecting of working activity by use of Technomatix Jack was realised for firm which deals with production of aluminium castings for car industry by method of pressure casting. The investigated working activity is surface finish of aluminium castings of various shape and size. Factors which during this working activity influence the worker are as follows [4]:

- *noise* – the worker uses hearing protectors during all working shift,
- *lighting* – during unloading and inspection of the castings the artificial lighting is screened,
- *height of manipulation plane* – if it is not optimal the backbone and the body of workers are stressed,
- *physical load* – repetitive working activity can lead to overloading of exposed part of the body and also to decline of work productivity. Long term one sided pursuit of such activity leads to development of occupational diseases.

3.1 Analysis of physical load

Castings with which the worker manipulates have a weight from 0.2 kg to 4 kg. They are the main factor at assessment of the extent of physical load on the worker. The worker carries out a demanding movement which causes loading of knees, backbone and hands. At regularly repeated activity during all working shift the probability of injury or development of disease is high. For decrease of local load it is necessary to make a complete analysis of working activity and working position. Its part is also the application of selected methods of evaluation of physical load.

The results of evaluation of working activity by tools are shown in figure 1. The model of workplace is created straight in Jack program. Into the virtual workplace is located a precise digital model of the human being [8], [9]. The result of Lower Back Analysis tool, which assesses the influence of load on hip area of the backbone is a small load on the area around vertebra L4 and L5.

From evaluation of position by help of Working Posture Analysis tool it results that the repetition of working movements can cause a serious damage of musculoskeletal system and it is inevitable to take corrective measures.

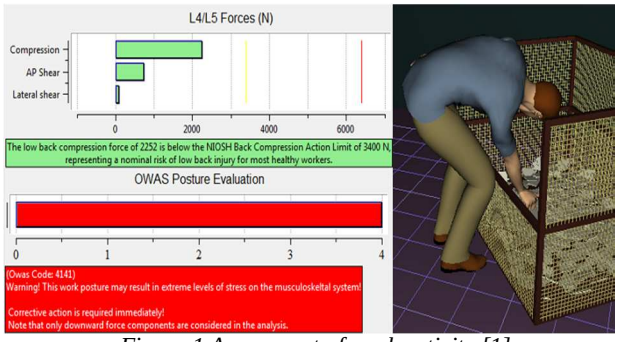

Figure 1 Assessment of work activity [1]

Since the results of evaluation of position by help of these two tools are greatly different a further tool was used for analysis of working activity – RULA. Detailed results of evaluation of position of upper limbs together with final score and proposals for solution are shown in figure 2.

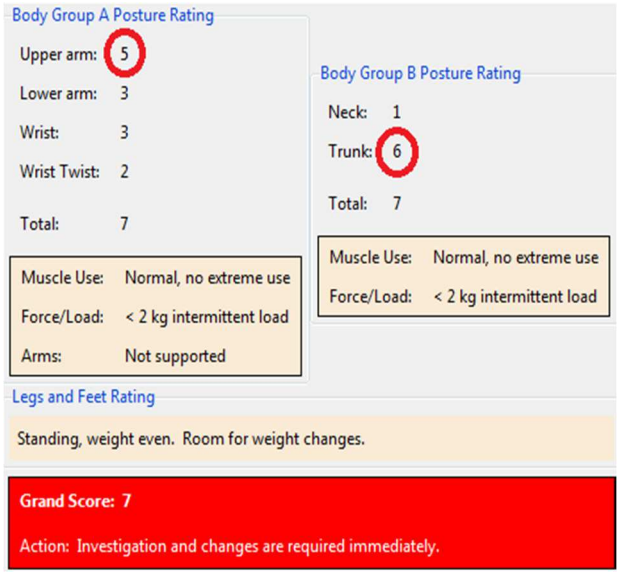

Figure 2 Assessment of position by RULA tool [1]

According to tool RULA is achieved score 7 what means that it is not allowed to perform this working activity during all working hours and it is necessary to take corrective measures for removal of detected risks. An advantage of application of RULA method is shortening of running time of evaluation of working position and flexible adjustment to conditions.

From comparison of results of three tools which were used for evaluation of physical working activity it results that the analysed working activity represents for the worker a risk of health damage.

Based on the results of an analysis carried out by help of Task Analysis tools in Technomatix Jack program a simple measure was proposed the introduction of which would cause decrease of excessive influence of physical load in the workplace of sanding and so the investigated

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working activity would also be made easier for the human being.

3.2 Way of decreas eof excessive loads

A model of workplace was created in Technomatix Jack program .
The given model of workplace is composed of:

- model of guide rail,
- model of crate,
- model of sanding machine,
- model of container.

Individual components and items of workplace model are shown in figure 3.

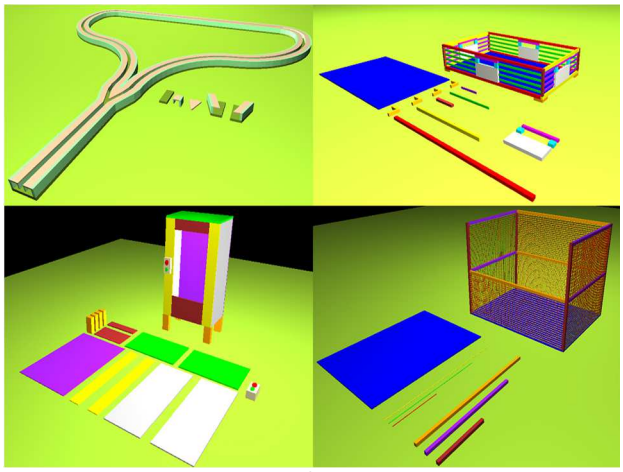

Figure 3 Components of the workplace model [1]

For simulation of working activity there was used the digital model of human being. The model of workplace of sanding cleaning of aluminium castings is shown in figure 4.

Figure 4 The model of analyzed workplace [1]

After creation of the model of workplace and implementation of model of the worker it is possible on the basis of the time of duration of individual working tasks to create a simulation of analysed working activity.

In model of the analysed workplace were solved the proposed measures with the goal of decreasing the physical load the influence of which was provably risky.

For removal or decrease of physical load are used measures of technical and organisational character. Technical measures have priority therefore for making the analysed working activity easier a forklift was proposed. Its use would remove the inappropriate working position in forward bend as well as decrease the load influencing the hands and body of the worker at manipulation with material. The model of forklift which serves the lifting of container with castings or pallet with cranes was created in the Technomatix Jack program. The truck is able to lift the container into the height which suits the worker best. Model of forklift is shown in figure 5.

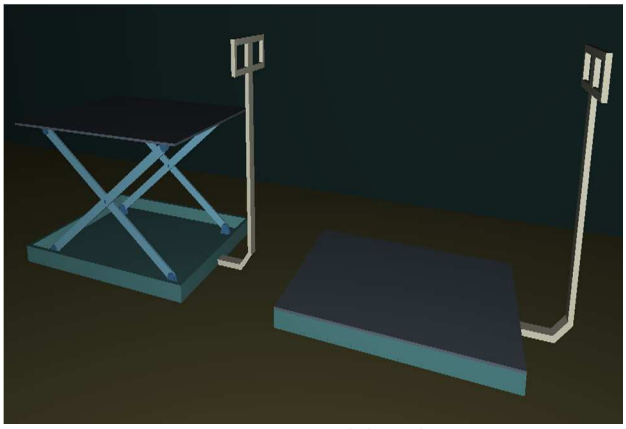

Figure 5 Model of forklift [1]

It is possible to adjust the forklift to workers with various body heights. The truck is mobile the worker will put it on the place which suits him. The surface of the truck is the same as the surface of the container. For verification of the correctness of proposal were used the same methods as before its introduction. Removing castings from the container and storing them on the hanging tree is by use of forklifts significantly facilitated. From the results of evaluation of tools RULA, Lower Back Analysis and Working Posture Analysis it results that a reduction in physical activity occurs in all assessed areas. The evaluation of physical load before and after implementation of the measure (proposal of forklift) is shown in figure 6.

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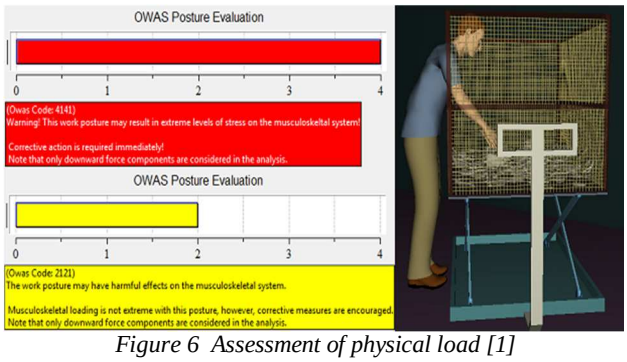

Figure 6 Assessment of physical load [1]

Tool Working Posture Analysis shows decline of score of loading during the analysed working position by 2 degrees what represents a change from critical unacceptable position to position with mild load.

Decrease of stress occurs also in the area of hip, the load decreased almost by half. This is confirmed also by results of evaluation by help of tool Lower Back Analysis. (Fig. 7) [1].

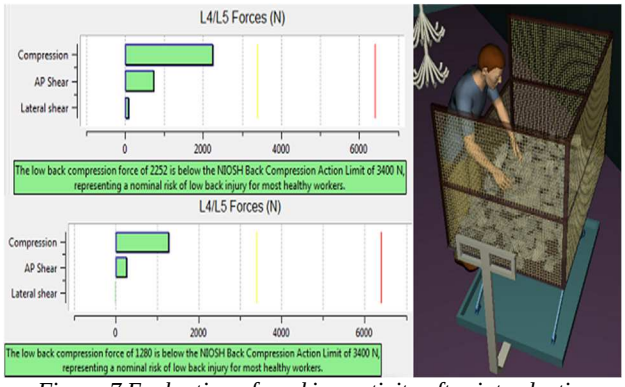

Figure 7 Evaluation of working activity after introduction of measure

Evaluation of load by RULA method points at improvement almost in all indexes. It was necessary to decrease the load mainly in the area of upper arm and body where the load at original position was critical. The results of evaluation of load before and after proposal of forklift are shown in table 2 prepared according to [1].

Table 2 Evaluation of original and proposed position

Position	**Evaluation**				
	Upper arm	forearm	wrist	body	Total score
Original	5	3	3	6	7
After introduction of proposal	**3**	3	**1**	**3**	**3**

In green colour is marked the score which points at improvement of evaluation after introduction of proposed measure. The score has an unchanged value only at forearm. The total score at evaluation of physical load by help of RULA method decreased by 4 degrees what means improvement of working position from unacceptable to acceptable with mild physical load.

A benefit of introduction of measure of technical character into the analysed working activity and working position is simplifying of working activity, decrease of physical load, decrease of risk of threatened health but simultaneously also increase of productivity of work and effectivity of production.

Conclusions

At performance of physical working activity there is a frequent occurrence of diseases of musculoskeletal apparatus which can result in occupational diseases. By revealing the risks which result from inappropriate working environment and inappropriately projected working activity it is possible to prevent the threatening of health of workers. It is possible to reveal these risks by help of created digital models and simulation of working activity.

By application of ergonomic tools of Technomatix Jack program and realisation of corrective measures it is possible to remove excessive physical load and to project the working activity so that it may not threaten the health of the human being and may enable him to provide optimal working performance.

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