

## Improving ergonomic conditions and productivity– a case study in a PVD coating production area

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### 1. INTRODUCTION

Due to demographic variation, fewer young workers are available and the overall number of workers will decrease. The length of absenteeism, especially due to musculoskeletal disorders (MSDs), increases with higher age (Möglich et al., 2015). According to Neumann and Dul (2010), if effectively applied in the design of operation systems, Human Factors can improve system performance while reducing health hazards for employees.

The aim of this work is to evaluate “How productivity is affected after the implementation of ergonomics improvements?” The case study takes place in a PVD coating production area, where workers’ complaints due to shoulder pains were rising considerably. These complaints come mainly from the processes of loading and unloading pieces from the suspension, before and after the product entering the PVD machine, respectively. This is a repetitive job and involves two awkward postures: flexion of the arms above 60° (from now on “arms up”) about 30% of the time and the difficulty to move manually a full suspension of 6kg, on average, from the machine carpet to a table every 3 minutes and vice-versa depending if it is an unloading or a loading process.

### 2. METHODS

The methodology used was the case study. According to Yin (2003), a case study should be defined “...as a research strategy, an empirical inquiry that investigates a phenomenon within its real-life context.” Following this key idea, the case study, as a research methodology, helps to understand, explore or describe a given system/problem in which several factors are simultaneously involved, in a real context.

The first step was the election of a multifunctional team, including operators, to analyze the process. Then this team suggested a workstation redesign in order to improve ergonomic conditions. After the implementation of the suggested improvements, the team measured the productivity and compared it with the base scenario.

#### 2.1. Measurement tools

RULA (rapid upper limb assessment) was the tool used to assess the postures, movements and forces exerted by the worker while performing the job, because it is especially useful for scenarios in which work-related upper limb disorders are reported. RULA score was calculated by weighted average of 4 postures (arms up, center arms, move suspension and container changing). The higher the score RULA - varies from 1 to 7, the higher risk associated and the greater the urgency to carry out a more detailed study and changes to the job.

Productivity was calculated using the number of pieces produced per hour because it is the measure typically used in this production area, being also one of the most well-known measures of productivity in the industrial sector.

#### 2.2. Workstation redesign

For the the weight of full suspension less than 2Kg, the found solution was to put the suspension horizontally to avoid arms up during the loading and unloading operations. For the others, a rotary structure was created and integrated at the end of the machine carpet, to avoid moving full suspensions.

Conditions were created to load and unload pieces directly, eliminating the process of moving suspensions, and the work plan was lowered to avoid the necessity of elevating arms more than 60° as well as the abduction of the arm to do the job. The Figures 1 and 2 depict, respectively, the unloading workstation before and after the ergonomic improvements.



Figure 1– Unloading workstation before improvements.



Figure 2 – Unloading workstation after improvements.

### 3. RESULTS

The Table 1 shows the RULA score and the productivity level before and after the implementation of the suggested improvements.

Productivity increased about 9% in the load operation and 5% in the unloading operation. According to RULA method (McAtamney & Corlett, 1993), the worst posture before the improvements was moving the suspension (scored with 6), and the weighted average was 5. After the workstation redesign, the risk level of MSD decreased from medium to low, means that more changes may be needed to reach negligible level.

Table 1– Productivity measurement and Rula score

Workstation	RULA Score		Productivity (pieces/hour)	
	Before	After	Before	After
Load	5	4	800	872
Unload	5	4	900	945

### 4. CONCLUSIONS

Due to the hard competition, demanding customers and competitive world that companies face, nowadays, it is very important to consider productivity measures while implementing improvements in the shop-floor. On the other hand, jobs are more repetitive leading to musculoskeletal disorders, increasing absenteeism and reducing productivity.

The conclusions of this study are limited to this case, but the authors believe that is possible to consider both aspects, ergonomic conditions and productivity, during improvements implementations. As illustrated in the section of results, the improvements reached in ergonomic conditions can contribute very positively for productivity increases. The authors' opinion is that ergonomic conditions must be considered when designing/redesigning a workstation in order to get effective productivity improvements. Job rotation is recommended in order to reduce repetitiveness. Other possibility is enlarge the job. Anthropometric studies are also critical to adjust the workstation to the body characteristics of the operators, e.g., their stature.

### 5. REFERENCES

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