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The Return on Investment (ROI) calculation, through the application of Occupational Repetitive Actions (OCRA), in a graphic industry sector

Natalha Gabrieli Moreira Carvalho*, Nelson Tavares Matias*, Claudia Lysia de Oliveira Araújo*, Rosinei Batista Ribeiro*, Bianca Siqueira Martins Domingos*, Natália Lemes Siqueira Aguiar de Souza*

**(Faculdades Integradas Teresa D'Ávila (FATEA), Av. Peixoto de Castro, 539 Vila Celeste, Lorena - SP, Brazil)*

ABSTRACT
The project aims to disseminate the quantitative results obtained with the implementation of the Occupational Repetitive Actions method (OCRA) in a job of a graphic industry sector. It also aims to spread this work and stress the importance of ergonomics and ergonomic analysis tools when applied to jobs, especially in the case of Physical Ergonomics and improvements in work production chain. The tool in question assesses aspects of Physical Ergonomics in productive seasons analyzing tasks that require use of the upper body members and with the results of this review can be implemented significant changes to improve the performance of work, preserving workers' health.

Keywords **-** Ergonomic tools, Workstations, Ergonomic assessment, Inadequate postures.

I. INTRODUCTION

This study was conducted aiming to assess the operation of a printing company in order to perform an ergonomic analysis using the method Occupational Repetitive Actions (OCRA). This method is used to prevent musculoskeletal disorders of the upper limbs. It was established in 1994 by the teachers and doctors Antonio Grieco, Enrico Occhipinti and Daniela Colombini from the University of Milan, due to the need for an objective method of work analysis [4]. What differentiated this method from others and made it complete, was the amount of analysed factors such as: organization of work, frequency, strength, posture, working time, break time and if the employee has other tasks during the day [2]. The Ergonomics aims to work in the organization, valuing adapting the environment to the employee, increasing productivity and improving social welfare [5]. Field theory, data collection and methods for analysing the damage occurred in a workplace are applied, identifying several types of disorders: absenteeism, employee turnover, accidents and injuries. Through Ergonomic Work Analysis (AET, from the Portuguese abbreviation to '*Análise Ergonômica do Trabalho'*) and employment of the OCRA method, was possible to perform the quantification and qualification of data from the study, identifying the ergonomic inadequacies, as well as evaluating the improvement of impacts according to the concept of Return on Investment (ROI). ROI is a profitability calculation tool applied on an investment [6].

This analysis is an update and implementation carried out in a graphic industry in the city of Lorena, Sao Paulo. In this project, it was aimed to examine the task, emphasizing the aspect of time and perceived displacement. Such a situation was to focus in the human diagnose and economic costs associated with the possible loss of time and movement. To account losses and inadequacies, it was proposed a purchase of equipment, however without leaving calculating the time required for the recovery of the investment made. This study is part of the actions of Anamaria de Moraes Ergonomics Laboratory, which has as its focus the disclosure of Ergonomics emphasizing its benefits.

II. OBJECTIVE

Analysing the worker's task of a graphic industry for the production of offset printings, highlighting the aspect of time and perceived displacement. Such a situation was to focus the human diagnose and economic costs associated with the possible loss of time and movement.

III. LITERATURE REVIEW

For the implementation of this project was performed an ergonomic analysis of the work in the printing industry of a graphic company located in Lorena, Sao Paulo. The use of the upper limbs was

observed in the performance of productive activities and use of the OCRA method as an analytical tool.

The OCRA method was chosen for this analysis of the work, due to the breadth of elements considered in the analysis, as well as the ability to analyse tasks with different cycles, taking into account the duration and the diverse tasks performed [4].

This analysis took into account the duration of workers' shifts, and the length of intervals performed. Video recording was performed and measurements of time, counting the charging motion, displacements, printing process and machine cleaning. Employee's shifts in activities in parallel were observed as well. Calculation tool also will be applied to obtain a conclusion for ROI. After the postural and Time and Motion Studies, it was possible to propose an ergonomic recommendation and thus reduce or even eliminate any ergonomic hazards found.

IV. METHODOLOGY

The Assessment Task stated by Karnas and Salengros [8] contains the following steps:

1. The task of the situation in context;
2. A description of the task (objectives, device construction principles, rules and procedures, operational program);
3. The description in reference to the variables that we could show the influence of the operator's behaviour (such as constraints, credibility factors...).

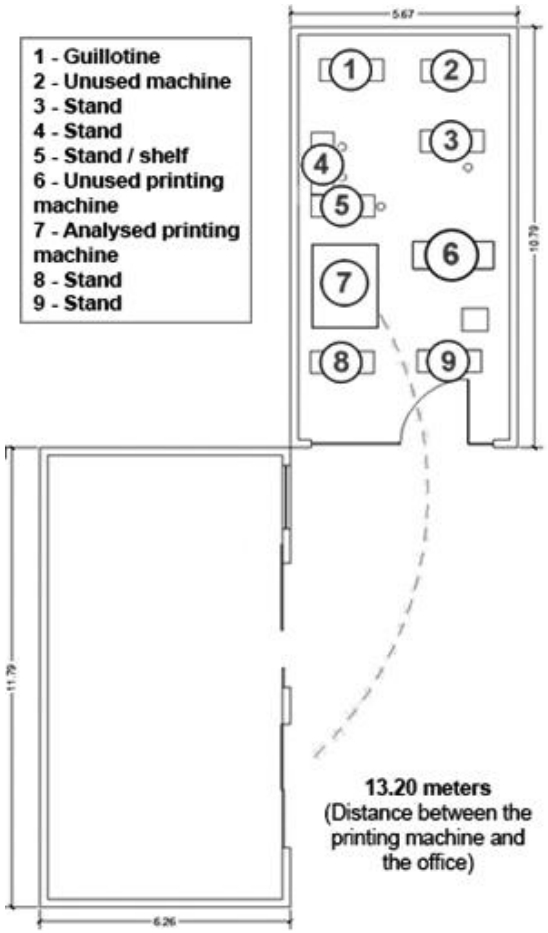
The study was limited to the manufacturing sector and printing graphic material. The environment has a structure of approximately 62m^2. In addition to this space, the displacement carried out the administrative sector that is adjacent to the printing sector observed. Finally, it was also ambulation between the storage and printing industry, however, not shown in Fig. 1.

They were considered the results of the Ergonomic Analysis and OCRA method previously performed, disregarding the steps of plate burning, mounting photolithography and separation of printed sheets. Currently no other official in charge of the functions that involve the assembly and recording the plate, so the observation of this new employee was made without the intention to study it or consider it in this project.

Another visit was done at the same printing industry, having now as focus studies of time and movements, adopted by graphic printer for their activities (Chart 1).

The printing process can be described as follows: the complete printing process recorded a total of 1 hour 14 minutes and 07 seconds containing the different tasks and steps (Table 1).

Fig. 1 - Graphic Industry Plant (top right) and adjacent the administrative section (lower left).



It was characterized as lost time that used to roam the administrative sector, deposit the bench support to the court and the bench cleaning and printing products. In addition, to be suspended takes momentary time due to printing machine settings, and guidance to the attendant.

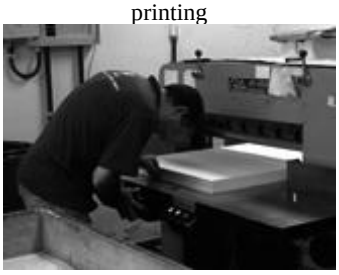
Task description	Ergonomic requirements	Body parts	Proposed solutions
a) Transportation of the paper reams 	Effort of the arms and legs by squatting movement, rising 28.75 kg close to the ground. After the load lifting, the employee backed the load on the head	Whole body	Using a pantograph table, reducing the inadequate postures and movements
b) Cutting and trimming paper for printing 	Back flexion and neck, and apply torsion in the column to watch the display that indicates the alignment of the guillotine. The systematic movement of the forearms against the need to handle the paper to the court also evidenced	Arms, shoulders, neck and back	Raising the height of the machine and improve the lighting along the machine
c) Adjustments in offset printing 	Bending knees and arms, these postures are assumed during a long time, to observe and adjust the printer for the printing process	Whole body	Raising the height of the machine and change the space environment
d) Printer cleaning 	Arm in abduction and wandering between the machine and the bench for the use of essential products for cleaning	Whole body	The use of a mobile station which could be deposited the required cleaning products thus decreasing the deambulation; raised floor, facilitating the operation

Chart 1 – Description of the tasks observed during the printing process.

Table 1 - time wasted in ambulation.

Step	Task identification	Time wasted in printing task	Total task time
Transportation of the paper reams	Initial	2’ 20”	1’ 06”
Cutting and trimming paper for printing	Initial	4’ 33”	1’
Offset printing	Ordinary	43’ 53”	12’ 35”
Printer cleaning	Final	11’	2’ 10”

In all the tasks, a loss of productive time were observed due to the employee’s displacement, when he was absent from his position. It should also be considered that on the day of notice the employee possessed varied demand services. While the printing machine effected, the employee monitored at all times, having been absent only on occasion, and shifting the distance of up to 13.2 meters (round) (Figure 1) to operate another machine not related to the process printing.

The course was conducted 6 times, being held on another occasion, to seek material for cutting, returning to the pressroom for the guillotine operation and then moving to the office, to monitor the progress of another employee in assembling the photolithography. Walking through the trip distance of 26.4 meters in 1 minute and 33 seconds.

It was noted upon arriving in the graphical environment, that it does not have windows, only an opening the size of its total width of 4.54 meters in length, which impedes the exchange of air in the room. The machines operated in the environment imposes high noise level when active, but have not carried out measurements in this way were not considered the information provided in the recommendations proposed by the NR 15 [10].

The first stage of observation devoted to the collection and transport of paper; the employee displaced to the warehouse located at a distance of 23 meters to accomplish the task, it is important to emphasise that the transport was carried out with the paper on his head, straining his neck and arms. Following led to ream to the print industry, and so made the cut. According to Laville [9] "When the load is heavy, the operator must have recourse to other mechanisms." Each stack has 250 sheets with a total weight of 28.75 kg and can be used other types of paper which have different masses. Information on the cargo handling are set out in Brazilian Decree - Law No. 5452, which approved the Consolidation of Brazil Labour Laws, Article 198 - Prevention Fatigue establishing the maximum weight that can be loaded individually by the worker at 60 kg thus the case is examined on schedule, but this effort is made several times during the working day in an improper way and could be avoided through the use of proper equipment for the job. Thus, there is the employee tax effort to bend the trunk to pick up the paper and get around to the guillotine and then to the space between seasons 2 and 3 (Fig. 1). It was observed a back flexion reaching an angle of approximately 85 degrees, aiming to handle the paper required for the beginning of the task (Fig. 2).

Fig. 2 - movement to handle the paper and start the transport.

Inside the printing room, the employee put the paper on the guillotine to start the cutting process. On several occasions, he flexed his back and stretched his neck to perform the alignment of the paper (Fig. 3). The NR 17 [11], which regulates Ergonomics at work, specified in Section 17.3.2: "For manual work sitting or has to be done standing, countertops, tables, desks and panels should give the employee good posture conditions, visualization and operation [...]". In this way, the benches of the workstation analysed are incorrect regarding the regulations, exposing the workers' health.

His total time of the cutting process was 4’3”, and 1” from the total, was spent by the employee moving around to deposit the cut paper guillotine the nearest bench. Apart from the physical effort, attention is demanded from the operator, once the cutter has risks requiring even for two-hand safety drive.

According to the report of the observed activity operator, despite the security mechanism contained in the guillotine, this had mechanical problems sometimes exposing the operator to risk because the blade has made the cut without being made the command and could have caused an accident.

Fig. 3 – Alignment to start the cutting process.

During the period, which predates the start of printing, the officer observed bent in angles greater than 30 degrees, in order to position the sheets to support the machine and make adjustments in the correct size of the sheet, the total time of these adjustments accounted for 12' 35". Already during the printing process, several positions harmful to the machine operator were observed: several times he crouched to view the process at close range; on occasion he was absent to perform other services in the printing office, however these activities were not observed.

In the final step of the process, the operator has carried out the cleaning of the printing machine, using various chemical concentrates such as the case of RC - 661 (Fig. 4) which is a humectant concentrate, requiring the use of safety glasses and gloves when handling. Importantly, the operator put on the knitted gloves with latex swimsuit, model expressly not recommended by AGFA (2015, p. 2-3) in their Material Safety Data Sheet. To minimize the potential for contamination by chemical handling is suggested that the gloves are of butyl rubber (thickness ≥ 0.36 mm, rupture time> 480 min), nitrile rubber (thickness ≥ 0.38 mm long Break> 480 min) or neoprene (thickness ≥ 0.65 mm, breakthrough time> 240 min) (AGFA, 2015, p. 2-3).

The operator did not use safety glasses, because it was already using glasses unsuitable activity, which do not offer the same protection of Personal Protective Equipment (PPE). The Safety Data Sheet recommend the use of safety glasses (AGFA, 2015, p. 2-3). Thus, it is recommended to use the task own glasses.

Fig. 4 - Wetting concentrate RC- 661.

In addition to the sleeves, the operator used as an interface for performing cleaning the tow, and during tow cleaning process stuck to rollers and the operator reacted with the opposite movement preventing their hand was pulled and pressed in the system (Fig. 5a) . The recommendation is for the operator to use in place of burlap scraps that do not produce so much lint and thus, reducing the possibility of accidents by pressing.

(a) (b) (c)

Fig. 5 - roller cleaning activity, in which occurred to hold cotton waste.

Subtitle:
(a) moment to start the cleaning movement of the reels;
(b) moment where the cloth is attached on the moving machine;
(c) after realizing that the cloth was pulled by the machine, the employee removed quickly by hand.

It was noticed strong chemical odour coming from solvents used for cleaning printing machine reels, and in one of these packages did not contain part of the label on the information on the Personal Protection Index (Fig. 6). It is suggested that is available in the printing industry, as well as by the administrative section copies of labels and their information so that if necessary the query happen quickly.

Fig. 6 - Solvent missing safety information.

While performing the cleaning was observed posture of bending the arms above shoulder level (Fig. 7). This position takes place in the perimeter of the whole machine, especially in the area are the where ink is transferred and print rolls. Associated with posture for the lateral displacement. It is recommended floor elevation in such a way to reduce the musculoskeletal impacts on the operator.

Fig. 7 – Risky posture.

During the printing process, this new analysis, it was perceived that there is a time period that does not add value to the task itself, due to wanderings from the paper transport most of the steps. The complete process of printing totalled 1 hour and 14 minutes, these 16 minutes 51 seconds were consumed because of shifts and adjustments in the printer (Table 2).

Table 2 – Time spent on each correlated task.

Task	Task duration (t)	t/s
Shifts and adjustments in Printer	16'51"	1011
Printing total time	1^0 14'	4440

According to reports of the operator carrying out bulk services, such as printing a magazine, are used 20 reams of paper, which takes seven shifts the deposit for removal of resin in this case, the task is accomplished with the aid of a hand cart to transport loads.

The method for ROI analysis predicted the calculation of time spent in wanderings and the value of employee work hours, allowing quantify the lost values that spend on movement between the collection of paper and cleaning of the machine, facts that do not benefit productivity [1].

The amount received per hour worked was: R$8.18 / 44 hours per week, totalling R$1,799.60, considering the Governmental contributions the value is R$2,329.92 / Month. Labour charges under the Consolidation of Labour Laws [3] (Table 3):

Table 3 - The applied percentages refer to a charity.

Charges	%
Holiday salary	8.33
1/3 without Holiday salary	2.78
Christmas bonus	8.33
Employee benefits	2.00
Employee's dismissal fund	8.00
Amount	***29.44***

To mitigate the collection problems, displacement and power of the printing process suggested the acquisition of a pantograph table, this way you can optimize the work done. The following pantograph tables were listed (Table 4):

Table 4 - Equipment capable of supporting inappropriate activities.

Brand	Price
Hydraulics pantographic table 1000 kg Me1000 Bovenau - Polyurethane wheels	R$ 1,819.82
Hydraulics pantographic table 500 kg Me500 Bovenau - Polyurethane wheels	R$ 1,542.76*

The equipment selected was the one with the lowest cost because the maximum load displaced by the employee was 86.25 kg for collection, i.e. load below maximum capacity permitted by the equipment. However, be warned that the maximum capacity of the transport system is not applied, unless there are three operators involved in the activity. Consolidation of Labour Laws (CLT from the Portuguese abbreviation to *Consolidação das Leis do Trabalho*) proposed by Brasil [3] provides in Article 198 that Sole Paragraph: "It is understood the prohibition of this article to remove material made by push or pull carts [...], wheelbarrows [...] may MTE[1], in such cases, to set various limits, to avoid being required of the employee services superior to their forces."

To convert the lost time in financial economics was applied the following calculation [7] (Formulas 1, 2 and 3):

[1] MTE from the Portuguese abbreviation to *Ministério do Trabalho e Emprego*, which means in English 'Ministry of Labor and Employment'.

IOP = TTS / TTO x 100 = %
(1)

Therefore: IOP = 1011"/4440" = 0.2277027 x 100 = 22.77%
Subtitles:
(IOP) Impact on Productivity
(TTS) Total Time Saving
(TTO) Total Time Operation

AS = DIP x AC
(2)

Therefore: AS = 0.2277027 x 2329.92 = R$ 530.53
Subtitles:
(AS) Anual Savings
(DIP) Designed Impact on Productivity
(AC) Anual Costs

PK = IC / AS
(3)

Therefore: PK = 1542.76 / 530.53 = 2.907 years
Subtitles:
(PK) Payback
(IC) Implementation Costs
(AS) Annual Savings

As discussed above using the OCRA method, the employee claimed to have severe back pain and shoulder, showing in this way the damage from years of work in repetitive activities. As OCRA, among the additional risk activities, not fit the tested weight 2, making use of both sides of the body, where: D corresponds to the right side and the left side E (Table 5).

Table 5 – Results related to complementary tasks.

Weight	Description			
2	Precision work is performed for more than half the time (work in areas lower than 2 -3mm) that require close viewing distance.			
2	There are more complementary factors (such as: back with curvature greater than 30°) which when considered in the total, take up more than half the time.			
Complementary	4	**R**	4	**L**

V. CONCLUSION

The renewal of the Ergonomic Analysis of Work to the printing sector of an educational institution allowed new situations were discussed in addition to the everyday issues faced by ergonomics. This document was possible to describe how the AET can contribute to the improvement of productive sectors, enabling tailor the job to operate and also bring economic benefits to the system involving humans and machines.

The postures and studied wanderings received an ergonomic recommendation, without however, present the project to each situation as it will require a study, further detailed. However the calculation of Return on Investment (ROI) showed that the acquisition of pantograph table - equipment recommended to mitigate the human costs and also reduce the time for activities that do not add value to print job itself, will be amortized over a period of time of approximately 33 months, though this time corresponds to the value found for only one task observed.

It is assumed by the volume of work currently carried out, as well as evidenced by future AET and subsequent time measurements which fit other activities performed by the employee, as well as printing, provide as a result for the return time less than that found. It was pointed out in this way, the importance of holding the investment. From a holistic view on the current printing system, it was understood that the acquisition of aid equipment in the shipping and handling charges to the employee's printing sector, will also benefit other sectors of the company.

Additional studies will be needed so that you can resolve or mitigate other remaining problems.

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