

DESIGN AND OPTIMIZATION OF A NEW LAYOUT FOR A COLLISION AUTOMOBILE AREA

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Abstract. *This paper reports a research work related with the development and optimization of a new layout for a collision automobile area (bodywork repair and painting), held in the Auto Sueco (Minho) of Portugal, the brand Volvo car dealership.*

In a first stage, the main concern was to gather knowledge about the reality of the company's hierarchies; its work volumes, workflows and their primary goals.

After that, based on the observation of the methods and working conditions, the company's financial situation and the global market, were established same design specifications, not only in what concerns the fulfilment of the minimum standards of the brand, but also to achieve the required ISO quality certification for the company.

Then, a detailed bibliographical and industrial research was performed in order to identify the main requirements involved in automobile maintenance, the related standards and the most appropriate equipments.

Done this framework, it was drawn up proposals for layout, which is taken into account issues such as functionality of the areas, internal and external flows, rate of work, issues in order to reduce operating costs, and possible environmental improvements within the energy efficiency.

The proposed layout, that this paper will discuss and present, has been suffering successive developments, which were subjected to analysis in meetings with people involved in the project (the responsible Auto Sueco (Minho), companies, architects, engineers, equipment suppliers, among others) to reach a consensus proposal considered among several actors in the project.

Keywords: *Layout optimization, Automobile bodywork repair, Automobile painting, Productivity, Energy efficiency*

1. INTRODUCTION

Auto-Sueco (Minho) is a dealer that centralizes its main functions in sales of vehicles, trucks, and after sales assistance. Since there is a requirement, made not only by Volvo (brand that the company commercializes) but also by the environmental legislation in force, to observe the fulfillment of certain requirements and procedures for the treatment of waste and effluents and emissions, it is necessary to evolve the current reality to a minimum level, in order to ensure the satisfaction of these requirements. The increase of productivity is also a goal that the company desires to achieve. Although the company has developed in this aspect, some critical points still persist. This way, in this research work, a new workshop layout for the collision automobile area was developed in order to increase the work quality and efficiency and the customer's satisfaction level. To accomplish these goals, in this work, the paper is organized as follows. In Section 1, it is presented the challenge proposed to achieve in this work. In Section 2 the characterization of the Auto-Sueco company is briefly presented, as well as, the workshop layout limitations. Section 3 presents and discusses the development of the new layout. Finally, in the last section, the main conclusions and some future work are drawn.

2. AUTO SUECO (MINHO)

2.1. Generalities

The Auto Sueco (Minho), established on the 11th of June of 1979 in Braga (Portugal), focuses its activity on the Commercialization of Automobiles, consisting as the concessionaire of the Volvo mark for all of the Minho region.

Chronologically speaking, it is important to refer that in 1981 the company inaugurated its building headquarters in the city of Braga, in 1988 opened installations in Guimarães, in 1989 started activity in Barcelos with the opening of a stand and a counter to sell parts, and in 1996 it opened another stand in V.N. Famalicão.

Currently, it makes use of a total area of 15.500 m², of which 7,600 m² is covered area destined for their workshops and exposition stands. In 1991, when they was thought to advance with the process of certification of the System of Guarantee of Quality, the Administration was conscientious of the challenges that it would have to face and that only the most apt would have the chance to be successful. Today, they are sure that only with high performance standards, technical and commercial, it is possible to continue in the vanguard of the preferences of its customers. Therefore, it is presently a certified company for the “Commercialization and the after sales assistance of vehicles of the brand VOLVO”, according to ISO 9001:2000 (ISO, 2000).

Exceeding, at this moment, one hundred workers and about 30.000.000€ of annual global income, the Auto-Sueco (Minho) is one of the most important companies of the automobile sector in the Braga region. (AUTOSUECO, 2009 and VolvoCars, 2009).

2.2. Current characterization and limitations

Currently, with the global financial crises installed, and particularly in the automobile sector, a great decrease occurred in what respects the business volumes.

Since the income is not the expected one, it becomes more difficult for the company to advance with projects that aim to increase its quality and efficiency in work, such as the remodelling of the installations. Therefore, the probability of them becoming impracticable economically, and consequently delaying these projects, is high.

At the moment the main problem is the actual collision workshop layout to have high operating costs due to reason of the body repair area (figure 1) to be placed far away from the painting area (figure 2). This means spending too much time in the vehicles transportation between areas, given that in some cases the same car needs to make the trip 4 or 5 times, sometimes in the same day. Also, the existent automobile painting section not fulfilling, the standards imposed by the Volvo mark and the environment European standards.

The remodelling of these two areas involves workmanships of civil construction, and the acquisition of new equipment, being that the main objective of the planning is to stop the labouring the lesser time possible.



Figure 1. Actual automobile bodywork repair.



Figure 2. Actual automobile painting area.

2.3. Customer loyalty

Today, one of the most important aspects in any business that provides a service or a product is to focus on the client. The client is a vital point for the development of the company not only economically, but also in what concerns prestige and credibility. It is important for there to be a correct and innovative internal policy in order to ensure a good final satisfaction.

The quality of service/product will be reflected in the long term. Currently all companies should have a quality manual, which they should try to follow as closely as possible in order to comply with the current quality policy which is Total Quality Management – TQM (ISO, 1994).

With the expansion of the market with regards to car care, there has been a considerable increase in competition within workshops. The multi-brand workshops, some of them international, have upset the expectations that the dealers used to have in regards to their own maintenance workshops. These types of workshops offer several maintenance services at very competitive prices. But, it is clear that sometimes the quality of the services decreases with the price. Because of this, the dealers chose to invest in marketing strategies and customer loyalty. This is achieved through innovative and creative advertising campaigns, a good customer treatment when they go to the facilities, a good service quality and cleanliness, and surveys for the customers about their overall satisfaction.

Auto Sueco (Minho) has client loyalty policies called Second to None and Customer for Life. The purpose of monitoring is to measure the degree of customer satisfaction comparatively to the quality of the offered products, the

services performed and the environmental performance of the Auto Sueco (Minho). It is done to almost all the company's clients, through these programs of by the company's own quality department, as presented to proceed (AUTOSUECO, 2005):

- Customer for life: Program developed by the Volvo Car Corporation, to evaluate the satisfaction rate of car clients at a national and a European level.

- Second-to-None: Questionnaire conducted by Auto-Sueco (Minho) in accordance with the standards of Volvo Trucks that looks to assess the level of satisfaction of customers of heavy vehicles at a national and European level. Figure 3 shows results obtained for the years from 2001 to 2008.

- Satisfaction Surveys: Questionnaires made by Auto-Sueco (Minho) to their customers, in order to evaluate their level of satisfaction for services provided by workshops and components departments;

- DQA: Department of Quality and Environment.

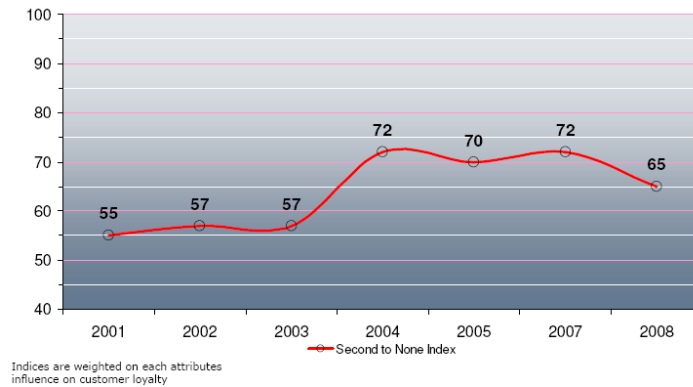


Figure 3. Second-to-None index in Auto Sueco (Portugal) [intranet www.auto-sueco.pt].

3. NEW LAYOUT DESIGN

The design of a new collision layout was performed according to the following works, related with the design and optimization of production facilities: Canen *et al.*, (1996), Sha *et al.*, (2001), Sarker *et al.*, (2006) and Waghodekar *et al.*, (1986).

3.1. Objectives

This research project intends to reach the following goals:

- State of the art of the organization of automobile collision areas, fulfilling, in particular, the applicable standards;
- Evaluation of the real necessities of the company;
- Selection of the necessary equipment;
- Conception of the layout of the new automobile collision area;
- Drawing and dimensioning of the facilities infrastructures.

Currently the areas of more recent automobile collision are facing a more distinct reality of that being lived by the Auto Sueco (Minho) collision area, in a time that the conditions are far from the ideals. It becomes difficult to fulfil certain objectives, especially the environmental ones.

The companies real needs go through the renewal of the current area of collision since, globally analyzing, it is the area that is in more obsolete state. As a result, the conception of a new layout for this area involves the renewal of some existing infrastructures and the construction of new. Inherent to this change is the acquisition of new painting equipment, mainly a new greenhouse, two zones of preparation, and two compressed air deposits.

All the indispensable infrastructures such as compressed air, electricity, hydraulics, treatment of effluent liquids, informatics networks, among others, will have to be re-dimensioned and redesigned.

To point out, the special approach that will be given throughout this project, to the strict fulfilment of the effective standards in terms of hygiene and security in the workplace, as well as of the applicable environmental standards. (Ahrens, 1996, Rosander, 1992 and Silva, 2006).

3.2. Conceptual design

The developed conceptual design had as starting point the actual automobile collision workshop, which includes the existing equipments. It is also important to refer that the new solution shall pay attention to internal flow in the company organization, as well as average of the existing quantity of service orders (clients).

It was also important to do a, to inquire the physical needs of external parking in the workshop, and of volume services in the workshop. Thus, it was performed the lifting of daily service work orders of collision during approximately four month. The results of this lifting are shown in the figure 4.

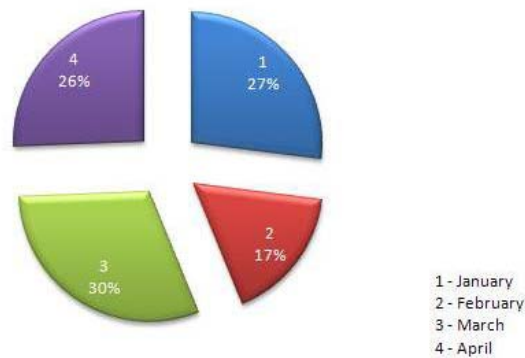


Figure 4. Service work orders for vehicles in the collision workshop.

To minimize the operation costs, the best solution is to join the two areas of collision, body repairs and painting. The main problem is related with the available physical space for this junction. Fig. 5 shows the actual collision layout.

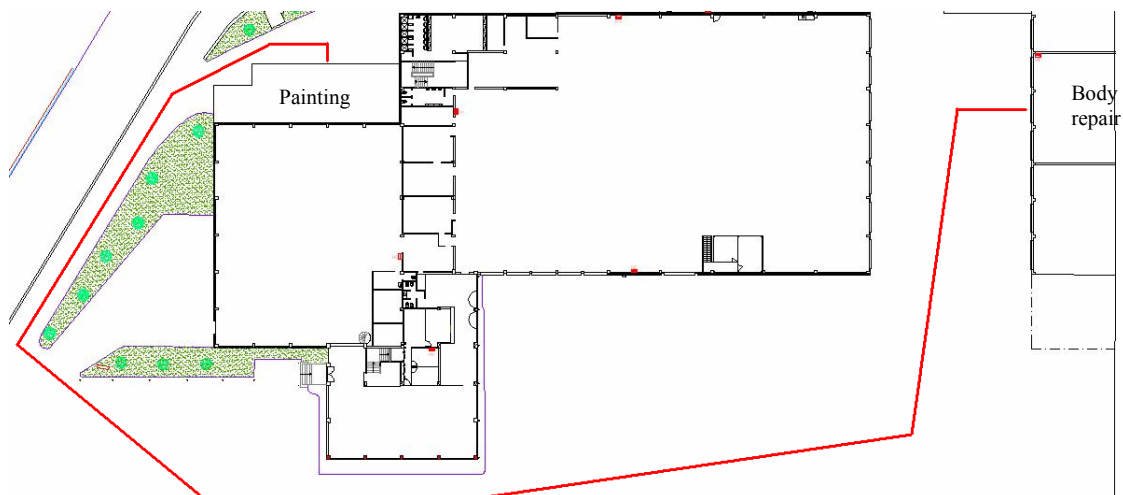


Figure 5. Actual collision layout (in red the route between the two main areas).

Since Auto Sueco (Minho) assists vehicles and trucks, there is also the aim to separate them. In what regards the physical painting area there is a significant increase, as can be verified in the figures 6 and 7, respectively, for the actual and proposed layout. For the physical body repair area the same situation occurs, that is an increase of available area, as show in figures 8 and 9, respectively, for the actual and proposed layout.

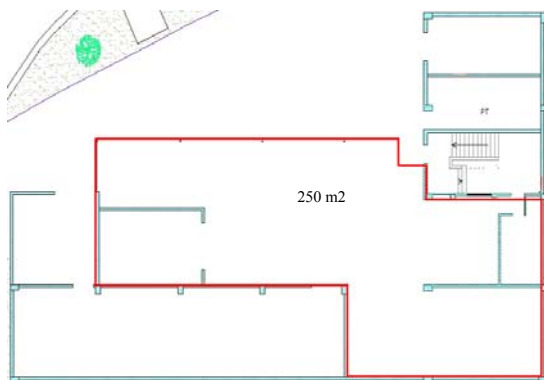


Figure 6. Actual painting section (red line).

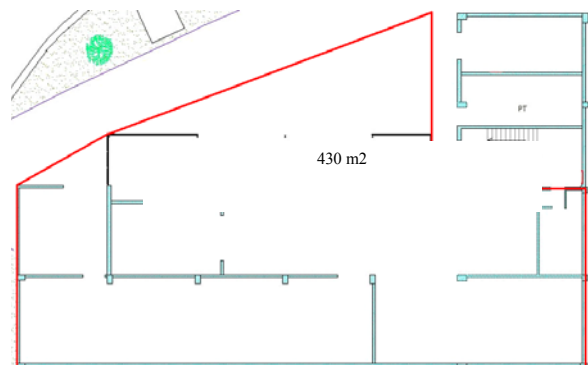


Figure 7. New painting section (red line).

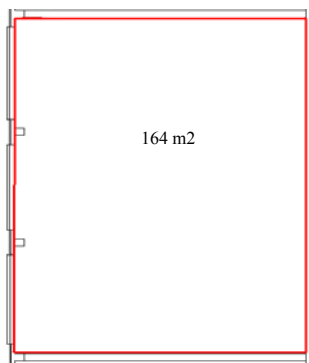


Figure 8 Actual body repair area section (red line).



Figure 9. New body repair area section (red line).

A significant increase in the level of the available physical space exists, although in the case of the body repair the functionality is a little engaged because the exterior support park disappears.

3.3 Approved layout

After some meetings and different solutions to the problem, we opted for a solution that consists of the total remodelling of the existing painting section, and of the construction, on the floor over this area, of a new body repair area. This allows the centralization of the vehicles collision area. Figures 10 and 11 show, respectively, the final layout approved for the painting and for the body repair areas.

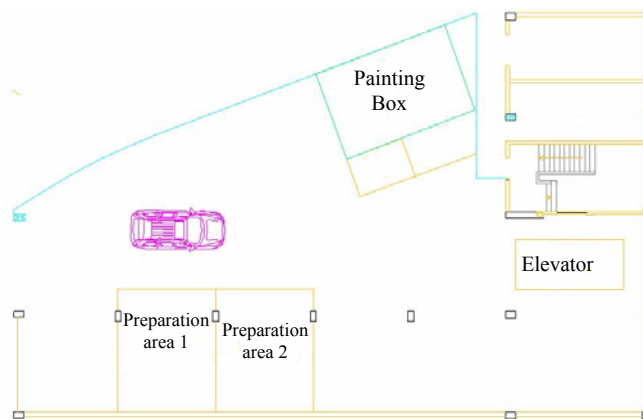


Figure 10. Layout of the new painting area.

The transition between sections will be made by an elevator (ACL, 2009) between floors or through the exterior
The layout of the body repair area is the most flexible since there does not exist machinery of great volume as in the painting area (USIITALIA, 2009 and BLOWTHERM, 2009).

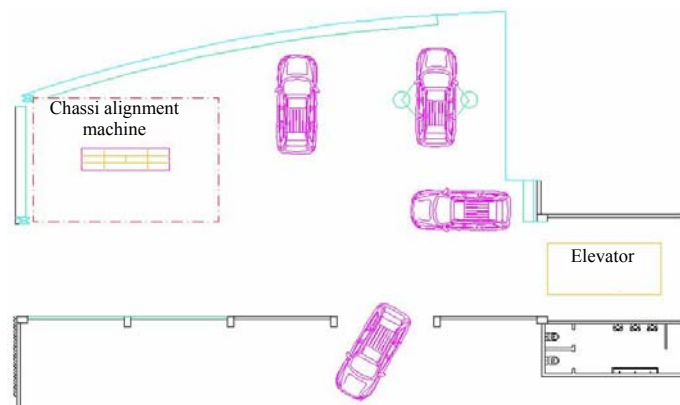


Figure 11. Layout of the new body repair area.

4. CONCLUSIONS AND FUTURE WORK

In this paper, it was presented and discusses the design of a new workshop layout for automobile collision area that was developed in order to increase the work quality and efficiency and the customer's satisfaction level. This layout was obtained fulfilling strictly the effective policies in what concerns work safety and hygiene, as well as, the applicable environmental policies.

The future work deals with the physical implementation of the new approved layout, where the main item to pay attention, is to assure the workshop and warehouse laboring in order to guarantee the minimum services for compromised requested services, without losing any quality. To achieve this purpose, it will be necessary, to careful planning the transference stages and the required new equipment installations, such as: compressed air, water, electricity, informatics and hydraulics networks.

5. REFERENCES

- ACL, 2009, <www.acl.pt>, access on-line in 1 Feb. 2009.
- Ahrens, V., 1996, "New Organization Concepts for Distributed Production Systems", *Kybernetes*, Vol. 25, No. 2, pp. 24-39.
- AUTOSUECO, 2009, <<http://www.autosueco.pt>>, access on-line in 1 Feb. 2009.
- AUTOSUECO, 2005, "Quality Management handbook", Auto-Sueco Minho, Braga, Portugal.
- BLOWTHERM, 2009, <www.blowtherm.com>, access on-line in 15 Feb. 2009.
- Canen, A.G., Williamson, G.H., 1996, "Facility Layout Overview: Towards Competitive Advantage", *Journal:Facilities*, Vol. 14, No. 10-11, pp. 5 – 10.
- ISO, 1994. "ISO 8402:1994 - Total quality management – TQM", International Organization for Standardization.
- ISO, 2000. "ISO 9001:2000 - Quality management systems – Requirements", International Organization for Standardization.
- Rosander, K., 1992, "Design of Production Systems for Batch Production in Short Series to Reduce Lead Time", *International Journal of Operations & Production Management*, Vol. 12 No. 4, pp. 53-60.
- Sarker, R., Mohammadian, M., and Yao X., 2006, "Design of Production Facilities Using Evolutionary Computing", *International Series in Operations Research & Management Science*, Vol. 48, Chap. 12.
- Sha, D.Y., Chen C.W., 2001, "A New Approach to the Multiple Objective Facility Layout Problem", *Journal:Integrated Manufacturing Systems*, Vol. 12, No. 1, pp. 59 – 66.
- Silva C., 2006, "Production Systems Organization", University of Minho, Braga, Portugal.
- USIITALIA, 2009, <www.usiitalia.com>, access on-line in 15 Feb. 2009.
- VolvoCars, 2009, <<http://dealerpages.volvocars.se/pt/pt/dealerpages/120/default.aspx>>, access on-line in 1 Jan. 2009.
- Waghodekar, P. H., and Sahu S., 1986, "A Critique of Some Current Plant Layout Techniques", *International Journal of Operations & Production Management*, Vol. 6, No. 1, pp. 54-61.

6. RESPONSIBILITY NOTICE

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