

## DEFINITION OF A NEW WORKSHOP LAYOUT FOR AUTOMOBILE MAINTENANCE AND COMPONENTS WAREHOUSE

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

*It was intended to be performed the maintenance of the mechanical workshop of cars and storage of components of the company.*

*The performance of this intervention is due primarily to issues relating to the importer's orders of the brand in the country "Volvocar" and to obtain certifications required by the company itself. Concerning that issue, it is necessary to improve the quality of the functionality of the areas in question.*

*Thus, a framework was initially done according to the reality of the business, operation, personnel, characteristics of services respecting the rules of trade, existing equipment as well as a data collection on the volume of work and a bibliographic study on this theme.*

*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 this research project, namely, architects, engineers, equipment suppliers, among others to reach a consensus proposal considered among several actors in the project.*

**Keywords:** *Layout improving, Automobile maintenance, Productivity, Energy efficiency*

### 1. INTRODUCTION

Auto-Sueco is a company that has existed in the Portugal history (1949) for 80 years. It was founded by Mr. Luiz Oscar Jervell and Yngvar Poppe Jensen, whose initial activity was to represent Volvo's trademark in the North of Portugal. Nowadays the Auto-Sueco activity is scattered throughout the whole country and within many areas besides the automobile line, such as the industry, commerce, services and real estate.

The main functions of the Auto-Sueco (Minho), S.A. Company (concessionary) are selling light and heavy vehicles, as well as its respective after-sale assistance. Considering that Volvo's trademark importation in Portugal is conceded to Volvocar, and Auto-Sueco (Minho) it is submitted to requests imposed by the importer, which in this case, he requested the physical separation of the after-sale maintenance areas for light and heavy vehicles. In the present time they are found in the same place. An image of Excellency close to the clients is desired to be created and maintained, especially of light vehicles, once Volvo is a trademark of a medium-high segment, it searches for the difference even in the image near its clients. Not forgetting the possibility of improving the functioning of the workshop, as well as improving the quality of the provided services. This way, in this research work, a new workshop layout for automobile maintenance and components warehouse 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), S.A. initialed its activities on June 11th 1979 in Braga, and the facilities were inaugurated in 1981. Currently, Engineer Mário Oliveira is the administrator of the Company. Its main activity is in the light and heavy automobile commerce and maintenance. The company was established as a concessionary company for Volvo's trademark in the Minho region.

Referring to the expansion plan, in 1988 new facilities in Guimarães were opened, and in 1989 it began its activity in Barcelos with a stand booth and a counter of components, and in 1996 a stand booth was opened in V.N. Famalicão.

Presently, it has a total area of 15.500 m<sup>2</sup>, being 7.600 a covered area destined to workshops and exposition stand booths. In 1991, when they were in doubt in advancing with the certification process of the Quality Warranty System, the administration was conscious of the challenges it implied, and that only the most capable would have the opportunity to win. Thus, it is guaranteed that there has to be a high technical and commerce performance standards to continue on the top preference of its clients. The Auto-Sueco (Minho), S.A is a company certified with the "Marketing and after-sale assistance of VOLVO trademark vehicles", according to ISO 9001:2000 (ISO, 2000).

Currently, the Auto-Sueco (Minho), S.A surpasses one hundred workers and around 30.000.000€ global annual invoicing. Auto-Sueco (Minho) is one of the most important companies of the automobile line in the region of Braga (AUTOSUECO, 2009 and VolvoCars, 2009).

## 2.2. Actual characterization

Considering the global crises installed, mainly in the automobile sector, presently we have observed a significant reduction concerning the business volumes.

Thus, being hard to reach the normal income, it becomes harder for the company to put forward projects that aim at increasing its work quality and efficiency, such as remodeling the facilities, seeing that it implies voluminous financial investments. The probability of turning them economically unconquered and the chance of being postponed is high.

At the moment the main problem is in the light automobile maintenance section. The Volvo car's importer demands dividing the maintenance workshop (light/heavy) when changing the warehouse area.

The reorganization of these areas involves essentially interventions in the civil construction level, once new equipments will most likely not be obtained.

The main requirement considered in the reorganization planning performed was linked with the shortest implementation time with the smallest services quality and efficiency losses, being these issue more important due to the specific company business branch.

## 2.3. Satisfaction and client fidelity

Nowadays, one of the most important aspects of all companies that provide any type of service, are the client focalization. This is the fundamental element for the company's economical development as well as for its quality exterior image. This idea is always present in everything that is done, in order to improve quality in any kind of provided service.

It is important to mention that there is a strong market competition in the multinational maintenance service provided, as well as the retail chain (supermarkets) that offers multi-trade services at very competitive prices, which makes the concessionaries adjustable to a reality associated with an economical degraded conjecture with a competition that presents a stronger argument and more competitive prices.

This way, the company has the need to proceed with internal strategy readjustments for high quality provided services, and also to find a way to reduce internal costs, in order to have a continuous quality improvement, from the workshop maintenance services, as well as the warehouse in providing internal and external components. External readjustments, such as creating publicity campaigns, are also important to the Company, to make visible the image of the quality provided by the company and its services.

At Auto-Sueco (Minho), there is a client fidelity policy it's the Second-To-None and Customer-For-Life programs, doing inquiries to the clients frequently after the maintenance or selling component service provided, as an objective of monitoring and comparing the level of clients' satisfaction for quality provided services. 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:

- Customer for life: Program developed by Volvo Car Corporation to evaluate the automobile client satisfaction index at a national and European level;
- Second-to-None: Survey done by Auto-Sueco (Minho) according to Volvo truck standards, with the objective of evaluating the heavy vehicle client satisfaction index at a national and European level;
- Satisfaction Surveys: Surveys done to there clients by the Auto-Sueco (Minho), with the purpose to evaluate there satisfaction degree for the provided services by the workshops and component section;
- DQA: Environmental and Quality Department.

This concern aims at trying to turn loyal the bigger number of clients possible, since the weight of the maintenance service provided, selling components in an this type of company is very important (Ahrens, 1996, AUTOSUECO, 2005, Rosander, 1992, Silva, 2006).

As conclusion, figure 1 shows the client typology in function of their satisfaction and fidelity level with the company.

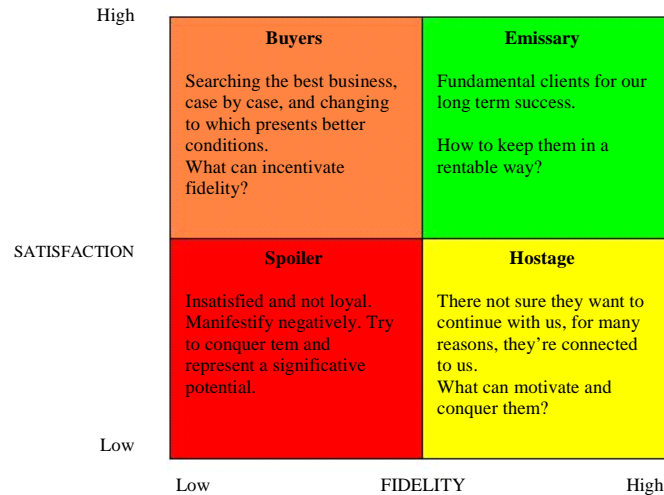


Figure 1. Client typology.

#### 2.4. Actual layout limitations

At the moment, the area for the automobile maintenance workshop has a 600 m<sup>2</sup> area, where there exists an area only for maintenance, an area for electricity, an area to diagnose damages and the vehicle circulation area.

The workshop has ten lifts, 8 of which have two pillars (OMCN 199 UE models), one of the four pillars (OMCN 402 model) and one of four pillars (STERTIL KONI ST 4040 model) for vehicle steering alignment. Furthermore, it has wheel equilibration equipment. It also has technical trough of disposition and gathering of lubricating fluids, water, compressed air and artificial light and junction lines between the deposits (situated in the heavy vehicle service station and the referred trough, as well as workbenches to place the components and tool cupboard. All of these equipments will be replaced in the new workshop.

There are also containers to receive the separated residues according to the company's environmental policy aspects.

In the electricity area we have a place available for three vehicles. In each one of the places it has its own workbench and tool cupboard, as well as a testing and verification office of electrical components.

The area where the damages are detected, there exists a reserved area for the vehicle and a counter with an equipped a computer system that allows the access to the central unity to detect vehicle problems (STERNIL, 2009 and OMCN, 2009).

At the moment, the main limitation of the maintenance area (figure 2) is due to the fact that the internal circulation of vehicles is not possible between the vehicle exposition stand booth and the workshop. In case of a new vehicle delivery for the client in climacterically rainy conditions, it is an unsatisfactory factor for the company, because this operation will have to be done inside the own workshop.



Figure 2. Photography of the actual workshop.

The present warehouse, shown in figure 3, has a total of 700 m<sup>2</sup> area. This area is slightly reduced due to existing offices for approximately 650m<sup>2</sup>.

It has ten shelves for heavy components that will be reused in the new warehouse, and eighteen shelves for light components that will be substituted by two automatic warehouses in the new solution, which will be added to one of these elements already existing in one of the warehouses. This will allow a considerable reduction of area needed to place the shelves.



Figure 3. Photography of the actual warehouse.

In this warehouse area there are also two areas devoted to the offices. One is dedicated to sell components to customers and an internal accounting office of this area, as well as another division for the commerce of light vehicles, belonging to the rest of the division. Figure 4 shows the previously described actual workshop and warehouse layout.

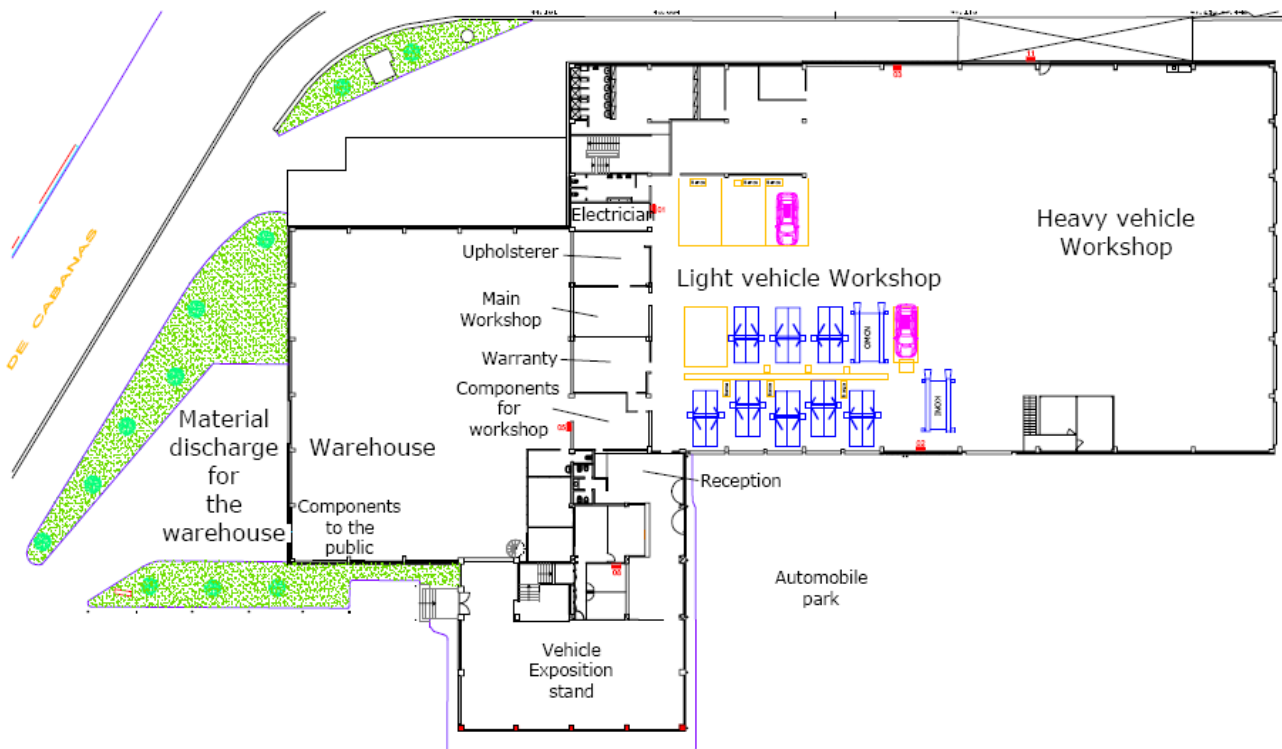


Figure 4. Actual workshop and warehouse layout.

The main limitation for the area meant for the warehouse is that to supply components to the heavy vehicle workshop, one need to cross the light vehicle maintenance area. The shelves also take up a lot of space, the same space that can be useful for a maintenance area which could increase the capacity of work posts.

### 3. DESIGN OF A NEW LAYOUT

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

Canen *et al.* (1996) discuss the role of the computer; and the contribution of facility layout to an organization's competitive advantage and describes experiences of organizations with facility layout.

Sha *et al.* (2001) presents a new approach for computing the adjacency scores, stacking of departments, and reserving or changing the department's shapes and dimensions. The system algorithms are based on calculating the minimal distance between departments and modified departmental closeness rating.

Sarker *et al.* (2006) presents a critical review of the state-of-art of evolutionary computation techniques for solving complex optimization problems which has particularly useful for many real Operations Research /Management Science (OR/MS) problems. They are more robust than traditional methods based on formal logics or mathematical programming. Evolutionary computation techniques can deal with complex optimization problems better than traditional optimization techniques.

Waghodekar *et al.* (1986) described and discussed the main features of the major existing approaches designed to solve the multi-goal layout problem. The procedures and capabilities of two heuristic approaches of the construction type are outlined in this work. MFLAP (Multi-goal Facility Layout Planning) is a construction type algorithm based on cell formation technique. MFLAPSA (Multi-goal Facility Layout Planning under the constraints on Shapes and Areas of Facilities), like MFLAP, is also a construction type heuristic based on cell formation technique but it incorporates additional constraints such as shape, location flexibility and exposure for a department.

#### 3.1. Objectives

As mentioned earlier, to do this research project, the physical separation of the workshops is the fundamental basis. Thus, solutions for this problem were studied in order not to negligent its functional aspects and security functions, as well as the accomplishment of the rules and present legislation, at a technical, environmental and hygiene level.

The following aspects were taken into account to reach the objectives of the new layout design:

- Internal flows of the functioning of the respective areas to intervene;
- Applicable legislation;
- Quantity of work orders in the maintenance workshop;
- Conception of a new layout of the maintenance workshop area for light vehicles;
- Conception of a new layout of the component warehouse;
- Design and dimensioning of facilities and necessary networks.

At this moment the reality of the automobile maintenance workshop does not vary much from Auto Sueco Minho's reality. This workshop's reality is different from most of the automobile workshops, since we are discussing a concessionary representing a common trademark for light and heavy vehicles. Facing this reality and the suction of service quality for the client, it is where the relevance of this project is focused, where the best solutions for the areas in change, seeking improving work conditions and services. It is important to mention the special focus that will be given through this project to the rigorous fulfillment of the effective policies in what concerns work safety and hygiene, as well as the applicable environmental policies.

#### 3.2. Conceptual design

The developed conceptual design had as starting point the actual automobile maintenance workshop and warehouse layout (see figure 4), which include: existing equipments, lifts, workbenches, technical trough to fluid lubricant hose fixation (oil supply and extraction), artificial light, water and compressed air, as well as the inclusion of an extraction system for exhaust gases, that don't exist in the workshop at the moment.

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).

In addition, it is also important to focus on the possibility of improving the energetic and environmental functioning aspect of these divisions, know that the operational costs of an organization have an important weight in its budget.

It was also important to do a lifting of daily service work orders of the workshop, to inquire the physical needs of external parking in the workshop, and of volume services in the workshop. Thus, it was performed the referred lifting during approximately one month. The results of this lifting are shown in the figure 5.

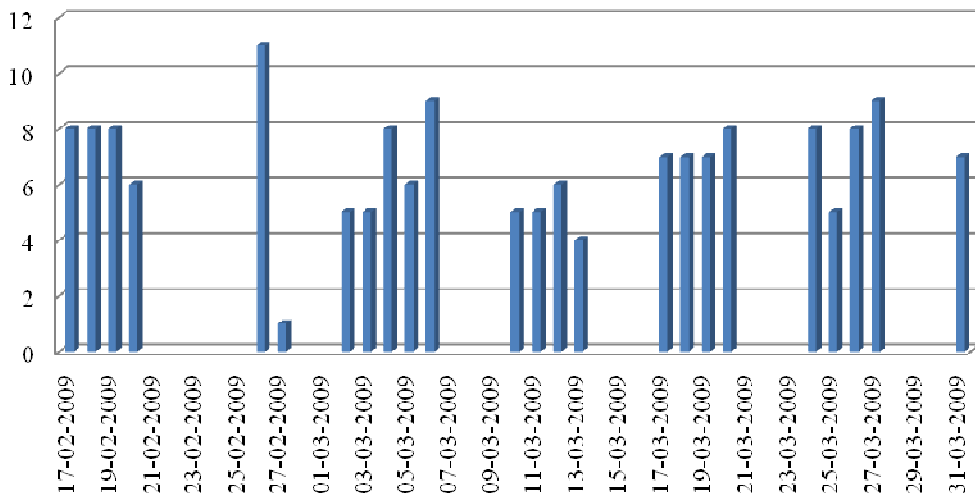


Figure 5. Service work orders for light vehicle maintenance workshop.

In the previous figure, we can observe the average quantity of work orders of the maintenance workshop, where you can see that eight work services orders are opened a day, even though it is a little different from reality, because of the economical and financial recession at the moment. Thus, it was registered a decrease of services, as well as in the other sectors.

### 3.3 Approved layout

After having many meetings and discussion with the group responsible for developing this research project, the responsible of the company, architectures and responsible elements for the layout definition, a consensual layout was found. Figure 6 shows the final solution obtained.

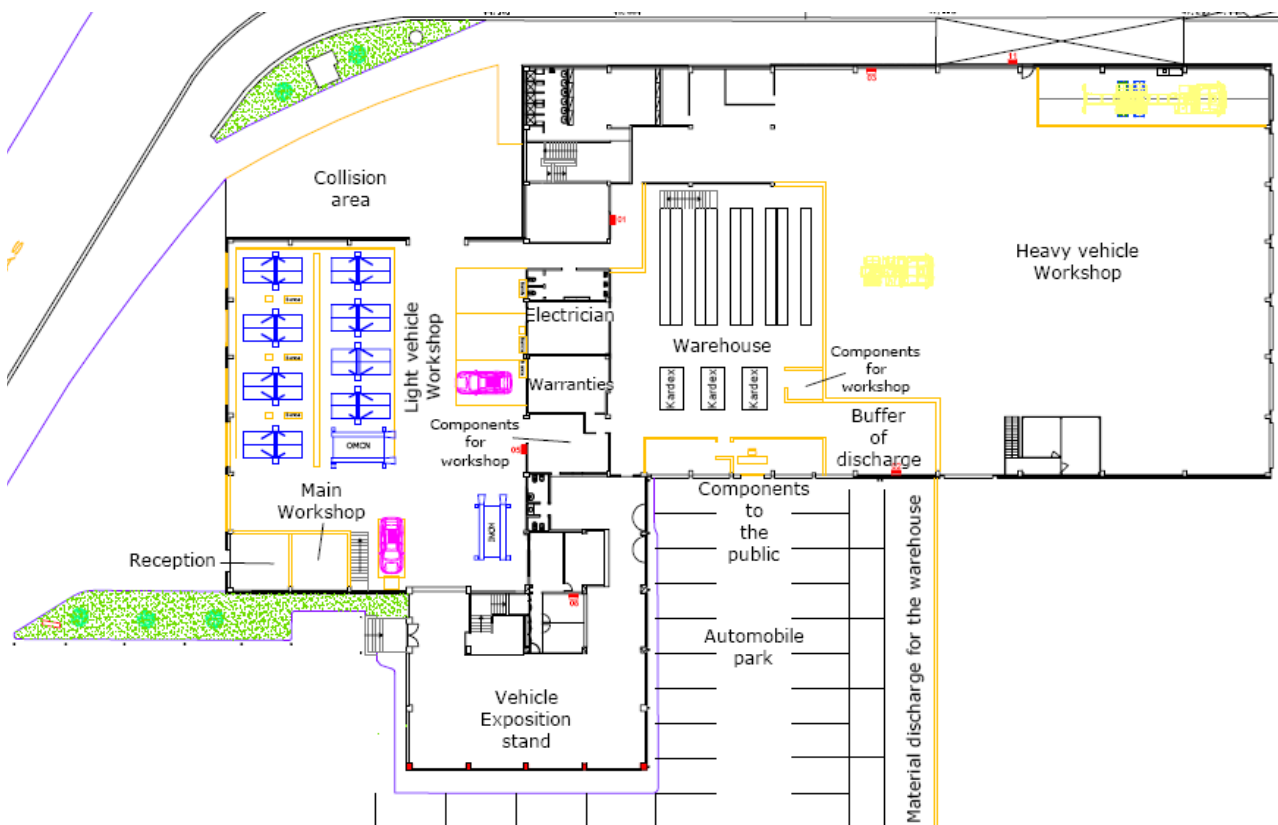


Figure 6. Final workshop and warehouse layout.

In the final layout definition of the workshop and component warehouse, it is guaranteed the 360 m<sup>2</sup> of warehouse area. The minimum demand area pre-determined by the company administration is 690 m<sup>2</sup> for the maintenance workshop that includes the maintenance area, electricity, automobile circulation between the workshop and the collision area.

In the maintenance area, all the existing equipments will be placed, elevators, technical trough for lubricant, water, light and compressed air. Furthermore, the installation of an extraction system for exhaust gases of vehicles in the inside of the workshop, this equipment will be installed for the first time, since it does not exist in the workshop.

All this positioning definition of the equipments will take in account the vehicle internal circulation aspects for the lifts and the electricity area, as well as the circulation for the collision area adjacent to the new light vehicle workshop. Providing labouring for the employees, foreseeing the reduction of displacements, reducing time, spent such for example in going to the component counter.

In the warehouse area, the shelves for heavy components will be installed. For this a platform (mezzanine) will be created to place components with larger dimensions relatively light. These shelves will have enough space between for the means of access of component elevation equipment for the different shelf levels.

It will have an office to sell components for the public and its accounting office and a specific area to put the components when they arrive, where it will be introduced the warehouse data base (buffer). It will also have predetermined areas for workbenches that provide components for the heavy and light vehicle workshop.

Some indications will also be made in the sense of improving the energetic efficiency of these areas. It will be indicated the change of the type of covering, for a type of solution that will allow a superior natural lighting, as well as a superior thermal isolation.

#### **4. CONCLUSIONS AND FUTURE WORK**

In this paper, it was presented and discusses the design of a new workshop layout for automobile maintenance and components warehouse 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 design of a new workshop and warehouse layout was performed according recent works, related with the design and improving of production facilities.

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**

- 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.
- Canen, A.G., Williamson, G.H., 1996, "Facility Layout Overview: Towards Competitive Advantage", *Journal:Facilities*, Vol. 14, No. 10-11, pp. 5 – 10.
- ISO, 2000. "ISO 9001:2000 - Quality management systems – Requirements", International Organization for Standardization.
- OMCN, 2009, <<http://www.omcn.it/en/catalogo.aspx>>, access on-line in 15 Feb. 2009.
- 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.
- STERNIL, 2009, <<http://www.stertil-koni.nl/en/products/ld4postlifts/st4040.html> >, 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.

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