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IMPROVEMENT OF PRODUCTION PROCESSES: CASE STUDY WITH DESIGN THINKING

Caíque da Silva Farias

Faculdade de Tecnologia de Itaquera Prof.
Miguel Reale, Fatec-Itaquera - Soldagem
São Paulo – SP

Walefy Thierry Oliveira Pereira

Faculdade de Tecnologia de Itaquera Prof.
Miguel Reale, Fatec-Itaquera - Soldagem
São Paulo – SP

Anna Cristina Barbosa Dias de Carvalho

Faculdade de Tecnologia de Itaquera Prof.
Miguel Reale, Fatec-Itaquera - Soldagem
São Paulo – SP

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ABSTRACT: Design thinking is a methodology or concept that shows the development of improvements with customer participation throughout the process. Improving is a market requirement for companies to become competitive. This is an important and necessary process for companies to grow and develop, but it is not a simple thing. Design thinking helps to understand the stages of the improvement process, in addition to facilitating the growth of the group participating in the project. This work aims to present a case study of a metallurgical company that had delays in its delivery processes and thus had high production costs. Through an analysis made using the design thinking methodology, it was possible to reduce costs, involve the work group and increase productivity.

KEYWORDS: Design Thinking, production, improvement.

INTRODUCTION

The industry has undergone a transformation over the years. This transformation was influenced by the global economy, which made competition much greater and with differentiated characteristics. Automation, process improvement and productivity gains began to influence company results. Thus, it is no longer possible to think of producing without method and without monitoring. This fact is a reality in medium and large companies that have investments in machinery and new technologies. Micro and small companies seek to produce in the best possible way without often understanding the importance of continuous improvement or understanding the processes themselves (Viana, 2020).

Competitiveness occurs when an analysis is made of the conditions of dispute in which companies are inserted. The Industrial

Sector has a great influence of Porter's 5 forces: The entry of new companies in the sector, pressure from substitute products, negotiating strength of buyers, negotiation with suppliers and competition.

Understanding how the forces external to the company and also the internal forces work makes the company stronger and more prepared to face the difficulties that competitiveness requires. Without constantly observing and analyzing these forces, it is possible to lose market share (Viana, 2020).

Productivity is an internal variable in companies that is part of the internal forces that need to be analyzed daily. It can be conceptualized as the efficiency of the use of inputs and the results obtained. The more you produce with the same resources, the more productive the company. Having productive companies is an important variable for competitiveness and for the company's growth. Without the analysis and understanding of the process and how it must be developed, it is difficult to grow.

The objective of this work is to present a case study in a small metallurgical company and its changes to become more productive. It was the subject of a course conclusion work on technology in mechanics: welding process developed in 2021, using *Design Thinking* as a methodology tool.

Throughout the work, basic concepts will be presented for the understanding of the company's applications, the development of the work and its results.

METHODOLOGY

The methodology used in the work was exploratory research. It is widely used for the development of works where there is a need to analyze situations that are not very explored. It consists of a bibliographic survey, interviews with people who know the area and an analysis made by the researchers (Gil, 2009).

This methodology is very interesting for this project, as there were several issues that needed to be studied, such as: the theoretical content on *Design Thinking*, the questioning and involvement of senior management, as well as the involvement of people who were part of the sector.

The work was carried out in a company that produces packaging machines. It has 40 employees, works shifts and has been in the market for 32 years. It was chosen by one of the authors to work on it and observe the need to implement improvement processes for the development of products with more competitive costs, making the company more productive.

The project development stages were guided by the *Design Thinking* methodology. As shown in figure 1, the entire *Design Thinking* process aims to bring the customer into the development and improvement process. This client can be internal or external. The methodology is developed from the moment that there is the detection of problems that could make the product or process, in this case, more productive. Then comes the need to start identifying which variables can be modified, why they are inefficient and if there is a vision of continuous improvement so that the next steps can be developed.

The Design stage arises precisely to identify the problems and raise with the top management if there is a vision for improvement. When this endorsement is given, the following steps start to involve the internal customers involved in the process.

In the research item, a bibliographic research was developed on design *thinking*, productivity, continuous improvement, 5 S, as well as a survey of the needs of the sector chosen for the prototype. The generation of ideas was developed with targeted research and meetings with the sector's working group. The best alternatives were chosen together with senior management and employees. In the meetings to prepare the changes, the factors that would help the improvement were raised and, from this stage, the implementation was carried out. The following section presents some of the concepts of *Design Thinking*.

DESIGN THINKING

The designer is the professional who can see the problem in a systemic way (aesthetic, emotional and cognitive). He is able to perceive the need for the well-being of people in their most diverse places of life such as work, home and leisure, making it easier to generate solutions for the identified

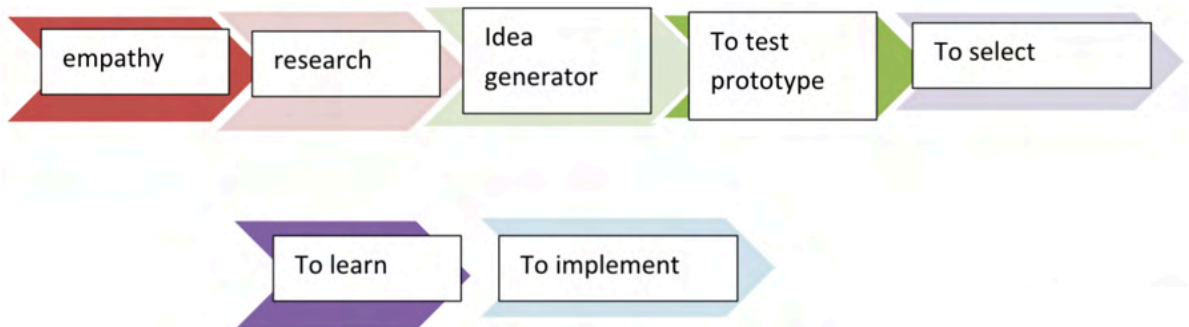


Figure 1 - Design Thinking Stages.

Source: Ambrose, 2011.

problems. The thinking of a designer is one of the important points of the *Design Thinking* (DT) methodology. That changes the look at the problem, making the analysis more multidisciplinary. Facilitating the results obtained.

Thus, it is not possible to think about a problem in a single way and from a single point of view, as people have different needs and different influences so that their quality of life will exist (Viana, 2012).

This is an approach that decentralizes the practice of design from the hands of specialized professionals, allowing its principles to be used by different professionals and thus generate varied applications and new solutions.

Design is the creation of something that enables a person to act or respond to a need that has been raised or a challenge identified. It does not happen randomly, it has a system that helps in the structuring of new products and new processes (Carvalho et al, 2018).

A good learning experience for using the DT methodology is the active participation of those interested in the result and in the improvement to be developed. Those involved can be employees, consumers, managers, customers, all those who benefit from the result of the project. It brings the needs, they are analyzed, confronted with possibilities for changes, verified the feasibility and then adjusted to reality (Bonini, 2017).

This question is interesting, because when thinking about innovation, the main concern is to create technology or to create the new. Often those who use the product are left out. This example can be verified in the use of Uber. It is a service that meets the customer's needs more easily, cheaper, more flexible, but Taxi has not ceased to exist, which has a complementary function. Another way of seeing the application of the concept is Ifood, a way to have food at home, without leaving

home. Bringing the market or the restaurant at home, which does not invalidate the existence of supermarkets and restaurants with physical stores. Much more practical, comfortable and safe (Kelly, 2014).

One of the issues raised by Design Thinking is the need to find an optimal point between the practical, the necessary and the technical, that is, what the person needs, but what is necessary for the product to exist and what is technically viable for it to be economically commercialized and produced. The examples above are a sample of what the application of DT brings (Carvalho et al, 2018).

What is viable for a business, what can generate a lot of money and can be technically developed is not always necessary or what people need. It is not possible to offer innovation in an imposing way. The need of people can generate the beginning of the search for new processes or products, but the difficulty is to technically meet a certain demand. This can also generate a possibility for innovation. This way, this list of factors must always be together so that *Design Thinking* can meet the desired goals.

From 1986 onwards, the vision of innovation became to seek technological solutions to satisfy customer needs and explore new markets, making innovation a direct consequence of *Design thinking* or methodology that seeks, in a multidisciplinary way, to understand how solve problems that are presented in existing situations and that often need transformations (Carvalho et al, 2018).

THE 5 S

The 5S is a tool developed in Japan after WWII by Ishikawa. The aim was to create a vision of quality and engagement in the workplace. But it goes beyond these objectives, because for it to be used it is necessary to understand the process, analyze what is

necessary or not, question what is done and create a sense of group.

The entire process of organizing the workplace helps the participating group to understand the importance of the production process and everything that involves resources for products to be developed productively (Silva, 2020).

The 5S is composed of five senses that starts with the organization of the place where the processes will be produced or developed and ends with the improvement of the worker's life. These are the 5 S(Silva, 2020):

- SEIRI (sense of utilization): this sense initiates the analysis process by making an analysis of what is necessary for the development of a task. In addition to an assessment of machinery, equipment and supplies to prevent unnecessary items from being underutilized or wasted due to lack of use;
- SEITON (sense of organization): after identifying what is needed, it is important that everything is in the proper place for use and that it can be found easily, such as tools, notes, guidelines, supplies, in addition to the appropriate organization of the work place;
- SEISO (sense of cleanliness): After taking out what you don't need and organizing the workplace, it's important to keep the place clean and organized. This sense helps in the group's commitment to develop something that is permanent and that needs to be continuously verified, becoming a habit in the company and wherever the individual is. In this sense, the issue of worker health and issues involving sustainability can be addressed, avoiding waste;
- SEIKETSU (sense of standardization): at this stage it is necessary to establish a work routine, with constant checks and continuous improvement. The group needs to help each other and work with

the engineering of methods to continue working productively and always improving;

- SHITSUKE (sense of discipline): this is the most difficult step, because it requires routines to be maintained and improved at all times. There are works with the group that can be done to discuss issues that arise and also to have suggestions for improvements. At this stage it is important to highlight the gains obtained and how it is possible to improve even more. The company needs to participate in the entire process.

The entire implementation process needs to be worked out so that it is not just a performance and physical change in the workplace, but involves improving the layout, the intellectual issues that involve carrying out tasks through appropriate methods and relationships in the work environment. (Campos, 2005).

The tool takes a while to deploy depending on the size and type of support the company offers. It is an interesting tool to work with *Design Thinking* because it helps in the analysis and improvement of what you want to improve or create and the participation of stakeholders becomes mandatory. This was one of the gains in the development of this work.

WORK DEVELOPMENT

The initial process of the work arose from the participation of one of the authors in the machining sector of the company, in a classroom discussion in the discipline of production management, questions arose about productivity, continuous improvement, indicators, DT and product development. The authors identified several productivity problems that could be analyzed and improved in the machine-producing company. So, conversations were started with the company's

management and management to see the feasibility of the work.

The initial step of the activities was made through some explanations, to the company's board, about what is and how the theory of *Design Thinking* is applied. The board found the proposal interesting and authorized the development of the work. Discussions were held with senior management to identify the strategic objectives that the company has established for its growth to make it clear what must be worked on.

The items identified as important for top management were: improved productivity, improved company layout, standardization of activities and greater control over production.

Faced with the need for improvement, the first stage of *design thinking* was carried out, which is empathy. At this stage, a survey was carried out with the employees and with the leadership, separately to identify the main existing problems. This activity was carried out through written research in the company's machining sector. The initial decision was to carry out a pilot work and, with the results, expand to other areas of the company.

The company manufactures machines. Its production process is by design. Thus, the development of projects must follow a schedule with inputs and processes according to the projects. Inventory control is done according to the projects and the tools used also according to the project.

In the research of the empathy map, a delay in the delivery of products was identified and, with that, a delay in the delivery of projects. One item identified with employees and managers was the lack of standardization of the tools to be used in the sectors, as well as a disorganization within these sectors. As the layout is by process, the need to identify the correct locations of the tools is important for the development of projects. It was also raised the lack of resources to make investments

in the short term and a lack of motivation of the employees due to the lack of correct orientation in the execution of the tasks.

Factory productivity was at 60%. Long delays in the delivery of products and complaints of defects by customers. Faced with the problems caused by the pandemic, the need for improvements has become a matter of survival. Employees gave suggestions to start the activities by organizing the layout of the machining area and the organization of the tools.

This stage of generating ideas was interesting because not only was it used to survey the possibility of improvements, but also fostered the group spirit and the responsibility of each one in the improvement. The choice to start the process was the use of 5S. Simple and easy tool to help organize the sector.

Training on the basic concepts of 5S was carried out with employees and the prototype application and testing stage was initiated. The main problems in the machining sector were identified and an organization was started in the area.

The changes were initiated by the first S - SEIRI - where it was identified what was unnecessary in the sector and that could be used elsewhere, those items that were not useful must be sold and the money used to buy tools or other necessary equipment.

It was identified that the non-standardization of the places where the designs of the projects were placed, caused the operations to have a loss of time of about 10% of the time, as the operators had to look for them and sometimes they could not find them.

This way, a cabinet was placed for drawings by code and by machine, preventing operators from having to waste time looking for them. This problem streamlined the production processes and avoided errors that occurred

due to the lack of use of the drawings at the correct time.

The tools used in the milling machines and lathes also did not have the right place, a cabinet with keys was separated where the tools were identified, a withdrawal sheet was created and one of the operators was defined as responsible for organizing these deliveries. Standardization was also carried out on the benches of each of the operators, avoiding unnecessary use of objects on them and always keeping them clean.

One of the problems found in the cabinets was a large amount of raw material in pieces left over from other projects. This made a waste of materials and also a disorganization in the closets. This way, a production schedule was made that avoided the use of several materials at the same time, and a schedule was established for the use of materials in all machines. This brought more agility, less waste and greater control of the materials used.

Figure 2 shows the cleaning cabinet that was done after machining before and after work.

The gain in the deburring operation was significant, about 10% of the time it was used before work. Another area of change was in the jobs that has already been mentioned and figure 3 presents an example of what was accomplished.

Another sector that underwent important changes was the welding sector. The processes were programmed by type of steel. So each day of the week was defined for a type of material, avoiding the use of different electrodes on the same day, causing waste of materials. Figure 4 shows the change made in the welding sector. The materials were divided into different cabinets, avoiding mixing and also not following the needs established by the schedule. This is a sector that is in the process of adaptation, but which

had a time improvement of about 15% in the results of product delivery.

Machines that were no longer being used were identified that were sold, thus avoiding waste of resources, as well as an increase in the work area. Thus increasing the productivity of the company. Figure 5 shows the two machines that were sold.

The times of operations performed in machining, welding and painting have been reduced. They are being studied to identify these gains. The operators themselves brought up these differences in discussions about the improvements. They realized that they were tiring less and producing more, that the work environment became more organized and easier to work with.

The work is still in the process of improvement, as a pilot was carried out and the board saw the results in the last half of 2021, so the work will be done in other sectors. the use of *Design Thinking* will continue to be applied to other improvements and to the involvement of the various areas of the company.

FINAL CONSIDERATIONS

The objective of this work was to present the use of the *Design Thinking* tool in the improvement of processes in a machine manufacturing company. This work lasted 1 year and is still in development.

There were many gains with the application of the tool, such as: reduction of defects, reduction of waste, productivity improvement, employee involvement, improvement of the work environment.

The use of *Design Thinking* in a metallurgical industry was very challenging, since there is no knowledge about it and the authors had contact with the tool in the classroom. The application had very good results for the company, saving materials, spaces and equipment. This is reflected in the



Before.



Later.

Figure 2 - Burr cleaning cabinet.

Source: Author.



Before.



Later.

Figure 3 - Milling machine workstations.

Source: Author.



Figure 4 - Cabinet of one of the types of materials in the weld.

Source: Author.



Machine 1.



Machine 2.

Figure 5 - Obsolete machines - sold.

Source: Author.

improvement of operations and in the vision of employees.

The results were achieved and are still in process, as the application of 5S is continuous. This was another interesting gain for the company, being able to use a simple and practical tool to improve its results and that of its employees. But in addition, there was a growth in training and knowledge generation. Showing that in any type of company it is

possible to make improvements as long as everyone is involved and there is a search for tools that help in this process.

There are still several works to be developed, such as: standardization of worksheets, survey of standard times, purchase of modern tools, automation of some processes and others. That they will certainly be able to use the DT tool to facilitate the change process.

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