USE OF RAPID PROTOTYPING IN PRODUCT DEVELOPMENT: A Case Study for Tool Manufacturing for Aeronautical Use

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Abstract. This article has the objective of exploratory, to present a study showing that Rapid Prototyping (PR) has become an important tool in Product Development (PDP), allowing the use of prototypes in many phases of the development process. Prototyping aids the product development process, since it enables the simulation of the product in real scale, allowing the identification of design errors. This research analyzes the relationship between the benefits of PR and PDP using the methodology of case study in an airline company. The study was conducted based on a review of the existing literature and a case of manufacturing a prototype part. With this, we intend to evaluate the influence of rapid prototyping on the issue of manufacturing time and lower development cost.

Keywords: Product Development, Rapid Prototyping.

1. INTRODUCTION

Over time, products become more complex due to market demand or the introduction of new technologies. However development must follow this evolution by reducing errors, increasing its agility in order to deliver a product to the market within the appropriate time and cost.

The use of new technologies is recognized as a relevant factor to improve the competitiveness of the company and its products. In this scenario, the Rapid Prototyping (PR) technology gains space, since it allows the construction of physical models of the products, which help the development team in the evaluation and decision making directed in several phases before the conclusion of the project (MACEDO, 2011).

The production of a prototype model, during product development allows studies on interference, functionality and aesthetic aspects, contributing to minimize errors that could arise during the production process of the final product. This is essential in the early stages of the project or in the pre-production testing and pre-production phase, because even at these stages the costs of product changes are very impacting to the development cycle.

Due to the integration with the CAD system, rapid prototyping has become an important element to speed product development, reducing the time and cost of obtaining prototypes.

The article aims to show how Rapid Prototyping technology can be used in tool development projects, so that the development time is reduced as the cost of the product is improved.
THEORETICAL REFERENCE

This exploratory research was developed from the literature survey already written on the subject, thus assuming the form of Bibliographic Research. This topic will present a review of the areas related to Rapid Prototyping within the product development process. 2.1

Product Development

According to Rozenfeld et al. (2006), product development is an increasingly critical business process due to the internationalization of markets, the increase of product diversity and the reduction of their life cycles, thus, new products seek to serve specific segments of the market, incorporating new technologies and adapting to new legal standards and restrictions.

For Machado & Toledo (2007), developing a product means that an idea can be materialized in the form of a physical good or a service to be rendered. In this way, the Product Development Process (PDP) is composed of planned, coordinated and controlled activities that aim to make the goal of creating a new product reachable. According to the authors, the development of the product begins with the perception of a market opportunity and ends with the production, sale and delivery of a product.

The Product Development Process (PDP) has become a fundamental method for companies to stay active and competitive. The changes facing the market place a new dynamic scenario for organizations and in particular for industries. Its products face competitiveness in price and quality with the like, forcing companies to constantly incorporate and develop new products and technologies, in order to reduce costs, improve quality, maintain and, if possible, expand markets (PINTO & FONTENELLE 2013).

Still for Pinto & Fontenelle (2013) the PDP is constituted by a sequence of applied activities that search through the identification of an opportunity, or necessity, to transform an idea into a product or service to be commercialized. The probability of success of the new product is conditioned to the effective construction of the process that directly implies the reduction of its costs.

Companies must make decisions in order to get the link between the objectives and the business strategy and the series of product development projects. Projects should reflect the direction and strategic intent of the company's business. Another important strategic issue is the definition of the role of top management in relation to product development projects. Generally, this occurs in the final stages of project development, when managers try to solve problems and errors when the cost of change is relatively high. However, the most influential and profitable action by top management must occur in the early stages of project development, ie in planning, when many future problems can be diagnosed in advance, and solutions delivered in advance (TAKAHASHI & TAKAHASHI, 2007).
The Product Development Process (PDP) has been much researched because of the great importance that companies have given to it, being one of the ways to become competitive in the current market where competition is increasing. In an environment of great competitiveness, internationalization of operations and rapid technological changes, companies are required to be agile, productive and high quality, which depend on the efficiency and effectiveness of the PDP. Superior performance of this process then becomes a prerequisite for ensuring technologically updated product lines with performance, cost and distribution characteristics consistent with the current level of consumer demand.

Faria et al (2008) cites that the PDP is considered complex due to its multidisciplinarity and the need for good planning. The approaches that study product development come from different, interrelated areas, but with specific foci. The most significant approaches are: quality research that emphasizes the prevention and control of errors; engineering and management, with a focus on product technology and manufacturing process, and management and strategy, respectively, among others.

According to Pinto and Fontenelle (2013), the multifunctionality of Product Development Management (GDP) refers to the need to involve several functional areas, such as market, research and development, and also to a lesser extent, but always desirable logistics and production, within corporations and large companies. For the authors, it is advisable that the practice of GDP in companies be interoperable or multifunctional in decisions and actions.

There are several methodologies for the development of products, proposed in the literature, composed of several stages or phases. The development of new products can be seen as a passage from the abstract, from the intangible, which contemplates ideas that are still subjective and not very clear, to the concrete, the tangible, the result: "physical product" (Takahashi & Takahashi, 2007). According to Rozenfeld et al. (2006), the PDP is typically divided into several phases or stages, in order to facilitate understanding and control of the process, where a phase is marked by the completion of one or a set of important project results. The PDP can be divided into five phases: concept, product planning, product engineering and testing, process engineering and pilot production.

The product development system can be understood by the input, processing and output scheme, market-driven and technology. The management of this system, called GDP, refers to the set of processes, tasks and activities of planning, organization, decision and action involved so that the considered system achieves the results of expected success. Achieving success means knowing how to integrate the various agents, external as well as partnerships, supplier and client, and internal as functional areas of marketing, sales, engineering, R & D, production, in order to work cooperatively, making the system the group and individual efforts and competences in qualitative...
and quantitative concepts, methods and techniques (PINTO & FONTENELLE, 2013).

In this sense, the various decisions of the project to carry out this transformation encompass both technical and economic market areas. The combination of development phase decisions, described below, in a progression in time decreases uncertainty, characterizing the process of product development analogous to a "funnel" (TAKAHASHI & TAKAHASHI, 2007). These phases, according to the authors, are as follows:

Phase 0 - Concept assessment: aims to evaluate product opportunities and start the product development process.

Phase 1 - Planning and specification: aims to clearly define the product, identify competitive advantages, clarify functionality and determine the feasibility of development in a more detailed degree than phase 0.

Phase 2 - Development: aims to develop the product itself, based on the decisions taken and approved of the "phase 1 review". The details of the project and development activities take place at this stage.

Phase 3 - Test and evaluation: The objective of this phase is to perform a final test and prepare the production and the launch of the product.

Phase 4 - Product Release: aims to verify that production, product launch marketing, distribution system and product support will be prepared to start activities.

In the initial stage of planning a market research is done to know the trends, from there several ideas are launched and are being tapered as the first specifications are made. The early stages are the most important in the process of developing new products. At these stages development spending is still relatively small, research has only occurred on paper, and design work consists of cheap designs and models. Products that begin with a good specification, discussed and agreed upon by all decision makers in the company, and whose early stages of development are well followed up, are three times more likely to succeed than those with vague specifications or poor initial follow-ups made. Thus, it is very important to get right in the development process (TAKAHASHI & TAKAHASHI, 2007).

According to Rozenfeld et al. (2006), many authors further expand the scope of the PDP, including early-stage strategic planning activities and production follow-up and product recall activities on the other end. For the author, the main division of PDP activities is classified into three stages that include pre-development, development and post-development, as explained below:

1) Pre-development: in this phase, also known as product planning, the product to be developed is defined, that is, the scope of the development project, economic evaluation of the project, assessments of project risk capacity, definition of indicators for project monitoring and definition of business plans.
2) Development: this phase involves a greater number of activities related to the design of a product, and can be divided into four stages. In the Informational Project the acquisition of information with the client (needs and desires) about the project in question and its subsequent interpretation is made. In the Conceptual Design phase based on the information obtained in the previous phase, the concept to be adopted by the product is proposed. It is carried out, a synthesis of the structure of functions to be performed by the product in order to meet the needs of the consumer. In the Preliminary Project phase, knowing the concept and the functional structure of the product can be dimensioned, selecting materials, forms, components, manufacturing and assembly processes, etc. At the end of this phase, the products are fully structured. In the Detailed Project, final design phase, the arrangement, shape, dimensions and tolerances of the components are finally fixed.

3) Post-development: in this phase there is initially a planning of how the product will be accompanied and withdrawn from the market. The teams and resources required for engineering changes are defined for the purpose of correcting potential failures and / or adding improvements requested by customers. It also sets goals for when the product should be withdrawn from the market. Product monitoring should be done to make continuous improvements until the targets set during the PDP are met and the product is discontinued. The product is then withdrawn from the market and all measures regarding the disposal of the material to the environment must be taken.

According to Pinto & Fontenelle (2013) it is possible to list eight critical success factors for product development management:

1) solid work on product definition and project justification;
2) deep dedication in capturing market data and customer voice throughout the project;
3) product with superior value for the customer through differentiation and special benefits;
4) precise and anticipated clear definition of the product, before the beginning of development;
5) launching the product on the well-planned market, with adequate and competently executed resources;
6) strict decision points on whether to continue or abort the project under development;
7) responsible, dedicated, supportive, and strong leadership groups;
8) cross-functional orientation in terms of work groups, market research and global products.

At present, the project activity is closely related to the technological innovation strategy drawn in each organization, and is considered as a factor of good corporate performance. Companies link their success in the marketplace with the way they design their products and their ability to organize themselves to serve consumers by processing and learning by analyzing the
development cycle of their products. The companies' concern with their development and project management models has been increasing, as well as the evaluation of the level of maturity in which these management models meet (MACEDO, 2011).

The projects are characterized precisely by the lack of routine, that is, by the presence of the unexpected. One of the reasons for the presence of uncertainty comes from the fact that the projects are progressively elaborated, that is, in their initial phases there are no detailed specifications at the required level, and as the project is developed incremental information is added. Normally, the choices of alternatives that occur at the beginning of the development cycle account for approximately 85% of the costs of the final product. That is, it is at precisely the moment of greater uncertainty about the product and its specifications that most decisions are made (VOLPATO, 2007).

According to Volpato (2007), it should also be considered that the risk of adjustments in the project should be mitigated in the following phases, since the cost of modifications increases throughout the product design cycle. These are the initial stages of project development that allow project expenditures to be minimized.

According to Kaminski (2004), within the process of developing a product there are two distinct moments, that of design and development and that of design. This means that when developing a product it is necessary to define the applications, users, processes and specifications that this product will have in other words to establish the concept for this product. This characterizes the design. What characterizes the term project is that part of the process in which, with the developed concept, it is necessary to construct this product within the pre-established period.

The globalization of the economy has created in all industrial sectors an increasing need for rapid response to market demands. This type of response translates into a drastic reduction in the time to market of new products being a critical factor for the competitiveness and commercial aggressiveness of the companies, thus determining their survival capacity (COSTA ET AL, 2013).

According to Sant'Anna (2015) the integration and speed between the various stages of product development are undoubtedly key elements in the competitiveness between companies. Thus, the rapid transition from product to production is an increase in competitiveness that CAD / CAM (Computer Aided Design / Manufacture) prototyping offers companies as a key determinant for successful new product development.

Still according to Sant'Anna the industries use some strategies that reduce the time of development of products:

1) listening to the consumer's voice to understand their needs early in the development
cycle;

2) investing in technical training for rapid learning and translating the needs of consumers into new product development;

3) developing groups that interact interdisciplinarily for concurrent engineering;

4) promoting continuous learning through rapid product modifications and product line extensions.

According to Costa et al. (2013) the production of models, prototypes or test bodies is a fundamental tool for the designer to evaluate the project, in addition to allowing the client and the user to do the same. Prototypes have been produced by means of manual modeling techniques, maquette or even carpentry of molds and sculpture it all long before rapid prototyping technologies. Rapid Prototyping (PR) technology has become an important tool to support the PDP by providing shorter development cycles, time, products with better quality and reliability, and minimization of waste. This type of technology allows the manufacturing of parts directly from the 3D model of the CAD system with different materials and in a shorter time, without the need of any tool. For this reason, it excludes traditional design constraints, such as design for manufacturing, where the part must be designed for specific manufacturing processes, such as milling, forging, molding, etc.

2.2 Rapid Prototyping

According to Kaminski (2004), although design and design are similar terms, it is fundamental to clarify where rapid prototyping goes into the process of product development or product set.

Rapid prototyping is a manufacturing process based on the addition of flatbed material that emerged in the late 1980s, due to the industry's growing need to reduce costs in the product development process - "faster is better." The recognition that a large part of the high manufacturing costs is concentrated in the development phase is at the origin of the concept of concurrent engineering or simultaneous engineering. At first, the intention is to integrate design and processing in the product development phase, but in broader terms this involvement should be extended to market analysis and the marketing sector (RAULINO, 2011).

According to Junior (2015) rapid prototyping is an interactive process involving manufacturing and the evolution of rapid prototypes, characterized by different design teams cooperating with each other in parallel. In practice, the rapid prototyping process is a reflection of a competition for the best solution in a group of alternative solutions.

According to Fonseca (2004), rapid prototyping (PR) consists of several technologies that allow to produce three-dimensional models and prototypes from drawings generated in CAD-3D programs or objects scanned with three-dimensional scanners. Unlike the traditional processes,
made up of craft techniques and/or employing common machines working with material removal processes from raw material blocks (electro-erosion, milling, turning, etc.), the rapid prototyping process uses liquids (polypropylene, ABS, resins, waxes, paper, polyester, ceramics and metals), to form pieces, layer after layer, in a supervised process by computer.

The high speed and variety of information technology applications enabled the emergence and deployment of CAD/CAM/CAE systems. In this scenario Rapid Prototyping emerged as one of these systems, available in different technologies (VOLPATO, 2007).

Also according to Volpato (2007) rapid prototyping refers to a class of technologies that can automatically build physical models from a model generated in a CAD system. With these technologies it is possible to perform repetitive tests, such as constructing a prototype, testing, redesigning, constructing, and testing again. It can be defined as a manufacturing process that uses the addition of the material used in the form of successive flat layers, that is, it has its production process based on layered manufacture.

According to Joaquim et al. (2004), rapid prototyping (PR) consists of several technologies that allow the production of three-dimensional models and prototypes from drawings generated in CAD-3D programs or objects scanned with three-dimensional scanners. Unlike the traditional processes, made up of craft techniques and/or employing common machines working with material removal processes from raw material blocks (electro-erosion, milling, turning, etc.), the rapid prototyping process uses liquids (polypropylene, ABS, resins, waxes, paper, polyester, ceramics and metals), to form pieces, layer after layer, in a supervised process by computer.

According to Gorni (2001), the term fast prototyping designates a set of technologies used to manufacture physical objects directly from data sources generated by computer-aided design systems. Joaquim et al. (2004) argue that the introduction of CAD/CAM technology offers above all the possibility of producing models and prototypes directly from computerized data, consequently this technology is present in new types of production processes known as "rapid prototyping" (rapid prototyping), "desktop manufacturing", "solid freeform manufacturing", layered manufacturing, etc.

Increasingly, the term Rapid Prototyping has become more usual and correct for all types of rapid prototyping, independently of the process of adding or removing material, or independently of the use of hardware and software technologies (DVORAK, 2004).

According to Junior (2008), the prototypes provide designers and engineers with a quick piece to see, fit, test functions and realize the possibility of producing this product. One of the great contributions that rapid prototyping brings to the development of products is precisely the construction of prototypes that are often not possible to be done serially. This increases the level of perception of the project team of what is possible or not to produce and analyze and reduce the
complexity of the product in order to enable its production. Joaquim et al. (2004) contribute by saying that through the use of three-dimensional models (prototypes), the user (internal or external customer) is given the opportunity to express their competence and practical understanding and to evaluate with the project team the restrictions and technical possibilities at play in the project. According to Joaquim et al. (2004) and Costa et al (2013) highlight the impressive advantages of employing rapid prototyping technologies: a eficiência e rapidez na realização da interface entre os desenhos elaborados em sistemas CAD/CAM e a rápida obtenção de modelos físicos em 3 dimensões que, dependendo do material empregado e da sua aplicação, podem até ser submetidos a testes funcionais;

1) the evaluation of the design (functional model) and subsequent on-site modifications that are necessary, in an exceptional way reducing the time between the idealization of a product and its consequent launch in the market;
2) improvement of quality and productivity and reduction of production costs, in a matter of hours a process that could take weeks if carried out by traditional methods;
3) the possibility of elaboration of prototype tooling and durable molds for the production of medium parts lots;
4) the possibility of carrying out research and development, with deadlines and low costs, to maintain and / or improve the competitiveness of products;
5) great flexibility and agility for modifications in the creation, development and / or manufacturing phases of products (Simultaneous Engineering);
6) ease of reproduction of single parts for which there are no detailed drawings or molds, usually for maintenance or development of new products from existing products (Reverse Engineering).

2.2.1 Rapid prototyping by adding material

All rapid prototyping equipment must be able to construct rapid prototypes via the addition of layered material and also all equipment has the ability to construct complex geometries without the aid of other tools. The term rapid prototyping is a relative term, since the construction time may vary according to the complexity and size of the prototype, depending also on the model and speed of the equipment (Gorni, 2001).

According to Volpato (2007) the construction shares the same technical steps: o The computer analyzes a solid modeled in a 3D environment and defines the fabrication of this object through layers. These layers are then systematically recreated and combined to form an object.

According to Busato (2004), the stages of the rapid prototyping process follow:
1) Modeling in the CAD system to obtain the 3D model
2) Conversion of the CAD model to the language format used by fast prototyping machines
3) Conversion Verification
4) Creating the media
5) Construction orientation
6) Suction and preparation for construction
7) Construction
8) Post-processing: removal of substrates and excess resin, post-cure and surface finish

According to Volpato (2007) rapid prototyping can be classified according to the state or the initial form of the raw material used in manufacturing. Thus, PR technologies can be classified into processes based on liquid, solid and powder. Also according to Volpato (2007) we have the following classification:

1) Based on Liquids: In this category, we find Stereolithography, which is characterized by the polymerization of a liquid resin by an Ultra-Violet laser; and Inkjet Printing, in which liquid resin blasting occurs through an inkjet printhead and subsequent curing by exposure to Ultra-Violet light; among others.

2) Solid Based: In this process the material may be in the form of filament or blade. Some of these processes fuse the material prior to its deposition, such as FDM - Casting, while others only cut a sheet of the added material, as in the case of Laminar Manufacture.

3) Powder Based: Laser can be used for its processing as in the case of Selective Laser Sintering, or an agglutinette applied by an inkjet printhead, used in Three Dimensional Printing.

2.2.1.1 Stereolithography

The prototype is constructed by photopolymerization of a liquid epoxy resin using an ultraviolet laser beam. Because the resin is liquid and relatively non-viscous, the complexity of the models can be extremely high. Since the surrounding environment is liquid, all areas of the swing pieces require solid resin supports. After being removed from the machine, the model undergoes a post-cure which will give it maximum strength. Finally the models can be subjected to sanding / polishing operations, or even painting, thus improving their appearance and functionality (LINO & NETO, 2015).

As can be seen in the scheme of Figure 3, the photocurable resin is inserted into a container containing a layered platform that moves downwardly to each layer constructed. The platform is initially covered by a thin layer of resin (approximately 0.15 mm). The equipment already has information about the geometry of the first layer, so the laser beam is moved by means of an optical assembly that reproduces the 2D geometry obtained in the slicing of the part represented in the CAD system. When the resin is exposed to the laser, it polymerizes by changing from the liquid
state to the solid thereby forming a layer. The process is repeated until all the layers of the object have been formed (MACEDO, 2011).

The machine contains a bowl filled with resin, inside which there is a platform that moves vertically. A computer transmits to the platform the first layer of the virtual model to be polymerized, and then the numerical control of the machine positions the platform on the surface of the resin and the mirrors direct the laser beam to the portion corresponding to the first slice. A localized reaction is triggered which promotes the formation of a polymer chain between the monomer molecules dispersed in the resin, with solidification occurring (RAULINO, 2011).

2.2.1.2 Fusion and deposition modeling (FDM)

Modeling by melting and deposition of molten material is the second most used process for the construction of fast prototypes and, unlike Stereolithography does not use laser during the process. The prototypes are manufactured by extrusion and controlled deposition of thermoplastic filaments. ABS (Acrylonitrile Butadiene Styrene), which is a rigid and light thermoplastic material (MACEDO, 2011), is used as the main material for the production of prototypes.

The feedstock is melted and applied by means of an extrusion head on the building platform which remains at low temperature. The extrusion head runs through the profile formed by the slicing of the 3D model, giving rise to the first layer. After this each, the height of the machine platform is adjusted and the process restarts, resuming the manufacturing cycle. Figure 4 shows an operating scheme of the machine. This system can operate with various plastic materials such as ABS, elastomers, nylon among others (PIZZOLITO, 2004).

According to Macedo (2011) several materials are available for the development of this process. ABS offers good resistance and is the material most used by this technology, however, materials such as polycarbonate and polyphenylsulfone present better resistance to temperature and are being inserted in this process.

According to Macedo (2011) the FDM technology does not require post-curing processes of the materials and can be used in quiet environments, since there is no noise during the prototyping process. It is still necessary to improve the accuracy of the process, which is not too high and the speed of the process, which is limited by the flow rate of the material in the extrusion head by a spout.

With these machines there is no waste of material and little need for cleaning, as opposed to stereolithography. Another notable difference is the occupancy of a much smaller space, since the drive motors require less power and cooling than the lasers. These characteristics allow their installation in non-industrial environments (RAULINO, 2011).

Unlike traditional manufacturing processes, which depend on the mold forming steps, the
new manufacturing process configures the product directly from a three-dimensional image file. Removal of the equipment, the part is ready to go to the oven (MACEDO, 2011).

3 METHODOLOGY

This research has a qualitative approach with an exploratory objective involving a survey of literature already written on the subject and a case study.

The problem formulated for this research is: the development of products with the speed, cost and quality required for manufacturing tooling.

The purpose of this work is to study, analyze and evaluate the contribution and advantages that Rapid Prototyping offers to the manufacturing cycle of a new tooling.

This article will involve the study for analysis and verification of the production of a tooling by means of rapid prototyping to be used in the maintenance of aircraft. The experiment will use a set of pieces for the collection of oil or fuel residues and prototype fabrication using two types of Rapid Prototyping, Stereolithography and FDM, studied in this work as well as traditional method of manufacturing. This set of pieces is formed by a rectangular bowl and a funnel. By means of realization of estimate of price and time of delivery without the manufacture of any piece at this moment. With this, we intend to establish parameters of comparison between time and cost of manufacture of all the pieces to be produced.

To achieve this, four suppliers were asked for an estimate of the price and delivery time for the supply of 10 sets of pieces, including 5 rectangular bowls and 5 funnels, but not yet made of any part. Table 1 shows the cost and delivery time of each supplier:

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Process</th>
<th>Cost (R$)</th>
<th>Term (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Traditional using stainless steel</td>
<td>3,500,00</td>
<td>90</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>2,900,00</td>
<td>90</td>
</tr>
<tr>
<td>C</td>
<td>PR Stereolithography using photosensitive resin</td>
<td>1300,00</td>
<td>10</td>
</tr>
<tr>
<td>D</td>
<td>PR FDM using ABS (Acrylonitrile Butadiene Styrene)</td>
<td>800,00</td>
<td>15</td>
</tr>
</tbody>
</table>
4 RESULTS AND DISCUSSION
To choose the supplier some criteria should be used as a decision factor. In this work the decision factors are time and cost, in this sense we have chosen the suppliers C and D. However considering only the same criteria in the identification of the best PR process would not be possible to identify the best process, since Supplier C was more fast while Supplier D was the cheapest. It would be necessary to insert a third decision criterion, such as quality.
The cost of the part produced by Supplier C was approximately 38% higher than the cost of the part manufactured by Supplier D. On the other hand, as observed in Table 1, the cost and the shorter manufacturing time of the parts are inversely proportional because the technology if presented more expensive is also the fastest.
Once again it is evidenced that only by these two criteria, cost and time of manufacture, it is not possible to determine the best supplier. The quality item could be the determining factor in the choice of supplier so some items could be evidenced by this criterion: external and internal finishing, final appearance and strength, dimensions and geometry.
Both rapid prototyping technologies were suitable for the manufacture of prototype parts since it is possible to build with cost and time inferior to the traditional methods.

CONCLUSION
The study sought to show how rapid prototyping technology can streamline product development projects and, through the case study, sought to show the best technology to be used in prototype fabrication, thus reducing the time and cost of the prototype cycle. product development.
Considering the case study comparisons were made between two technologies of Rapid Prototyping, Stereolithography and FDM, and with the traditional method of manufacturing seeking to establish what would be the best technology used in the design for manufacturing of prototype parts considering lower cost and manufacturing time. However, in this research it was evident that it is necessary to gather information and define the objectives of the construction of the prototype in order to establish the process to be used.
It is concluded that both technologies presented differences in the cost and time of manufacture of the prototypes. When time is a decision factor in the choice of prototyping technology to be used, then the technology to be chosen is stereolithography, but when the cost becomes the decision factor the FDM technology proves to be more appropriate. As for the quality of the prototypes, it was not possible to say which technology would be the most appropriate.
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