FROM INVANTION TO INOVATTION: PATENT CASE IN A BRAZILIAN UNIVERSITY

Felipe Celso Linhares Ferreira, felipe.linhares.ferreira@gmail.com [1]
Eduardo Romeiro Filho, romeiro@dep.ufmg.br [1]
Antônio Eustáquio de Melo Pertence, pertence@demec.ufmg.com [1]

[1] Federal University of Minas Gerais, Av. Antônio Carlos, 6627 – Campus Universitário, CEP 31270.901, Belo Horizonte, Minas Gerais, Brazil

Abstract. *Innovation is been considered as essential to the technological and economic growth and for a new level of sustainable development in Brazil. The knowledge generation is the fundamental gap at the universities to support innovation processes through scientific inventions and new research. However, we perceive a gap between knowledge generation and innovation, particularly in Brazil. The world production of scientific papers has been growing since the end of last century, but the proportional growth rates that demonstrate innovation, such as the registration of patents, are being disregarded. This article presents a technology development case from a research focused on the design of a product, from its conception as part of an engineering undergraduate work until their preparation for technology transfer from the University. The aim of this article is to demonstrate through this case how the knowledge generated can be transformed into technology and prepared for implementation aimed at solving real problems. We present the main stages of the product development, from its conception to the engineering solution, as well as the market research and patents for the development of technical solution, going to the description of the preparation process to go to the market, through the structure of technology transfer of the University. The result shows the methodology of an innovation development since its inception until the implementation of the patent on the market.*

Key words: *Innovation, product design, mechanical design , technology transfer, patent.*

1. INTRODUCTION

This article describes the process of developing a fastening equipment for climbing use, with industrial potential use. The article main objective, however, is to demonstrate how an idea emerged in the academic environment can become a product with potential commercial application, that is, an innovation. The innovation aspect is important, especially considering the need for technical generation solutions by the University focused on solving society problems. It is well known that Brazil, although it has significantly increased its scientific production in recent years, still has a long way to go in terms of patent registration and the introduction of innovations in the market (Nunes et al., 2013).

The equipment idea arose from a desire observed by some climbers, in view of the difficulty to climbing up vertical and negative walls that have little or no grabs to hold, thus requiring better equipment that gives them greater agility, safety and economy. These climbers need to drill the rock and install parabolt bolts with varying thicknesses, which are installed in place without the removal possibility, increasing climbing costs and leaving human industrial material where there was nothing before. In addition, installing the parabolts, you need other tools like the hammer and bushings. For this installation and assembly, the climber needs to use both hands, which obviously has become very complicated, since his greatest need is to hold on to the rock to prevent his fall.

Similarly, in the industrial environment there are several difficulties for the union between parts and equipment, as well as the transportation and movement of loads inside and outside a factory. This device can be used for fixing between any part or equipment for lifting, moving and fixing, requiring only a guide hole (often already existing in the parts). Solutions such as usual bolts and lifting bolt screws are currently used, which require threaded holes and tools for fastening in the case of bolts.

The equipment developed requires only one hole to realize its fixation. Its installation can be done with only one hand and does not require any other type of tool, so that its expansion takes place inside the hole. Soon after its use, it can be uninstalled as easily as your installation. No type of human residue lags behind in the environment, and the equipment can be used again, several other times.

1.1. Inovation

For Schumpeter (1976) innovation can be considered the economic development engine, because it is a process of 'creative destruction', in which there is a constant movement for the creation of something new that simultaneously destroys old references and establishes new ones, as a way of searching new sources of profitability. The OECD (2017) presents different types of innovation, such as Technological Innovation (new products and processes), Product (selling

a technologically transformed product) and Process (substantial change in production technology). For Tidd et al (2008), innovation is a process that transforms opportunity into new ideas and puts them into practice. Today, innovation is widely recognized as a source of competitive advantage in an ever-changing organizational environment (Thomas and D'Aveni, 2009). Although there are several definitions and concepts aimed at innovation, it can be seen that the basis of the innovation idea is related to change, economic development and the search for solutions for the market and society.

Despite its obvious importance, the innovation processes can't be defined or methodologically structured. As Garud et al (2011) argue, innovation is usually a nonlinear process, with ups and downs, prone to misjudgments that eventually lead to dead ends. In short, a very complex and difficult management process.

On the other hand, technological innovation refers to a new (or substantially improved) product and / or process for the company, not necessarily new to the market / industry and may have been developed by the company or another company / Institution (PINTEC, IBGE, 2015). In this case, many of the knowledge applied to a particular innovation in a specific sector can be leveraged in a new situation, increasing the chances of innovation success.

1.2. The project as a way of innovation supporting

If the innovation process is admittedly non-linear, product and process development itself can both be structured in a way that meets certain principles and objectives and meets specific metrics. As an example, in the Industrial Design area, the structuring of these principles can be grouped in what some authors call "briefing" (Philips, 2008), while in Engineering areas, specifications are generated from which the product must be planned and developed, In order to meet the observed needs. The main question is how the project is inserted in the innovation process, since engineering, geared to the generation of solutions to technical problems, is by nature prone to inventive activity, especially in what Pahl et al (2003) call "projects new".

In order to evaluate this aspect and to define the better methodological process to the product development, three methods available in the literature were analyzed. The applied method represents the interpretation result and evaluation of the literature, absorbing the characteristics considered more adequate of each author's proposals. The first source was (Romeiro et al, 2011), which proposes that the project development is not only a method that enhances the creative activity of the designers in the search for the best results, but also addresses aspects related to the project life cycle as a whole. The methodological proposal for product development starts with the formulation and analysis of the problem, followed by its synthesis, generation and evaluation of ideas, selection of the most appropriate option and execution of the same.

Baxter (1998) presents the process of developing a new product the way it is done in contemporary companies, covering all aspects of development for series production, relating more to industrial design and engineering. It has as its central theme the management and control of the product development process and seeks to demonstrate that the application of systematic methods is rewarding.

In the same vein, Medeiros (1981) proposes a methodology with a degree of extension that ranges from the stage of problem identification, addressing the definition of the need or the problem formulation, passing through the stages of analysis, requirements definition and development. The product design is treated, including the final solution detailing, testing with prototypes and the design review. This methodology consists of four main stages, the sequence of which may vary according to each project developed. These stages are the identification, analysis, definition of requirements and, finally, the development stage, all of which can be subdivided into a series of sub-stages, according to the product. For the applied method presentation, the flow chart presented by Barroso (1982) was used to demonstrate the interdisciplinary development of the industrial products project.

2. METHODOLOGICAL PROCEDURES

Three methodological procedures used by researchers and applied in the market were analyzed in the subject. Through the interpretation and evaluation of the three options, a methodological process was applied to the product presented here, absorbing the best directions of each author.

Romeiro Filho et al. (2011) have as one of the objectives in their methodology to provide students with a stimulus in the sense that project development is not only a method that enhances their creative activities, but also provides a Related to the introduction of computerized systems in this project activity. Its methodological proposal for product development begins with the problem formulation stage, followed by its analysis, its synthesis, generation of ideas, evaluation, selection of the best option and execution of the same. These stages are indicated for the development of products of medium complexity and with the company's control over the technology used.

Baxter (1998), presents in his book the process of developing a new product, in the mold that is made in modern companies, covering all aspects of the development for the mass production, relating more with the industrial design and the engineering. It has as its central theme the management and control of the product development process and argues that the application of systematic methods is rewarding.

We conclude the analysis of the researchers with Medeiros (1981) who in his dissertation proposes a methodology that ranges from the identification stage, which addresses the desire definition or the problem formulation. Passing through the analysis stages, requirements definition and development, in which the product design is treated, including

the final solution detailing, testing with prototypes, and project review. This proposal consists of four (4) main steps, the sequence of which can vary according to each chosen project model. These stages are the identification, analysis, definition of requirements and, finally, the development stage, all of which can be subdivided into a series of sub-stages, according to the product.

Figure 1 shows the methodological procedure developed and applied in the product mentioned herein

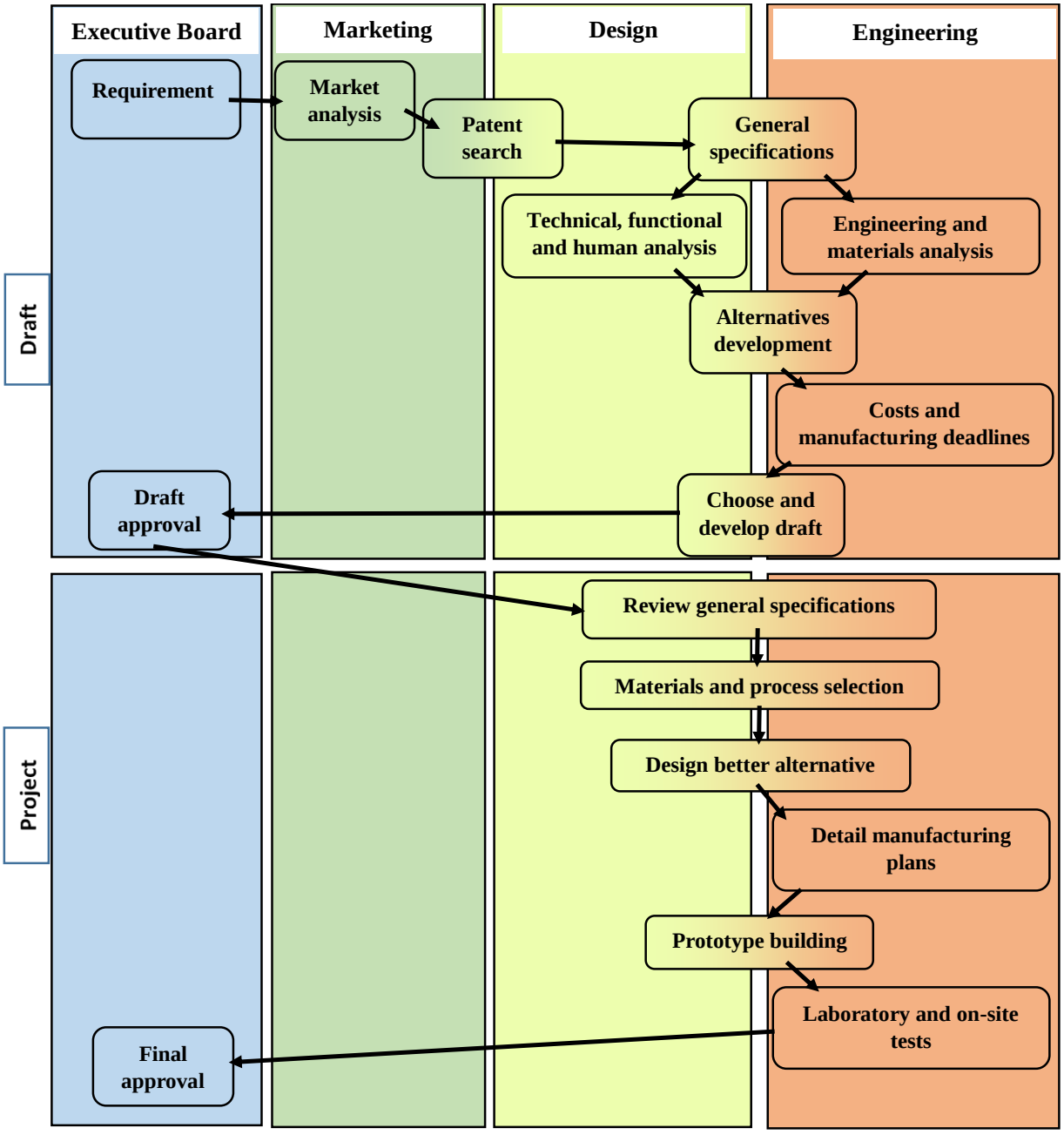

Figure 1. Methodological procedure developed and applied by the product authors.

3. PRODUCT DEVELOPMENT

3.1. Project objetives

Rock climbing, one of many adventure sports, rapidly develops in the Brazil, with a growing practitioners public (Niclevicz, 1994, 1995). Their equipment, almost in its entirety, are imported. With the high dollar's appreciation against

Brazilian current (Real), these equipment purchases are extremely unfavorable for practitioners from developing or underdeveloped countries, which causes demand limitations and practice of the sport.

Some Brazilian companies have started production of basic equipment, such as clothing, boots, special sneakers, carabiners and sttopers. However, there is a lack of equipment for artificial climbing, and there is a demand for these equipment, which are imported and expensive, compared to the average purchasing power of the Brazilian climbing public. Also existing equipment, besides being expensive, can't be used in rocks with a smooth surface, with vertical and negative slopes, thus generating a global gap in relation to this activity.

Due to these facts, the objective is the development and design of an artificial climbing equipment, with materials and technologies totally national, cheaper and of better fixation in the rock in relation to its imported similar ones.

3.2. Especifications

The specifications are intended to show what should be the betters characteristics for the product developed here. With this data, it is possible to orient to what sense the project progress should be prioritized, thus generating what is called a briefing.

For a new product development, it is important to consider the characteristics, desirers, priorities and other requirements requested, observed or required by the client or designer, for a particular project to be carried out. The characteristics of the new product were chosen and decided through a market research result, with twenty individuals who already use similar products regularly. This work will be based on the wishes and needs of the public interviewed, who is the target audience for this equipment.

The best detail of these characteristics is presented in the market research item.

3.3. State of the art

Considering its technical characteristics this equipment should be used to resist the forces of traction, flexion and the combination of both. Its critical part, the axis, must play the leading role of resistance against these forces. As there is no other similar product for reference or comparison, a main characteristic or demand for its development has been chosen, which should be solved by this new equipment. This primary demand is that the equipment should attach and loosen to a 10 mm hole using only one hand.

The outer cylinders (Fig. 2) aim to adhere to the rock bore so that it will generate a frictional force contrary to the tensile forces that will act on them. Due to this need, 0.3 mm deep traces were made on its surfaces to increase its adherence in the rock. So any, surface irregularity of the hole will be embedded in the edges of these traces, obtaining, therefore, the resistance against the rupture of this point of the rock, thus avoiding the realization of the undesirable pulling of the part when it is expanded and being handled by the user.

Functionally, this equipment aims to fix the user to the rock by means of expansion of its parts, in a hole previously made with the dimensions of ∅10 mm x 30 mm. Its operation consists of its placement in the rock bore by the climber using only one of its hands and then the expansion of its cylinders is performed through the 180 ° turn of its lever.

This lever has on its axis, a cams, with a lift of 1 mm (Fig. 2). This cam is connected to the main shaft through a bore which moves when the lever is rotated and the cams are pressed against it. In this way, the threaded cylinder, located at the end of the shaft, is moved along with it, since the two are threaded engaged. This movement of the outer cylinder compresses the central cylinder against the cylinder of the base of the equipment, such that this inner cylinder moves to the side, sliding through the chamfers between them, thus generating an expansion against the wall, thereby creating the Friction required to fix the apparatus to the rock.

3.3.1. Market research

A survey was conducted with the public that usually uses climbing equipment to identify the main characteristics that an equipment should have, and with that, to reach the expectation and the needs of these people. The questionnaire was applied to 20 different randomly selected people and aimed to compare the existing similar equipment to identify characteristics such as weight, practicality, necessity, safety, fixation and cost of a new equipment. A comparison was made between the characteristics of competitors already existing in the market and the expectation for the new equipment. The results are described in this work.

The ideal weight would be close to the weight of products already on the market, known as Cliff and Nut, because they received the highest marks of the questionnaire in this question. Comparing the weights of this item, the maximum weight of 125 grams for the new product was obtained.

As for the practicality, we observed that the ideal practicality would be close to the products called Camalot and Hexentric, with the respective highest notes. Through the research we observe that this practicality is given, due to its rapid placement in the rock, mobility of simple use of the equipment with only one hand.

The product desire is also a predominant feature in Camalot and Hexentric equipment. Through the research it is observed that this characteristic is due to its versatility to be installed in the various deformities in the rocks, such as

cracks and holes. However, these devices have a variety of sizes to fit each deformity individually and due to this variety, they must always be transported together, thus generating a lot of weight. The new product should be installed in a rock bore by the climber and therefore there is a need to use only one or two of this equipment, making it simple and extremely lightweight compared to the sum of individual weights of others, Making it much more comfortable and practical, thus increasing its need. It should be remembered that the equipment to make the hole does not constitute a sum of weight, since it is always taken by the climber, independently of the equipment that he uses in the artificial climbing.

Regarding safety, the best result was achieved by Camalot and Nut, as they received the highest marks of the questionnaire in this regard. Through the research it can be observed that climbing safety is due to its good fixation in the various deformities in the rocks, such as cracks and holes, that is, those that are better fixed in the rock promote a greater tranquility to the climber, to his Development. The equipment developed here should not be released from the rock until requested by the user, thus ensuring its safety and psychological tranquility while performing its tasks in climbing. This result was also repeated in the fixation of the rock, showing that both results are directly connected to one another.

Finally, we have the cost question, which through the questionnaire data, it was defined that the ideal cost would be close to the cost of Clif and Nut, which respectively have the values of US$ 45.00 and R $ 30.00. These costs are being represented in american dollars, however, since they are imported parts, it should be noted that their cost in the Brazilian domestic market is directly related to the exchange rate of the Dollar over the Brazilian change. The ideal market cost for the new product was estimated at up to US$ 45.00.

3.3.2. Patente research

This method developed step for this product has the objective of conducting a search for trademarks and patents on the NIIP (National Institute of Industrial Property) brazilian website in order to find existing products. These products may be the same or similar to the product developed in this project and Also the analysis of existing equipment in catalogs of companies producing equipment for artificial climbing.

In this way, we can analyze if the product developed here has already been created, that is, it has no place in the market, or if it has similar ones that will be competitors in the market.

When we find similar products we can analyze them and obtain data for the improvement of the product to be developed here, and also, what are the unnecessary characteristics that may be developing.

The analysis performed on the NIIP website was generated through keyword search. These words are directly related to the product developed here, so that, in general, they constitute characteristics, areas of operation and use of the equipment. The words used were; Climbing, mountaineering, artificial, rock, stone, protection, equipment, fixing, fixer, hole, penetration, fall and fit.

These words were inserted separately and together to find and verify products with unique or mixed characteristics, however the word climbing has always been inserted as a filter element in the search. The results presented in Table 1, were found below.

Table 1. Results for the NIIP website search of the new product keywords.

Request number	Request Title
PI9904031	Anchor point for climbing
PI9903997	Support step for climbing on poles
PI9806332	Device to aid in the escalation of structures of electric power transmission lines
PI9804229	Portable step for climbing on trees and wooden or concrete poles.
PI9500969	Modular unit for the formation of artificial climbing structures
MU8003043	Texture for artificial grapples for indoor climbing
MU7903011	Step for climbing structures
MU7902062	Portable step for climbing on poles and structures

With the analysis of the results, similarities were found, only for the first item "Fixed point of anchorage for climbing", because it is a fixation product. However, it can't be considered a similar product according to the definition presented previously, since it makes an anchorage of fixed and permanent form, contrary to the pretension of the presented product, movable fastener.

3.4. Solution chosen

After the ideas development and graphic options development for six months of work, 370 hours in ANSYS® simulation software was performed, which, according to Alves Filho (2002) allows the realization of multiphysical simulations using the finite element method. Four options of new products were obtained and among those options only

the one with the best characteristics to satisfy the market research carried out previously presented in this work was chosen.

Regardless of the aesthetic beauty, cost, weight and other relevant characteristics in each of the generations of alternatives, we have chosen the alternative that has the best balance between these individual characteristics. Thus, the item presented in Figure 2 demonstrates a set containing the largest quantity of values in a single product, making it the most competitive in the market for which it is intended.

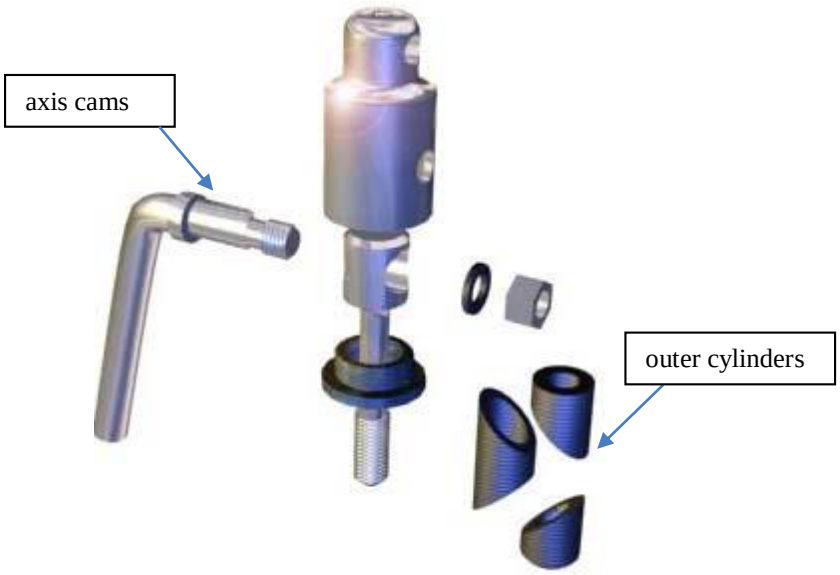

Figure 2. Demonstration in exploded view of the new product designed, to answer the market demands.

4. REGISTRATION AND TRANSFER PROCESS

The registration and transfer process was carried out fully in conjunction with the TTIC (Technological Transfer and Innovation Coordination), a competent body of the Federal University of Minas Gerais (FUMG), which provides full support to teachers and students for this purpose. According to TTIC (2017), its objective is to act in the management of scientific and technological knowledge, exercising, among others, activities concerning the dissemination of intellectual property culture, the secrecy of sensitive information, the protection of knowledge and the commercialization of Innovations generated at FUMG.

When contacting the TTIC it is necessary to present the demand presentation, by the student or teacher. From that moment, the professionals who work in the unit offer all the necessary support for the formation and structuring of the information and procedures necessary to carry out the process of registration and transfer of patent. All contact can be made in person, by phone or by email.

All legal documents necessary for the patent filing process are provided, such as: the inventor notification, the consultation form, the inventors' term of participation, and the inventive memo. In addition to assisting them, there is a team for legal and legal support, which reviews all documents submitted.

After all the completed steps the national application for invention, utility model, certificate of addition of invention and entry into the national phase, with the NIIP (National Institute of Industrial Property) is generated.

4.1. Patent registration

For the registration of the patent, the descriptive report of the product and all the necessary details, must be presented and reviewed, by the authors and evaluators and by the legal body of the TTIC. Only after the approval of all the parties is it sent to the NIIP for the registration of the patent.

After completing the process for this, the filing of the patent application was obtained, through process number BR1020160054982, with the NIIP.

From this moment, a monitoring by the NIIR, for the approval registry is initiated.

4.2. Transfer procedures and technology licensing

The procedure for the transfer and licensing of technology to third parties, as described by TTIC (2017) itself, may be carried out by paying license fees and royalties. These fees shall be divided equally between the FUMG, the patentee and the inventors. The division between the inventors will be made according to the previous agreement made between them. In addition, licensing may also result in funding for a research project sponsored by the licensee as payment for the license or part thereof.

For this, the procedure must be done through the legal counsel of the TTIC that generates the support in this case and follows the licensing process. It may provide additional information to interested parties and is located in the building of Administrative Unit II, at Pampulha Campus.

5. RESULTS AND DISCUSSION

Nowadays it is quite common for people working within the engineering community in Brazil try to implement a huge number of new ideas for innovative products that could solve a number of everyday problems. However, it is not certain that everyone knows how to carry out and develop the whole process from the invention to the innovation of a real product.

This work presents a real example of how to develop the process of creation and patent from the embryonic stage to the execution of the product and its legal stage as an invention. With this, the readers can base themselves on the fact presented here and generate by similarity, a new methodology, that fits the best way, for his, her or them invention or innovation.

The methodology develop steps for creating a new product can not be fixed only in the manufacturing process, technology process or any other process, but in the final objective, regardless of the difficulty or limitation to achieve this objective.

The process presented here began in the year of 2002 and only in 2016, fourteen years later, was the patent application stage reached. In addition, during the patent process was identified its industrial potential, expanding its market potential.

Lastly, the equipment developed requires only one hole to realize its fixation. Its installation can be done with only one hand and does not require any other type of tool, so that its expansion takes place inside the hole. Soon after its use, it can be uninstalled as easily as your installation. No type of human residue lags behind in the environment, and the equipment can be used again, several other times.

6. CONCLUSIONS

Some of the aspects discussed in this article are important for the analysis of innovation processes generated by the University, especially the idea of innovation aimed at solving technical problems of companies (through new products, processes and technologies) and the fact - Important - that an innovation developed for a specific company or market is not necessarily an innovation in another context.

Another relevant aspect is that the innovation process brings about the "destruction" of old ideas (as Schumpeter calls us, 1976) or the emergence of opportunities often neglected at first. There are classic cases of products generated from the observation of nature (such as the creation of velcro by the Swiss engineer George de Mestral) or the innovative application of solutions developed for another reality (such as the post-it case by Arthur Fry). In the case of this equipment, it was realized that a device originally developed for climbing had a much greater potential in other industrial applications than the one for which it was originally designed.

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