Methodological proposal for the transfer of industrial manufacturing processes in a transnational firm: A China-Mexico particular case

Propuesta metodológica para la transferencia de procesos de manufactura industrial en una firma trasnacional: Un caso particular China-México

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DOI: 10.35429/JEDT.2023.13.7.7.18 Received July 15, 2023; Accepted November 30, 2023

Abstract

This paper addresses the problem of the transfer of international production processes in the manufacturing industry and proposes a methodology to identify the essential activities required for it. The bibliographical research reveals the problems associated with the lack of an objective methodology in the management of projects for the transfer of processes between countries. In order to solve this problem and in the absence of a specific methodology, a case study was developed, based on the transfer of the Zoned Amplified production line of the Carrier company, from China to Mexico. In order to obtain a solid and complete methodology, different authors and proposed approaches for manufacturing transfers were compared, collecting the relevant information. As a result, a methodology composed of seven steps is proposed, either: factors for implementation, initiation of transfer documentation, design of the transfer plan, design for manufacturing, technology transfer and installation requirements, validation process and, finally, launch. This contributes to the industry in general, a practical and effective guide to address international process transfer projects, associated with specific standards in some cases, thereby overcoming the associated challenges and guaranteeing success in their execution.

Manufacturing processes, International transfer, APQP, Methodology for process transfer

Resumen

El presente trabajo aborda el problema de la transferencia de procesos de producción internacionales en la industria manufacturera y propone una metodología para identificar las actividades esenciales requeridas para ello. La investigación bibliográfica revela las problemáticas asociadas a la falta de una metodología objetiva en la gestión de proyectos de transferencia de procesos entre países. Con el objetivo de resolver esta problemática y ante la ausencia de una metodología específica, se desarrolló un estudio de caso, basado en la transferencia de línea de producción Zoned Amplified de la compañía Carrier, desde China hacia México. Para obtener una metodología sólida y completa, se compararon distintos autores y enfoques propuestos para transferencias de manufactura, recopilando la información relevante. Como resultado, se propone una metodología compuesta por siete pasos, a bien: factores para la implementación, iniciación de documentación de transferencia, diseño del plan de transferencia, diseño para manufactura, transferencia de tecnología y requisitos de instalación, proceso de validación y, finalmente, lanzamiento. Con ello se contribuye para la industria en general, una guía práctica y efectiva para abordar proyectos de transferencia de procesos internacionales, asociados a normas específicas en algunos casos, superando con ello los desafíos asociados y garantizando el éxito en su ejecución.

Procesos de manufactura, Transferencia internacional, APQP, Metodología para transferencia de procesos

Citation: MENDOZA-LEÓN, Jorge Guadalupe, GARCÍA-OCHOA, Juan José, VALENZUELA-EVARISTO, Aimée and SÁNCHEZ-ARENAS, Ricardo León. Methodological proposal for the transfer of industrial manufacturing processes in a transnational firm: A China-Mexico particular case. Journal-Economic Development Technological Chance and Growth. 2023. 7-13: 7-18

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1. Introduction

Technology transfer in industrial manufacturing has gained significant relevance in recent years. In particular, the international transfer of manufacturing processes has become a common strategy for companies seeking to diversify into new markets and optimize their operational efficiency. However, despite its importance, there is a lack of documentation and specific methodologies to guide this transfer process. This lack poses significant challenges in terms of product quality, process reliability and proper validation.

During 2018, United Technologies Corporation (UTC) announced its split into three independent companies, encompassing the aerospace, elevator and air conditioning divisions. This strategic decision materialized with the acquisition of Rockwell Collins, allowing the aerospace division to become an independent entity. Subsequently, on April 3, 2020, United Technologies formalized the separation of Carrier and Otis, while concluding the merger with Raytheon Company Cimate, Control & Security, a provider of heating, ventilation and air conditioning (HVAC), refrigeration and fire safety technologies, was renamed Carrier. As part of its strategy, the company has emphasized the importance of its independence, focusing on operational priorities, growth strategies and long-term profitability. These objectives include strengthening and growing its core businesses, expanding its product portfolio and geographic coverage, as well as developing digital services and offerings (Carrier Becomes Independent, Publicly Traded Company, Begins Trading on New York Stock Exchange, 2020).

In the context of diversification into new markets, Carrier has adopted international manufacturing process transfer as a key strategy. Although this practice is common in large companies, there is a paucity of specific information and documentation to guide the process of technology process transfer at the industrial level. The lack of a formal and registered methodology hinders the preservation of the quality of the final product, the reliability and reproducibility of the manufacturing process in the receiving unit, as well as the adequate validation of the process (Janodia et. al., 2008). Previous studies have shown several problems arising from the transfer of manufacturing processes in international companies.

A common problem is to determine whether the process should be transferred without modification (cloning) or whether it requires specific adaptations (Grant & Gregory, 1997).

In addition, it has been observed that the methodologies previously used for the transfer of manufacturing development lacked an analytical and systematic approach, resulting in a problematic process without clear direction, as well as being time consuming (Gerson et. al., 1998). It is clear that technology transfer requires proper documentation, a planned approach and trained personnel working within a quality system, covering all aspects of development, production and quality control (WHO, 2007).

In this context, the objective of this study is to develop a methodology for the international transfer of manufacturing processes. To achieve this, we will take as a case study the company Carrier, located in Navojoa, Sonora, which seeks to transfer the Zoned Amplified production line from China to Mexico. The purpose is to establish a systematic frame of reference to standardize, structure and organize the transfer process, providing a record that can be used in future related research.

The relevance of this research lies in its contribution to the industrial field by providing a methodology for the international transfer of manufacturing processes, based on the specific case of the transfer of Carrier's Zoned Amplified production line. The scarcity of systematic and structured information in this field highlights the importance of developing a methodology that facilitates the transfer process, allowing to reduce time, identify potential risks and provide tools and knowledge to the teams involved.

It is important to note that this study focuses on the process adaptation methodology, considering the current conditions of the case study, for which specific tools and approaches are proposed, according to the characteristics and needs of the manufacturing process to be transferred (Gaspar and Bustamante, 2019; Ruiz, 2015). However, it is clarified that the project will not cover the validation and launching stage of the new line, as another specific project will be required for that purpose.

ISSN-2524-2024

This scientific article will be organized in the following sections: after this introduction, there is the literature review section, then the methodology, presentation of results and finally the conclusions.

2. Literature review

2.1 Manufacturing processes

Manufacturing processes are sequences of related activities that occur in an orderly and sequential manner, with the objective of adding value to inputs and generating a specific output or service for a customer or stakeholder or system. Manufacturing involves the making of goods and articles, either by hand or by machinery, with the division of labor. Manufacturing can be viewed as a transformation of materials and information into goods that satisfy human needs. Manufacturing processes comprise a wide range of disciplines and use various levels of automation, which are carried out through a succession of operations that bring the material closer to the desired final state (Maynard, 2006).

Also, manufacturing processes can be classified into two main types: process operations and assembly operations. Process operations add value by changing the geometry, properties or appearance of the material, while assembly operations put components together to create a new assembly. Product development can be simple, with a single operation, or more complex, with multiple operations, depending on the specifications of the final product (Maynard, 2006 and Groover, 2007).

2.2 Elements of Manufacturing Processes

Manufacturing processes require five main elements, known as the 5M's: Material, Method, Machinery, Labor and Environment. The first of these refers to any element or input that is generally obtained as raw material; the second implies that each product, part or material requires a specific method to transform the raw material into the desired product.

The third is related to the machinery and/or equipment to give shape, size and properties to the material and comply with the product specifications.

The fourth is the skilled labor to operate the machinery and apply the manufacturing methods; and the fifth refers to the environmental conditions present in the production environment, which are assumed to have an implication in the four previous elements to reach the desired result.

It is important to mention that other elements are also considered, such as measurement and factors related to the environment, which are equally important nowadays. Thus, the interaction of this set of elements and their correct management, guide the achievement of the expected results of the manufacturing process (Maynard, 2006).

2.3 Production lines

A production line is a set of operations in sequence that are carried out in a factory to assemble components and manufacture a finished product (Maynard, 2006; Corvo, 2019). It consists of the organization of a process through the sum of a series of sequential operations, therefore, it is valid to assume as a synonym of production process. In these production lines, there may be intermediate or final workstations for quality assurance, as well as packaging stations. Each workstation performs a part of the total work required to manufacture the product.

According to Maynard (2006) and Medina et. al. (2019), production lines are of utmost relevance in industry, since all the processes necessary for the creation of a product are carried out in them. The design of a production line involves knowing the operations to be carried out and capturing them in a block diagram. To ensure efficient production, it is necessary to avoid downtime, guarantee good manufacturing quality, optimize workplaces and have adequate storage for the products (Figure 1). They also describe three types of production lines:

a) Single model line: This production line focuses on the manufacture of a single product model. It is used when market demand is high for a single product or when the company specializes in the production of a specific item. The design and configuration of the production line is completely adapted to the needs of the single model, allowing for efficient and optimized production.

b) Batch production line: In this type of production line, different products are manufactured in batches or groups. The products may be similar or have common characteristics that allow them to be produced together. For example, in automobile manufacturing, different models can be produced in batches, allowing resources to be shared and efficiency to be maximized. Each batch can pass through the production line following a sequential approach.

c) Mass production line: This type of production line is used when the company needs to manufacture large volumes of identical products on a continuous basis. The production line is designed to achieve high levels of efficiency and productivity, optimizing processes and minimizing changeover times between products. Mass production is applied in industries such as electronics, food or consumer goods manufacturing.

It is important to keep in mind that these are only examples of the three most common types of production lines, being the ones that apply to the case under study, in addition to the fact that organizations can adapt or combine them according to their specific needs.

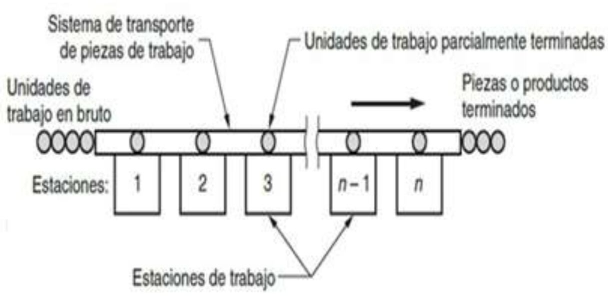

Figure 1 General configuration of a production line *(Adapted from Maynard. 2006 and Groover, 2007)*

2.4 Grant and Gregory's Methodology

According to Grant and Gregory (1997) and Janodia et. al. (2008), they mention that the demand for manufacturing process transfer occurs frequently in international companies; however, it should be taken into account that the study that supports this statement was published more than 20 years ago, so it is logical to think that nowadays this type of projects occur more frequently.

In the aforementioned research, the problem that companies have when deciding whether the transfer of manufacturing processes will be a cloning or an adaptation from the transferor to the receiver is mentioned, taking as a reference a set of factors divided into two dimensions, namely, 1) factors of adequacy and robustness and 2) transferability factors.

In the first group, 9 elements are assumed, ranging from the identification of the target market, through the analysis of organizational capabilities such as human resource skills, infrastructure, culture, supply chain; to the analysis of the environmental environment and the legal and regulatory requirements to be met. The second group of factors is based on the knowledge possessed and previous experience in this type of events, and also reviews the technological capacity and relevance, as well as the adaptability to change implied by the process to be transferred (Table 1).

Table 1 Factors influencing adaptation for a transfer setting
(Adapted from Grant and Gregory, 1997)

The fit of manufacturing processes can be systematically performed using the table as a checklist. Some dimensions of fit can be quantified and compared to a host capability profile, thus identifying areas of inadequacy that might otherwise go unnoticed until the start-up of the transferred facility.

As the authors mention to us, this table should be applied prior to transfer to verify whether the host is suitable for such a transfer, and whether retrofitting will be necessary.

2.5 APQP (Advanced Product Quality Planning) Methodology Quality Planning)

In addition, there are other methodologies and approaches used for the transfer of manufacturing processes, such as the Continuous Improvement model, the Knowledge Management model and the Project Management Based Approach. These methodologies focus on ensuring efficiency, quality and continuity of the process during the transfer, in addition to involving support in the incorporation of new technologies and sometimes even risk-sharing projects in the design and development of the production processes that are transferred (Mendoza and Valenzuela, 2014).

On the other hand, due to the high quality standards and new competitors in the automotive sector, and so organizations require different tools and techniques to help them improve their productivity, reduce costs, meet the requirements of their customers and maintain effective communication throughout the supply chain (Mora, 2021), a tool that has helped this sector, in the cases of product design and development, has emerged.

It is the APQP (Advanced Product Quality Planning) methodology, which is cited in this work due to its common application within the automotive manufacturing industry worldwide, as a base methodology for process transfers. The APQP tool is part of the Core Tools, which are a set of tools originally developed in the automotive industry to design, develop, measure, record, analyze and approve quality products and services that meet customer needs and expectations (Sillero et. al., 2019).

Within this set of tools there are 5 others, apart from the APQP tool, which are: PPAP (Production Part Approval Process), FMEA (Failure Mode and Effects Analysis), SPC (Statistical Process Control), MSA (Measurement System Analysis) and CP (Control Plan). All these tools are part of the IATF 16949:2016 standard (Quality Management Systems Standard specific to the automotive industry). Figure 2 illustrates the APQP model (AIAG, 2008; TDAE, 2021).

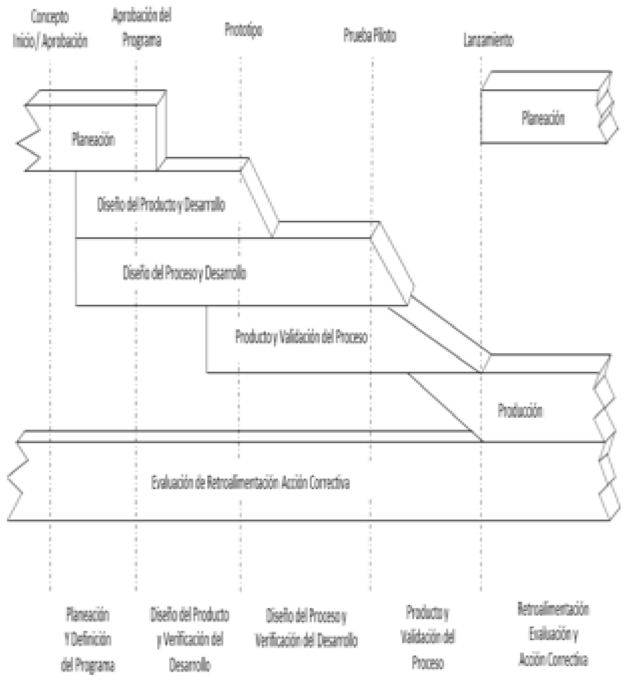

Figure 2 Time graph of a product quality planning (AIAG- APQP Manual, 2008)

The following is a brief description of each of the APQP stages (AIAG, 2008; Gutiérrez, 2014; Mora, 2021; TDAE, 2021):

1. Program planning. This phase has as inputs the legal and negotiation requirements established by the companies. These include the business plan, product characteristics and customer requirements.

2. Product design and development. It has to define the key characteristics of the product, the expected production processes and the potential suppliers needed in order to assess the feasibility of design manufacturing from the documentation submitted.

3. Design and process development. A production readiness review is performed to ensure that the process produces products consistently and compliantly according to customer and supplier requirements.

4. Product/process validation. At this stage, the product is produced according to the planned production using defined equipment and processes.

5. Feedback, evaluations and corrective actions. Define activities that include defect and price reduction, as well as time and product improvement.

According to the Advanced Planning for Product Quality and Control Plans manual (AIAG, 2008), at the project closure and entry stage of the project, the following activities are required (AIAG, 2008), at the stage of project closure and entry into production, the relevant aspects of the operation of the final product are evaluated and subjected to improvement processes in terms of quality, time and delivery and cost indicators. The participants in the project evaluate the positive aspects, as well as those that could be improved in the execution of the plan. Records are made of lessons learned and good practices applicable to future projects. This stage is assumed as the principle of Continuous Improvement.

It is important to highlight that the transfer of manufacturing processes can present significant challenges, such as the loss of tacit knowledge, adapting to new conditions and ensuring operational continuity. Therefore, it is critical to have a systematic approach and appropriate methodologies to ensure the success of production line transfer (Grant and Gregory, 1997; Borrero and Maya, 2018; Garcia- Sabater, 2020).

In addition to the steps mentioned above, there are other key considerations in the manufacturing process transfer process, such as risk management, which consists of managing the risks associated with the process transfer, is essential to minimize negative impacts; effective communication, which is critical throughout the transfer process, including keeping all stakeholders informed, from personnel directly involved in the transfer to customers and suppliers; another consideration is the measurement of indicators and follow-up, which involves monitoring process performance, analyzing the results and taking corrective action when necessary.

Therefore, the transfer of manufacturing processes is, in itself, a complex process that requires proper planning, documentation, evaluation, implementation and follow-up.

3. Methodology

This section describes the activities that were necessary to achieve the were necessary to achieve the proposed objective, that is, to develop a methodology for the international transfer of manufacturing processes, by means of the case of the company under study. Thus, based on the pertinent information of the technical and design aspects involved in a transfer, the proposed methodology is constructed, integrating and structuring the corresponding elements. It is important to mention that the actions described in each phase can be carried out in order or not, likewise, they are considered highly iterative.

Phase I. Project initiation.

Objective: Define the project for the transfer of the corresponding manufacturing process in general terms for approval.

Actions:

1. Identify the vision and objectives based on the results we want to obtain at the end of the project. It is important to determine whether the objectives will be measurable or quantifiable; they must have the characteristics of being realistic, achievable and precise, along with the importance of time constraints. In this way, we can have a general project direction.

2. Assign teams. Team assignment is one of the most important points for the success of a project, so it should involve, if possible, all interested and/or affected parties. After determining the participants, the project leader (who will be responsible for achieving the expected results in a timely manner) should be assigned.

3. List the main functions involved, along with their responsibilities, and assign them to the appropriate party. This should be done in a structured manner together with a communication plan.

ISSN-2524-2024

4. Initiate documentation for the transfer. All necessary documentation for the transfer of the manufacturing process shall be provided. The requirements that may be involved shall be documented together with the general plan. Likewise, the risks that may arise before, during and after the execution of the project should be identified and documented along with their possible solutions.

Phase II. Preparation of the transfer

Objective: Prepare all the necessary aspects to carry out the transfer of the manufacturing process effectively.

Actions:

1. Identify the resources and equipment required for the process transfer. This includes specialized personnel, machinery, facilities and any other resources needed to carry out the manufacturing process.

2. Establish a detailed schedule that includes all the activities required for the process transfer.

This will allow for proper management of time and resources throughout the project.

3. Designate a project team in charge of coordinating and executing the process transfer. This team should include representatives from different areas involved in the manufacturing process, such as production, engineering, quality and logistics. iv) Clearly define the roles and responsibilities of each member of the project team. This will ensure proper distribution of work and effective communication among all involved.

4. Conduct a detailed analysis of the existing manufacturing process, identifying critical points, constraints and areas for improvement. This analysis will serve as the basis for the design of the manufacturing process at the target location.

5. Establish the acceptance criteria for the transfer of the process, defining the quality, performance and efficiency standards to be met at the target location.

Phase III. Design of the manufacturing process at the target location.

Objective: Adapt the existing manufacturing process to the target location, taking into account local specifications and requirements.

Actions:

1. Analyze the differences and similarities between the source location and the target location, considering factors such as local regulations, supply of materials, availability of labor and any other relevant aspects.

2. Design the manufacturing process adapted to the destination location, taking into account the constraints and resources available at that location. This may involve modifications to equipment, changes in procedures or any other measures necessary to adapt to the any other measures necessary to adapt to the local environment.

3. Establish the validation criteria for the newly designed manufacturing process, defining the necessary tests and verifications to ensure its functionality and compliance with the established standards.

4. Develop the necessary documentation to support the new manufacturing process, such as procedure manuals, work instructions, specification sheets and any other relevant document.

Phase IV. Implementation of the new manufacturing process.

Objective: Implement the new manufacturing process at the target location in an effective and efficient manner.

Actions:

1. Conduct testing and validation of the new manufacturing process to ensure proper operation and compliance with established standards.

2. Provide training and coaching to personnel involved in the operation of the new manufacturing process. This includes both existing personnel as well as new personnel hired specifically for the target location.

3. Make adjustments and optimizations to the new manufacturing process, based on test results and feedback from the personnel involved.

4. Establish monitoring and control systems to ensure the quality and efficiency of the new manufacturing process.

5. Gradually transfer production of the manufacturing process from the source location to the destination location, ensuring a smooth transition and minimal disruption in the supply chain.

Phase V. Validation and optimization of the new manufacturing process.

Objective: Validate and optimize the new manufacturing process at the destination location to ensure its efficiency and compliance with established standards.

Actions:

1. Conduct a thorough validation of the new manufacturing process to ensure its compliance with previously established criteria and standards.

2. Identify opportunities for improvement in the manufacturing process and make adjustments to optimize its performance, quality and efficiency. iii) Monitor and analyze the key performance indicators of the new manufacturing process in order to identify possible areas for improvement and take the corresponding corrective actions.

3. Collect and document the lessons learned during the implementation of the new manufacturing process, with the objective of applying them in future transfer projects.

Phase VI. Closure and evaluation of the transfer project.

Objective:

To conduct a formal closure of the project, including documentation of results, delivery of final reports, and completion of administrative and logistical aspects related to the transfer of the manufacturing process.

Conduct an evaluation meeting with the project team and other stakeholders to review project results, identify lessons learned and discuss possible improvements for future manufacturing process transfers.

Conduct appropriate internal and external communication to report on the success of the manufacturing process transfer project and highlight the benefits achieved. Expected results: A successfully closed manufacturing process transfer project, with a full evaluation of the results and lessons learned documented.

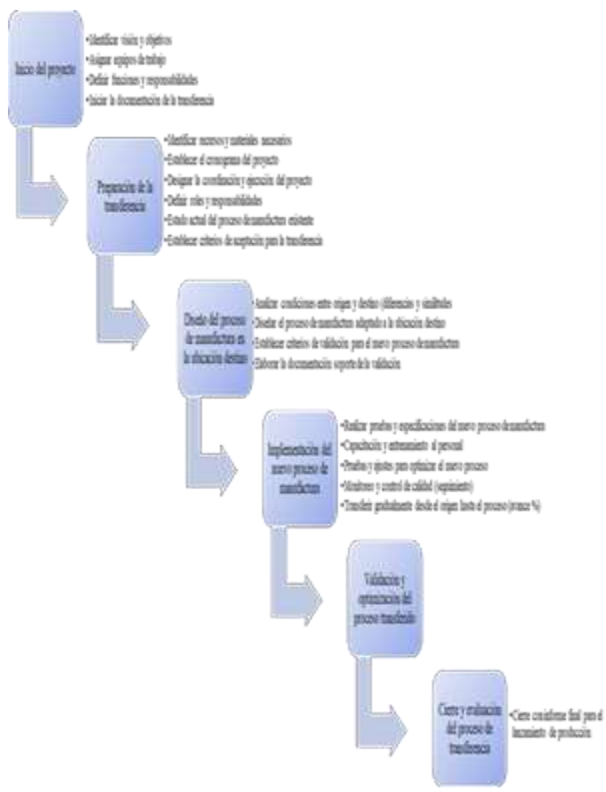

Figure 2 Phases of the proposed methodology
Own elaboration based on Grant and Gregory, 1997; Groover, 2007)

4. Results

The results obtained after applying the methodology

The results obtained after applying the methodology developed for the transfer of manufacturing processes in the case study are presented below:

4.1 Start of the project

The transfer project, called "Rebranding" and led by the New Product Introduction (NPI) area, started prior to the completion of this work, so detailed information on the initial decisions made to determine the type of transfer to be implemented is not available. However, it is known that a transfer adaptation was carried out. The vision and objective of the project were established, assigning activities to the teams involved according to their profiles and roles. These activities included the development of a communication plan in collaboration with the parent plant's project manager, the designation of a project leader and the initiation of the documentation of the process to be transferred.

4.2 Design of the transfer plan

Once the initial transfer requirements were approved, the responsibilities to be executed were delineated. The scope of the project was determined and the initial master plan was prepared, considering the critical elements that could affect the project. These activities were led by the project team, managers and the project manager of the parent plant. The detailed documentation of these activities is kept confidential and will not be discussed in this work for reasons of industrial secrecy.

The plant layout was defined by the NPI area together with the plant engineer. This decision was fundamental to determine the type of transfer to be carried out, opting for an adaptation due to the existence of a previous line of the same client with similar activities. It was decided to extend this existing line to incorporate the new process to be transferred.

Likewise, a review of materials was carried out, identifying the need to change suppliers to comply with the new brand requirements (from UTC to Carrier). This transition was mainly reflected in the documentation and packaging labels.

4.3 Design for manufacturing

The manufacturing team evaluated the technical specifications of the product to be manufactured. Although it was decided to change suppliers, the raw material remained the same. Since a similar procedure existed at the receiving plant, this activity was less complex and faster than estimated. In addition, the new suppliers were selected and approved, the documentation related to the engineering change was generated, and the labels for the final packaging of the transferred product were designed.

The tooling required for the operators was created from scratch, using SolidWorks CAD software to generate printed prototypes with the company's in-house 3D printer. The designs were developed by the manufacturing team and approved by the quality team, the project leader and management. Subsequently, the tooling was manufactured in larger quantities and with high-quality specialized suppliers.

4.4 Technology transfer and installation requirements

The transfer of machinery and technological elements necessary to ensure the successful operation of the transfer process was carried out. Specific details on the acquisition of materials and their validation are not provided due to confidentiality, but they were clearly defined in accordance with the design specifications.

4.5 Validation process

Finally, a comprehensive review was conducted for product launch, which included process validation testing, personnel training, establishment of quality inspection plans and definition of operational requirements, as well as the operational design of the production line or manufacturing process.

These results show that the implementation of the manufacturing process transfer methodology was successful in the case study. The existing process was adapted to incorporate the new product and the necessary changes were made in terms of suppliers, tooling and technology. The discussion of these results could focus on the effectiveness of the applied methodology, challenges encountered during implementation and lessons learned.

In addition, aspects such as the impact on product quality, process efficiency and customer satisfaction could be addressed. One of the highlights is the collaboration between the different teams involved in the project, as well as the assignment of clear roles and responsibilities, as well as the assignment of clear roles and responsibilities, as well as effective communication, which allowed the workflow to be coordinated and efficient. This facilitated the execution of the planned activities and contributed to the overall success of the transfer.

The decision to carry out a transfer adaptation, taking advantage of an existing line with similar activities, proved to be a wise one. This strategy minimized the impact on existing infrastructure and resources, while incorporating the new process in an efficient manner. In addition, by keeping the same raw material, the changes and complexities associated with the acquisition of new materials were reduced.

The design of specific tooling for the operators, using CAD technology and additive manufacturing, was another highlight of the implementation, since it allowed for greater precision and efficiency in the manufacture of the components required for the process. In addition, involving the quality team in the approval of the designs ensured that they met the required standards. The transfer of machinery and technological elements was fundamental to guarantee the successful operation of the process. Procurement of materials through the purchasing team and validation by the manufacturing team ensured that quality standards were met and that the necessary resources were available at the right time.

The final validation process, which included extensive testing, training of personnel and establishment of quality inspection plans, was crucial to ensure that the transferred product met the established requirements and specifications. This stage enabled potential problems to be identified and adjustments to be made before the product was launched on the market.

5. Conclusions

The present work on manufacturing process transfer has demonstrated the importance of having a detailed and orderly procedure to achieve success in the development of this type of project has demonstrated the importance of having a detailed and orderly procedure to achieve success in the development of projects of this type. Throughout the implementation of the methodology, expected results have been obtained and several problems have been overcome, which has allowed the achievement of the established objectives. Despite the challenges and limitations encountered, such as the Covid-19 pandemic situation that generated delays with suppliers, the systematic approach and rigorous planning have been fundamental to overcome the obstacles and keep the project on track.

Effective communication has been a key aspect of this process. Constant interaction between the teams involved, both internally and with foreign operations, has maintained a smooth flow of information and ensured alignment of all project participants, and has been particularly relevant in addressing the challenges arising from the international transfer and ensuring successful integration of processes.

Thus, based on the results obtained and lessons learned, it is technically recommended to maintain this methodological approach in future process transfers. Alternatively, having a well-structured and time-bound procedure has proven to be an effective strategy to achieve efficient and quality results.

The successful implementation of the manufacturing process transfer methodology has confirmed the importance of planning, communication and rigorous follow-up in this type of project.

Through team collaboration, problem solving and adaptation to changing circumstances, the objectives have been achieved.

The APQP methodology can be of significant help in taking into account all factors related to product design and development, as it offers both inputs and outputs, and suggested tools for the creation of quality products, within the context that is commonly used (automotive industry).

ISSN-2524-2024

However, the methodology proposed in this work, offers all this having a unique approach to manufacturing process transfers, making the course of the project more manageable and in shorter times with quick decision making.

Finally, this work lays the groundwork for future process transfers, providing valuable guidance for obtaining optimal results and promoting success in similar projects, particularly for the productive context of the company under study.

Acknowledgements

This project has been funded by the PROFAPI 2023_035 program with internal resources from the Instituto Tecnológico de Sonora.

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