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PROPOSAL OF TRAINING MODEL BASED ON KNOWLEDGE MANAGEMENT TO CNC

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Summary - Today companies present us with the future of the global economy since, there is this powerful era of knowledge and the great advances of technology, however, organizations present a delay of adaptation for their new members and the aerospace industry is no exception. This work proposes to implement a training model based on Knowledge Management and its strategies, since they have shown that they can adapt to any typeof industry. The implementation of a method for supporting the training process for new CNC programmers in an aerospace organization will improve learning times and the preservation of tacit knowledge within the area. The research aims to eliminate knowledge dependence between programmers by creating a versatile system where the techniques used in the work area can **be observed.**

Index of Terms – Knowledge Management, Technical Personnel, Good Practices, Information Systems.

I. INTRODUCCION

The research is conducted at a world-class aerospace company specializing in the machining of structural parts, motors and precision parts in light alloys and hard metals. The industrial processes of a company of this type are developed through the use of codes (prog branches of design and manufacture) that make the CNC equipment execute the necessary cuts or processes and manufacture the parts that are sent to the customers. The work team consists of five programmers in which there is a coordinator and four programmers; the coordinator is the one who verifies and

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organizes the new programs to be carried out and also, is the one with the most experience and has the responsibility of training new programmers. The training requires a lot of attention and time, so the coordinator neglects the other activities that are in his charge. The problem detected is in each time the hiring of new programmers is made; the training time is increased, this is measured with the time it takes to do their first program alone. The research is based on literature on topics such as Knowledge Management, Training for Technical Personnel and Learning Management System and then the creation of a Training Model based on Management of Knowledge. Being an investigation in process, the results presented in this article are few, but the first observations and comments that have been obtained have been positive.

II. ANTECEDENTES

Knowledge Management (QM) is the activity of generating, processing and storing knowledge within knowledge bases. Support activities include creating, accessing, retrieving, updating, and deleting knowledge (and the structured data that accompanies it) from a knowledge base. Data, a priori knowledge and conditions are inputs to the activity of knowledge engineering [1]. An effective GC culture in rules and practices that promote the transfer of information and knowledge between the personal and between the different administrative levels [2].

Wiig model for building and using knowledge (Figure 1). How we organize and maintain knowledge [3]:

Public knowledge: The most accessible knowledge is predominantly explicit, routinely taught and shared, and generally available in the public domain. Public knowledge is primarily systematic, although some are idealistic and pragmatic.

Proprietary experience: Proprietary knowledge assets are unique knowledge that knowledge workers possess and share in their work, or that are integrated into technology and other proprietary manifestations. It may be explicit, but it is often communicated through specialized representations or languages. Shared experience is mainly pragmatic knowledge, although this type of knowledge also includes idealistic and systematic knowledge, and experts can refer to automatic knowledge.

Personal knowledge: the least accessible and most complete knowledge, exists tacitly in people's minds and is used unconsciously in work, play and daily life. Personal knowledge consists of a small part of automatic knowledge. However, most personal knowledge consists of idealistic, systematic, and even pragmatic knowledge that is not clearly explained or understood.

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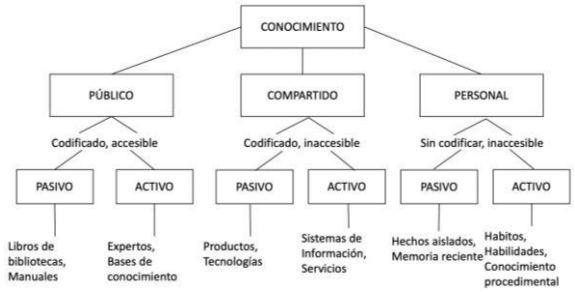

Fig. 1. Model for Building and Using Knowledge, Wiig (1993), Own Elaboration.

The GC cycle of Bukowitz and Williams (Figure 2). It is a knowledge management process framework that describes "how organizations generate, maintain, and deploy a strategically correct stock of knowledge to create value." In this framework, knowledge is composed of repositories of knowledge, relationships, information technologies, communications infrastructures, functional skill sets, process know-how, environmental responsiveness, intelligence organizational and external sources, between other. The Phases of "obtain", "learn" and "contribute" sound of nature tactic. They are Caused by Opportunities or lawsuits market-driven and usually result in the daily use of knowledge to respond to these demands. The stages of "evaluate", "build/maintain" or "disinvest" are more strategic in nature, brought about by changes in the macro environment. These stages focus on more far-reaching processes to match intellectual capital with strategic requirements [4].

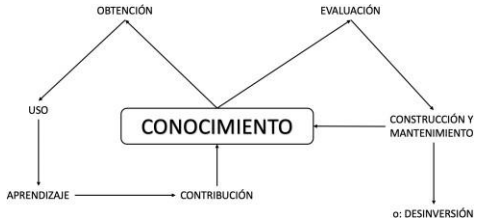

Fig. 2. Cycle of GC, Bukowitz and Williams (2000), Own elaboration.

Spiral model of knowledge (Figure 3). [5] In his view, knowledge is created through the interaction between four modes of knowledge creation: socialization, the conversion of tacit knowledge into tacit; internalization, from explicit to tacit; combination, from explicit to explicit and outsourcing, from tacit to explicit.

Fig. 3. Spiral Model of Knowledge, Nonaka and Takeuchi (1999), Own elaboration.

Four forms of knowledge conversion [6]:

Socialization: tacit to tacit. Socialization is a process of sharing experiences and thus creating tacit knowledge such as shared mental models and technicalskills.

Externalization: from tacit to explicit. Externalization is a process through which tacit knowledge is enunciated in the form of explicit concepts. It is an essential process of knowledge creation in which tacit knowledge becomes explicit and takes the form of

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metaphors, analogies, concepts, hypotheses or models.

Combination: from explicit to explicit. The combination is a process of systematizationof concepts with which a system of knowledge is generated. This form of knowledge conversion involves the combination of different bodies of explicit knowledge. Individuals exchange and combine knowledge through various means, such as documents, meetings, telephone conversations, or computerized communication networks.

Internalization: from explicit to tacit. Internalization is a process of converting explicit knowledge into tacit knowledge and is closely related to "learning by doing". When experiences are internalized into the tacit knowledge base of individuals through socialization, externalization and combination, in the form of shared mental models and technical know-how, they become very valuable assets. In order for explicit knowledge to become tacit, it is helpful for knowledge to be verbalized or diagrammed into documents, manuals, or oral histories. In addition, documents or manuals facilitate the transfer of explicit knowledge to other people, allowing them to indirectly experience the experiences of others, that is, to re-experience them.

Information technology is useful for acquiring instant knowledge through the GC process that improves organizational performance [7].

OLMS is defined as a technology-enhanced online learning environment that aims to solve administrative problems, keep all resources in one place, provide a better course structure, display most of the characteristics of online activities and is more independent and flexible [8]. A typical LMS should provide all the functions of the communication tool to ensure easy communication and feedback between instructors and studentsand also between studentsand peers [9].

According to [10] the characteristics that a good LMS must have are:

TABLE 1
CARACTERISTICS OF AN LMS

Feature	Description
Content development	Content development is important in the design of a course. The course should be student-centered. The focused approach in the student will support the students and motivate them to learn.
Discussion areas	The discussion will bring a dynamic element to the online class. It will be the key to making the course an interactive experience. Discussions will allow students to communicate with each other and with the instructor.
Group participation	LMS should allow students to work together in small or large groups. Be able to share documents, chat, send emails, and work together in environments synchronous and asynchronous.
Calendar	Instructors will be able to post all due dates on the calendar. The calendar can also serve as an organizer anticipated.

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TABLE 1
CARACTERISTICS OF AN LMS

Feature	Description
Chat/Whiteboard/Mail	An instructor will be able to incorporate synchronous learning through chat rooms and whiteboards. The instructor will be allowed to have different students answer questions and even post questions in the chat room. Email is a good means for you groups communicate with each other.
Student studio tools	Having study guides available will help students review materials of the course.
Audio/Video	Plain text in an online course can be very boring. Adding audio and video to a course will minimize slippage of the materials.
Site Administration	The LMS should provide maximum flexibility to support the ongoing needs of both experienced and flawed beginners. Ease of use for both teachers and students is critical to the success of an online course.

According to the research carried out by [11] where you make a diagnostic general about the tasks in the Different Phases of the process by means of staff interviews, surveys and observations who works in the respective phases of a company of the metalworking sector located in Bogotá, as well as how measurement of the Different Activities What herself perform in the process. Research gets lthe results of the diagnosis show that at the level of knowledge management there are gaps in some dimensions being the theme of registration y creation of knowledge that requires the most attention. Herself Proposes Suggestions a implement Looking improve the management of knowledge in their dimensions with qualification casualty how sound the implementation of concept maps and application of lessons learned.

Likewise[12] it implemented a procedure that improves documentation, access and dissemination of information in a government agency in Hermosillo, Sonora. The procedure was segmented into five steps: obtaining and analyzing the information, and then selecting indicators and with these propose a solution, which once implemented, was evaluated to ensure the constant improvement of the process. Finally, a final stage was included where the information resulting from the application of the procedure was analyzed to detectr areas of opportunity for improvementthat are feasible to implement in a next iteration, which allowed to create a gradual process of improvement in the dissemination of knowledge among the workers.

[13] present the benefits and how platformsas e-learning are most widely used in industries. These authors originally from Indonesia designed an e-learning platform that eliminates the boring learning process and offers new operators a dynamic CNC machine learning experience. There were two main activities in the development of e-learning for the boring process activity. The first part was the knowledge conversion process based on the SECI model to identify, analyze and structure all tacit and explicit knowledge related to boring activity. The second part was the software development process to design the e-learning based on the requirement raised by the company. The design of the e-learning also considered the stages

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of the Bukowitz and William KM cycle to keep the functionalities of e-learning aligned with the flow of the KM cycle process.

III. Objetivo General

Design and implement a method supported by GC that allows structuring, documenting, recovering, and sharing knowledge, experiences and experiences, through a versatile system to support the training process of new programmers in the Aluminum Industry of the Machining department, which will serve to obtain better productivity in the work team reducing delivery times.

IV. Planteamiento Del Problema

The coordinator is currently the one who gives the training to the new programmers and, in addition, is in charge of the team that consists of four programmers. The training process requires a lot of time and attention on the part of the coordinator, getting him to abandon his other activities. The work team must deliver the programs made in a previously fixed time, but having new programmers this makes the delivery time not met. The lack of adequate training for new programmers in the Aluminum area hinders the delivery of the requested programs, negatively affecting the productivity of the work team.

V. Msuit

Below is the GC-based model to support the GC training process

new programmers that will serve to obtain greater productivity in the work team reducing delivery times.

The literature related to QM is very broad, for this work three models of knowledge management were studied in the previous chapter, which are works of the authors [3], [6] and (Bukowitz and William, 2000). [3] organizes knowledge in the form of a semantic network, where it can be accessed and retrieved using multiple input paths,[6] underscoring the need for a kind of integration of the two approaches — tacit and explicit —, from the cultural, epistemological and organizational point of view, and finally the authors(Bukowitz and William, 2000) describe how organizations generate, maintain and deploy a strategically correct stock of knowledge to create value. The models, although they focus on QM, each of them is different from the other and that is why each model was analyzed to know which one adapts to the problem previously raised. And that is why the Spiral Model of Knowledge [6] is the one that is selected for the creation of the training model of this research. It should be clarified that the QM was one of the topics that were studied to develop the training model (figure 4) presents the themes and relationships of each of them for the creation of the training model.

Fig. 4. Concepts and their relations for the creation of the model.

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To carry out an adequate structuring for the creation of the proposal of the model of this research, it was decided to analyze four topics as shown in Figure 2. The topics have a connection with the research and each topic is related to each other. The QM works with the human resource in area experts and the Training requires the human resource as instructors and apprentices. On the other hand, the topic of Training involves the concept of learning as well as the LMS topic, where it is sought to have a flexible learning system for instructor as for istudiante. As mentioned above, CNC Programming requires a level of knowledge in the CNC area and that is why this topic maintains a relationship with LMS, where the topic CNC Programming obtains benefit from acquiring knowledge with LMS. And finally, the relationship between CNC Programming and GC is located in the concept of knowledge as it is a crucial point for new CNC programmers.

Having carried out the study of literature, a training model was developed, which is presented in Figure 2, the model is supported by the fundamentals of the literature and the experiences of related studies, but above all it is based on the methodology of [6] that allows structuring, documenting, recoveringr, and sharing knowledge, experiences and experiences.

Fig. 5. Proposed model.

The proposed model (Figure 5) consists of four phases:

1. Interaction
2. Structuring
3. Representation
4. Transmission

These phases present how the research will unfold and will then be described.

A. Interaction

It is here where the model began and although all the stages of the model are important, it is here in the first phase when you will have the face-to-face interaction with those members of the work team who have experience in the Aluminum area.

It is proposed to use the following techniques:

1) Structured interviews with experts in the field: The structured interview of subjectmatter experts is the most commonly used technique to convert an individual's key tacit knowledge into more explicit forms [4]. It is recommended to make use of the open-ended question type since, open-ended questions tend to be broad and impose few limitations on the expert. Open-ended questions are not followed by

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options, as they are designed to encourage a free response [14].

2) Observation of the work process in the area: The objective of using the observation technique is that, although we know that you can not observe someone's knowledge, what you can observe is to identify the experience. Reflective observation is an excellent practice to be able to assess efficiency (how well are we doing this?). And effectiveness (should we be doing this or something else?). Of all organizational activities, whether they are routine operational tasks. The key is to make use of tools like audio or video to record what the expert knows.

B. Structuring

The fundamental role of the knowledge structuring phase is that it allows to organize knowledge to share and use what is known collectively. The storage of the knowledge of the team members of the Aluminum area can be achieved through a variety of tools such as metaphors, cognitive maps, knowledge taxonomies and models.

It is proposed to use the following tools:

1) Cognitive Maps: A cognitive or knowledge map is a representation of the "mental model" of a person's knowledge. Cognitive mapping is a powerful way to encode captured knowledge because it also captures the context and complexinterrelationships between different key concepts. The purpose of maps Cognitive or knowledge is to better structure explicit knowledge and thus store it in corporate memory for long-term retention.

2) Knowledge Taxonomies: Once *the* key concepts that are necessary for the training of new programmers have been identified and captured, they can be organized into a hierarchy the information that is handled by the team coordinator, this is called structural knowledge taxonomy. Knowledge taxonomies allow knowledge to be represented graphically in such a way that it reflects the logical organization of concepts within a particular field of specialization or for the organization in general.

C. Representation

The third phase of the training model aims to digitize knowledge that was structured by cognitive maps and taxonomy graphs developed in the previous stage. At this stage of the model, the importance of embedding and archiving knowledge in repositories is remembered.

[15] define "repository, repository or archive" as a centralized site where digital information is stored and maintained, usually in databases or computer files.

1) Digital *Documents:* It is proposed to make use of digital documents since these files have the ability to be registered on a storage medium for easy identification and retrieval. Regardless of the format of the information: text, image, sound and audiovisuals.

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The digital documents will be able to store the information obtained in the previous stages; in the interviews given in the interaction with the members of the team, as well as in the maps made in the second stage of the training model.

D. Transmission

Last but not least, the fourth phase of the training model aims to disseminate and systematize the information generated in the previous stages. This systematization will be developed withthe help of thetechniques, tools and repositories generated in the previous stages. To this end, it is proposed to create a dynamic information system, simple to understand and capable, so that the individuals of the team of the area of study continue to apply and work on theknowledge they develop through their work.

VI. RRESULTS PARCIALES

As mentioned above, this research is in process so below, we will explain the partial results that are had and those that are expected to be obtained from the proposal of the training model.

A. Interaction

The technique of structured interviews was directed to the personnel of the programming team, the purpose of the activity was to obtain a good understanding of the CNC programming process of the work team in the Aluminum area in the Machining department. This technique was fundamental because it is necessary to know the current state in which the Individuals operate the programming process. The interview was applied to each of the five members of the work team. Figure 6 shows the CNC programming process that programmers follow.

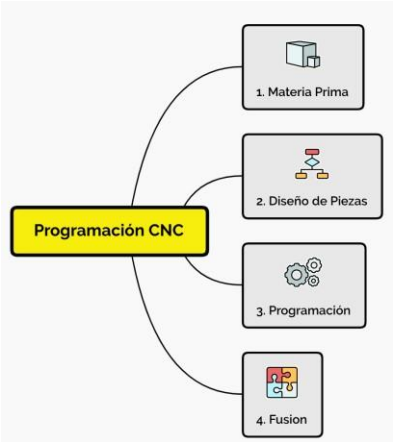

Fig. 6. CNC programming process in the organization.

Each stage involves a series of activities which each programmer must perform as part of the programming process. The following describes the four stages:

1) Raw material. It is where the coordinatorhands with the Director of Engineering, make the purchase or selection of the raw material, which in this case is Aluminum.

2) Design. It is the preparation of the programming where they perform the modeling of the operations that they will use in the piece to be designed and what tools they will need to implement in the design of it.

3) Programming. It is the machining process for the design of the part. Programming performance is independent of each programmer. The machining process is divided into subassemmables which are:

- Indus. It is delivered by the team coordinator to programmers with little experience and is composed of the piece, theraw material and the dimensions. Its function is to be able to visualize how the final piece should be.
- Fixture. It is the support between the part and the CNC machine.
- Construction. It is everything necessary for the programming of the part and is based on the plane of the piece. It is composed of tools, operations, machining trajectories, machining strategies, cutting conditions, among others.

4) Fusion. When the part passes to the CNC machine in plant for the development of the physical part, it is necessary to carry out a control between CNC programmers, CNC machine operator and other departments. That is why Workshop Documents (DA) are used, "documents *d'atelier*"), these documents are assembly instructions for the fixture as well. as well as tests that are carried out to measure the pieces.

The interview was applied to the five members of the work team where the questions sought to understand how the programming process is; what tools they use to carry out their work, what types of repositories they use, whether they make use of documentation, and whether they have communication with other departments. The questions also sought to know how much knowledge each member had and, above all,to know how they obtained this knowledge.

The programming of the part is free for the programmer; according to the experience of each programmer they can choose what strategies, tools, trajectories to perform in the machining. CATIA allows programmers to visualize the tools, cutters —milling, toroidal milling, drill bits, careado milling, rhymes, among others—, the machining trajectories they develop which are programmed with different colors to be able to visualize the difference between the trajectories, as well as the machining strategies. Figure 7 shows the linear trajectories indicated with green lines of a 1.25-inch Facemill, this machining operation consists of roughing the largest amount of raw material.

TABLA 2
TIPO DE DATOS

Type of Data	Observation
Xls	Excel files locally.
Docx	Local archives.
Books	Information about the CATIA design tool.
Oral	Informal communication.
Shared	Shared files.
Mail	To request information with the other departments involved and maintain communication with operators.

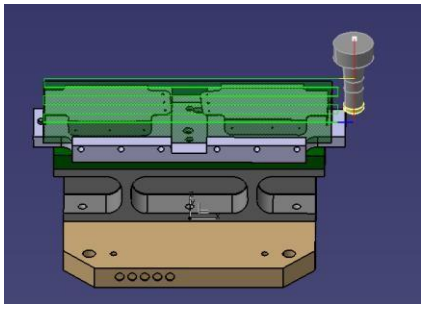

Fig. 7. Linear machining trajectories in CATIA.

It is known that you have a great deal of valuable tacit knowledge in the process of

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CNC programming in the study company, this assumption was confirmed in the interviews conducted, in addition the different ways in which knowledge is found in the programming team were determined and were grouped in Table 2.

Table 2 groups the different answers obtained in the interview, as well as a description of their functionality. It can be seen that the team of programmers maintains communication between them throughout their activities.

B. Structuring

Having observed the CNC programming process and the working mode of the programmers of the aluminum equipment, we will proceed to learn more about the key activities for the programmers in the programming process.

In the interviews, the question "what is the most important activity of the programming process?" was asked. to which the programmers replied that the Operations Modeling stage. Figure 8 presents the Operations Modeling activity accounted for in the part design stage of the CNC programming process. It is in this phase where the coordinator invests a lot of time and concentration to be able to assign a piezto a programmer. According to the interviews that were made to the coordinator of the team of CNC programmers it was known that in order to carry out a good programming of parts, a good modeling must be done, or as it is also known, industrialization.

Fig. 8. Operations Modeling.

To perform an Operations Modeling, the coordinator must first know how the piece to be programmed will be according to the client's request, since the pieces have critical points, which are the Geometric Tolerances. The Geometric Tolerances indicate which are the key points for the assembly of the next component of the part, that is why the programmer must respect the critical points indicated by the Geometric Tolerances. The coordinador needs to secure those critical points and does so by structuring the operations it will use in the programming of the part, as well as the tools that will be necessary to secure the critical points. The tools require a good analysis since the coordinator needs to study if the tool should go through a test or should be calibrated. Therefore, the modeling of the piece is considered of vital importance because it is an explanation of what path the programmer should follow and what his tools will be.

C. Representation

The progress made in the research with the interviews, the structuring of knowledge and the analysis carried out allows this research to continue to the third phase of the training model. In this phase the creation of

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repositories with the information obtained from the previous phases of the training model.

However, in the first phase of the model it was obtained that the team of programmers has repositories in different formats and that they are used throughout the development of their work, so it was not necessary to create new documents or implement a bas e of data.

D. Transmission

After having conducted interviews with the team of programmers to know the process they must follow to carry out the programming of a piece and having documented the key activities of the process, the creation of the system thatwill be to support the training of new CNC programmers. For this, the obtained by the techniques, tools and repositories generated in the previous phases will be used. The objective of the fourth phase of the training model is to carry out a dynamic information system, simple to understand and capable, so that the individuals of the team of the area of study continue to apply and work the knowledge they develop through of their work.

For the decision of which tool would be used for the creation of a dynamic information system, we chose to choose a learning management system (LMS) since LMS has been demonstrated to automate the administration, monitoring and generationof reports of training events. LMS has two main objectives which are to make learning more independent and to do

LMS users may be able to record, save, manage, publish learning via the web, and print documents available through the LMS [16].

An analysis of the most popular e-learning platforms on the network was carried out. Platforms such as Atutor, Claroline, Dokeos, Ilias,Moodle and Sakai were the most mentioned by other researchers on the internet. According to research conducted by

[9] they found that Moodle and ATutor have the best communication tools with a user-friendly interface. The information is easily accessible on the Moodle and ATutor websites, Ilias also makes the information available to potential customers. Claroline and Sakai are LMSs with complex web pages that make it difficult toobtaininformation. For that reason, he made the choice to choose Moodle as an LMS tool for this research.

The installation of Moodle was carried out accompanied by MariaDB for the storage of the data. The work environment was on a virtual server connected to a server that the company has in physical in France. After having made the configuration of users and permissions, a structuring of courses was created which is focused on the CNC programming process that the team currently works. It was decided to create a structure that had a direct connection with the stages that are involved in the CNC programming process (Figure 9). The courses will be identified as modules and each of them will tempt a programmer responsible for the creation of content. In addition,

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within the modules there are two of them that will focus on the training of new programmers. One of them is "Introduction to CATIA V5" which will be the basic content of the CATIA design software.

As mentioned above, the research is still in process and that is why the complete analysis of the interaction of the platform with the team of programmers is not yet in place. However, there are the first comments about the Moodle tool, from "It is easy to use", "It has a very nice design" and "The resources it has arevery appropriate".

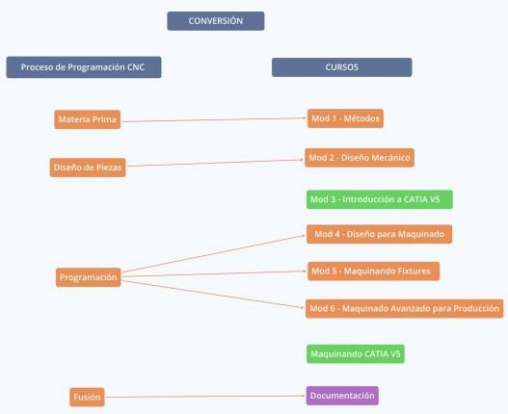

Fig. 9. Conversion of the CNC programming process to Courses.

VII. CONCLUSIÓN

According to what has been studied in the literature, the importance of sharing with organizations the benefits they would obtain by using the training process and the use of IT services is known. Knowledge Management and its strategies have shown that they can adapt to any type of industry and that is why there are many advantages that are obtained when working with this area of research.

This document presents the progress that has been obtained in research, where it is known that the aerospace industry despite having an enormous capacity of technologies also requires the support and guidance of the Knowledge Management, in addition the research continues in process so the results are still being analyzed. This project in development aims to design and implement a method supported by Knowledge Management that allows structuring, documenting, recovering, and sharing knowledge, experiences and experiences, through a versatile system to support the process of training of new programmers in the Aluminum area of the Machining department.

It is expected that the implementation as a solution of this model based on Knowledge Management and good practices will create a better interaction between current individuals in the work team, as well as those who are about to enter and above all, knowledge and valuable experiences will be stored. As of the members achieving that the team presents a better productivity.

Finally, it is expected to eliminate the dependence of knowledge between programmers by creating a versatile system using an LMS tool where the techniques used in the work area can be observed for the benefit of the team of programmers in delivery time of works as well as well as in the professional growth of a programmer.

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RECONOCIMIENTO

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