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**FORMALIZATION OF THE PRODUCT DEVELOPMENT PROCESS: WHAT IS ITS
IMPORTANCE FOR THE INFORMATION FLOW?**

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Abstract:

In the process of products development, the common theoretical orientation is a formal process with well defined phases, becoming the process more controlled, and reducing the variability of the information flow which is main raw material for the activity of product development. But, what happen in the practical one? Has the flow of the information been facilitated with the existence of a formal product development process? This exploratory research looked for a concept for different processes of product development, from the evaluation of three enterprises, and to identify the main benefits for the flow of the information by using a formal product development process. We applied the following criteria to collect data: conceptual analysis, secondary sources, and case studies.

Key-words: Product Development; Information flow; Process Formalization.

benefícios da utilização de um processo formal para o fluxo da informação. Recorreram-se de dados secundários, análise conceitual e estudos de caso.

1 Introduction

When it comes to enterprise management, changes take place in many different sectors and such changes arise from their need to follow the instabilities caused by the strong competition of the business world. Thus, if the scenario were stable, there would be no need of altering operations and business activities.

This way, not only the internal scenario but also the external one are permanent variables which influence enterprise development across the time. Consequently, the operations management should also change, so that the goals and profitability can be kept, even if the enterprises are facing situational changes.

In such an intense and dynamic scenario, new products and processes development have increasingly become the main focus of competition (Wheelwright & Clark, 1992). This new industrial competition, which is strongly focused on product development, is being controlled by forces that have been coming out in many industries around the world in the last decades. They are: the creation of an intense international competition, of segmented markets with sophisticated customers as well as the technological advances (Clark & Fujimoto, 1991).

The product development corresponds to a number of activities organized in order to change a product concept into a tangible finished product, which begins with the perception of a market opportunity and ends with the product production, selling and delivery (Ulrich & Eppinger, 2000). The product project activities, process project and manufacture system project are essential to the product development (Kim *et.al*, 2000). These activities affect, in a significant way, the success of a new product development project, which may possibly design the prosperity of a manufacture enterprise.

According to Ulrich & Eppinger (2000), the product development process depends not only on the product developed, but also on the organization to do so. Although the development processes have their own particular characteristics, making them identifiable among other

development efforts, the phases of any development process can be categorized into a generic sequence in order to be applied to many different systems and organizations. In the product development process, besides the material flow (models, prototypes, etc.), the product which will flow, in most of the cases, is information. If one accepts that the basic product in the product development process is the information, then, all kinds of information in these processes should be considered.

This exploratory research aimed at conceptualizing the PDP and identifying the main benefits of the use of a formal process with pre-defined phases and procedures for the information flow in the PDP. In order to do so, three enterprises were evaluated.

The research methodology will be presented in the next section. After that, some main studies on the product development process will be analyzed. Then, some models which focus on the information flow as well as the main mechanisms and tools used for this purpose will be presented. In another section, the case studies on this theme will be described. Finally, the conclusions and final considerations will be presented.

2 Methodology

For the purpose of this study, enterprises which declared to use a formal product development process were selected. These enterprises were identified in scientific studies which were already presented. (Bernardes 2000; Camargo, 2000; Carvalho, 2005). Enterprises from different areas were chosen in order to obtain the relative importance of the formal process as well as the consequent particularities in the information flows.

At first, the information about the products development process of the chosen enterprises was collected from scientific studies, such as papers, master's dissertations and doctoral theses. After that, case studies were conducted aiming at triangulating the collected data.

According Leonard-Barton (1990), a case study is a story about a past or current phenomenon created from multiple sources of evidence. It may contain data from direct observation and

systematic interviews as well as from public or private files. Actually, any relevant fact in the event flow which describes a phenomenon will be a relevant datum in a case study, since the context is important. For this reason, visits to the enterprises were made in order to observe the products development activities, interview people who are involved in the process and analyze documents available for checking.

In order to keep the enterprises anonymous, their names were change to: enterprise “A”, “B” and “C”.

To make the data collection easier, a form with the following characteristics was used: two diagnostic questions, a scale to check the process degree of formality, a blank to be filled with the process formalization and information flow indicators, a blank for information on the current status and a blank for opportunities of improvement indicated by the interviewers.

The diagnostic questions were subdivided in: 1) Is the product development process formalized and understood? 2) Is the information flow, which is necessary to the development process, part of this formalization?

Evaluation scales consist of statements which express not only a favorable attitude but also an unfavorable one in relation to an analysis object. The interviewee is usually asked if he/she agrees or disagrees with a statement. Each answer receives a numeric value which will reflect the agreement or disagreement degree. For this specific research, a scale based on a central parameter of the process formalization was elaborated from the theory. The scale which checks the process degree of formality started in level 1: There is no formalized product development process (it was previously verified that no enterprise would be at this level, once all the chosen ones were identified as having a formal process), and finished in level 5: The product development process is formalized and constant revisions are accomplished as well as all the participants understand its phases and take part in the improvement process.

The formalization indicators observed were logged in a specific blank and basically grouped in: a process representation diagram, documents and/or management software.

The current status and the improvement opportunities were basically collected from the interviewers' personal judgment.

3 The Products Development Environment

The effective products development has become an essential competence and has been differentiating the enterprises with focus on the customer from the other enterprises of a certain industry. The different environments in which the enterprises have to operate have become highly competitive. As a consequence, many organizations have been making efforts to meet the environmental demands. However, these enterprises have failed many times (Morgan, 2002). In this context, some specialists have identified the products development as being of fundamental importance for the organizations survival in this environment. According to Wheelwright & Clark (1992), there are three fundamental forces which created this environment: the intense international competition for quality, cost and term; fragmented markets and fast technological changes.

One may conclude, therefore, that the enterprises need to differentiate from their competitors based on their relationship with these three environmental forces, and that the customers will use some criterion to evaluate this differentiation among the products offered by different enterprises. One of these criteria will be the product value, that is, the ratio between the product usefulness and the customer's willingness to pay for it.

The products development process is fixed between two critical points: the documentation regarding the product requirements created in the end of the conceptual development and the build-to package which is generated at the end of the evaluation and tests phase. Between these two points, the customer's needs or requirements are transformed in a set of instructions which will allow the production of the desired product.

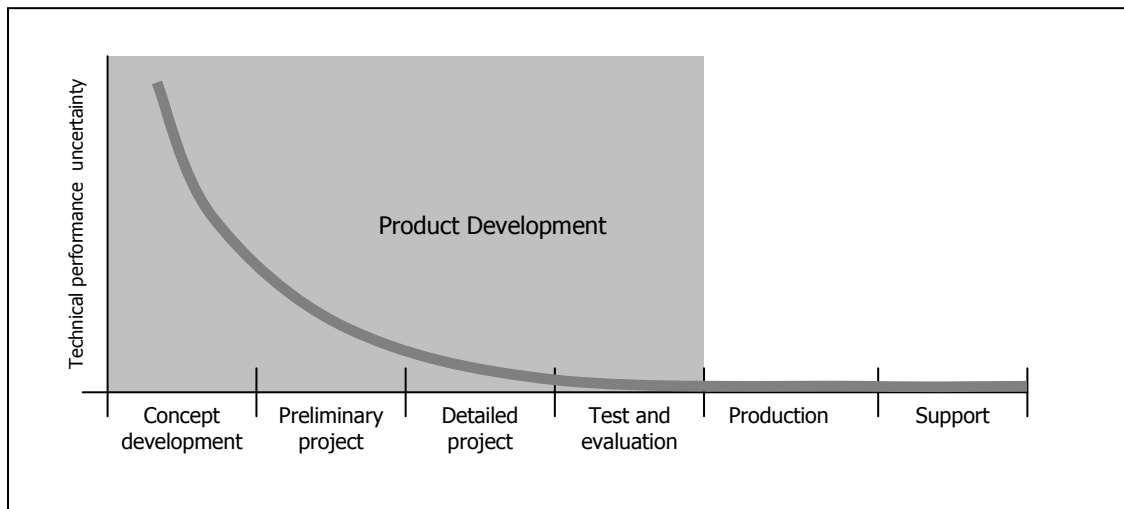


Figure 1 – Uncertainty in technical performance measurements in the product cycle

Source: Adapted from Chase (2001).

Figure 1 uses the uncertainty in the Performance Technical Evaluations (PTEs) to illustrate the process. The PTEs are introduced based on the project requirements documentation. The uncertainty towards the expected results is eliminated with the completion of the documents which supported the manufacture. This uncertainty reduction due to the perfect information flow can be compared to the value creation (Browning, 2001).

4 The PDP Representation Approaches

The process-based approaches design the product development procedures and are the main tools for the formalization of a PDP. In general, these approaches offer a sequence of the product development phases and describe the activities that should be included in each phase. Cooper's model (1983), for instance, is composed of seven phases as shown in Figure 2.

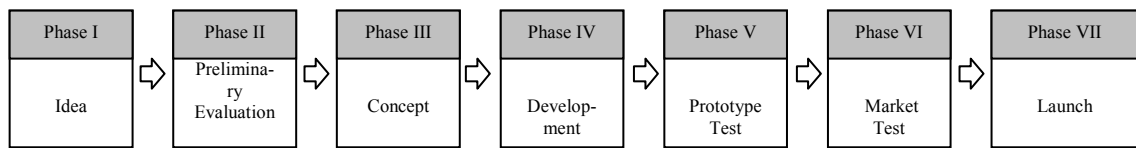


Figure 2 – Seven-phase flow diagram for the product development cycle

Source: Cooper (1983).

In Figure 2, Cooper (1983) identified in each phase what he called Market Activities and Technical and Production Activities. The activities for each phase are:

Phase I - Ideas and Initial Filter Creation (go no go).

Phase II - Preliminary Technical Evaluation (Technical and Production), Preliminary Market Evaluation (Market) and Preliminary Evaluation (go no go).

Phase III – Concept Identification (Market), Concept Creation (Technical and Production), Concept Test (Market) and Concept Evaluation (go no go).

Phase IV – Product Development: engineering project and prototype (Technical and Production), Market Plan Development (Market) and Evaluation (go no go).

Phase V - Internal Prototype Test (Technical and Production), Prototype Test with Customers (Market) and Evaluation (go no go).

Phase VI – Project Completion and Production Test (Technical and Production), Marketing Plan Completion and Market Test (Market) and Pre-selling Business Analysis (go no go).

Phase VII - Total Production (Technical and Production), Launch in the Market (Market) and Post-launch Control and Evaluation.

According to Cooper (1983), a new product launch always implies taking high risks. However, a lot can be learned regarding the effective management of the product development process through a revision of previous experiences. Not all products development projects will follow this model strictly. Most likely, elements which were not

observed and special circumstances will determine additional phases, such as the recycling of the presented phases or the elimination of some of them.

Cooper’s explanation is quite similar to the aim of this study, which is: to make efforts in order to find out how a formalized PDP can contribute for the information flow.

In a more recent study, Ulrich & Eppinger (2000) designed the products development process in six sequential phases, as shown in Figure 3.

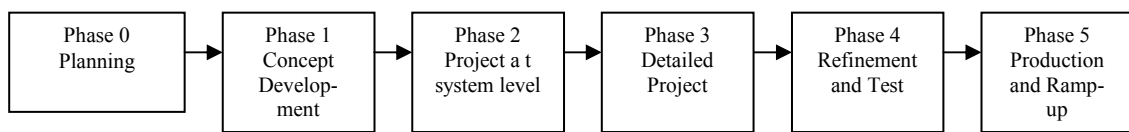


Figure 3 – The product development cycle

Source: Ulrich & Eppinger (2000)

As in the Cooper’s model, the one presented in Figure 3 also covers, in each phase, a number of feedback processes activities. Their main purpose is to facilitate the information flow.

In a more detailed way, Ulrich & Eppinger (2000) present the front-end activities which cover the concept development phase. Figure 4 provides a more detailed view of such phase:

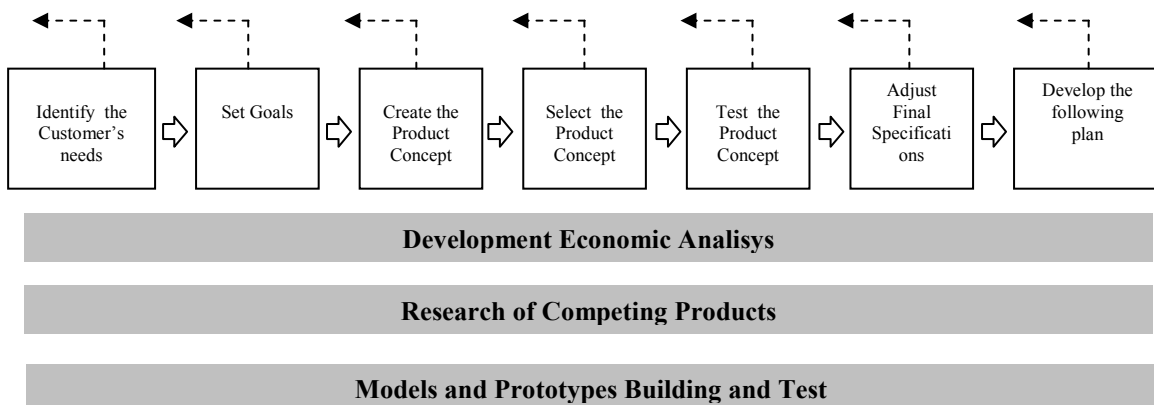


Figure 4 – The front-end activities covering the concept development phase

Source: Ulrich & Eppinger (2000).

In Figure 4 the white arrows represent the process flow which includes the information flow. The traced arrows represent the feedback in each development phase. The gray boxes, which go along the whole process, represent activities that permeated each phase of the process. The process-oriented approaches can differ in terms of details offered in the description of the phases in the product development or used terminologies. However, from the viewpoint that all the approaches propose steps that should be taken in the product development and that offer foundations based on propositions, the process-oriented approaches are very similar.

5 A more detailed representation of the information flow in the PDP

The representation of the products development process here presented is the result of the study accomplished by a Study Group on Product Development called Lean Aerospace Initiative — LAI — from MIT, which is a multidisciplinary team with representatives from the aircraft engine, aircraft structure, space and airplane industries. The group designed the product development process in terms of phases, exploring their interfaces, borders and outputs.

Figure 5 offers the flow representation of the value in a product development process. This representation was based on the program of phases proposed by IEEE (Institute of Electrical and Electronics Engineers) in order to allow the comparison with other processes definitions. The proposed model was elaborated so that it could be adapted to many different types of development programs.

The proposed flow doesn't divide the products development in what one can call discreet programs phases. It tries to divide it in product data phases which may or may not happen simultaneously with the associated program phases.

This set of information can be used in several ways: first, it provides a common language for the communication among different types of programs; second, it offers a means of keeping

the focus on the value flow through the interfaces among the programs phases. In addition, it provides a way of measuring and comparing the products development processes.

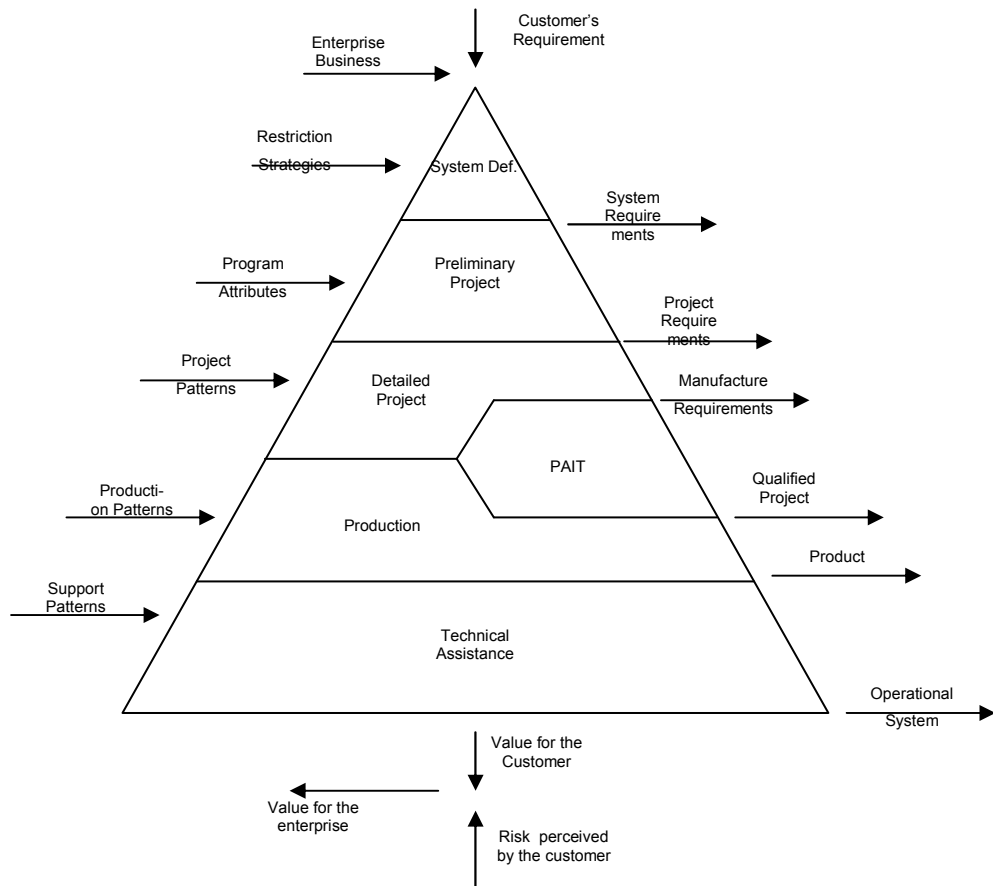


Figure 5 – Product Development Representation Based On The Value Flow

Source: LAI (2001).

Figure 5 descriptions define some of the methodologies which can be used in the information flow mapping.

The information flow begins with the System Definition phase which has a set of customer's requirements (basically: cost, schedule, performance) as an input, Enterprise Business Position (desired ROI and portfolio management), and the Risk Position for the Customer.

The restrictions (culture, evaluations and training) are applied so that the customers' needs can be converted in system requirements.

The Preliminary Project phase receives the system requirements of the System Definition phase and applies the system attributes to develop a design-to package. At this point, the operational risk is better defined to include the project risk or the risk that the system project presents of not being feasible due to technological restrictions. The activities of this phase will be focused in the reduction of the project risks.

The Detailed Project phase receives the set of project information generated in the Preliminary Project phase and applies project patterns to develop a build-to package. The project risk defined in the Preliminary Project phase will be lessened during this phase due to technology and multiple project concepts use. Once the project risk is reduced, the operational risk is better defined, including, at this moment, the manufacture and performance risk, that is: the risks of not being able to manufacture a product, or the risk of not reaching the desired performance. Analyses and simulations can be used to reduce these new risk factors.

The PAIT phase (Production, Assembly, Integration and Test) receives the set of manufacture information developed by the Detailed Project phase and applies prototyping and qualification patterns in order to qualify the project. At this time, the phases begin to be simultaneous. The qualification test results directly feed the project detail process. This phase is also used as a test for the reduction of the manufacture and performance risks. The key points for this risk reduction are the prototyping accomplishment and the way these prototypes are used in the qualification test. The output of this phase is the project qualification.

The Production phase receives the qualified project and applies the production patterns in order to generate a product. At this point, the risk is usually associated to the production rates.

The Technical Assistance phase provides the necessary resources to keep the customer's system operational.

The process output, as a whole, is the value for the customer (cost, terms and quality requirements were met) and value for the enterprise (desired profit, portfolio improvement).

6 The PDP Formalization and the Information Flow

Due to the subject complexity, especially for the high level of secrecy needed for the development of new products, we decided to do some case studies by using enterprises which declaredly have a formal products development process and made the needed information available either through texts, documents, interviews or direct observation.

The formalization was evidenced by the existence of a flow representation of the development process in each of the chosen enterprises.

In order to identify the relationship between the information flow and the PDP phases, a research form was elaborated aiming at collecting information on two basic subjects:

- 1) Is the product development process formalized and understood?
- 2) Is the information flow, which is necessary to the development process, part of this formalization?

Is the PDP formalized and understood? This question aimed at finding out if the enterprise actually had a formal development structure. The existence of a process flow representation, which was previously considered for the enterprises' selection for this research, was used as starting point for the process analysis. Mainly to verify how the information flowed from a phase to another, and therefore, how the input and outputs happened in each phase of the products development process.

Is the information flow, which is necessary to the development process, part of this formalization? Another analyzed point was if the process, graphically represented, referred to the facilitator mechanisms to the information flow.

Three different enterprises with the characteristics mentioned above were selected for this study. The enterprises' names will be omitted and they will be identified as enterprises A, B

and C. Enterprise A belongs to the Brazilian aeronautical industry, however, its performance goes beyond the national territory borders. Its main products are aircraft used for regional passengers' transport and airplanes for military purpose. Besides, it supplies other international aeronautical enterprises with pieces. The information was basically obtained through three sources: interviews accomplished during three on-site visits in a period of six months; direct observation during those visits and scientific papers studies about the enterprise. An engineer (PhD) who was the representative of the institutional connection department and an engineer who was the representative of the technological development department were interviewed.

Enterprise B is governmental and its main activity is the development of aeronautical replacement items for the Brazilian Air Force airplane fleet. This enterprise's product development process has the following main characteristics: high degree of simultaneity of developing products and also an almost-totality of development based on the customers' need. In order to answer the questionnaires, monthly visits were accomplished across a year. The interviewees were from the top management, engineer body and technical staff.

Enterprise C is related to the automobile sector and has been working on products development in a remarkable way; it also stands out for being, among the competing enterprises, the first one to invest in activities of product engineering in Brazil in the seventies. From that decade on, the enterprise has been varying substantially the scope and reaching of their product engineering activities, by following the development strategies adopted by the corporation.

The products developed by enterprise C are characterized by the use of platforms developed abroad. This way, the Brazilian engineering operates marginally, supplying information which is private and specific to the Brazilian market. The derivative products have more elaborated

activities of the Brazilian products engineering, however, some specifications are previously defined by the head office.

The interviews were accomplished with a manager who is responsible for the costs reduction in the products development process. The questionnaires were answered through electronic mail and there were no on-site visits. Some sources of secondary data, such as: scientific papers, dissertations and theses regarding the enterprise were also used for the purpose of data triangulation. Table 1 summarizes the answers collected from the research.

Table 1 – Summary of the issues related to the formalization and information flow of the PDP in enterprises A, B and C.

Enterprise	Is there a formal process?	Is it followed? (If not, how is the PDP done?)	Do the participants understand it?	Who takes part in the improvement process?	Is there an evaluation of the flowing information?	What are the tools used for the information flow analysis?
A	Yes, there is	The process is followed according to the pre-established phases.	Due to the developed product complexity, not all the participants understand all phases.	There is a team who is responsible for the research of new techniques that may improve the process.	The enterprise has software which makes the information available and at the same time enables the evaluation of how the following information may change the previous project specifications.	CAD Software, especially the Computer Aided Tri-dimensional Integrative Application (CATIA) by IBM, and the ones made for specifications evolution and follow-up.
B	Yes, there is	The process is followed according to the pre-established phases.	The main people involved in the development process understand its phases.	All the participants can take part in the improvements processes which happen occasionally.	The information flow is formalized, but there is not a criterion to evaluate the information.	ERP Systems.
C	Yes, there is	The process is followed and can be followed through specific documentation.	According to the interviewee, the process is widely known and propagated.	A specific department is responsible for the improvement activities and initiatives.	The enterprise has two integrated systems which share the engineering information and mechanisms of associated project revision.	Basically two engineering software: Pro-Engineering and the Computer Aided Tri-dimensional Integrative Application (CATIA) by IBM.

The product development formal processes of each enterprise are now presented in a more detailed way.

6.1 Enterprise A

Its product development process has already been explored in several academic studies. It is considered a more integrated, flexible and architectural model in information net. Figure 6 shows the phases of this process:

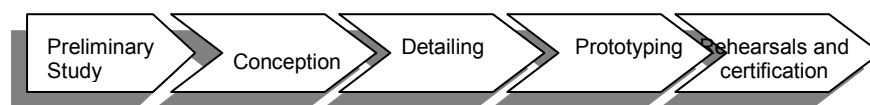


Figure 6 – Macro flow of the products development process of enterprise A.

Preliminary Study – market analyses and definition of some technical specifications.

Conception – refinement and configuration validation.

Detailing – in this phase, systems requirements and aerodynamic behavior are detailed.

Prototyping – the prototypes are manufactured.

Rehearsals and Certification – they certify the aircraft to the homologating agencies.

Enterprise A considers each new project as an opportunity to implement managerial improvements. The process represented in Figure 7 has incorporated aspects of simultaneous development and has become what is called Products Integrated Development – PID, as shown in Figure 7.

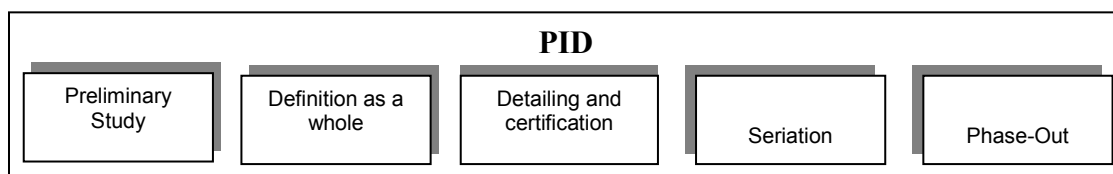


Figure 7 – Representation of the Products Integrated Development from Enterprise A.

Source: Nascimento *et al.* s/d.

The product integrated development designates a new way of treating the business functions integration in the airplanes project. The idea is to create integrated processes and to widen the scope of the project teams in order to incorporate more functions from the rest of the

enterprise and even from the outside. It is important to bear in mind that Enterprise A has undergone a reengineering which has divided it into processes and designated a team to be exclusively responsible for this organizational change.

As previously mentioned, enterprise A products development processes have always been a means of introducing new management and engineering tool. In a recent program, the enterprise introduced the electronic mock-up, which has contributed to the implantation of the new vision of the project integrated team. Besides this one, other tools were introduced into this program. New tools' identification and evaluation are the main roles of Enterprise A Technological Strategy Program. The new system in use enables the interaction between the project designer and the project through a virtual reality system. It allows the engineer to insert his/her part of the project into the computer and shows the result in such a way that the project designer can explore the internal part of the product, as if he/she was really inside it. He/she can also see what happens when his/her project is integrated into the group of project that hundreds of other engineers are doing. More than that, devices which enable other kinds of interaction are to be added to the virtual reality system. For instance, torque gloves will allow the engineers to feel the necessary manual effort to open a closet or a door.

Enterprise A also has another software, which works as an "electronic calendar" used to follow the specifications evolution, provide information on drawings, specifications, their implementations, changes, development state, that is, it allows to scan the specifications. It took six months to make the necessary adaptations to the device and to the organizational changes generated by the software. The main problem was to implement the culture of formalizing documents which used to be "in the people's mind."

This software is also used for the requirements management, from market requirements to the more detailed ones. It also allows doing management configuration and vertical integration. As the structure of the product is built, it sets the connection with the requirements tree in a

parallel way (performance specification, conformity, quality). During the Joint Definition Phase, each partner creates the system micro requirements under his/her responsibility.

In order to reinforce the importance of this information management tool, the process was different in previous projects development. Enterprise A puts in details even the micro requirements which the supplier or partner would have to manufacture. In some cases, the specifications were not compatible with the supplier production processes, causing reworks (Camargo Jr. et al. *apud* Nascimento *et al.* s/d).

6.2 Enterprise B

The Enterprise B products development process is formalized in a document which was first elaborated together with the implantation of a quality system. This document is followed in all its stages for any project. The process is complex in the way it is represented, once not only the product development stages, but also all the administrative activities are included in the diagram. Figure 8 (which is intentionally distorted in order to preserve the enterprise information) provides an idea of how the process is structured.

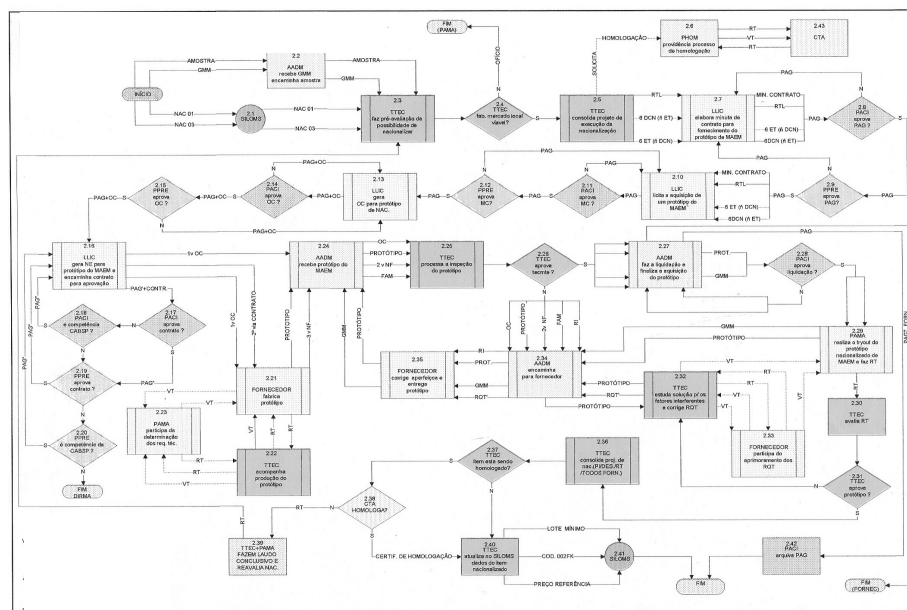


Figure 8 – Representation of Enterprise B Products Integrated Development.

This type of representation of the products development process shows the lack of definition on the part of the enterprise towards its essential competence. Even having the development of new aeronautical products as main activity, the administrative activities of suppliers auction are shown in a more detailed way in the document, which formalizes the development process.

Figure 8 flow chart was elaborated by the engineer responsible for the quality system. In interviews with technicians who take part in the process and engineers, it was noticed that, in general, they understand each phase of the development process, which can be summarized in six. Figure 9 shows the simplified representation of the process.

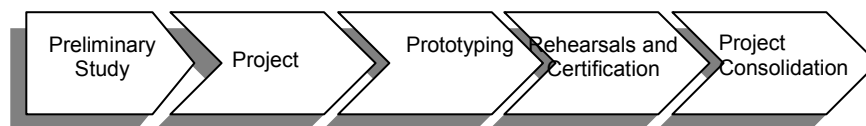


Figure 9 – Product Development Process of Enterprise B, except for the administrative activities.

Source: elaborated by the research authors

The process improvements are occasional; however, all the involved people can take part in it. In order to have an effective participation, people need to understand better the organization core activity. According to the engineer who is responsible for the quality system, the perception of this core activity lies on the products development and the acquisition of the manufacture service of the products which were already developed.

In order to manage the information, enterprise B uses integrated management software. This management integration was made as to assist the organization as a whole and based on its functional areas. Therefore, it does not have a specific module for the product development.

The information concerning this process can be obtained in a software module called

"nationalization" which makes information about the customer's request and technical specifications available.

The information flow among the products development process phases can be obtained in a physical document called Technical Specification (TS), which follows all the phases of the product development process. However, the permanent information in this document is aimed at sporadic consultations, for instance, when a problem arises. It does not have a specific purpose of providing information for the process analysis and improvement.

It was verified through direct observation that the mechanical drawing of a piece had no revision identification. It makes the process fragile, once it is likely that a not updated source of information is being used. It would cause unnecessary reworks, if this information was effectively considered not updated.

As the quality system was recently certificated, the enterprise remodeled its processes and started to understand the products development as a result of four large processes (Figure 10):

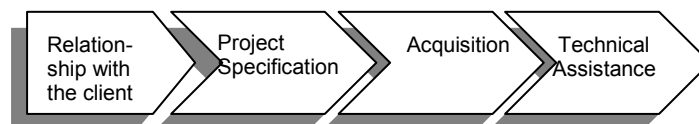


Figure 10 – Macro process of the Product Development Cycle of Enterprise B.

In general terms, enterprise B is quite behind Enterprise A and C regarding the information control and analysis, and consequently, the performance of the interactions elimination. Concerning enterprise B, it was noticed that most project interactions are about those activities after the process. It is due to the fact that enterprise B, as observed in the Figure 5, establishes contact with the suppliers (acquisition) very late. Therefore, the information on manufacturability which should be incorporated in the beginning of the process is inserted in the end, causing unnecessary rework.

6.3 Enterprise C

Enterprise C has not made the information on the specific phases of its development process available; however, it assured that, in the development activities, there are several control points which guarantee the previous executed activities and that the process can proceed to the next phase.

Also, there are systems which make possible to follow the developments, the systems to evaluate the certifications course, the systems to manage changes and the system to follow-up the tools and pieces in suppliers.

Enterprises A and C have an engineering software called CATIA, which enables the integration of several development teams as well as the integration of the engineering and manufacturing. Besides CATIA, enterprise C uses Pro-engineering software for the product specific parts project. The use of these tools facilitates the control of the information, which flows from one development process phase to another because the information is available at anytime to the interested people.

The improvement initiatives in the development process, as previously mentioned, are under the responsibility of a specific department. Although the data from interviews have not shown great efforts towards the elimination of waste in the process, the interviewee identified a number of waste.

According to the interviewed manager:

“The information flow follows the corporate procedures strictly and revisions are not frequently done.”

As previously mentioned, there are systems which evaluate the certifications course; systems which manage changes and system which follows-up the course of tools and pieces developed by suppliers.

7 Final Considerations and Conclusions

In Brazil, researches on the products development process are still incipient and for this reason, the collection of secondary data is difficult and limiting. Perhaps, it is due to the fact that the enterprises' PDPs are linked directly to its competitive advantage in the market and therefore, surrounded by a lot of secrecy most of the times. Also, the enterprises analyzed in this research could not make available a lot of information, and the conclusions here gathered are the result of the triangulation of data from different sources, which is a common procedure for researches based on case studies.

The products development processes formalization seems to be an important tool for the PDP structuring and following-up. However, not all the participants of the processes know them in details, due to either the enterprise's condition with many people involved or the lack of perception of this need. This lack of knowledge concerning the phases of PDP on the part of some people involved causes some problems in the information flow because undesired information may proceed to a next phase. Enterprise A has important mechanisms for the information flow verification and analysis. These mechanisms offer the identification opportunity, the anticipation of possible interactions responses and at the same time they enable the recognition of "seedlings" and its consequent elimination. This process becomes feasible due to its formal structure. Enterprise B showed some fragility concerning the reliability of the flowing information even if it was following the phases foreseen in the formal process. Although enterprise C showed to be concerned about providing the PDP with technical improvements, there was no evidence of solid attitudes towards the information flow improvement.

It was verified in enterprises A, B and C that the PDP information flow is, at a bigger or smaller extent, directly related to its formal structure. However, not all of the enterprises make a conscious connection between the sequence of the process activities and the information

flow. It is due to the fact that these elements are already intrinsically related. As a consequence, the improvement opportunities towards the information flow and treatment seem to be away from the enterprises' routine.

Therefore, the formal process has been helping, in a significant way, the products development process mainly concerning the information flow. However, better results could be obtained if the enterprises had a pro-active attitude towards quality mapping and analysis, the information pertinence and importance which flow in the product development process.

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