Product development through collaborative environments applied to tools.

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Abstract: Information exchange among teams involved in product development is and should be increasingly encouraged and supported by shared development tools. The emergence of collaborative project environments proves that this is a strong trend. However, for a collaborative environment to be truly effective, it is essential to understand the relations and information that will be shared by the many actors involved in the process, as well as their relations and their core competencies. This paper explores the importance of product development and how it is possible to accomplish that in a collaborative environment. The development process of injection moulds was selected as an environment to explore the ideas presented in this paper.
Keywords: Collaborative environments, communication, injection moulds

1. Introduction

The need to develop new products with a reasonable amount of innovation and within short deadlines is one of the greatest challenges that companies have had to face lately. According to BAXTER (2000), a manufacturer who is unable to move fast enough in this new business world may be seriously compromised.

In this sense, VALERIANO (1998) also points out the importance of integration between the project and the organization and the need to follow up and manage the project in a dynamic way.

Therefore, the need for shorter deadlines in the development of new products and also for a dynamic management of the unfolding of the project and its subsequent manufacture required the development of new methods and new tools that would promote a faster project development. Thus, tools such as CAD, CAM and CAE were responsible for a significant increase in the speed of new developments. However, with the advent of economic globalization, markets expanded their borders to global scale. In that moment, the manner in which people and companies communicate started to require a new project perspective, one which arose with the Internet and with the concept of virtual organizations.

Information technology and communication allow for real time interactions that create a time unit without a place unit in the virtually organized companies. Clients may contact virtual organizations, regardless of where they are, as long as they have access to a computer and a modem (STEIL and GARCIA, 1999).

The proposal for a collaborative environment in this paper was based on the detailed and careful analysis of the characteristics of the mould development sector in Caxias do Sul using field survey, that is, a questionnaire, in order to learn how relations are processed between actors in this process and which information is important. Based on that, standard analytical tools such as IDEFO and IDEF3 (www.idef.com) were used to model in a most accurately way that which was obtained during the field survey. Thus, section 2 starts with a review of the environments for collaborative projects in general, then it focuses on these environments within the context of mould development. Section 3 demonstrates how the actors of the process will start to interact based on the proposal for a collaborative environment. Section 4 presents a computer software application of the collaborative environment based on which the actors in the process will interact. Finally, in section 5, an analysis is made and a conclusion is drawn on what has been discussed throughout this paper.

2. Environment for collaborative projects

Collaborative environments and projects are increasingly more commonly used in the world due to the perspective of getting better performance from work teams and reducing failure possibilities. This is due to the fact that the teams can operate in situations where information is obtained in real time or, in the worst of scenarios, in a very short period of time in addition to being able to interact directly with those who generate the information.

Collaboration is therefore nothing but placing development and production teams, clients, suppliers, among others, to work together, regardless of their physical distance and the time differences that separate them.

Maria Edicy Moreira, (CADESIGN, 88) shows in her report about Collaborative Projects that in Brazil there are already several collaborative environments designed as project development-oriented portals. However, these portals are mostly dedicated to the fields of architecture and civil engineering. Examples of such portals are: Gpro, Neogera, Construtivo, Sistrut and Allproject.

In the mechanic sector, collaboration portals are quite rare, and the few existing ones are located in the United States, such as Soliwork's 3D Team-Works and 3D Parstream.net, Autodesk's Streamline and IBM's Enovia. It is important to point out that the portals dedicated to mechanics are essentially based on CAD software developed by these enterprises, that is, they produce and manage data using their geometries.

However, reality extrapolates geometries and requires that other product data such as production, process, costs and equipment also be a part of the collaborative environment.

More specific work with an emphasis on development of injection moulds may be found in the work of LEE et al, 1997; LEE et al, 1997; ONG, 1995; SHAKSHUKI et al, 1995 and WILLENS et al, 1995, however, they are limited with regard to the characteristic of collaborative environments. The possibility of proposing a collaborative environment is also based on the ease of communication that currently exists mainly via the Internet.

In addition to the portals previously mentioned, several projects have been developed with a view to using the Internet as a means to offer integrated development among the parts involved. In this sense, mention may be made to the work of HUANG and MAK, 1999, AL-ASHAAB et al, 2001 and ZHOU et al, 2002, both proposing platforms for the development of products based on the Internet.

Next, a case study will be presented in which a specific collaborative environment was developed for product development in the tool sector, the final products of which are injection moulds for plastic.

2.1. Collaborative environment applied to tools

Several kinds of information are required for manufacturing a mould, such as the geometric characteristics of the product to be injected, data of the process and the injecting machine, some general definitions of the mould, budget, projects, etc. Such information, which is required for the development of the injection mould, are scattered about among client, tools and project office. Thus, for such a product to be developed, it is essential that these actors interact amongst themselves in a swift, dynamic and unequivocal manner. The ways that such information is processed are intimately connected with the core competencies of each actor in the process, which will be further explained in item 2.1.2.

2.1.1. Identifying the main information and functions in a collaborative environment for mould development.

A new mould may come to be manufactured when a company (client) contacts a tool maker to provide price quotes for molds and to assess the viability to manufacture a certain product. When this happens, it is the beginning of a cycle of information exchange between the actors in the process.

The first piece of information to be supplied to the development process, within a collaborative environment, portends to the technical characteristics of the product that will originate the mould, followed by toolmaking and projects.

As the mould development process continues, the degree of interference of each actor over the necessary information being generated varies. The variation in the degree of interference over the necessary information for mould development will be discussed in item 2.1.2.

From the viewpoint of mould manufacturing, toolmaking is the main element of the process because in addition to manufacturing the mould it acts as a link between the client and the project design office. The tool maker is the one that

receives the request from the client and sets in motion the project design office. The tool maker is responsible for keeping contact with the client and transfering the necessary requirements to the design office for the development of the mould project. Client and project offices, however connected they appear to be, do not necessarily characterize the client/supplier relationship since the tool maker is the de *facto* contractor. However, at a given moment, communication and information exchange between project office and client start to take place in an indirect form, that is, they both end up exchanging information regardless of the tool maker. This makes the relationship between the actors and the process of information exchange become unstable, once a paralel system of communication is established, thus creating a redundant source of information as shown in Figure 1. When this happens, information may be misinterpreted and spin out of control, especially when client approval of the services being developed is involved.

Hence, it is necessary to recognize which piece of information each actor in the process needs to generate, in which way it is possible to promote the interaction among actors based on the information generated, and the level of interference of the actors in such information.

2.1.2. Main competencies in the collaborative environment of mould development.

For the process of mould development to occur without any trouble, it is important to be familiar with the characteristics and responsibilities of each actor in this development environment. Thus, it became clear that a careful analysis of this process was needed in order to understand it and later organize it adequately. The analyses performed for the definition of competencies were based on mouldings IDEF0 and IDEF3, shown in Figure 2 and in Figure 3 respectively. The IDEF tools have been used in several jobs both for better understanding of the process as in CHENG-LEON. 1999: CHO and LEE, 1999; HUANG and MARK, 1999, and for the comprehension of this tool's potential for analysis (COLQUHOUN et al, 1993). Thus, starting from the analysis performed with IDEF tools, it was possible to identify the points where the process could be improved, and to contribute to the definition of the core competencies of each actor. This will allow for information exchange to favor all those involved, thus speeding up the exchange process and at the same time keeping such information under control.

As a consequence of such analysis, it is possible to obtain a transparent environment, the result of which is clear, fast and organized information that allows for the speeding up of the process of injection moulds development.

According to ABREU (2000), Core competencies are the group of necessary or essential skills that must be defined and organized for a specific activity to be developed in an adequate manner.

In this paper, core competencies were presented in order to define the skills and functions developed by each actor in the process, and thus to better understand its relations with the information involved in the process of mould development.

An analysis of client-related competencies showed that they refer to the supply of specifications that the injected component will have, such as: material to be used, material shrinkage, component geometry, aesthetics , production and productivity demands, characteristics of the process and building characteristics of the mould. Figure 3 uses a scheme to represent client competencies and their relation with IDEF0 and IDEF3 moulding.

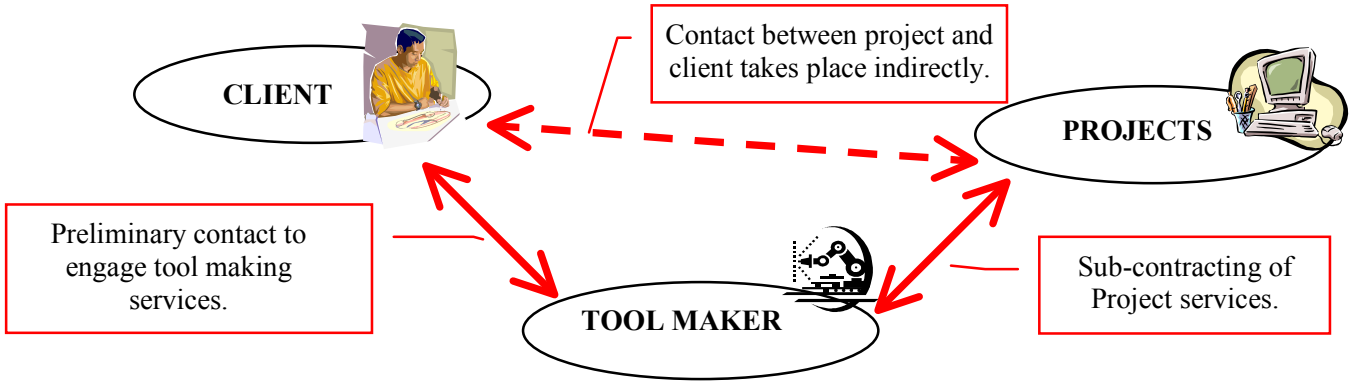

Figure 1: Relation between Client, Tool maker and Projects.

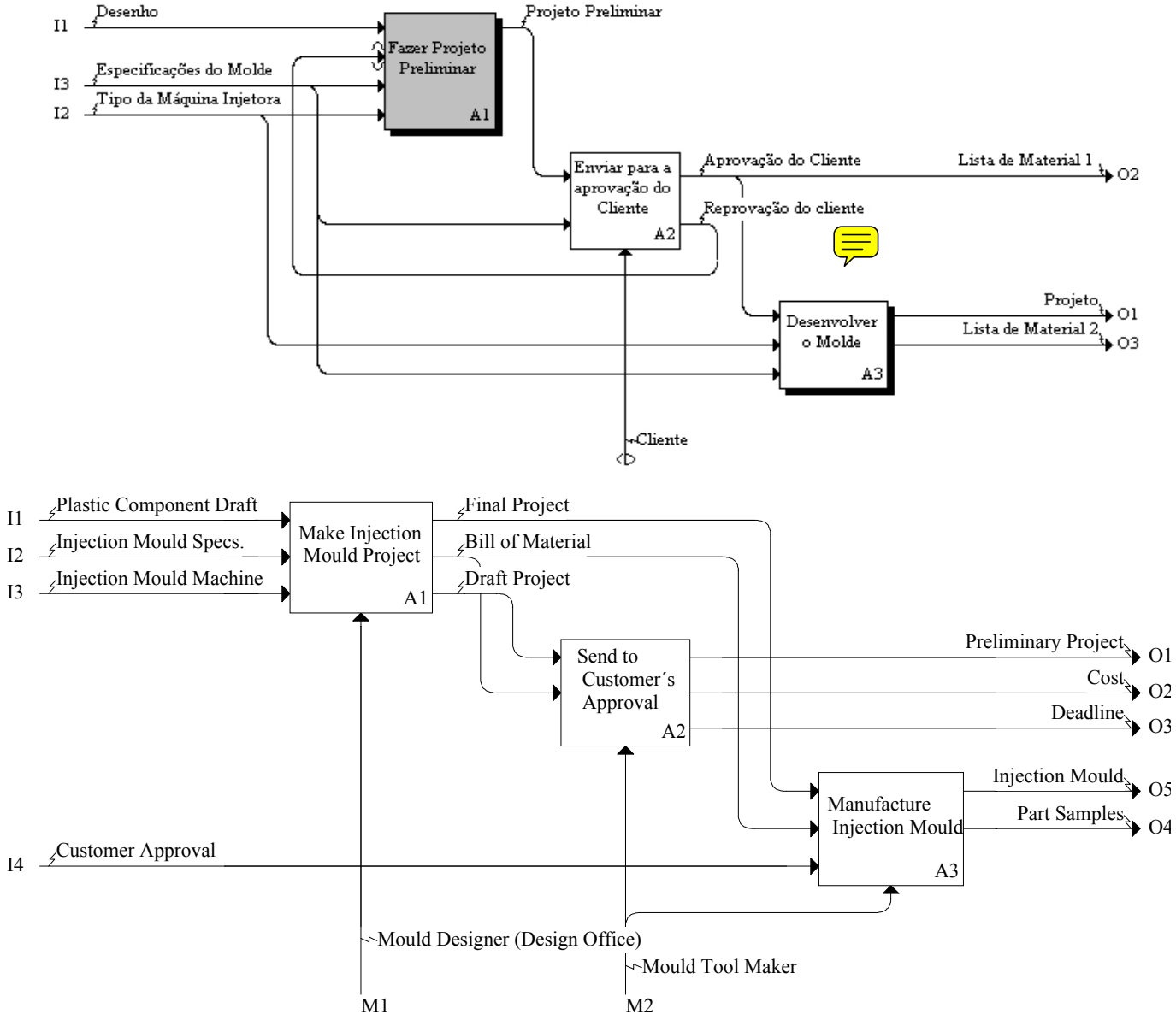

Figure 2: Functional modeling for the moulding development project (IDEF0).

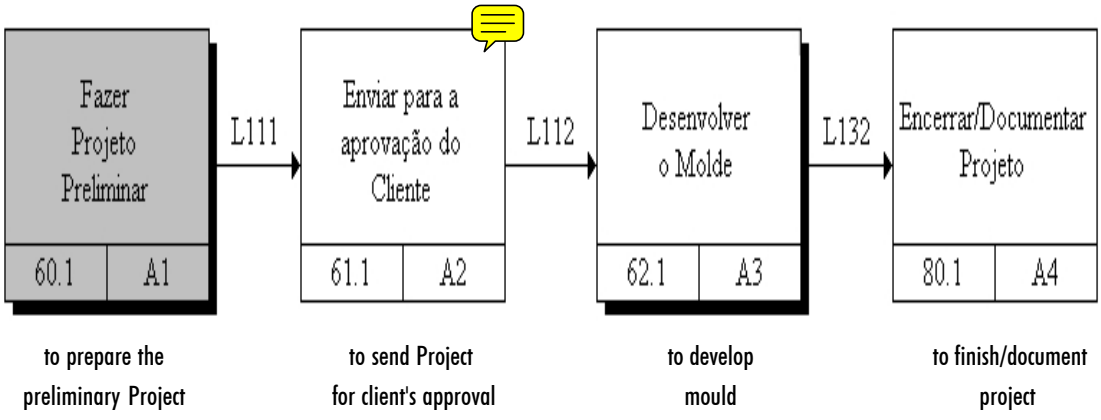

Figure 3: Modeling the process for the moulding development project. (IDEF3).

An analysis of competencies regarding the toolmaking process shows the complexity and the scope of this activity. The tool maker performs the activities of budgeting, project management, machining processes and heat treatment, machine selection, equipment and tools for the manufacture of moulds, CN geometric modeling, assembly and adjustments. Figure 4 shows these competencies and the need for interaction with both internal and external teams.

Based on the definitions of core competencies taken from the IDEF analyses, it is possible at this point to establish the level of interference the actors have in the information generated in a collaborative environment. Table 1 shows some information required for the process of mould development supplied by actors in the process.

3. Collaborative environment of support to the mould development of plastic injection moulds.

As stated before, there are several Internet portals that offer collaborative environments for project development. However, none presents a specific solution to the mould injection development sector.

Therefore, the collaborative environment proposed seeks to allow for an integration among actors in the process of injection mould development in a way that enables them to interact and exchange information in a clear and dynamic manner within a specific environment for this sort of development.

Consequently, the environment is structured in such a manner as to allow each actor to work within his/her core competencies, and thus be able to control and be aware of his/her information. In addition to that, other actors interact with each other because the information placed there will be visualized by and commented on by all users. Figure 6 shows the integration that the actors in the process will start to have in a collaborative environment. Another highly relevant fact in this environment is the possiblity for actors to make the necessary alterations throughout the mould development phase and at the same time record and justify such alterations. This will act as the mould's development history, and may help future developments.

Table 1 – Specifications for mould development and the level of interference over them.

Requirements / Specifications	Client	Toolmaking	Projects
1. Client Information	∩	•	•
2. Injected component information:			
2.1 Geometry	∩	∪	∪
2.2 Material	∩	•	•
2.3 Production Volume	∩	•	•
3. Injection Mould Machine Information	∩	•	•
4.Mould Information			
4.1 Mould Material	∩	∪	∪
4.2 Finishing	∩	•	•
4.3 Engravings	∩	•	•
5. Mould Manufacturing			
5.1 Equipment	•	∩	∪
5.2 Heat Treatments	∪	∩	∪
5.3 Manufacturing Time	•	∩	•
6. Project			
6.1 Project Cost	•	•	∩
6.2 Project Design Time	•	•	∩
6.3 Number of Impressions	∩	∪	∩
6.4 Feeding System	∪	∪	∩
6.5 Ejection System	•	∪	∩
6.6 Project Management	∪	∪	∩

Level of interference: ∩ – strong ∪ – little • – none

4. An experimental environment supporting collaboration in the injection mould development process.

From the operational standpoint, the operation of this environment is based on the use of a software application designed specifically for this end, which acts with every one of the actors involved in the process by means of specific interfaces that allow access to a common databank. Using such databank, each actor will be able to access the environment, which may happen through the Internet, an intra or extranet, or a combination of these possibilities, and to insert or alter data regarding their core competencies, thus interacting with all others. In this information exchange process, each actor is responsible for the data that he/she is supplying the system, which is recorded on the only databank residing with the tool maker, as well as for their update.

Figure 7 shows the three main areas of data insertion and follow-up generated in the environment, which are the following:

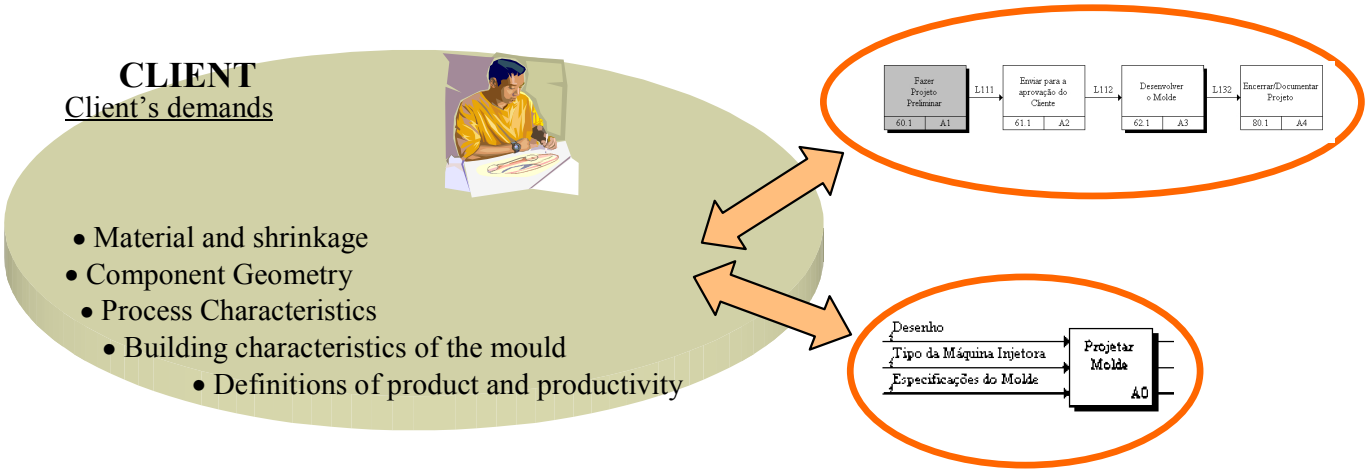

Figure 4: Core competencies of the client.

- Product Information area: in this area, each actor can add or edit information about a project that is either starting or in progress;
- Comments area: this area is where actors can input their comments related to any changes made in the product, in the mould project, or may exchange ideas.
- History area: this area serves as a databank for the changes made during the development process.

Another important factor is the possibility to follow the status of the mould development throughout the process, that is, being able to track approvals or rejections of the budget the budget, the preliminary project, the final project, the samples or even whether the project is with the design office or with the tool maker and in which phase. Tracking projects becomes more interesting and more critical when there are several projects in progress.

5. Conclusion

This paper sought to show the importance of a collaborative environment in the sector of product development applied to injection moulds. As it is an important industrial sector that is increasingly under pressure both in terms of delivery deadlines, as well as in the level of difficulty that injected component geometries present, communication among the actors involved in this process may contribute towards reducing manufacture deadlines and improving the

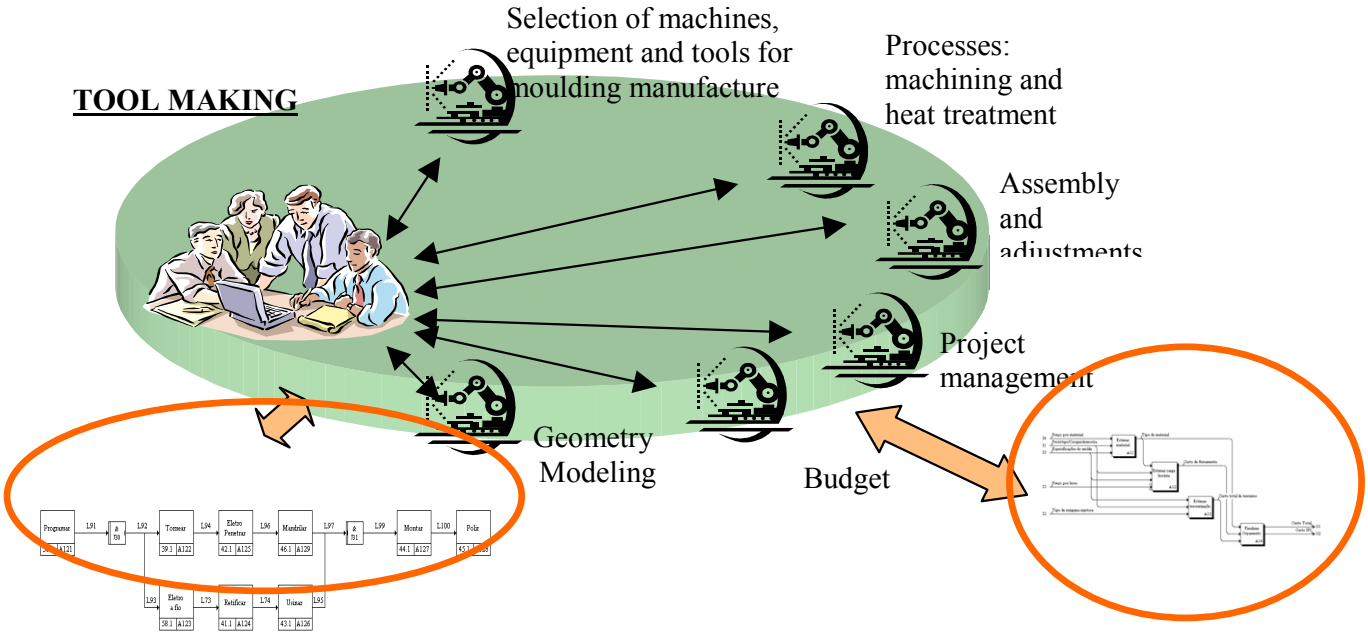

Figure 5: Core competencies of the tool maker.

quality of moulds due to a higher efficiency level and greater dynamism in information exchange.

Based on a field survey, this paper also focused on the importance of proceeding to a detailed and careful analysis of the sector's characteristics, in order to become more familiar with the way the relationship among actors in this process takes place and which information is important.

Starting from that point, standard analysis tools such as IDEF0 and IDEF3 were used to detail more accurately that which was obtained in the field survey. Another important factor for the proposal of a collaborative environment is the great ease with which communication occurs at present, whether by using the Internet, extranets, intranets or a combination of all of them.

Finally, it is essential to point out the importance of knowing in detail the ways by which the relations between the actors in the process occur, which information must be considered so that the work can achieve its goal and in what way communication can promote the required speed so that not only the industrial segment of mould manufacturing can be helped, but also any other segment of product development that wants to operate in a specific environment.

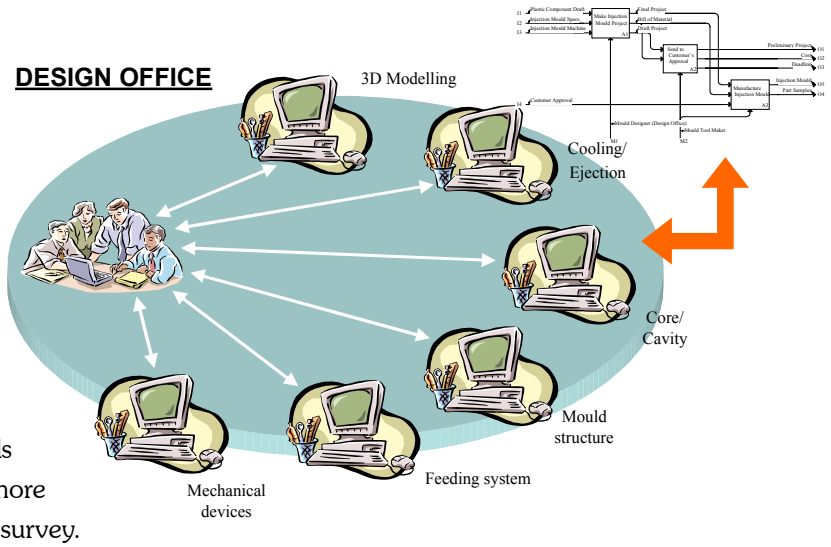

Figure 6: General depiction of a collaborative environment

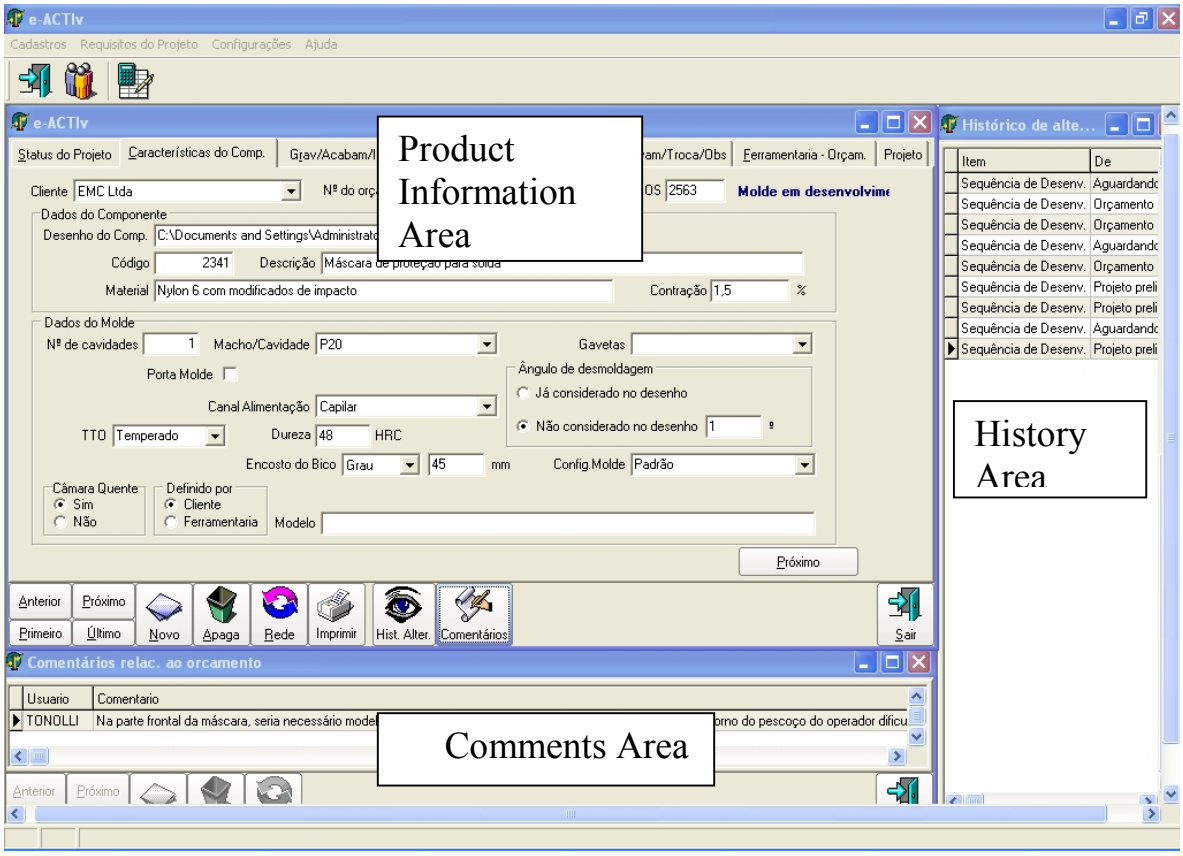

Figure 7: Screen dump for product information, comments and history.

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