INSTRUCTIONS FOR THE DETAILED PROJECT OF INJECTED PLASTIC COMPONENTS USING DFMA

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Abstract. *The injection molded plastic components (IMPC) are generally alternative economic, efficient and necessary for the mass production of products. However, the process of development of these components is complex, mainly in the phase of detailed project. This phase is initiated with one the conception selected in the conceptual project phase, which presents one high degree of abstraction. As result of the detailed project has the drawing/project of the component. In the detailed project modifications in the form of the component occur, aiming at mainly its manufacturability, assembly and moldability Currently, works exist on methodologies of development of IMPC that treat since the informational project of these components until the manufacture of the injection mold. However, these methodologies if show including, requiring the development of works that focal the use of methods of DFMA (Project for Manufacture and Assembly) in the aid to the definition of the component form of more systemic form. Under this target, the objective of this work is to instruct, of methodology form, some lines of direction of the project detailed for the definition of the form in IMPC, under the boarding of the DFMA. Thus, the possibility of reworks or redesign of the component can be minimized, still in the Detailed Project phase*.

Keywords*: injection molded plastic components, methodology, Detailed Project and DFMA.*

1. INTRODUCTION

The current period of training of development in the plastic sector comes showing the position reached for this type of material, in the production of consumption good, especially the gotten ones for the process of molding for injection.

In the constant search of the operational efficiency and better productivity, the first step given for the organizations was to improve the productive system. With the evolution technique, currently, many companies had started to implement programs of guarantee of the quality in the conformity of the product. However, those companies who develop differentiated products and with quality have more quality.

Front to this, much attention is being directed to the project process, therefore the quality cannot be inserted in a product not to be that she has been projected in it. One of the main results was to the discovery of the importance of the manufacture costs and assembly. It was raised then, merit of the principles of one of the more important methodologies of project, the DFMA (Design will be Manufacturing and Assembly), originated in the Europe in years 70, whose objective is to simplify the product in order to reduce costs (Catapan, 2006).

In this direction, this article is presented in the form to display some parameters of project for the definition of the form in injected plastic components in the phase of detailed project, organizing the knowledge of systemic form, under the optics of the DFMA.

2. PROCESS OF PROJECT OF INJECTED PLASTIC COMPONENTS

The process of molding for injection is one of the main processes in the area of manufacture of plastic parts. About 32% of the produced plastic parts in Brazil they are manufactured by this process (Mascarenhas, 2002). The capacity to produce complex parts in great amount and in necessary way is responsible for this. Although its great use, the conditions of molding of parts for injection during the accomplishment of its cycle, can take to the sprouting of effect or phenomena compromising the structure of the part, its dimensional tolerances or even though its appearance.

The knowledge of these effects for the project team can assist in the development of the product in its phase of detailed project, especially in the determination of specific forms, the analyses of moldability, easy manufacture and assembly, which can be carried through with aid of the DFMA methods.

According to Blacksmith (2002), the process of development of injected plastic components, is characterized for being an activity to multidiscipline, and carried through in a fragmented environment. Multidiscipline, for considering information proceeding from distinct fields of knowledge. Multidiscipline, for the project of the injected component to involve the iteration and interaction of relative information to these fields of knowledge.

Multidiscipline, for the project of the injected component to involve the iteration and interaction of relative information to these fields of knowledge. E, broken up environment, for the nature of the organization of the involved companies in this activity, that is, generally exists a responsible company for the project of the component; other, responsible for the process of injection e; one third, that it executes the development of the injection mold, as Figure 01.

Moreover, it is important to stand out that, in some cases the project of the mold is made by the company manufacturer of the mold.

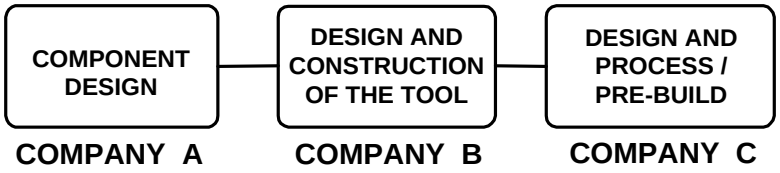

Figure 01. Cycle of development of injected plastic components, apud to Back (1998)

It is treated therefore, of a development process justifying the adoption of an environment of simultaneous engineering, therefore it is a process intrinsically to multidiscipline divided in three great distinct phases and with strong interrelation. Moreover, normally a company is executed for more than that presents a low degree of integration. The project of the manufacture process involves the determination of the process parameters and it is only concluded with the manufacture and approval of the lot pilot of the product.

Considering these aspects, it is important that the project of injected components is carried through in systematic way, looking for to integrate the different fields of knowledge and the involved sectors, in accordance with the principles of simultaneous engineering. In other words, to assure a good quality of the project of the component, it must have a harmony enters the form of the component with: the specifications of project, process, mold, material of injection and cost, as illustrated in Figure 02.

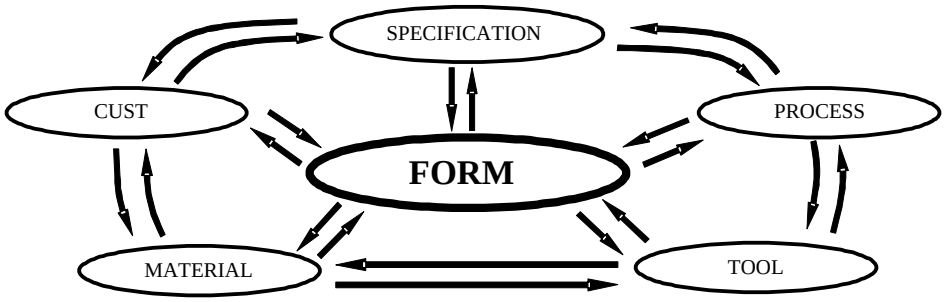

Figure 02. Relation of project specifications, apud to Catapan (2006)

The project of a plastic component is influenced by relative factors to the type of material, conditions of easy manufacture, moldability and the related ones to the service for which the component was projected (ex: easy assembly). Being about plastic components, the evaluation of the moldability of the component becomes important, therefore this evaluation can minimize the problems that normally occur in the production (Daré, 2001). In such a way, it can be anticipated and be annulled to the causes of these problems, guaranteeing the quality of the component and the attendance to the project specifications. Currently, distinct computational programs exist that make possible the analysis of the moldability of the product, however the same one are carried through when the product meets in advanced phase of development.

According to Blacksmith et al. (2003), a characteristic of the project of injected plastic products is the fact of the same being carried through taking in account, information, established on the basis of rules, recommendations, strategies and principles of solution, normally, gotten from the knowledge of specialists. On the other hand, these information are considered of isolated form, in the form of tacit knowledge, therefore they do not consider the nature to multidiscipline and to multidiscipline of the same ones.

The initial development of the injected component is carried through on the basis of subjective recommendations of project, information and using itself of the experience of specialists. However, the methodologies of project of systems technician do not consider these aspects, a time that the development of the system is carried through, mainly, on the basis of its unfolding function, as Catapan (2006). Moreover, these methodologies do not contemplate the way by which the injected component is developed and also they do not possess procedures and tools capable to minimize the occurrence of the problems, it discloses most common, as: related to the development of injected components they are the inadequate generation, evaluation and exploration of the viability economic technique and of the alternatives of conception of the component. Soon, it has an inefficient evaluation of the component in relation to the easiness of production, the costs of the injection process and to the project of the injection mold.

Although some proposals of methodologies of project of products to exist, each one of them with its particularities, perceive that all possess similar elements. According to Ogliari (1999), the existing differences between the

methodologies, occur normally in the terminology used for the authors and in the detailing of the project processes. From the similarities between the classic methodologies, a model of consensus for the process of development of products can be established. This model can also be visualized in Figure 03.

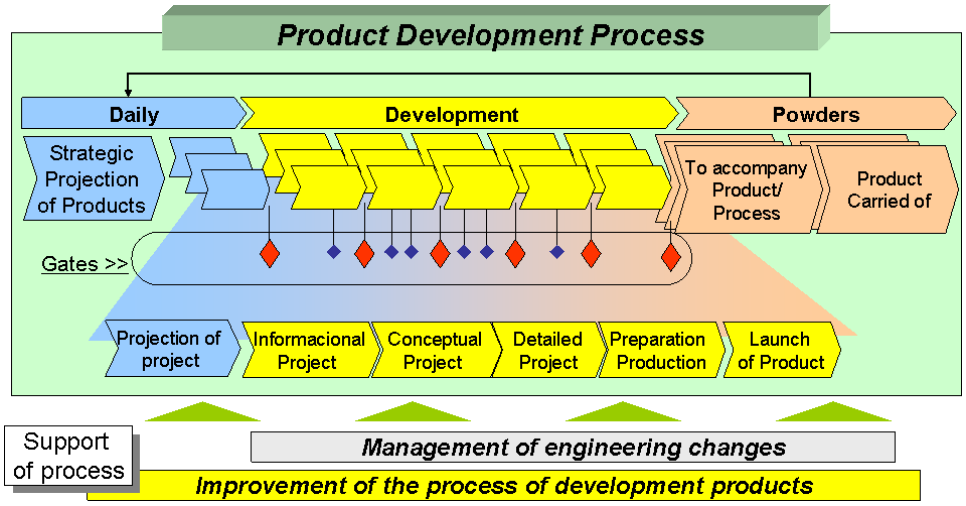

Figure 03: Process of Development of Products (Apud to Rozenfel et al, 2006)

Daré (2001) makes some considerations how much to the adequacy of the generic methodologies to the project of injected plastic components. The author still considers that the project of components must be dealt with a particular form, justifying the study and proposals of specific methodologies, even so if he can use many recommendations and tools proposals for the generic methodologies.

Considering the necessity of a more specific boarding for the project of injected plastic components, searching they had considered some systematic, having been that the majority of them follows the philosophy imposed for simultaneous engineering, in which its stages are carried through simultaneously. Some authors as Back (1998), Blacksmith (2002) justify that the conduction of the process of development inside of an environment of simultaneous engineering is basic to correspond the current requirements in relation to the reduction in the time of development of new products.

In this direction, one notices that the main problem, inhabits in the fact of the methodologies not to offer has supported the phase of detailed project considering the DFMA boarding.

3. DESIGN FOR MANUFACTURING ANDASSEMBLY - DFMA

The DFMA, Design will be Manufacturing and Assembly, is a philosophy that uses diverse concepts, techniques, tools and methods to perfect the manufacture of components or to simplify the assembly of products, using for such, since the analysis of values of tolerances, the complexity of the product, minimum number of necessary components, layout of the product amongst others. The DFM (Project for manufacture), translates the search during the project, in becoming more easy the manufacture of the components that will form the mounted product after. While DFA (Project for assembly) evaluates the product all, not only the parts individually, and tends to simplify the structure of the product while it keeps the flexible project looking the most efficient use of the function of the component. When it is making the assembly of the product the least expensive and as optimized as possible.

The necessity must be standard out to always evaluate well the necessity of a component, having to look for to reduce to the maximum the number of components in the end item.

For such, use of three basic rules can be made to verify the necessity of definitive component (Souza, 1998):

1. Exists necessity of relative movement between the parts?
2. Exists necessity of specification of different materials for chemical physical reasons/?
3. The component must be dismountable to facilitate maintenance?

Another important aspect is the verification of the possibility to integrate functions in components when possible, therefore, components with functions integrated do not need to be mounted e, generally they possess minor cost of manufacture compared with the addition of the costs of the separate parts.

According to Souza (1998), Forcellini (2003) and Catapan (2006), in a general way, the project for assembly has as main lines of direction:

- To project for a minimum number of components;
- To use standardized components and processes;
- To develop a boarding of modular project;

- To use unidirectional a clamped assembly/;
- To facilitate to alignment and insertion of all the components;
- To eliminate screws, springs, sheaves;
- To eliminate adjustments;
- To use and to promote the work in team (simultaneous engineering).

Already the project for manufacture has:

- It compares the use of different combinations of materials and selected processes of manufacture for the parts of an assembly;
- To look for to standardize materials, finishing and components;
- Components with ergonomic form;
- It determines the impact in the cost with the use of these materials and processes.

4. PROPOSAL TO ORGANIZE THE KNOWLEDGE OF THE PROCESS OF PLASTIC COMPONENTS INJECTED IN THE OPTICS OF THE DFMA, FORM OF PROJECT INSTRUCTION

In this item it will be possible to visualize in the 04 Fig. and Fig. 05 that difficulties in the elaboration of the preliminary drawing in injected plastic components exist in the phase of detailed project, had to the possible re work since the form of the conception of the product until the form of the end item. To the end of this item it will be possible to identify where it will be possible to attribute the methods of DFMA for this phase of project.

According to Rozenfeld et al (2006), with the conclusion of the conceptual project, initiates it phase of detailed project. In this phase, the project team must look for to improve the form and the dimensions of the selected conception, aiming at to test its compatibility space. Later, this conception again will be evaluated according to economic aspects technician and. As result, they have project of the definite product. The detailed project involves the modification of the form of the injected component aiming at its manufacture. Also, structural aspects and of moldability of the component are evaluated, having as resulted, the modified project of the component.

To present as the injected component it can be modified, aiming at its easy manufacture and moldability will be considered the product illustrated in Fig. 04. The initial project of the component (illustration to the left) was modified (illustration to the right), through the alteration of the rays of rounding and the angles of exit of the tool, aiming at to improve its moldability and the process of manufacture and, of the inclusion of a texture with the objective to improve the appearance of the component (Catapan, 2006).

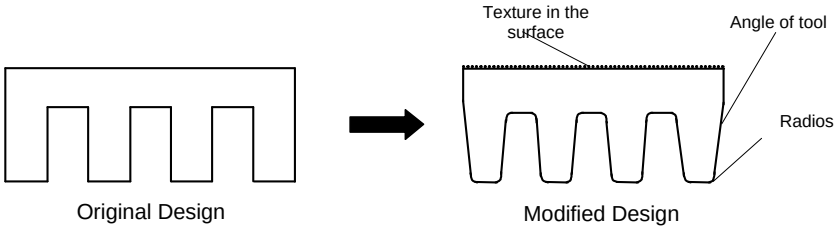

Figure 04. Comparison of the original project for the modified project of an injected plastic component, aiming at its easy manufacture, apud to Catapan (2006)

To present as the injected plastic component it can be modified, aiming at its easy assembly, will be considered the product illustrated in Fig. 05. The initial project of the component (illustration to the left) was modified (illustration of the way) through the elimination of some screws for alteration with rabbet and a screw, plus an alteration occurred (illustration to the right), through the elimination of all the screws and adding snap-fits (element of setting for constructed rabbet of flexible plastic material) to facilitate to the assembly of the component in the system technician.

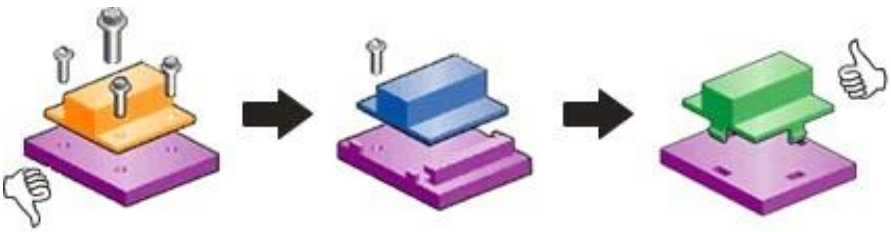

Figure 05. Comparison of the original project for the modified project of an injected plastic component, aiming at its easy assembly. (GE Plastic, 2003)

According to Blacksmith (2002), the place that in the detail phase project he is carried through reworks aiming at to implement modifications in the form of the product due to the geometrics of the conception to be inadequate in relation its easy manufacture, moldability and the interfaces of the component with the system technician (when necessary mounted product already), being able to increase the project time consequently and, its cost.

Whichever to the methodology or adopted systematic, is verified that in if treating to the detailed project it has a consensus in the direction to use the knowledge according to DFMA boarding. In the model considered for Daré (2001), these knowledge could be used in the initial tasks of the phase of the preliminary project, getting an important effect in the definition of the form of the component that is being developed, preventing reworks of the same in this phase of project. Thus, Catapan (2006) considers a project systematic, for the definition of the form in injected plastic components, using the DFMA and, this, can be directed to the orientations for designers, in form of project instructions.

At the beginning of the phase of detailed project, the team of product development must identify the parameters (requisite of project) of bigger importance under the boarding of the DFMA methods. That is, to prioritize those parameters that facilitate to the manufacture and the assembly of the component. At this moment it is basic that an integration with the Designers, the Designers of the Product and the responsible team for the manufacture of the mold occurs, a time that limitations and parameters of manufacture process can determine characteristics in the component. Soon, in this task, it must have a good agreement for the project team, therefore, in case that he is not clear-cut which are the main parameters, it will be able to have unnecessary interactions in the posterior phases between the team of project of the component and mold of injection.

Following the methodology of Daré (2001), at the beginning of the phase of preliminary project, the necessity exists to detail the beginning of the preliminary project to be carried through, as: to make a revision of the requirements and restrictions of project, to define which will be the functionality and usability of the component and to define which will be the raw material to be used to inject the component. This makes with that in the following phases of project, some problem that comes to happen, for virtue of one me the definition of these activities, as for example: parts as the same material mounted in the system technician and this will have relative movements between them, causing an extreme consuming of the material for being equal.

With these carried through steps, it is necessary that the project team aims at to the manufacture, molding and assembly of the final component. For this, the DFMA is a very efficient method, therefore, under a systematic order, it makes with that it prevents unnecessary interactions and reworks for the following phases of project. With the displayed one above, it is clearly the necessity of explain which would be these recommendations/instructions of the Detailed Project, following the boarding of the DFMA.

With this, in Fig. 06, they will be displayed, which are these instructions for attainment of the preliminary form of the component no longer beginning of the phase of detailed project, under a systemic order, to eliminate the iterations during this phase of project.

5. CONCLUSION

Through this work, it was looked to demonstrate to the importance and the contributions of the boarding of DFMA applied to the project of injected plastic components, therefore the use of the resources proceeding from this technique at the beginning of the phase of detailed project, provides a bigger possibility of execution of integrated project, according to rules of Simultaneous Engineering.

Moreover, it allows to the reduction of the number of iterations and interactions in this phase of project, reducing consequently the time of development of the product. Another excellent aspect of the boarding of the DFMA in the project of components injected is the fact of if preventing rework, a time that can be established evident and less subjective parameters for form of the product. In short, with the integrated boarding of the DFMA in the detailed project, capacity will be had to project the component being aimed at to implement in the end item, characteristic that they assist its easy manufacture and assembly, favoring increase of his quality, reduction of cost and to assure stated periods of launching of the product in the market.

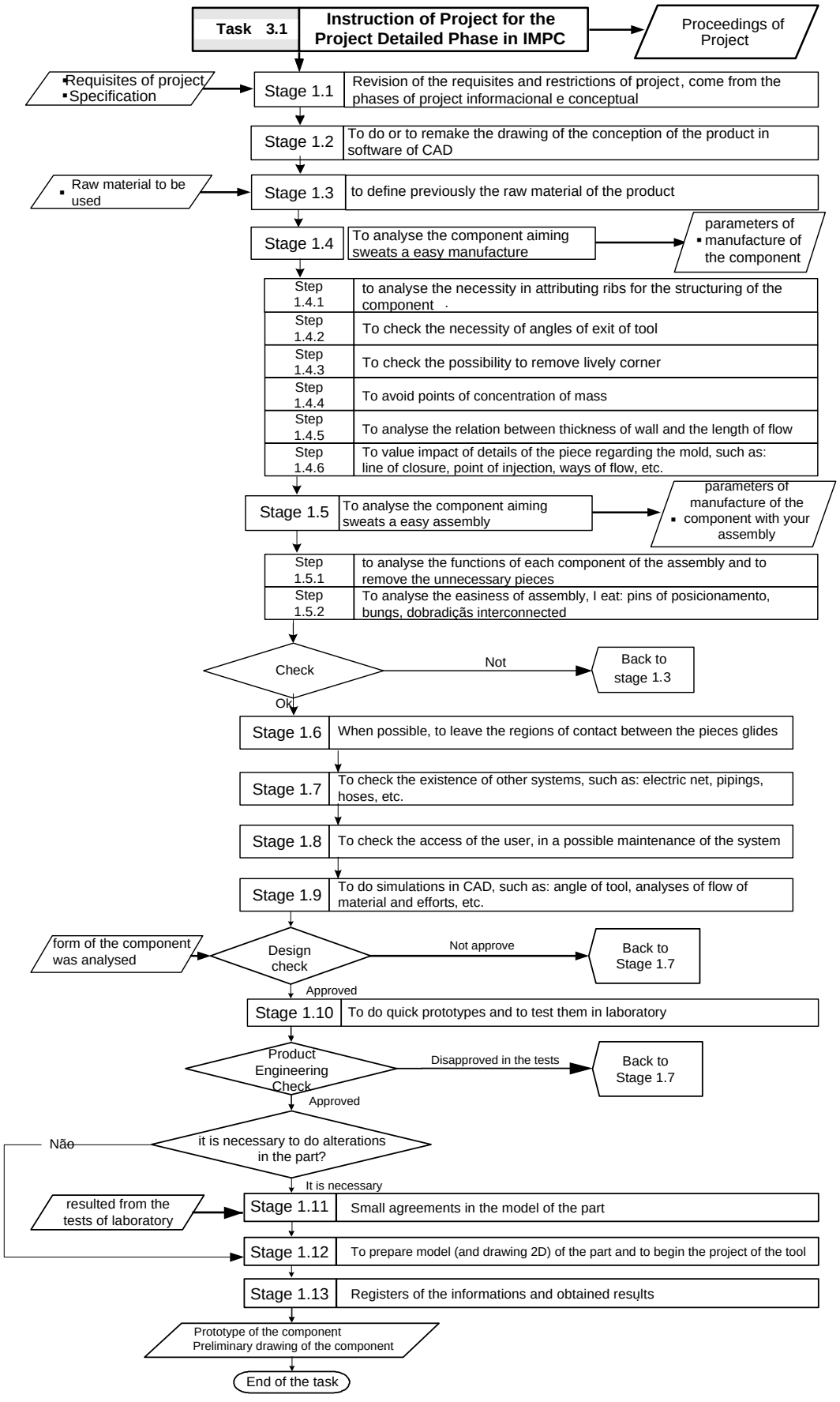

Figure 06. Instructions of the Project Detailed for the definition of the form in injected plastic components, using of the DFMA

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