A preliminary NPD analysis in a steel company

Angelo Varandas Junior, Paulo Augusto Cauchick Miguel
University of São Paulo
e-mails: avarandas@cosipa.com.br; cauchick@usp.br

Abstract: The steel industry is under an intense pressure to introduce new products. This justifies a growing concern with the effectiveness of the new product development (NPD) process, in which performance depends on various factors found in the literature. In the case of the steel industry, one of the relevant factors is the manufacturing process design, not only because this is a continuous process but also because it involves significant investments to prepare for production. Thus, this paper conducts a critical analysis of the process design stage in a company from the steel industry sector. It proposes identifying the organizational practices and their respective interfaces, involving areas of marketing, product engineering and manufacturing. It also considers the way multifunctional teams are integrated, the decision making process, and the criteria used to evaluate the NPD results. The paper concludes that the company adopts organizational practices that create a framework for NPD and that the integration of functional areas is one of the success factors within NPD.

Keywords: product development process, process design, metal industry.

1. Introduction

The new product development process (NPD) has become essential to obtaining competitive advantages for companies and is one of the most important activities to maintain market position. The demand for the introduction of new products has increased intensely, justifying a greater concern with NPD efficiency and effectiveness. Performance depends on effective and efficient NPD management, which should go beyond seeking lower costs, to also find desirable conditions for competitiveness and getting the product to market as quickly as possible, the manufacturability of the product, and for creating and strengthening, in each project, the capabilities required for NPD in the future (MUNDIM et al., 2002).

With constant changes in products, NPD has undergone an evolution which is presently divided into three stages, according to Rozenfeld et al. (2006): sequential development of products, which has focused mainly on the division of tasks; specialization and emphasis on the functional areas; integrated development of products, which is characterized by encompassing simultaneous engineering approaches from Clark and Wheelwright's (1992) development funnel, and Cooper's (1993) stage gates; and new approaches to integrated product development, which include lean development and design for six sigma and the maturity models.

Associated with these changes in the NPD, Rozenfeld et al. (2006) stress that the NPD is made up of four inter-related macro topics: strategy, which includes portfolio management, performance of the process, engaging in alliances and partnerships, dealing with cross-functional, interdepartmental and organizational relations, which include management of the organizational structure; leadership and personnel training; activities and information which have to do with the operational phases and with the normalisation and control of the information generated, and resources, which are techniques, methods and support tools.

In addition to the four inter-related macro topics, NPD is presently viewed as a business process focused on the final client, integrating people and functional areas in a search for simultaneity in carrying out tasks (CHENG, 2000). Using this concept of process, several authors divide the NPD into distinct phases aimed at making it operational, for example Clark and Wheelwright (1992), who divide the NPD into four phases: concept development, product planning, product/process engineering and pilot production/increased production, alternating with phase revisions to create a managerial decision point for assessing the possibility of continuing the project and the risks involved. The first two phases are concept development and product planning, which include obtaining and organizing information about market opportunities, technical possibilities and product requirements. The phase of engineering of the product/process involves detailing the project-build-test

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cycles, until they reach the maturity needed to begin production. The last phase includes increasing production volume, which encompasses refining the costs and quality in the production process.

It can be perceived in analyzing the NPD phases that product design details are translated into manufacturing plans at the process design stage. The information at this phase includes the definitions and data necessary to make the product. At this phase, there are more frequent changes to the design, which can result in the loss of previously completed work (BARKAN, 1992). According to this author, modifications to the engineering are considered as first order problems in the NPD, and can be utilised as a control item to measure the effectiveness of the operational part of the NPD. Finally, the reworking of the process design has direct impacts on costs, time and development and indirect impacts on the quality of the products.

Expenditures for reworking have been cause for concern in the steel sector, the focus of this study, in function of the introduction of new products generated by the market and the importance of the design to these companies. The Brazilian steel industry's strategy for growth is based on the upgrading of products and technological innovation via incremental technical changes to its processes (PAULA, 2002). Thus, structuring the NPD is also necessary for these companies, due to their natural complexity, especially their organizational nature, as classified by Clark and Fujimoto (1991).

The companies in this sector today have complex organizational interfaces, including relations with different people, resources, and knowledge and company functions, such as marketing, product engineering and manufacturing. Moreover, to develop a new product it is necessary to interact with these organizational interfaces, which are managed by different people with different views of the importance of NPD as company business, causing difficulties in its management (COSTA SILVA, 2000). Further, in the process design phase there is a need for greater structuring of management and using NPD support methods due to the intensification of problems with organizational interfaces and the increased project costs at this stage. The concept of organizational interface used in this article refers to the management of diverse company functions involved in the NPD and different NPD objectives (HAQUE et al., 2003; KRISHNAN; LOCH, 2005).

In this context, the present work aims to make a preliminary analysis of the NPD process in addition to the phase of design process, seeking to identify and compare organizational practices in the NPD of a unit in the Brazilian steel sector with those in the literature by means of a case study of an exploratory nature.

2. Theoretical framework

Developing a theoretical reference is done in the following way: it begins with a broad search about NPD, a horizontal sweep which contemplates the following subjects: NPD, interfunctional integration of NPD, support methods for NPD and a structural reference for understanding NPD. After this stage, a more directed search is undertaken, a vertical sweep, funnelling the concept of NPD in the phase of process design and with the theoretical concepts and research questions are identified using this information.

First a bibliographical search was done using principally the CAPES portal for journals, as well as searching libraries and some sites for articles, theses and dissertations. With a read on the material initially found, three topics were identified which were considered relevant to the theme (the vision of NPD as a business process, the influence of the complexity of the process and product, and the process design phase). Then, the outlines of the theme "NPD process design phase" were determined. One hundred and thirteen works from different sources were consulted in this review of the literature and forty-four were selected as more directly related to the process project phase. In the publications analyzed, the research methodology most utilized was the case study (40%), followed by the survey (32.5%), theoretical-conceptual works (15%) and reviews of the literature (12.5%). The approach of the studies, depending on the nature of the variables, is divided into qualitative (48.3%) and quantitative (51.7%), in which the main data collection tool was interviews (50.0%) and questionnaires (28.5%), while 21.5% used both data collection instruments. At this stage of the literature review, the main topics related to the NPD that influence the process design phase were identified, those cited by various authors who research this matter. Part of these results (due to extension of topics) are (GRIFFIN, 1997; CHENG, 2000; COOPER; KLEINSCHMIDT, 2000; CHRONEER et al., 2001; LARSEN; KIM, 2001; BLAKEMORE, 2002; BONNER et al., 2002; SILVA, 2002; HAQUE et al., 2003; HART et al., 2003; KENNY, 2003; HOLMES; CAMPBELL Jr., 2004; NOBELIUS, 2004; SYAMIL et al., 2004; SHANE; ULRICH, 2004; SYAMIL et al., 2004; ABDOMEROVIC et al., 2005; ANTONI et al., 2005; FREDERICKS, 2005; THIA et al., 2005; Van OORSCHOT et al., 2005; AKGUN et al., 2006; KRISHNAN; LOCH, 2005):

- Environment of uncertainty;
- Team learning;
- Collaboration and communication;
- Meeting deadlines;
- Definition of responsibilities;
- Directives for project managers;
- Duration of the cycle;
- Understand problems of the areas involved;
- Involvement by upper management;
- Strategy;
- Avoid loss of knowledge;
- Success factors;
- Projects management;

- Management;
- Performance indicators;
- Technological innovation;
- Interaction of the process variables;
- Control mechanisms by upper management;
- Continuous improvement and performance;
- Organizational changes;
- Need for clear standards;
- Planning the process;
- Process designs and complex products;
- *Product development business process;*
- Team productivity;
- Information system;
- *Stage-Gate* and revision of phases;
- Multifunctional teams;
- Decision making;
- Team work;
- Using statistical tools; and
- Integration.

The topics found by this search were analyzed according to their individual specificity and were selected due to their importance relative to the study's research questions, as indicated in the section that follows. In reality, the concepts and importance of these topics in the literature on NPD are interrelated and grouped under the four NPD macro topics (strategic, organizational, activities/information and resources). These selected topics complement each other in the search to perfect the NPD management structure. Nevertheless, since the 32 topics highlighted in the literature and shown in Table 1 are a large number to be analyzed, and thus only those most relevant to the steel sector will be dealt with in this article. These are listed further along.

3. Research design

Research needs to have a methodological approach so that the stages in carrying it out are completed with maximum rigor and objectivity, with a well defined focus and limitations in order to arrive at reliable and valid final results. This also permits that the study be replicable in other environments or under other conditions. In this sense, the present study presents the following features, according to the following typology (YIN, 2001; VOSS et al., 2002): inductive analysis, a qualitative nature, a descriptive nature of the variable with general objectives of an exploratory nature and a case study approach.

The analysis is inductive, since the line of reasoning moves from the specific to the general, although with limitations in the generalization of results. It is of a qualitative nature, due to the nature of the variables and methods, whose results are presented in a descriptive form with some very restricted causal relationships. The work is of an exploratory nature, since the literature is relatively limited in its chosen scope, whether due to its theme, theoretical level, process design, or the design of the process, or due to the empirical investigation of the steel sector in this subject. The context and the phenomenon are important to the present study, which explains the adoption of the case study approach.

It is important to use multiple collection techniques to obtain more robust results (EISENHARDT, 1989). Therefore, to make the choice of methodologies for this work operational, the following tools were used to collect and analyze data: document analysis, questionnaires, non-structured and semi-structured interviews and direct observation. According to Croom (2005) cited in Miguel (2007) the use of diverse sources of evidence permits the use of the triangulation technique, which includes interactions among the various sources of evidence to sustain the constructs or hypotheses in an attempt to analyze the convergence of the sources of evidence.

Developing the case study involves the following stages:

1. Analysis of the documentation of operating procedures, reports from executives on the status of on-going projects, minutes of meetings and complementary documents on the NPD as well as the use of a questionnaire that the company studied responded to for the PINTEC, (a Research Project for Technological Innovation);
2. Development and application of a questionnaire for the area of production engineering to comprehend the NPD, based on a referential structure comprised of Clark and Wheelwright's (1992) six dimensions: project definition; organization of the project and the personnel involved; leadership and management of the project; problem resolution, tests and prototypes; managerial and control revisions, and changes to the project;
3. Adaptation of the main topics listed in the theoretical work, (section 2) with the first being used to assess the degree of importance of each topic of the NPD and then be applied to the areas involved in the NPD. These data was obtained by three engineers from the organization studied (from the areas of marketing, production engineering and manufacturing);
4. A non-structured interview with the superintendent of production engineering, who is responsible for the process design phase in the company's NPD (approximately two hours in duration), to seek more information and clarifications of the process;
5. Development of a specific questionnaire to understand the process design and its variables. The following were used to develop the questionnaire: the document analysis pointed to earlier, including the PINTEC questionnaire (item 1); the questionnaire for understanding the NPD (item 2); the topics from the

theoretical referential judged to be most important by the areas of marketing, production engineering and manufacturing (item 3); and the information obtained from the non-structured interview with the superintendent of production engineering (item 4). This specific questionnaire was applied to the areas involved in the NPD; and

6. Carrying out a semi-structured interview with the superintendent of production engineering after the return of the questionnaire answers, specific to the process design phase, which aimed to clarify doubts and to check the alignment of the concepts with the hierarchical levels of the company.

4. Case study – company profile and descriptive results

The main reason for choosing the company studied was that the organization has a structured and documented NPD that fulfil the requirements for quality standards (ISO TS 16949, 2002), in which the requirements of element 7.3 of the standard include having a NPD in place. Another reason for the choices is the ease of access to information, since the one of the authors works in the steel sector. It is worth noting that the company has invested R$ 32 million in research and development; generation of 5,487 direct jobs and approximately 10,000 indirect jobs; and earning of net revenue of R$ 3.5 billion. Thus, its importance in the industrial context of the state of São Paulo and the country is well established. The organization studied is part of the largest steel producing complex in Latin America, with decades of production and growth, positive results, and a production capacity of 4.5 million tons of steel per year. The company is part of the leading group supplying plane steel to strategic markets in national industry, such as automobiles, auto parts, naval and large diameter tubes, with contracts for technical cooperation with research centres and steel mills in Japan, having achieved important certifications such as the Japanese Industrial Standards (JIS) certification, awarded by the Japanese Ministry of Industry to companies that utilize statistical controls and have systems to assure quality for thick plates, in addition to the Q1 Ford, which qualified the company to be a world supplier for Ford motor company. Following is a description of how the NPD is structured at the company studied, based on the six dimensions of the theoretical issues proposed by Clark and Wheelwright (1992).

4.1. Description of the NPD structure at the company studied

The company analyzed has the following structure for personnel involved with the NPD: doctorates (02); master's (20); undergraduate degrees (309), and technicians with high school diplomas (148). With respect to the process design, which is the focus of the present study, the company has an engineering production area that is responsible for carrying out this phase. The team is composed of 16 employees, including the positions of managers, engineers and technical assistants who have the following functions: coordinating the technical assistance activities for clients/customers, doing studies and new product development, lending technical assistance to factories to meet their training needs, providing technological updates and innovations; generating new business and increasing productivity. The principal types of projects developed by the company are for derivatives or upgrades, varying from reduced costs versions of existing products to projects to improve a process. These projects generally require much less resources than do projects that involve significant advances, since they simply improve on existing products and processes, through extensions of their applications.

The main motivators for these new development projects are the strategy for the sector in which the customer is within, the search for wider margins of contribution and the technological evolution of the product. The company uses the following performance measures to control the NPD: analysis of profits generated by new products; the time spent on each phase of the NPD, and real time vs. planned time. They also consider as measures of success: the level of product performance (production, sales and financial return); the goals for margins on new products; the goals for profitability of the new product; the percent of sales of new products in total revenues. The main methods for NPD company support are: market analysis; analysis of risks and potential failures; analysis of technical and economic feasibility; analysis of manufacturing cost; Failure Mode and Effect Analysis (FMEA); statistical and metallurgical techniques and a descriptive method in the "Guidelines for Monitoring the Experience" (an internal document).

The company studied developed eight projects in the last two years: three are in progress, two were suspended and three were concluded and launched on the market, among these, one is in the sector of industrial equipment and two are in the construction sector. The development time for new products varies widely, depending on their complexity and strategic importance to the company, on average the three finished projects had a 2-year duration. In the period from 2003 to 2005, the company put approximately 50,000 tons of new steel products on the market, for revenues of R$ 64.5 million, with a gross margin of R$ 15.5 million. Revenue from new products was approximately 1% of the company's net during this period. Based on this analysis, it was possible to develop an overview of the company's organizational structure and its teams for new product development, as shown in Figure 1.

The six dimensions are detailed according to the data collection carried out at the company:

- Project definition:

The marketing area holds a meeting with the production engineering section to define the portfolio of products under development, as well as the priorities for NPD for the next

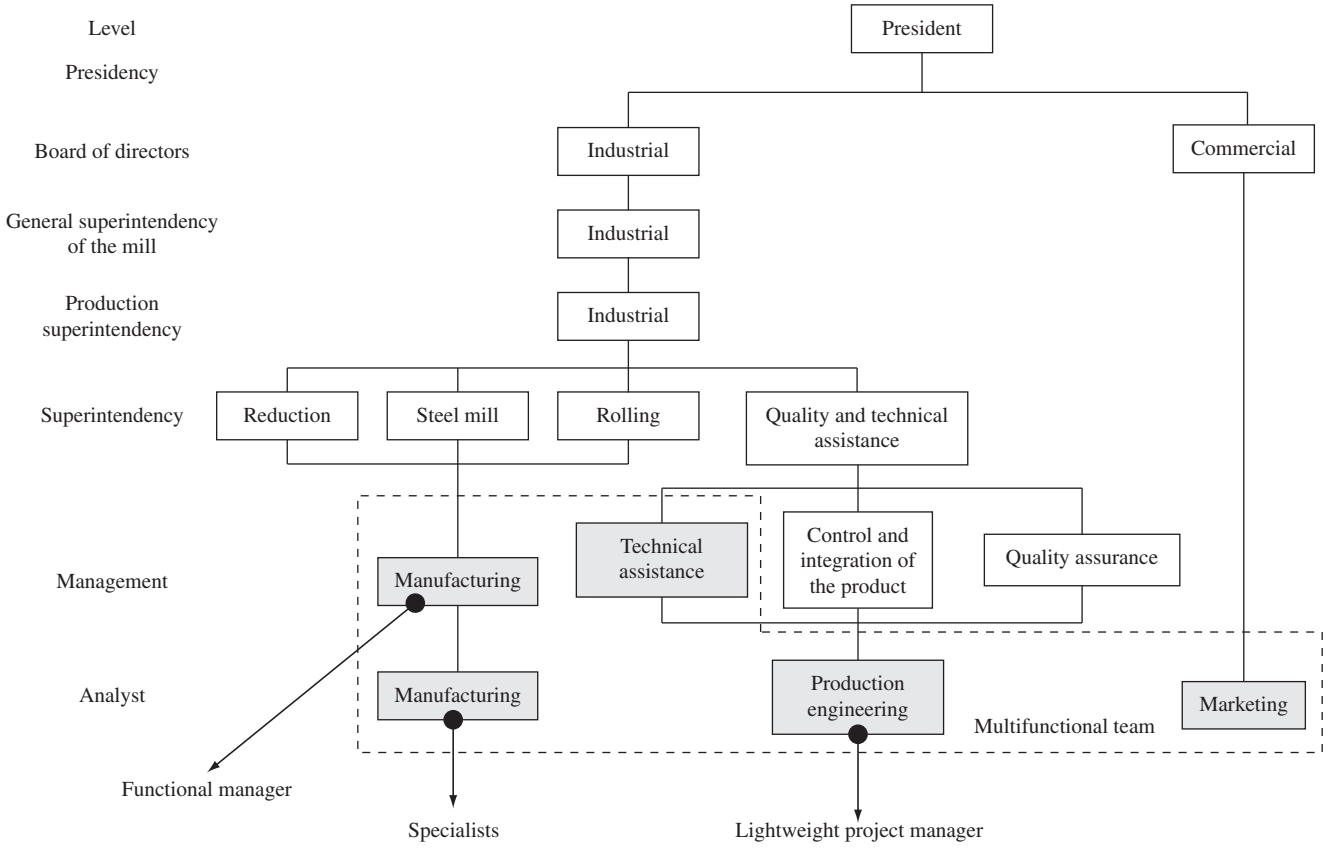

Figure 1. Organizational structure and NPD issues in the company studied.

period. This does not prevent other priority projects from arising in the course of the year which might even mean interrupting the development of other projects. Projects usually enter the list by various means: requests by clients; information on competitors; market analysis; recommendations from research reports and information from the literature. Nevertheless, project entries for the 2006 to 2007 period were 100% concentrated on market analysis. The projects for product development contemplated upgrading projects for the internal market and export of semi-finished products. These are balanced according to the company strategy, in an attempt to serve the market. The distribution of projects by business area was: industrial equipment (37%); export (25%); construction (25%) and household appliances (13%).

Regardless of where the idea originates, the NPD begins in the marketing area. It must be consulted and it authorizes development after prospecting the market. Projects are defined according to different approaches: new product development; their fit for use; improvement of products already on the market, and quality improvement projects. To define the project scope, the marketing and product engineering areas define the new projects that will be developed as well as their scope. Then the product engineering area discusses the technical issues with the manufacturing department; if the project is viable, meetings are scheduled to discuss the technical benchmarks and a document called an "Guidelines for Monitoring the Experience" (cited earlier) is drawn up, which highlights the development goals, the characteristics of the request, the responsibilities of each area, as well as the production benchmarks. Tests for clearance and complementary tests are defined, as well as the benchmarks for releasing the product. The NPD is divided into five phases: project input; project output; project verification; project validation, and project consolidation.

- Organization of the project and the personnel involved:

The organizational structure of the project is distributed as follows: the marketing areas originates the request and is the overall coordinator; product engineering is responsible for technical development and manufacturing making sure that benchmarks for manufacturing defined in the "Guidelines for Monitoring the Experience" are respected. The team is multifunctional and includes one person from each area that participates in the NPD (marketing, product engineering and manufacturing) and is defined during the

"Guidelines for Monitoring the Experience" preparation phase. Every new project has a project manager from the product engineering area, who is responsible for project planning and control, developing the "Guidelines for Monitoring the Experience" and discussing it with the manufacturing area until arriving at a consensus over the benchmarks defined therein. The project manager also monitors how the industrial trial is carried out, analyzes the results obtained, makes changes when necessary, provides information to the areas in charge of implanting the new products in line with company specifications, and writes the final report on development. There is a functional manager in the manufacturing area, who is responsible for allocating resources to the departments and negotiating schedule. There is also an expert who represents the functional areas at project meetings and acts to carry out activities in the NPD. There can be more than one functional manager and specialist per project depending on the facilities that are part of the production route for the new product.

• Leadership and project management:

The marketing area is responsible for overall coordination of the NPD and delegates the lead on each project to a team leader (marketing) who along with the other areas involved in the NPD carries out product development. In the industrial trials, the product engineering manager is responsible for project progress, supervising the work of the project manager, an engineer from the product engineering area; the functional managers supervise problems that can come up in their areas of activity as a result of the development in progress.

• Problem resolution: tests and prototypes:

Both statistical and metallurgical techniques and the project manager's practical knowledge are used to interpret the results obtained and attempt to solve problems. Testing is based mainly on the oscillation of variables in the process, in conformance with the project specifications. The number and type of tests vary according to the operational criticality of each facility involved in the manufacture of the product. Some examples of tests are: oscillation of the oven temperature for reheating the plates, thickness and plane of the rolling, mechanical properties, addition of alloys, soldering, finishing, etc. and this can be done within the production program and some tests can be done at the client site to accompany product performance.

• General revisions and control:

Phase revisions occur at the end of each phase and are mandatory for transition and an assessment of the possibility of project continuity and the risks involved in this decision. Intermediary revisions can also be done before the end of each phase. This saves time by correctly redirecting the project before the phase revision in the following situations: when there are operational difficulties in obtaining the product; when the results obtained do not meet the normative specifications; or when even though they meet the legal and normative provisions, there are difficulties in product application at the client site. When there is a need for revision before the end of the phase, a critical analysis is done which points out the reasons for making changes; an addendum to the "Guidelines for Monitoring the Experience" is prepared and disseminated to all the areas involved. If necessary a new schedule is created and reported to the commercial area, which communicates the reasons and new schedule for this stage to the client. The company has well-established criteria about which sub products are necessary for the transition to the next phase, as illustrated in Figure 2.

• Alterations to the project:

Changes to the project are made when corrections are needed or when the trials do not lead to the results desired in the technical specifications. When necessary, the project manager formalizes complementary instructions by means of a revision or an addendum to the "Guidelines for Monitoring the Experience" to inform the personnel involved. These alterations are discussed with the units involved and the viability of implementation is analyzed. When necessary, a new activity schedule is written and the FMEAs are reviewed. When activities that compromise the final deadline for project conclusion are postponed, a critical analysis of the plans and projects of the client as well as possible market losses to the company is done and delays are reported to the customer.

After a referential structure has been used to understand the NPD of the company, three analytical categories are used to make a structural analysis of the organization (ZANCUL et al., 2006): organizational structure; roles (division of tasks), responsibilities and autonomy; and cross-functional integration mechanisms.

A company's organizational structure varies according to the types of projects, that is, the product engineering area, coordinator of the phases of the project in the NPD process is divided by category according to the product to be developed (thick plates, hot laminated strips, cold laminated strips and sheets for export). It can be seen that the organizational structure is similar to that of a "lightweight team" in which the engineer from the production engineering area (lightweight manager) is responsible for the progress of the industrial trials. However, he/she does not have autonomy over the processes of development done in manufacturing. There are manufacturing managers (functional managers) who are directly responsible for problems in development that can occur in their respective areas of activity during the NPD. When it is not possible for the project to proceed as planned due to divergences among members of the multifunctional team, the discussion moves up a management level to the level of the superintendent and later to the level of the board (note that this has not yet occurred).

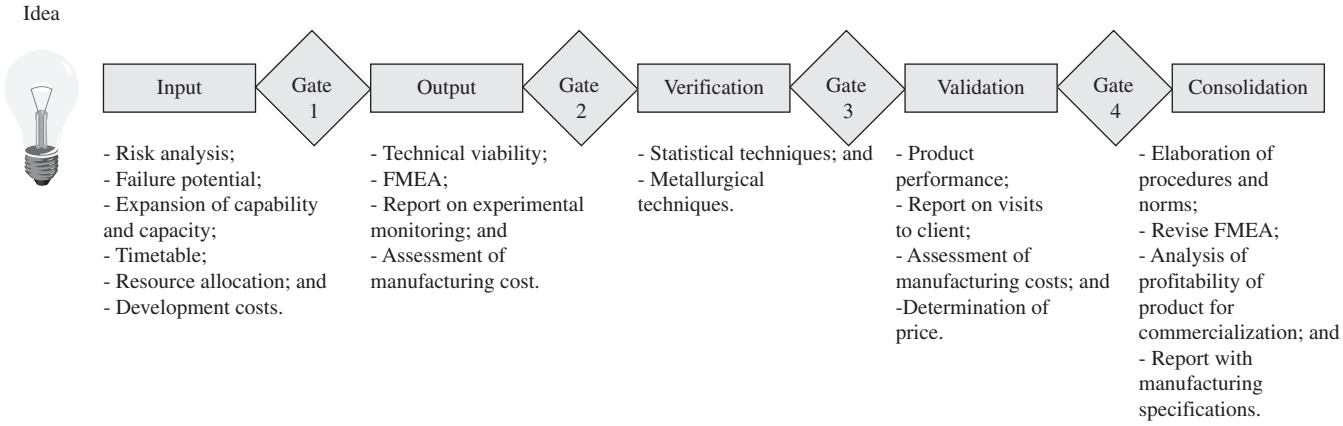

Figure 2. The deliverables for phase transition in the NPD in the company.

The concepts of the roles and responsibilities of those involved in the NPD are the same as those presented in the literature on the subject. Under the item integration, the company adopts simultaneous activities and development teams. Integration occurs principally through meetings, exchange of e-mails and reports on NPD monitoring. However, there are some factors that can impede integration, especially since each functional area has different priorities and also due to the great physical distances between the areas involved in the NPD.

To sum up, the company's adopting a "lightweight" cross-functional structure and utilizing a multifunctional team for the NPD results in some differential advantages such as: improved channels of communication, better dissemination of information, improvements to cooperation and to cross-functional relationships. These characteristics contribute greatly to reducing development time as well as to adjusting the process by virtue of market effects, competitors' behaviour and operational restrictions. After comprehending the company's NPD structure, the next stage is to understand the process design phase works and how the variables in this phase are interrelated.

4.2. Preliminary analysis of the process design phase in the NPD

This analysis aims at understanding the main topics identified in the literature related to how the company carries out the process design phase. These main topics were identified in the theoretical framework based on the work of several authors. Then, a list of topics was created. It also intends to verify whether the areas involved understand the importance of the main topics in each phase of the NPD. Then, the degree of importance of each topic in the company NPD was assessed to have a more refined analysis of the topics selected, thus reducing the number of topics to be dealt with in this article.

The first step resulted in 32 topics selected as most important from the literature (in section 2). The topics were rated by professionals from the areas of marketing, production engineering and manufacturing. A scale adapted from the one usually used in the QFD method was used: 0) no relationship; 2) low relationship; 3) moderate relationship; and 9) strong relationship. The topics were rated with respect to their importance to each phase of the company NPD (concept development, product planning, product/process engineering and pilot/increase in production). However, since the focus of this work is on the process design phase, only the topics rated as most important to this phase were taken into consideration. The ten main topics based on the results of applying a questionnaire to the areas involved in the NPD are: collaboration and communication, team work, team learning, understanding the problems of the areas involved, technological innovation, interaction of the process variables, need for clear standards, team productivity, continuous performance improvement, and information systems. They correspond to the topics with the highest evaluation in the process design, with a grade of around 46 points which represent 85.2% of the total possible 54 points.

Those topics served as the basis to prepare another questionnaire whose purpose was to investigate in greater detail how these topics inter-relate and how they influence the process design phase of the company's NPD. This questionnaire was developed using open ended questions that included issues about the cross-functional integration of the development team; communication among the teams; how productivity and development team performance is controlled; whether practices for continuous improvement and learning exist; the influence of technological innovation

on the process; the information system helps in processing the data and whether there are clear procedures for carrying out the NPD. Then, a preliminary comparison between the answers in the questionnaire and the literature was performed (more detailed results can be found in Appendix 1).

The main results so far are:

- Team work is very important in carrying out the process due to the nature of the steel manufacturing process. The use of a multifunctional team at this stage in the NPD facilitates the work of those involved in terms of sharing knowledge;
- Collaboration and communication are achieved by periodic planned meetings and monitoring the projects of new products via reports, makes the exchange of information within the organization easier as well as solving operational interferences during the industrial trial;
- The practices associated to continuous improvement occur in two ways: by effective problem solving in addition of the support of a software (ISO SYSTEM) which documents proposals for improvement, especially those related to new product development; and
- Another topic that is critical to process design is the degree of technological innovation, which is restricted by the state-of-the-art of the facilities that limits the manufacture of certain products due to the increasing customer.

5. Concluding remarks

This article demonstrated that the company carries out the phase of process design in the NPD according to what is in the literature, since it applies techniques and support tools for NPD which aid in the structuring of this phase. In addition to these practices, it is worth emphasizing the nature of the company's cross-functional integration, which due to the different areas involved in the process design is able to seek more effective communication. It also considers a "lightweight" project manager responsible for coordinating the entire operational phase and avoiding possible communications problems among the functions involved in this phase.

One final remark is that the company demonstrated a relatively small number of new products developed and the financial results with the NPD are less than 1% of net income. Nevertheless, the development of new products is strategically important to the company because it is the way to maintain important markets and commercialize latest generation products to diverse national sectors. Thus, based on this preliminary analysis, a highlight in the process design of the NPD is the state of technology of the facilities as a limiting factor which restricts the manufacture of certain products. Due to this situation, it can be concluded that there is a constant need for investment in product/process technology and that the process design phase is important in the NPD, principally in companies that have many organizational interfaces and operational complexity. Nevertheless, further analysis is to be carried out in a near future to validate current findings.

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APPENDIX

Appendix 1. Analysis of the influence of the process design phase on the company NPD.

Main topics	Literature	Process design
Team work	Throughout the process design, it is important to try to work in teams so that the parties involved perceive that their individual contributions fit into a greater whole, provided by the overall effort of the entire team.	A multifunctional development team is created, coordinated by Product Engineering, always attempting to work in teams.
Collaboration and communication	Communication refers to exchanges of information, whether verbal or written. Collaboration is distinguished from communication due to its focus on such aspects as working in groups, sharing resources, mutual trust and common vision and objectives, that is, the more informal and subjective aspects.	Communication occurs through periodic meetings; exchanges of e-mail and project progress reports.
Team learning	Learning takes place mainly through the exchange of information gained in the process design trials and the most important is to remember to document it.	All the documentation is filed and results are disseminated by means of the report. When activities are updated, they are regulated and the personnel involved are then trained.
Understanding the problems of the areas involved	By integration an understanding of the limitations and variables of the process involved in the Project for the Process is sought.	Area specialists state the restrictions of their installations for the process at the meetings.
Technological innovation	Essentially, technological innovation consists of the search for, experimentation with and development and adoption of new products and new production processes.	One limiting factor in the process design phase is the state of the technology of the installations, which might limit the manufacture of certain productions.
Interaction of the process variables	This consists of having a common vision of the activities of the process and their variables and sharing information and resources to obtain better results.	There are many totally different installations involved in the process design, which require specific knowledge and thus the need for specialists to participate in the meetings and provide their knowledge.
Need for clear standards	Standardization is establishing common rules and procedures that are uniformly applied to all in almost all situations.	There are quality standards and complementary documents in the companies which detail all the procedures of the process design.
Team productivity	The team's productivity is directly related to the conditions provided by the project managers and the results obtained with the process design.	Monitoring is of the product, but it demands of the development team: technical results, product costs, and meeting planned deadlines.
Continuous improvement and performance	Every change is an opportunity to improve learning, the management methodology most used is based on the cycle of planning, execution, verification and corrective action (PDCA cycle)	Companies use the PDCA and monitor the performance of the product in order to make adjustments. They also have the ISO SYSTEM software.
Information system	Is used as a support tool, facilitating the manipulation of data in the use of techniques and methods available in the area. Its main advantage is speed in processing and analyzing data, facilitating the generation of reports.	There is a database in the "System for automation of production" and statistical tools.