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INTEGRATING NEW PRODUCT DEVELOPMENT PROCESS REFERENCES WITH MATURITY AND CHANGE MANAGEMENT MODELS

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ABSTRACT

One of the most recognized best practices to improve new product development (NPD) process performance is the use of business process models to integrate activities, techniques, and methods. In recent years new product development models have been proposed, with complementary contributions. The challenge is how to use them to identify the improvement opportunities and how to orchestrate change actions. This work presents a NPD model, named PDPNet, whose singular characteristic is the integration between a business process reference, a maturity model and change management model in order to support the full product development change cycle. This paper also presents the evaluation of this approach in a case study about the PDPNet model implementation at an agriculture machine company. The method of the field research is the case study. The collected data techniques were participant observation, documental analysis and research diaries. The main contribution is to demonstrate the advantages in using distinct models consistent with each other, specially the separation between the Business Process Reference Model, that is, the practices, methods and tools, from the Maturity Level Identification as proposed by the PDPNet Model.

Keywords: product development process, reference models, maturity model, change management.

1 INTRODUCTION

New product development process (NPD) is vital to competitiveness in all sectors of economy. Among the best management practices is the business process approach [1], which seeks to integrate activities from different enterprise functions, such as quality, marketing and project management, in order to obtain performance excellence. To apply this approach, the use of a formal NPD process is fundamental, that means to produce a map describing the new product development process. The business process modeling, or enterprise integration, provides a set of techniques that makes this possible [2].

Kalpic and Bernus [3] demonstrated the importance of this approach in a case study specifically in the new product development area. The authors explain how reference models can be helpful in activities related to the project, management and execution of business process. Since the emergence of the business processes approach on NPD, more or less elaborated reference models have been proposed to help professionals identify the best available practices [4, 5].

The bibliographical review presented in section 2 analyses some of the most known models and as a result two aspects can be noted. The first identifies the lack of NPD transformation models, i.e. guidelines instructing companies on how to manage process improvement activities. The second one refers to the need to integrate the three types of models, i.e. process, maturity and change management, instead of having just one model to meet the three objectives. This implies the conception of distinct models making progress and kept independently, but which could be used jointly, enabling diagnosis (by means of maturity assessment), identification of needed practices (with the process model) as well as prioritization and identification of transformation strategies in the changed model (NPD change model).

Since 2002 a network of researchers and professionals involved in product development have developed a reference model, PDPNet, composed of three independent and integrated models: a

process model, a maturity model and a transformation model. This work investigates the PDPNet integrative character of a maturity, process and transformation model as support in applying the processes approach in product development.

2 OBJECTIVE

The objective of this paper is to present the PDPNet model and report an application case at a agriculture machinery factory. This paper describes mainly the experience gathered from the integration of different types of process models. Overall, this study also contributes to developing the model by identifying perceived improvements and assessing its application potential.

3 NEW PRODUCT DEVELOPMENT PROCESS MANAGEMENT

One of the classical definitions of the product development process is given by Clark & Fujimoto [6]. This seminal definition marked the beginning of the utilization of the processes approach in product development management. Until then effective product development was seen as the responsibility of engineers, thus disregarding the integration of marketing, planning and product introduction activities in factories.

In the last decade, it has expanded to include activities related to strategic planning and production follow-up and recalls, as proposed initially by Clark & Wheelwright [7]. Several theoretical models have been utilized as reference to design and improve NPD, e.g. Pugh [8], Clark & Wheelwright [7], Cooper [9], Ulrich & Eppinger [10], Ullman [11], Baxter [12] and Clausing [13].

These models focus mainly on describing practices—i.e. activities, phases, methods and tools—acknowledged as effective in product development projects. Nevertheless, these practices are often dependent on each other, i.e. adopting one of them depends on the existence of the others. It is meaningless to apply QFD if the company cannot select projects and seek information efficiently. This—aggravated by the broad and multidisciplinary nature of NPD process—makes it difficult to identify which practices, tools and techniques should be prioritized in specific cases where the model is being implemented.

In the late 1990's, there appeared several NPD models with distinct characteristics, focusing on the assessment of evolution levels: the maturity models. Besides indicating practices, a maturity model allows to assess the evolution level of companies, with regards to its adoption. The most famous of these models is the CMMi model by Software Engineering Institute [14]. After studying this model, it is possible to notice that—despite allowing level identification—it approaches practices rather broadly; it does not specify the best way to implement them as some of the more detailed process models do, e.g. the model described by Creveling [15].

4 THE PDPNET MODEL

The PDPNet product development process was devised by a network of research groups and professionals from the field of product development management. These researchers convened in a practice community on the Internet and met regularly from 2002 to 2004 [16]. The result of this collective work was recently published as a book, in Portuguese, and has a web site [17, 18]. The model comprises three distinct parts, and named models: Process Reference Model, Transformation Model and Maturity Model as detailed in the following items. In truth there are three independent and coherent models that together aim to provide support to the NPD process management.

4.1 The PDPNet process reference model

The PDPNet process reference model depicts the best practices for managing the product development processes, presenting and relating phases and activities to several practices and methods available in the field. Its goal is to integrate available practices and to elucidate them in detail irrespective of the company's evolution level. Its purpose is to address all practices regarded as effective. It is equivalent to a body of knowledge (BOK) regarding product development, arranged in phases.

The reference model is divided into three macro-phases: pre-development, development and post-development. Each macro-phase is divided into phases, activities and tasks, respectively, which, taken together, constitute the best practices in the field. The Figure 1 represents macro-phases, phases and support processes.

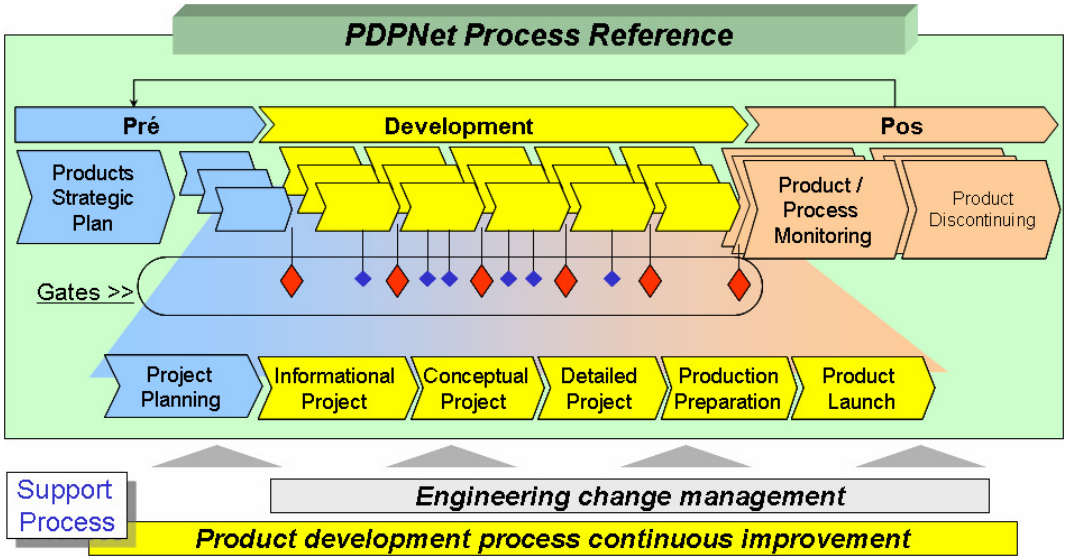

Figure 1 – Macro-phases and phases of PDPNet process reference model.

- Pre-development macro-phase (blue). Pre-development is the link between the projects developed by the company and its goals. It includes the company's strategic product planning, which involves the Corporation or Business Unit Strategic Plan deployments on project portfolio, with the evaluation and track of selected projects. In the Project Planning phase each project is detailed and examined as to their continuance or discontinuance. The cost of changes at the end of every project is always higher than at the start of the development process, thus good planning in the initial phases may provide the company with a competitive differential.
- Development macro-phase. This macro-phase includes the phases in the informational project, conceptual project, detailed project, preparation for production and product launching. All these phases entail detailing of technical, commercial and production information, involving elements such as technical drawings, prototypes, homologations, records, partnerships with suppliers and production processes. The information phase comprehends translation of the analysis of market and customer information into engineering specifications.
- Post-development macro-phase. Follow-up of product life cycle is performed in this macro-phase. In this phase it is possible to assess the product performance in the market, its withdrawal and improvement processes that could be implemented.

There are recurring activities in all development phases such as assessing each phase with well defined criteria (gates), monitoring economic viability and documenting decisions made and lessons learned. In the model they are grouped under the label of generic activities for didactic purposes. A second set of activities was structured as an independent process. They are designated as Support Process: Engineering Change Management and Continuous Improvement. The first contains the activities that must be performed to guarantee that changes in specification and information concerning the product be appropriately analyzed and registered. In accordance with the activities to transform mistakes or problems identified during the process into improvements and suggestions.

There is a total of 30 activities organized according to phases and macro-phases. The Activities are subdivided into tasks and also categorized in relation to nine areas of knowledge: project management, environment, marketing, product engineering, process engineering, production, supplies, quality and costs.

This set of activities and tasks is associated with descriptions that offer help to professionals about how they are put into practice, which is described as philosophies, methods and tools. A philosophy is a set of general guidelines that should be followed when carrying out the activities. A method is a set of steps to execute one or more activities. A tool is something that supports the performance of activities or methods, resembling an information system.

To each of the Philosophies, methods and tools the model provides detailed descriptions. The objective is to indicate how users may obtain more information concerning its use. An important aspect of these descriptions is that they enable contextualization of each of these elements, showing

the type of products, businesses and other characteristics of the model for which these tools, methods and techniques are most appropriate.
Thus, this model accomplishes more than the best practice descriptions. The PDPNet process reference model shows what should be done by means of the activities, how to perform these activities through the descriptions of philosophies, techniques and methods, and where to look for additional information.

4.2 The PDPNet maturity model

The NPD maturity model is used to support identification of the evolution level reached by a company at a given moment. It depicts maturity levels and shows which activities should be formalized and implemented at each one of these levels. The description shows a hierarchy of priorities regarding activities in order that higher levels can only be achieved if lower levels have already been reached. The model—according the CMMi model—utilizes five possible evolution stages:

- Level 1 – Basic. When the company systematically carries out a set of practices deemed as essential for the effective management of product development: integration with top administration, a sufficient organizational structure, project detailing, definition and deployment requirements, among others. This level is subdivided into four sublevels, each one grouping practices according to areas of knowledge: product engineering, marketing and quality, manufacturing process engineering and projects, costs and environment management. The sublevels are identified as 1.1, 1.2, 1.3, 1.4 and 1.5. These areas represent logical adoption (selection?) orders and are interdependent.
- Level 2 – Intermediate. Practices are standardized, thus results are predictable. At the previous level it was sufficient to have them performed, even with variations. This level is also subdivided into four intermediate levels consistent with the knowledge areas; they are named as 2.1, 2.2, 2.3 and 2.4.
- Level 3 – Measurable. Besides being standardized, there are indicators that assist in assessing the performance of activities and the quality of results.
- Level 4 – Controlled. The company works systematically to correct practices whose indicators have deviated from expected values.
- Level 5 – Continuous improvement. There are institutionalized processes with which to improve the business process itself, i.e. the product development process. They may take place in the short run or in the long run. The authors propose two models. The first model is the "incremental improvement process", one of the processes that provides support to the NPD reference model. The second one is the NPD transformation process model, which aims at deeper and long-term improvements.

Each maturity level indicates a set of institutionalized practices, as in the CMMi model. In the PDPNet model this is constantly verified by formalized activities. The assessment of a particular practice is done through observation and classification according the levels: a) not observed (there is no evidence of the activity performed); b) ad-hoc (the activity is done but in an inconsistent manner) ; b) formal (the activity is done according to clearly defined rules and procedures); and c) measured (beyond formalized, the activity is measured and is continuously improved).
In order to facilitate handling the model, the levels are divided into sublevels and classified into knowledge areas. For instance, Level 1 is subdivided into 5 sublevels. Figure 2 shows how Sublevel 1.1 and 1.2 information are synthesized in the model. The maturity model consists of the description of all sublevels following the same format.
The characteristic that mostly distinguishes the PDPNet Maturity Model from CMMi Staged Model is the integration with the Business Process Reference Model. The use of the Product Development Reference Model is able to identify philosophies, methods and tools that could be used to improve the practical level. In other words, the user can be informed about existing methods to solve the problem. The CMMI for development 1.2 can help to illustrate this idea. The specific practice is the lowest CMMI model level. An example is the specific goal named "Establish Estimates" [19 p.340] which is made up of the specific practice (SP) "Estimate the scope of the project" [19 p. 341]. The model also represents typical work products (as example WBS) and the subpractices and resources (as "Develop a WBS based on the product architecture"). Some SP's contain resources with lists of physical facilities, as for example computers peripherals and softwares,. It is undoubtedly a detailed description.

However, it is considered as excessively generalized information for a novice user. In practice, this user must to search for additional information to implement it.

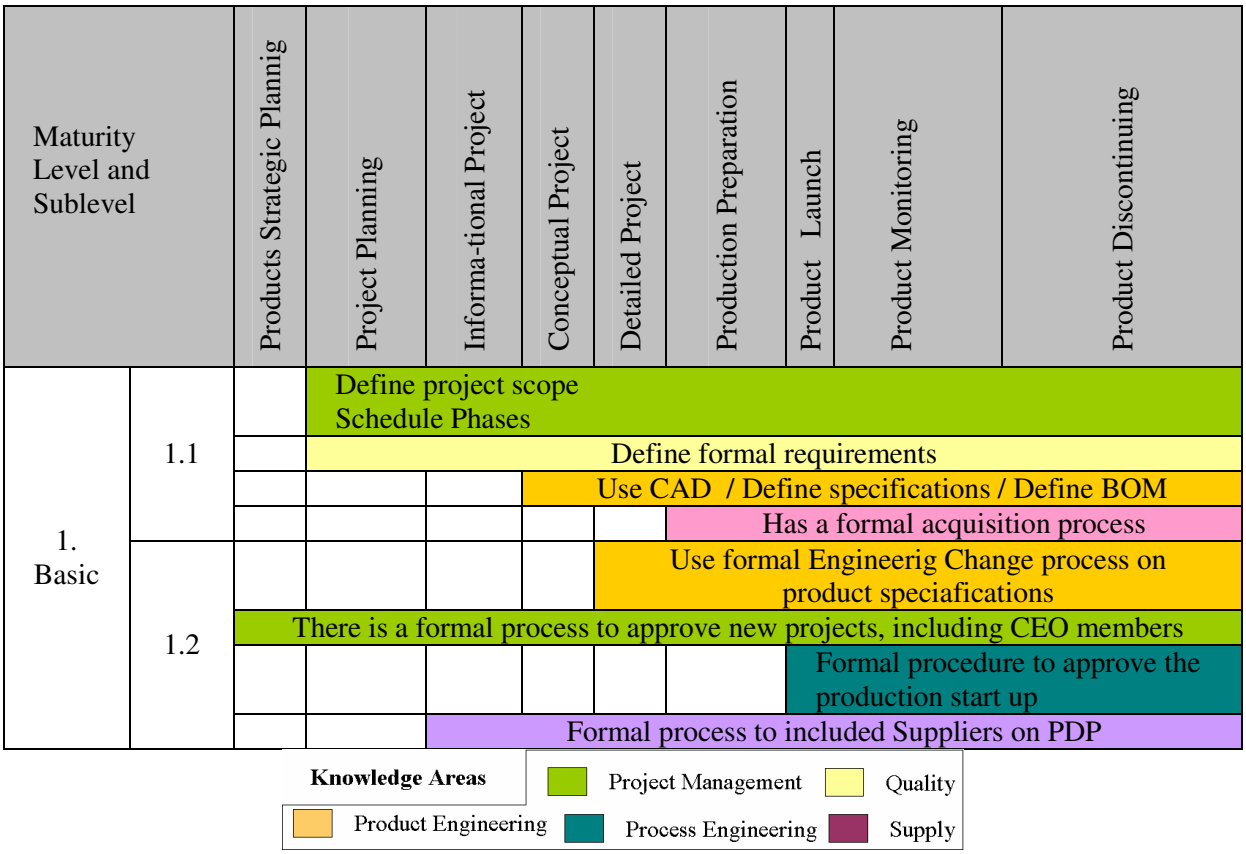

Figure 2 – A synthetic representation of PDPNet maturity model.

Otherwise at the PDPNet model, the maturity identification stops at the scope definition statement level. The details are in regard with how to implement it and techniques are presented at the Reference Business Process Model. This characteristic allows to split a broader model into two minor and manageable models: one assigned to identifying the maturity gap (The PDPNet Maturity Model) and the other to provide the techniques and methods collection (The PDPNet Process Reference Model).
In order to complement this information, the PDPNet Change Management Model can be used to support the selected process of which actions are pertinent according the situation. This model similar to the SCMC is described in the next section.

4.3 The PDPNet change management model

The PDPNet change management model describes how to implement desired changes so that companies may reach the maturity level. It is based on concepts of change management and project management, since broader change actions become projects. A set of change projects is managed through a specific portfolio. Each project generates a proposal to change the NPD business process, including new standards such as procedures, forms and other necessary tools necessary to institutionalize the new way to conduct business. The model is schematically shown in Figure 3.
The core of the model is the infrastructure for change, i.e. to clearly define in the organizational structure of the company who will manage and follow up the improvement actions and ensure the necessary resources to carry out the project.
The first step is to define an organizational structure through which the change may occur. Defining responsibilities clearly avoids the common mistake of identifying improvements in the development process, assigning them to a professional—or to a group—without an effective follow-up process, could result in inaction in the long run.
The model proposes that the company should establish a team responsible for designing and maintaining the NPD process and desired changes. This team should be composed of functional and

project managers pertaining to all functions involved in the product development process. The role of this team is to identify and prioritize improvement projects, indicate who will be responsible for carrying them out and following up their evolution. They should also be responsible for approving new business process standards, generated at the end of every improvement project, aiming at their systematization. This ensures that approved procedures meet the needs of everyone involved.

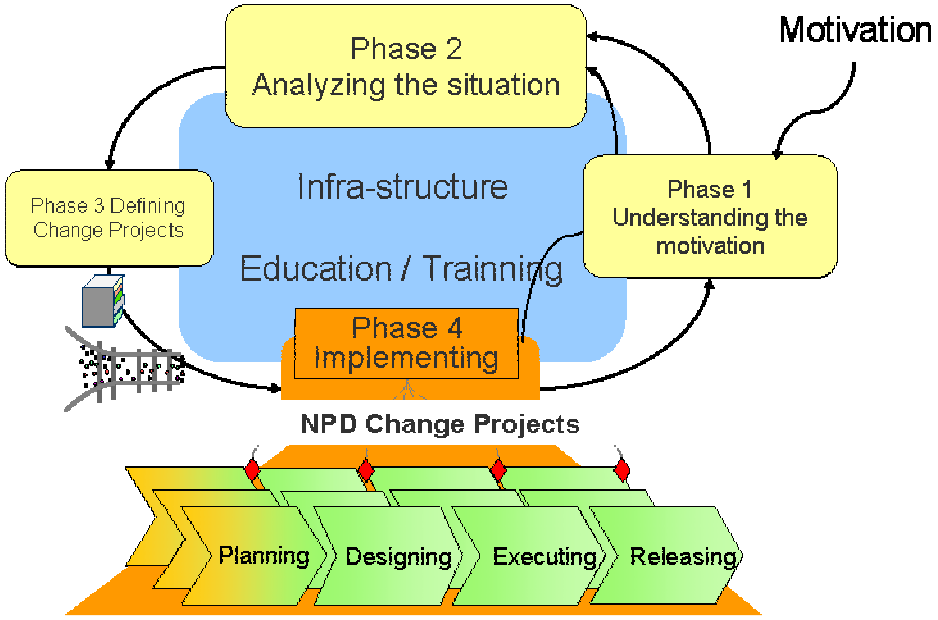

Figure 3 – PDPNet transformation model.

The second infrastructure aspect to be addressed is the team's modus operandi. Since it is composed of dedicated professionals whose role is critical to routine NPD activities, a simple routine is needed. It should not compromise members' performance in the remaining activities. Weekly or fortnightly, short and well planned meetings can be an alternative.

Finally, to enable the Committee members to make decisions and prioritize improvement projects more effectively it is necessary to provide them with reliable and adequate information about the product development process as well as about minor tasks, such as preparing follow-up reports and examining quality regulations and suppliers demands that can affect the process. These tasks may be assigned to specific professionals, whose role is to ensure the systematization of information (e.g. performance indexes of product development) and assistance during committee meetings (e.g. drafting memos, analyzing regulations and standards that can affect the business process requisites)—what the literature on project management has termed as Project Office.

Once this infrastructure is created, the model proposes that the transformation cycles should be initiated, which are described in the same way as the process reference model, i.e. by phases and activities. There are four distinct phases:

- Phase 1 - Understanding motivation and necessary changes. During this phase the team in charge of the engineering program develops—based on strategic planning—a shared vision of the goals that it intends to achieve as regards the product development process. For instance, in the case of a company in a very competitive environment, e.g. in the field of high technology, marked by unstable patterns, the goal may be to achieve excellence in speed and understand the customers' needs, whereas for a company in the medical field the goal may be to achieve excellence in product performance. An important aspect is that there should be a unified field of vision with regard to the most significant performance dimensions and goals;
- Phase 2 - Analyzing the situation. Once goals and challenges have been understood as regards the product development process, the team analyzes the present situation of the business process using the aforementioned maturity and process reference models;
- Phase 3 - Defining change projects. Once the situation has been identified the development of change projects should begin, i.e. projects that will insert new practices in the company's process model. The model proposes that these projects should be managed through a specific portfolio of improvement projects. Similar to product projects, improvement projects should be

prioritized. The criteria utilized should be dimensions as the impact (in short, medium and long term) and investment. It is important to choose a portfolio that has the highest impact—in the sense of meeting the goals of necessary improvements—and is capable of balancing short-, medium- and long-term actions with low investments. Balancing actions —including short-term ones— is vital to generate uninterrupted results and promote motivation among collaborators.

- Phase 4 - Implementing actions. This phase comprises executing improvement projects and the support team's work when collecting information, such as improvement project and process performance indicators. Consistent with the concept of gates present in the process reference model, every project should undergo a set of phases. Each transition is monitored by the Committee, which is in charge of approving or rejecting the improvement project. The specified improvement project phases are: planning, designing, executing and tracking.

4.4 Integration among models

Figure 4 schematically shows each model, which together form the PDP model and the relationship among them. The existence of three consistent and interdependent models is a differential feature of the PDPNet model, considered as very advantageous regarding maintenance. An example of this may be found in the process reference model. Everyday new methodologies, tools and techniques that can assist product development are created. Some of them are specific, which means that they are only valid in given contexts, a special type of productive process or market. In this case, when there is a model that combines maturity with practices, it is difficult to opt for the inclusion of a practice given its non-universality. An alternative action is to incorporate generic guidelines.

The manner by which the PDPNet model is structured could prevent this problem from occurring. Practices could be easily integrated to the process reference model, which elicits application context information. The decision on whether they should be included in the company or not may depend on checking the maturity model and users' options as recommended.

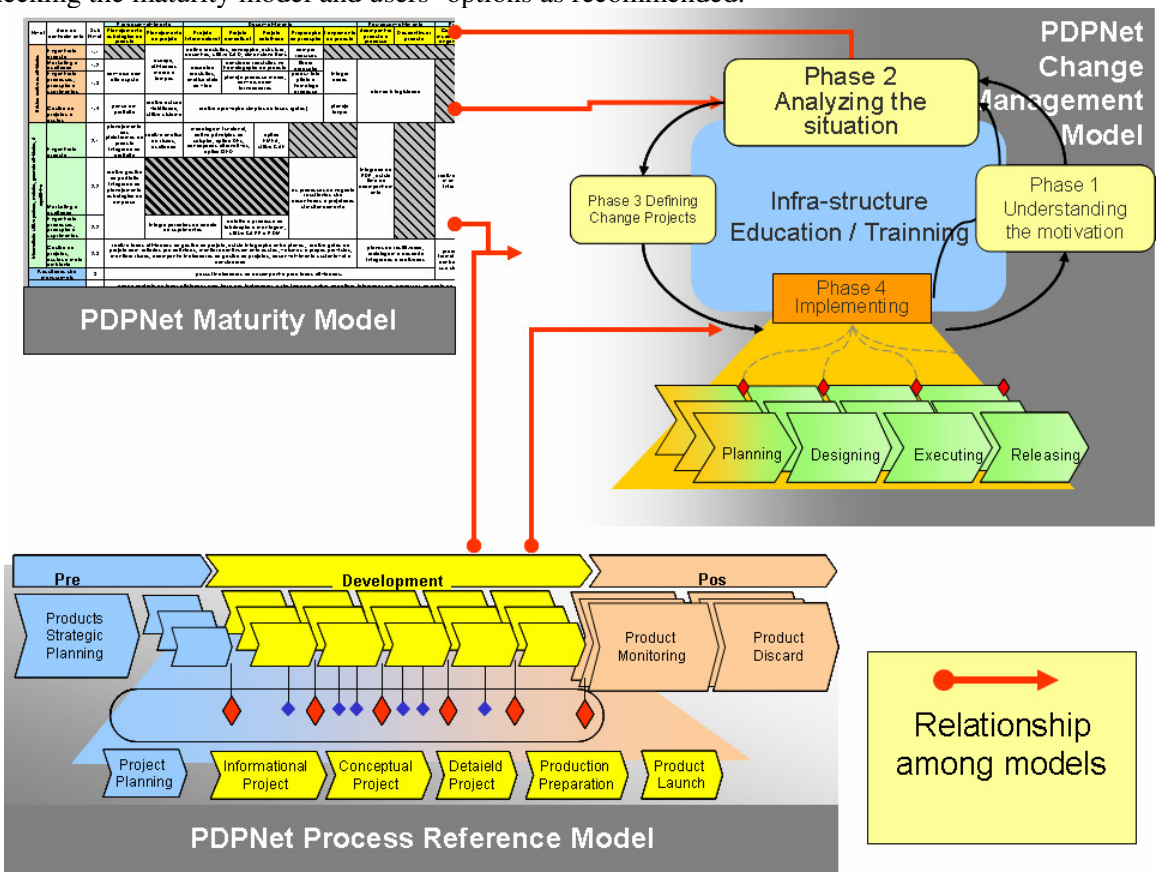

Figure 4 – Components of PDPNet model to NPD.

5 METHOD

This paper recounts the application of the PDPNet model at a company in the field of agriculture machinery (soil preparation and planting). The research methodology employed may be termed as a single and holistic case study according to Yin [20]. The business process of the company in question constituted its analysis unit, considering both the product development process and the actions taken to improve it. It describes the application of the PDPNet model to the development and implementation of a program to improve the company's product development process aimed at:

1. Assisting managers in diagnosing the company's present NPD status;
2. Building a basic infrastructure (organizational structure, information system and essential practices) that can promote more predictability and control in the development of new products, i.e. planning activities, terms and deliveries;
3. Increasing the launching rate of new products in view of product differentiation and expansion to new markets.

During the investigation the researchers accompanied the implementation by visiting the company for 18 months on a biweekly/monthly basis. Data were collected by way of interviews, documents and field observations. During this period the company's product development process was diagnosed.

6 RESULTS

6.1 Company and context

The company under consideration is located in Brazil and has 400 employees. It produces a variety of agriculture machinery, especially for soy bean and corn crops. It exports to several countries, is ISO-9001 certified and is known in the market for its quality products. In mid-2004, before the implementation of the aforementioned improvement actions, the Brazilian agribusiness sector, soy beans, went through a particularly serious crisis due to unfavorable exchange rates, unsupportive industrial policies and adverse international scenarios. It was consensually cogitated that the company needed to expand beyond the soy bean and corn farming markets.

The company operated in a classical functional manner. The functions that participated in product development were: product engineering, process engineering, prototypes, machining, technical assistance and Production and Planning. There was an engineering director in charge of these areas, except for the last one, which was managed by the industrial director.

The functional area of product engineering involves 15 engineers and designers. The company's functional approach was another problem acknowledged by its top administration. There were several inefficiencies such as faulty tools manufacturing , delays in process detailing and product delivery , among others with regards to applying classical management methods. The main inefficiency was the average time of new product development, which was estimated to range from 1.5 to 3 years.

The main phases of the improvement program were:

1. Diagnosing the company's NPD process. In this phase the company's present level of maturity was assessed through the PDPNet model;
2. Structuring the company's NPD improvement program. This phase promoted a series of changes in the company's organizational structure to delegate tasks and responsibilities that foster process transformation, in line with the proposed NPD transformation model;
3. Identifying and carrying out improvement projects. The identification and prioritization of improvement projects aiming at raising the company's NPD maturity level, as described in the PDPNet model;
4. Formalizing the company's NPD process. Actions were performed to formalize the company's new product development process, based on the aforementioned diagnosis and improvement actions.

6.2 Diagnosis of new product development process

This phase comprised a critical analysis of the company's problems, whose goal was to assess its maturity level in the management of the new product development process. The motivation to change was clear since the beginning of the project, as shown in the previous item. The diagnosis was carried out by the researchers in the first semester of 2005, during four weeks on a weekly basis.

The analysis was conducted internally by the NPD director with the help of one of the designers from the product design area. It chiefly used the maturity model assisted by the process reference model. These professionals began by identifying the documents that described the company's NPD process. The most important documents were the Quality Assurance System procedures. The documents and professional experiences assisted in executing the activities and identifying the level of formalization. The results were discussed with the researchers. There were relevant gaps observed in these practices and related to Level 1 of the maturity model. The main aspects are presented in Table 1 according the maturity level described in Figure 2.

Table 1 – Maturity Assessment Summary

Level	Assessment Criteria	Level	Analysis Summary
1.1	Define project scope schedule phases	Ad-Hoc	The planning phase included especially the analysis of economic viability and deadlines. It did not seriously take into account aspects such as risks, customers' needs, project strategies;
	Define formal requirements	Ad-Hoc	The common practice was to identify a requirement list without formal validation or control during the development process.
	Use CAD/Define Specifications/Define BOM	Formal	The enterprise was using 3D CAD and PDM application. There were formal specification documents. Some problems were identified in the use of PDM as parts of the documents were out of the control range of the PDM System.
	Has a formal acquisition process	Ad-Hoc	Only to commodities parts. The enterprise did not have a formal strategy and politics for co-design.
1.2	Use formal Engineering Change Proccess	Formal	The enterprise had a formal process that works only after the conceptual phase.
	Portfolio Management (formal process to approve new process)	Not observed	The company did not have a formal system to manage the portfolio of new products. Decisions concerning the portfolio were informal and were made at top administration meetings and via product engineering initiatives;
	Formal procedure to approve the production start up	Formal	The enterprise had a formal process to approve the startup.
	Formal process to include suppliers on PDP	Not observed	Each relationship and agreements to support the project had been assigned using different process.

The PDPNet Maturity Model also considers that the enterprise must present basic characteristics to enable the business process management: an organizational structure consistent with its needs and environment; b) a well formed and integrated product development team. In this case the problem was the organizational structure. The company displayed a classical functional organizational structure which is insufficient to support a well established PDP process.
Therefore the analysis demonstrates the existence of flaws in the identification and control process regards the Level 1 of PDPNet maturity model. The company was classified as being in Level 1.1. of the model. The assessment allowed the group to have a shared view of the main inefficiencies that needed to be addressed.

6.3 Structuring the NPD improvement program

The first action would be to rethink the company's functional structure. This would demand, however, to reexamine its whole organizational chart, which would be quite lengthy and time consuming. The group chose to introduce two fundamental measures: to formally define the project manager's role, which did not exist before, and to define the improvement team.

A matrix structure was established by creating project manager positions. Aiming at diversification, specific project managers were assigned according to product areas. There were three areas in which to incorporate new markets and types of equipment, going beyond the planting area and the aforementioned crops. A new functional area was also created to address the performance of tests, prototypes and high technology projects.
A team of managers from the product engineering area, the Engineering Committee, was in charge of the program. Improvement projects are defined by the committee and carried out by individuals selected among its members. People of related areas are invited to participate as specific needs arise. Results generated by teams are presented to the Committee, which has the responsibility of validating new standards. There was a sponsor, a director from the engineering area, and one of the Committee members acted as a focal point, concentrating information to be conveyed to the Committee. Figure 5 shows the structure created.

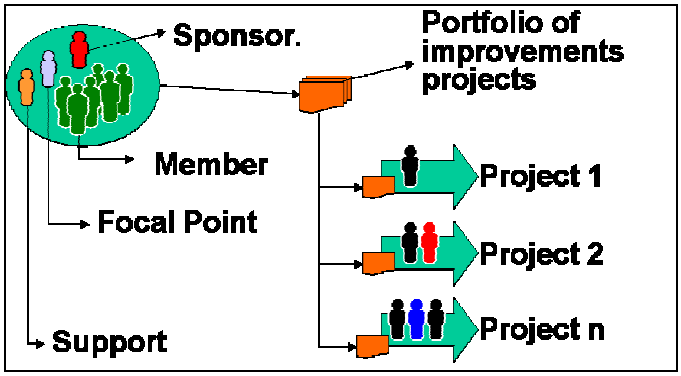

Figure 5 – Organizational structure for NPD continuous improvement.

In the middle of 2005 this work began to be assisted by one collaborator, which immediately impacted the program evolution. This infrastructure evolved and was consolidated at the end of the work, when it was named as Project Office. It assists in the improvement program as well as in the work carried out by the project Managers. The tasks assisted were: elaboration of standards and procedures related to the NPD process, consolidation of information and product portfolio reports, generation of information on performance and progress of NPD projects, generation of information about NPD improvement projects, assistance in conducting process improvement processes.

6.4 Identifying and executing improvement projects

Using the assessment performed in the previous phase, the Engineering Committee identified about 30 projects with a good potential to improve the NPD process. In order to prioritize them the group assessed the impact work and total investment, as described in Item 5.2. The main goal selected for the first phase was to reach Level 1, i.e. the basic level of the maturity model, thus obtaining a stable development process. Four initial projects were chosen:

- Introduction of a system to create and manage the project portfolio (medium term);
- Implementation of system to control resources (medium term);
- Improvement of document management system (short term);
- Mapping of NPD process with phases and gates (long term).

During the first year the pace was slow due to the project managers heavy workload, as previously mentioned. The mapping project was put on hold, and the teams' efforts were directed to the other projects. Two projects were finished on time:

- Aggregated project plan;
- Solution of specific problems in the document management system.

A third project was partially implemented at this time: project to implement a resource control system. This project involved the introduction of information systems capable of integrating resources from diverse functional areas in a single pool, discriminating their allocation in each project. It enabled introducing weekly planning of activities performed by people involved in the development of the company's products.
As the previous projects were finished new improvement projects were initiated:

- Mapping and optimization of the project procedure for supplied parts;
- Organizational restructuring of areas related to NPD.

The first project is over now and the second one is in its final phase.
This effort resulted in a project prioritization system that contributed a larger quantity of products to the company. Instituting a resource control system also allowed identifying dysfunctions and dissipations, which are now being addressed through specific improvement actions.
The final result was the achievement of the basic maturity level (Table 1), as initially planned.

6.5 Formalization of the NPD process

This phase was in progress at the end of the period of observations (mid-2006). In this period the design of the company's NPD process containing five phases, based on the PDPNet process, had been proposed. The smaller number of phases is due to the process of adapting to the company's reality. This means that names and procedures long standing in the company were not changed. Changes were restricted to improving practices.
The model has not been approved by the Committee yet, but it is important to comment that as improvement projects established new practices, there were many alterations in task instructions and procedures of the company's Quality System aiming at institutionalizing the aforementioned improvements, even without having a standard process model.

7 CONCLUSIONS

The reference models are essential tools in NPD management using the business process approach. Creating these models is fundamental to help professionals, but the complexity of the NPD process is challenging. Despite the large number of proposed models, there are aspects that must evolve.
This paper describes a reference model to improve the NPD process, named PDPNet, developed by a network of researchers and professionals. The model comprises three independent parts, i.e. three models with specific functions: (a) a process reference model that helps users perform the process activities, methods and techniques; (b) a maturity model that assists in identifying the company's present status; and (c) the aforementioned transformation model.
Results from the case study and the analysis of the model indicate that the PDPNet model helped to establish a permanent transformation process of the company's NPD process, which indicated the best practices as well as enabled establishing a system—internal to the organization—to keep this ongoing until strategic goals were reached.
The results of this work show that it is very advantageous to use distinct models consistent with each other. In special separating Business Process Reference Model, that is, the practices, methods and tools, from the Maturity Level Identification. The maintenance of each model makes it simpler. The degree of comprehensiveness—concerning the reference of the NPD process itself—may be higher. This is so because it is possible to include practices that are valid in specific contexts and to describe them in depth, provided that users refer to this model one part at a time, guided by needs identified during the diagnosis phase. Otherwise, the maturity model can focus specifically on the general practice evaluation, the gaps. The link between them allows a direct identification of activities related to gaps in terms of the company's maturity evolution. Then, users may choose which methods, tools and principles can be implemented to improve the maturity practice according their specific context and product characteristics.
Another important advantage to the integration of models: it is easier to obtain a more customized model and, thus, better suited to the company's needs. Since the proposal mainly focuses on the transformation and maturity models, it emphasizes what the company needs instead of what should be done according to the reference. Hence, it avoids the tendency, usual in the process references approaches, to adapt the company to the model, i.e. to change aspects that work well or names just to make them consistent with the process reference. The PDPNet model allowed the well-founded assessment and alteration of aspects that could truly contribute advantages to the business process.
The transformation model, surprisingly, gained more importance than the other models in the case in question and was fundamental to the success of the implementation. When the company's professionals understood the concept of systematic changes deriving from improvement projects the team's focus was enhanced and the performance of improvement actions advanced. This suggests that the research about transformation models should be intensified and be regarded as important as the process and maturity models.
In terms of research project, the present work emphasizes the importance of continuing to develop the change model, which played a fundamental role in the implementation under consideration. The effort

to change would have been greater as attested by the problems faced in the beginning of the implementation when the transformation process had not been thoroughly understood at the company.

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