IMPLEMENTATION OF THE PHASE REVIEW PROCESS IN THE NEW PRODUCT DEVELOPMENT: A SUCCESSFUL EXPERIENCE

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Abstract

Recently, the success in new product development process has become one of the main competitive advantages. Thus, many companies are looking for improving their new product development (NPD) process, to launching products as fast as possible with the required quality and low costs. To achieve such objectives, many organizations have designed phased-review processes that cut across functional areas of the NPD. One such process with wide acceptance is the Phase Review Process. Phase Reviews are checkpoints that take place at key periods in the product development process to review the opportunity/development effort, assess it from a business and strategic perspective, and determine whether it is worthy to continue the development, redirect or kill it. New product development best practices usually include such processes, however little has been written on how to implement such practices. The available literature reports generic issues and recommendations, without describing a structured approach. This paper describes and analyzes a practical phase review implementation process, pointing out difficulties and stating recommendations to improve and support a successful implementation. The results, compiled after an industrial case study, show clearly the improvements achieved for the proposed implementation.

Keywords: Phase review, stage gates, new product development, implementation processes, project management.

1   Introduction

Formal new product development (NPD) processes have had a profound impact in a way that some companies manage, measure and control their NPD programs. NPD process can be thought as a formal blueprint, roadmap or template for driving a new product project from the idea stage through the market launch and beyond [1].

A path to formalize NPD is the Phase Review Process, that became popular in the 90´s thanks to Cooper [1], [2], [3] and McGrath *et al* [4] contributions. The pioneer formalization of the NPD process was done by NASA in the 60´s through structured decision points. That initiative was followed by several companies which coined different names such as stage gate review, phase review, phase gates, gate review, phase approval, kill points, phased transfer review, tollgates and quality gates [5].

In this paper, differently from others with deal with the same subject, the authors focus on the Phase Review itself, not on the details and activities of the NPD process (NPD Reference Model), such as stage gate system [3] or PACE [4]. It is understood that Phase Review is a sub process embedded in NPD process which consists essentially in a meeting that takes place usually in the end of each phase of the NPD process, with its proper procedures, organization, inputs and results.

Phase review process is extensively studied in literature. Some papers and surveys [6], [7], [8], highlight phase review process as a NPD best practice, highlighting its different approaches and application areas. A number of authors describe the process in different level of details and purposes [3], [4], [6], [9], while others are doubtful of such process [10], [11], [12]. Nevertheless, few authors have described in details its practical implementation. Most of the available literature focus on the concepts applied and achievements.[3], [4], [9], [13], [14]. It is worth mentioning that Cooper [2] and O´Connor [15] have proposed guidelines from Phase Review implementation, based upon several case studies.

This paper aims at contribute to increase the successful implementation cases set as wells as detail an implementation experience in an aerospace industry. The analysis focuses on the main implementation aspects: implementation methodology – definition and evolution, implementation staff, supports required, training, concepts customization and company characteristics. The final result is a practical approach to implement such process, presenting guidelines and recommendations needed for achieving its expected results.

This work is an action research, where the authors are also the project implementation owners. Besides the author's experience in the project, this article is based on analysis of documents related to project implementation, such as plans, meeting notes, and guideline books written for the process. A literature review was done to support both implementation and the paper. The manuscript is structured in 3 main sections: Literature Review, Phase Review Process Implementation and Lessons Learned/ Recommendations.

2   Literature review

2.1   Phase review process

Generally, NPD processes are split into phases or stages [3], [9] through phase reviews, where all the NPD activities in that phase are evaluated to determine whether it is worth or not to continuing the development process (see Figure 1). Phase Review Process is an activity that calls for effective product development decisions and drives the remaining of the process. They are decision-making meetings that occur at the end of each phase. The agenda of the meeting consists of a list of well-defined and clear goals. Projects need to fulfill these goals in order to proceed [4].
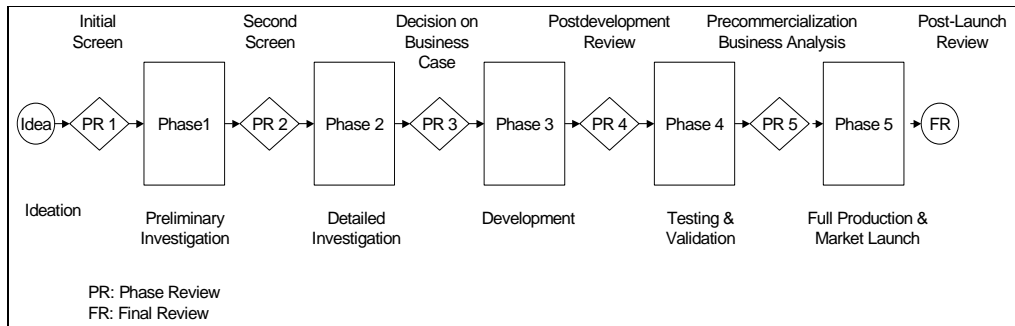
Figure 1. A generic phase review process. Adapted from Cooper [3].

Each phase review has predetermined inputs, decision criteria, and outputs. Phase review inputs correspond with the deliverables of the preceding phase activities. Phase review outputs are orders to conduct ongoing phase activities. Inputs and outputs demand cross-functional work during all phases [14]. Phase reviews are analogous to the quality-control checkpoints on a manufacturing assembly line, used to check the quality, merit and progress of the project. Like a production line, phase reviews occur in different periods throughout the new product process [3].

2.2 Implementation Approaches

Cooper [3] has proposed a framework for NPD design and implementation based on stage gates concepts. This is composed by three steps: Conceptual Design, Detailed Design and Implementation. Conceptual design consists of an outline of the NPD process that should identify phases and reviews, with their names, the purpose of each phase and review and a list of likely activities in each phase. This step also assigns the implementation staff. This aims at getting commitment from top management. Then, the next step details the conceptual design. Typical activities of this step include: phases description, phase reviews description, phase review process procedures, project organization and implementation plan. The Implementation step consists of a set of events and activities created to train and inform people about the phase review process and to fit the company's projects into the new system.

O´Connor [15] proposal is similar to Cooper's [3] in many aspects. He divides the NPD implementation in 5 steps: Laying the Foundation, Gaining Initial Commitment, Effective Change, Working the Transition and Monitoring and Improving. The important difference between both proposals is the continuous improvement step, composed by improvements of actual process through benchmarking of best practices followed by a comparison with the company's practices. The Laying the Foundation step is similar to Conceptual Framework, Gaining Initial Commitment is similar to Detailed Design and Effective Change and Working the Transition are similar to Implementation step proposed by Cooper.

2.3 Problems and Barriers for Implementation

Lately, problems and barriers were raised and discussed extensively among those who support and criticize the phase review process. The outcome of such discussion was a rich set of tips and clues for achieving successful implementation of the phase review process. First of all, it is necessary to take a look at the criticism about the phase review process to enumerate potential problems and barriers that might inhibit a successful implementation. The main criticisms of phase review processes are [10], [11], [12]: phase review introduces barriers that slow the process down in several ways; the usage of phases suggests sequential development, turning out slower the communication with market; phase review suggests an emphasis on

money keeping; in several companies the phase review itself is like a fantasy; rules are not followed and the behavior pattern is dissimulation spread from managers down to team members.

Cooper [3] who supports the phase review process points out additional problems: initial skepticism as a result from the lack of training and education and bureaucratic perception of the process.

Finally, based on case study in several companies, O´Connor [15] cited as potential barriers: gaining top management commitment and involvement; gaining consensus on exit criteria by top management for each phase review; harmonization with the product portfolio of the company and finally, organizational culture.

3   Phase Review Process Implementation

The company analyzed as case study, is one of the leaders in aerospace industry. The company has been improving several processes, techniques and tools in order to achieve the best results in its NPD. The phase review process was one that deserved company priority right from the beginning of the newest product under development, because of its challenges: new technologies involved, this product was the first to have full development with partners and an aggressive time-to-market. Soon after the clearance of the company to implement the phase review process, the planning phase for the implementation took place.

Planning the implementation

This initial phase started of with the choice of the owner of the implementation project. A senior manager with a large experience in aerospace industry, part time involved with the project, has been chosen. Then it has been formed a multidisciplinary team, composed by senior managers and experts in technology, process and project management, with a twofold mission: to plan the implementation and work as an advisory staff during the entire project. It has been designated an operational leader, full time dedicated to the project, with expertise in phase review concepts, responsible for dealing with daily activities.

The implementation methodology was structured as a detailed project, based on Cooper [3] and O´Connor [15] works.

The main strategy was to define a pilot program to test and improve the process, verifying its adaptability, consolidating new culture through a successful case and then implementing to all ongoing programs under within the company. Consequently, the initial implementation project was divided into 4 steps: Conceptual Framework, Detailed Design, Pilot Implementation and Continuous Improvement.

However, it has been found in the Pilot Implementation that there was need for further detailing, process matureness and culture creation. Thus it has been created an additional step – Job One Implementation, to this end., Practical experience has also shown that, due to product complexity and organizational culture, the Detailed Design step should continue until the end of Job One Implementation, in a simultaneous and integrated way.

Table 1 shows the phase review implementation steps, the main activities for each phase and the actual time required for accomplish each step. These are detailed underneath.

Table 1 – Implementation project steps, main activities and time required.

Step	Main Activities	Time Required
1. Conceptual Framework	Analyzing current process and practices Analyzing literature Making benchmarking Designing conceptual model (phases and reviews) Gaining top management commitment	3 months
2. Detailed Design	Designing procedures Defining exit criteria Creating templates, standard and documentation Gaining medium management commitment	12 months
3. Pilot Implementation	Testing concept, procedures, exit criteria model, templates Gaining team leaders commitment Registering process lessons learnt Starting the behavior change	4 months
4. Job One Implementation	Proving process efficacy Creating process culture Consolidate procedures, templates and documentation Formalizing entire process Registering process lessons learnt	6 months
5. Continuous Improvement	Implementing in the whole company Registering process lessons learnt from each phase review Change procedures and exit criteria when necessary Transferring process coordination to a functional department	Continuously

3.1 Conceptual Framework

The objective of conceptual framework was to gain top management commitment from most vital departments and pilot program. A framework has been built based on phase review current practices, current NPD process and organizational culture and other best practices found in literature [3], [4], [5]. Meetings with company experts and senior managers took place to get tacit knowledge from the company about NPD process and programs history. This also helped to achieve consensus in the implementation team about what was the best phase review model for the company. The final model was adapted from an existent NPD model, taking into account its phases and activities. Figure 2 shows the NPD reference model proposed, with phases and phase reviews.
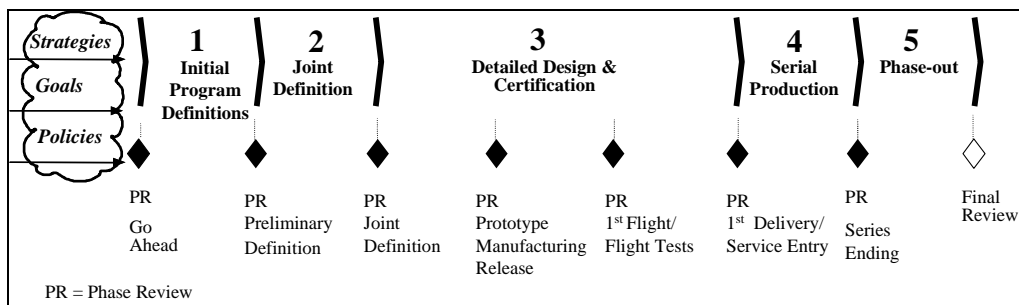

Figure 2 – Conceptual Phase Review Model defined.

The outcome of this step was a brief document that identifies the phases and the reviews, describes the main elements of phase review process (decision process, main deliverables, main exit criteria and organization), explains the strategy for implementation and ongoing execution and finally, details the implementation plan. Such document, which has become the basis for the implementation of phase review, deliberately conceals details, procedures as well as phase review exit criteria or deliverables. Such approach turned out to be of great importance for getting commitment from top management.

3.2 Detailed Design

In the Detailed Design step, the framework previously proposed has been completed, through the definition of procedures, templates, exit criteria, deliverables and documentation related to the process.

The objective of this step is to prepare the process for the pilot implementation. As mentioned before, practical experience has shown that the Detailed Design had be revised and reworked due the impact of the company culture in the process. Skepticism was predominant is this step and it was necessary more time to make the process more familiar to the people involved. This was achieved through a better involvement of senior managers and experts in the operational activities of implementation. In the end, they turned out to be the owners of the process.

Another challenge of this step was to identify the exit criteria and deliverables. Exit criteria and deliverables should be designed taking into account a multidisciplinary approach, what did not happen due to the engineering culture of the company. It became feasible only after the edition of a clear and consistent documentation, which explained the concepts, reasons and benefits of the phase review process for all stakeholders.

Because of these problems, this step had to be planned again, with new schedule and new approach, concurrently with the Job One Implementation step.

3.3 Pilot Implementation

It was performed in the Preliminary Definitions Phase Review[1] of the aerospace program. The program team leaders and program managers defined the exit criteria, validated by technology senior managers and experts. The exit criteria were divided in two blocks: program management and engineering issues. Program management criteria by their turn, were divided into: organization and process, planning and control, integrated product development and procurement. Engineering criteria evaluated the adherence between aircraft preliminary design and aircraft requirements.

According to process designed, the assessment of exit criteria had to be done through multidisciplinary meetings. To this end, there were three meetings, two for engineering criteria and one for program management issues. Program managers were accountable for each criterion. The Program Director and the Engineering Director were the decision-makers in both meetings.

The phase review experience pointed out some problems and the consequent lessons learned. First of all, resistances occurred, as expected in organizational changes, and they were due phase review process existent before, based on PDR (Preliminary Design Review) and CDR (Critical Design Review). At the beginning of the engineering criteria review, differences between the new method (Phase Review) and the PDR and CDR were not understood. After

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[1] In this phase, the requirements and the basic aircraft configuration are defined.

many meetings held for explaining the concepts, the process and differences, it was possible to get the chief engineer, program managers and team leaders commitment. It became clear then, that the Phase Review Process is broader than the former PDR or CDR, because it encompasses multidisciplinary criteria, not only engineering issues, and it could be used as a powerful tool to manage and control the Program.

Another important issue to be explained was the definition of the exit criteria. They were not multidisciplinary enough in practice as they were composed by issues that were responsibility of individual departments of the company. The engineering culture of the company also contributed to concentrate the criteria in technical issues. It has been found that some criteria shouldn't be considered for the phase review whereas others were forgotten. This indicated the need for a different approach for defining the exit criteria. It is worth mentioning that the company didn't have at that moment a template and a clear assessment procedure. The lack of those items caused misunderstandings in exit criteria achievement and proofing. Therefore: the discussions in the meetings had different levels of information; some criteria were reviewed in details, in an operational level, while others were focused in the broad picture. Sometimes there were no evidences that could proof that issues were accomplished; so many issues were not discussed and matured enough for the following phase review. Such effects also showed that the process was not mature yet and trainings were not enough to disseminate the phase review concepts.

However, the pilot implementation step brought some very useful contributions. The Program maturity level was evaluated in an integrated way, and the managers could understand the risks of moving forward to the next the phase. The phase review focused not only engineering issues like in the previous PDR and CDR processes but also on business decision criteria.

The pilot implementation allowed the company to learn how to get to a new phase review process effectively. The practical experience indicated the phase review process need for matureness and culture creation. Therefore, the phase 2 was extended and was defined a Job One phase review.

3.4 Job One Implementation

This was carried out in a company NPD program that was at the First Flight Phase Review[2] because this review is the most multidisciplinary and critical of a new aerospace product development.

Differently from the pilot implementation, multidisciplinary exit criteria were designed for the Job One phase review, considering in the same issue subjects like plans, operation and maintainability, logistics support, product functionalities safety and documentation; aircraft configuration and aircraft safety.

Therefore, each exit criterion was not under the control of just one company department, but rather, it cut across many areas like engineering, manufacturing, quality, customer services, planning, configuration control and procurement. Templates for exit criteria were created, as well as the indication of the necessary checks to evaluate the related issue. Usually, these evidences were performance indicators. Whenever applied, it was necessary to indicate the associated documentation, which should substantiate the exit criteria accomplishment. The templates became the official template of the company for the phase reviews, used both for exit criteria and presentations of the phase review meetings

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[2] The first flight phase review checks if the program was qualified to perform safely the prototype first flight; if the necessary activities to start the flight and ground tests were accomplished; and if the program goals were accomplished.

In order to assure the proper definition of the exit criteria, a company senior who was also an expert in the product development and responsible for the pilot and job one implementation, had to validate exit criteria before the meeting reviews, in order to guarantee the quality and the adequate level of the information.

Preliminary peer reviews were created to provide exit criteria self-assessment with a detailed and simple procedure to assess each item of the exit criteria. People have been trained on how to deal with the preliminary peer reviews procedures and with the exit criteria assessment procedures. The concepts, procedures, the criteria model and the templates were tested and created as basis for the training material.

The NPD program carried out more than thirty preliminary peer reviews and one big meeting for the phase review. Engineering, Procurement, Manufacturing and the Program director attended the meeting, along with team leaders, program managers, technology senior managers and technology experts.

In this phase review, the criteria assessment was clearly defined for the appraisers. Each exit criteria checklist item could be approved for the next phase. The phase review process contributed to streamline the closing of pending items and to release the aircraft first flight at the earliest date possible. Like so, the appraisers could make a better risk assessment of the review, considering the probability and severity of each risk.

The job one implementation definitely consolidated the phase review culture in the company. The aircraft program case study has established a new time record in the industry for the first flight and was the aircraft with less pending items in the history of the company.

After this phase review, the implementation team formalized all the process and documented it in a roadmap. Then, the Phase Review Process was disseminated to other company programs, and it became embedded in the new product development process. It has already been established in the company, getting into continuous improvement phase.

3.5 Continuous Improvement

This step provides a process to assure continuous evaluation and improvement of the entire phase review process, considering its procedures, templates and exit criteria. The process is composed by four sub-process: adapting the reference model for each new program, adapting exit criteria model for each phase review occurred, gathering and registering lessons learned from each phase review occurred and changing the reference model whenever necessary.

There are multidisciplinary teams accountable for such activities, coordinated by a department that is responsible for project management procedures in the company. These teams are composed by persons coming from functional areas: preliminary design, engineering, manufacturing, procurement, quality and customer service and at least, one person responsible per program. They are technology senior managers, technology experts, program managers and team leaders. This assures their involvement in the phase review process and consequently, corroborates their feeling about process ownership.

The Pilot Implementation has already been carried out in six phase reviews in five different programs and provided some improvements on the exit criteria list and in the phase review procedures. This confirms that the continuous improvement step is efficient.

4 Key conclusions

The implementation of the phase review process was a huge success, being a milestone of the product development process in the company, supporting the program to achieve the main objectives of new product development. The development schedule was achieved (faster new aircraft development of the world). The consensus between users, top and senior managers is that design and product quality has improved. It was also consensus that the Phase Reviews provided integration and less rework, reducing development and product costs.

This implementation has shown a difference compared to Cooper's [4] and O'Connor's [15] implementation approaches. The Job One Implementation step has been created to consolidate the process in the company, through a successful and structured case. This was essential to obtain success in the implementation, creating the process culture in the company. However, this step would not be necessary if the Pilot Implementation step had been efficient. Spending more time in the Detailed Design step could make Pilot step efficient, providing a more structured and strong implementation project.

Authors identified also other lessons learned and recommendations that can help carry out a successful implementation, what should be carefully analyzed during implementation planning and Detailed Design. In order to summarize the entire implementation, three blocks of lessons learned and recommendations for a successful implementation are given: potential barriers, critical challenges and key success factors. The authors believe that a careful analysis of such issues followed by a company adaptation help to carry out a successful implementation.

Potential barriers should be treated with involvement and training of stakeholders and a consistent process concept. Critical challenges are those activities that are the most difficult to perform and depend on a careful analysis of NPD process, culture, internal relationship and hierarchy of the company. Finally, what is considerate by the implementation staff as the key success factors of implementation, those actions and strategies that were essential for the success of implementation. Table 2 summarizes this lessons learned and recommendations.

Table 2 - Lessons Learned and Recommendations for a successful implementation of the phase review process.

1. Potential Barriers
Organizational Culture
Engineering culture of NPD
2. Critical Challenges
Exit criteria definition for each program phase
Achieving a multidisciplinary approach
Defining roles and responsibilities
3. Key Success Factors
Spending more time in Detail Design step
Treating the implementation as a detailed project
Providing autonomy to implementation staff
Getting commitment from high level and senior managers
Giving to users (project staff, engineers and team leaders) the ownership of proceedings and key concepts
Giving controlled flexibility to project scope respecting the process guidelines
Working with users during the process learning curve

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