

**CONTINUOUS IMPROVEMENT IN PRODUCT DEVELOPMENT
– A COMPARISON OF THREE APPROACHES –**

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Abstract

Most quality initiatives in product development have been aimed at improving the product, while the process-focused methodologies, such as continuous improvement and process management, have not been given as much attention. In many operations, the product development organization is not included in quality initiatives due to the special characteristics of product development activities. A central aspect in this context is that most organizations find it difficult to improve and learn if work is carried out in the form of projects.

The intent of this paper is to investigate a number of different approaches to continuous improvement in product development. The study focuses on how an organization can improve the product development process through the transfer of knowledge gained in one product development project to other projects. The similarities and differences between approaches in terms of temporal distance, responsibility, team composition, vehicle of knowledge transfer and scope of improvement are investigated. The strengths and weaknesses of each approach are identified and managerial implications of their applicability in different organizational contexts are discussed.

Introduction

To have a formal process for product development has during the last decade become a differentiating factor between success and failure in product development (Cooper 1993). A study by Griffin (1997) of 140 American firms concludes that about 40% of the firms have adopted a formal product development process. The typical structure of product development processes is a multi-functional stage gate approach (Cooper 1993). When an increasing number of companies start adopting formal product development processes, organizations must find new ways to stay ahead of their competitors, i.e. they need to develop new standards to work with product development and find ways to improve these standards on a regular basis.

During a workshop and case studies in Swedish organizations the authors met a number of different improvement structures in the participating organizations. The use of continuous improvement in product development has not been thoroughly investigated in academia, and when investigated it is often described as a unified approach. To treat continuous improvement this way, does not fit very well with the practice that the authors met during the case studies. Each organization used multiple improvement structures and a range of activities connected to practical improvement work.

The overall purpose of this paper is to create a better understanding for continuous improvement (CI) in the context of product development. More specifically the aim of the paper is to describe and analyze three different approaches for CI in product development. The focus however, is on improvements of the work practice, less on improvements of the product being developed. The article shall provide a deeper insight on how to choose an improvement approach and design the improvement structure to fit an organizational context where product development is conducted in the form of projects. The paper ends with a discussion on the use of CI in product development and our main findings of this study.

Continuous Improvement

The concept of CI has its origin in mass production industry in the beginning of the 20th century and has now developed into one of the core principles of Total Quality Management. From its start in production, CI now is being used throughout the whole company. However, the success of CI programs in Western industry has been limited and they have primarily been applied at the operations part of the business (Caffyn 1997). The reasons for the limited success have amongst other things been attributed to a lack of process orientation and cultural differences compared to Japan (Lillrank et al. 2001). Regarding product development, the iterative nature of the process, the long time-scales and the fact that product development is intangible makes the application of CI in this context more difficult.

Since the focus here is to better understand different approaches for CI in product development an organizational design perspective, as proposed by Lillrank et al. (2001) will be adopted as a starting point. Lillrank and his co-authors define CI as “... *a purposeful and explicit set of principles, mechanisms and activities within an organization adopted to generate ongoing, systematic and cumulative improvement in deliverables, operating procedures and systems. CI contributes positively to the organization’s target achievement.*” (Lillrank et al. 2001 p.43). One of the main building blocks of this perspective on CI is that to reach continuity in the improvement activities, a permanent support structure and general visions about desirable development targets are needed (Lillrank et al. 2001). In this work the authors will focus on the organizational design dimensions of these support structures.

A Framework to analyze Continuous Improvement in Product Development

In this paper it has been chosen to make a deeper investigation of the improvement structure along a number of central dimensions. These dimensions are expected to enable a multifaceted understanding of a CI approach in product development and have been chosen through a literature review. Their origin is previous studies of CI in product development, see Caffyn (1997) and Bartezzaghi et al. (1997). The suggested dimensions for analysis of improvement structures in product development are (1) Temporal distance, (2) Responsibility, (3) Team composition, (4) Vehicle of knowledge transfer, and (5) Scope of improvement.

Temporal distance is a central factor in most management issues and is important to CI

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as well. It makes a difference whether action is taken during the project or after the project, in regular predestined intervals or randomly when needed. One of the main problems of CI in product development is the separation in time and place of the lessons learned and their application.

Responsibility for improvement activities is a central 'people' dimension in improvement activities of product development. Lillrank and Kano (1989) describe the Japanese quality circles as being separate from the formal organization operating under special rules and principles. Bowen et al. (1994) argue for that it is the purpose of each project development team to improve both the product and the product development process.

The *composition of the improvement team* is a decisive determinant of the space of possible benefits. Even so, the improvement activity can be organized in different ways, for example as a special task team, project team or a process team. A special task team is a temporary group composed by representatives of each department affected by a problem (Daft 2000). Using a project team to do the improvement work, is the most common way to work with CI in product development, see Cooper (1993). In this case, the same group working in the product development project also performs the evaluation of the project, gathers experiences and transfers them to subsequent product development projects. A process team is a permanent group working with improvements of the work practice of the organization.

The essence of CI is typically to share knowledge within the organization. In order to overcome the space and time disjunction between the acquisition of past experience and its future application some *vehicle of knowledge* has to be used, see Bartezzaghi et al. (1997). A vehicle of knowledge is a means through which knowledge can be transferred in spite of the time and space barriers existing in the organization. There are mainly three categories of vehicles; (1) people, (2) reports and databases, and (3) organizational elements such as procedures, tools, methods and organizational structures.

The *scope of improvement* describes the degree to which the improvement has impact on the organization. On the one hand it is obvious that not every improvement can be applied to every part of a product development organization or even the whole company. In case of an improvement, which is applied directly to the present project, it is a matter of intra-project improvement. If improvements are made available to other projects or even the whole organization they are typically codified in organizational elements and inter-project improvement takes place.

Three Approaches to Improve Product Development

Three improvement approaches have been identified from empirical fieldwork and through the literature review. These approaches have been labeled *Problem Solving*, *Post-Project Review* and *Process Management*, and are illustrated in Figure 1. Problem Solving is a purely problem-driven approach, where an improvement team is composed when a crisis arises during a development project. In Post-Project Review, an assessment of a project is conducted after its completion, or alternatively on the completion of each project-phase. The third approach is characterized by the existence of a team that works with process improvements on a regular basis.

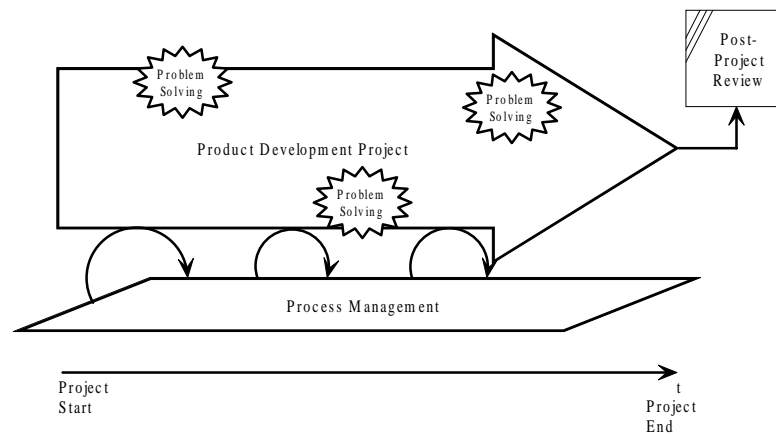


Figure 1: Three Structures for CI in Product Development

Problem Solving

Lillrank and Kano (1989 p.18) define this approach as a “*team approach where a task force is put together to solve a certain problem*”. The members can be from various units and levels in the organizational hierarchy, and the team is dissolved as soon as a solution for the problem has been developed and implemented (Daft 2000). This approach for CI has received limited attention from academia, which is to be expected since (1) it is regarded as a defensive quality approach and (2) even though many organizations use it, it is often not a deliberate approach. On the other hand it is a fact that organizations consisting of human beings are never perfect and consequently there will always be a need for problem solving.

Some organizations rely on external or internal consultants who are engaged on an emergency basis, i.e. once the problem is acute the consultant is brought into the project team and solves or facilitates solving of the problem and then leaves again. Consequently the solution is typically focused on the present project, and the usability of this solution in future projects is at best considered a pleasant by-product, i.e. the scope of the improvement is limited to a single project.

Post-Project Review

In many models for product development a last step of project evaluation is included. This stage is called *project audit*, *post-implementation review* (Cooper 1993), *post-completion audit/review* or *postmortem project evaluation*. The purpose of this stage is twofold (1) to overcome late development problems and evaluate and reward project members and (2) to help the organization to learn from its experience (Bartezzaghi et al. 1997).

One possible approach to conduct a post-project review is to build a cross-functional team to review the project, conduct interviews with participants and gather data about project execution and performance. The mission of the team is to develop recommendations for changes in the product development process to be applied in

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upcoming projects. These Post-Project Reviews have the advantage that the project can be evaluated on the background of the results which the project actions have given. At the same time it is the weakness for the project itself as improvements for the present project are not possible anymore. Another ambivalent aspect of post-project reviews is the hermeneutical dimension, i.e. due to the temporal distance between the incident that is considered worth to lead to an improvement and the actual review the memories of the involved individuals are likely to give widely differing interpretations of the incident and its importance.

Process Management

A more recent approach to work with improvement of the product development process is by creating a process-oriented product development structure, with one or more process owners and process teams (Griffin 1997). The responsibility of the process owner is the design, implementation and CI of the product development process. Either a process team is assigned to work with the whole process, or a process team is composed for each sub-process. Improvements can be identified by the interdisciplinary process improvement team, which may also comprise project members of the different process stages.

The framework provided by a product development process provides a basis to improve on. Many researchers agree that a clear, well-communicated understanding of the central processes is elementary for enabling improvement at all. Most improvement initiatives rely on the employees who perform the day-to-day work to both guide the improvement program and make the actual improvements.

Discussion

The three identified approaches are not mutually exclusive, but rather should be seen as complementary. A parallel existence of all three structures and a systematic appropriate application of each one would enable an organization to capture a larger amount of improvements. To some extent, every organization works according to the problem solving approach when a severe problem arises during a product development project. At the same time, most product development processes include post-project review as a closure of each product development project, see e.g. Cooper (1993). Especially in organizations working with process management, we expect to find traces of all the three approaches to CI. The decisions each organization has to make are (1) how many resources to commit to each improvement approach and (2) what are the responsibilities of each improvement approach. The following section contains a discussion of the main similarities and differences between the three approaches to CI in product development. An overview of the three approaches according to the framework presented in the previous section is shown in table 1.

The three approaches have rather different characteristics in the dimension of *temporal distance*. In the problem solving approach, the temporal distance between the moment of experience and the improvement activity can be measured in days, i.e. the gained knowledge is quickly put into work in the organization. In the process team approach, the time period is weeks, and in the post-project review approach the time period is

months, sometimes years. The longer the temporal distance, the more people have forgotten when the time comes to reflect over what actually has happened in a project. When it comes to the post-project review, the personnel turnover during the course of the project can influence what experiences are available when it is time to perform the review. Peoples memory and personnel turnover makes such an approach hard to be successful for long-term projects, unless phase-reviews are conducted on a regular basis.

Perhaps the most important dimension in a CI approach is *who is responsible* for initiating and performing CI activities. In a problem solving and a post-project review approach, it is typically the project leader or the project group which identify problems. In businesses facing increased competition and that are forced to reduce lead-times for product development, the dual responsibility of both product and process improvement might be difficult to handle. On the contrary, in a process team approach the responsibility for process improvement is assigned to a parallel organization. As in operations the authors propose that less complex problems can be handled within the project, while problems of greater complexity are better handled in a parallel improvement structure, see e.g. Lindberg and Berger (1997).

The *team composition* is central to both the problem solving process and the transfer of gained knowledge to interested parties in the organization. In a process team, typically representatives from 2 to 5 projects are participating in the improvement initiative. This provides an environment where the participants who discuss the problems have different experiences of how these problems have been handled in other projects. Making a wide scope analysis of the possible problems and taking into account the multifunctional representation in such a group the experiences will be spread through personal channels. In a post-project review, the focus is on a single project, which makes it possible to make an in-depth analysis of the project as a whole. A special task team, as used in problem solving, contributes with knowledge that is not present within the project, for instance competence about a specific methodology as Quality Function Deployment (QFD) or Design for Manufacturing (DFM) that is needed to solve the problems present within the project.

The *vehicles of knowledge transfer* used in the different approaches are quite different. It has to be pointed out, that all approaches use multiple vehicles to transfer knowledge, but different vehicles of knowledge transfer are dominant in the different approaches. Knowledge can be transferred in the organization by converting successful project activities to standard practice, which is a means of codification. The problem solving approach uses people as the dominating vehicle to transfer knowledge, making this an example of a personalization strategy. The other two approaches, where knowledge transfer is often performed through reports, databases and organizational elements are examples on a codification strategy.

The intended *scope of the improvements* handled in the different structures is quite diverse, ranging from one single project to all future projects. This puts different demands on the other design dimensions, as team composition and vehicle of knowledge transfer. Since the problem solving approach is focused on intra-project improvement, it does not place strong demands on knowledge transfer. On the other hand, post-project review and process management focus on inter-project improvement and knowledge transfer has to be

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designed accordingly. One problem in this context is when an improvement approach intended for intra-project improvement is used for inter-project improvement.

Table 1: Three Structures for CI in Product Development

Dimension	Problem Solving	Post-Project Review	Process Management
Temporal distance	Immediate use of gained knowledge (Days)	Gained knowledge used at end of project (Months)	Specific time intervals (Weeks)
Responsibility	Project Organization	Project Organization	Parallel Organization
Team composition	Special task team	Product development team	Process team
Vehicle of knowledge transfer	People	Reports and databases	Organizational elements
Scope of improvement	Single project	All future projects	All future projects

Conclusions

More organizations are implementing a product development process based on concurrent engineering and a stage gate approach. When the differences in the design of the product development process become more subtle, the importance of how well organizations are able to adopt the process to changes in the environment will become a competitive advantage. In this paper five central dimensions for CI in product development have been identified, namely temporal distance, responsibility, team composition, vehicle of knowledge transfer, and scope of improvement. In a practical context it is important to connect these dimensions to structures or approaches that can be found or established in an organization. The approaches discussed here were problem solving, post-project review and process management. These approaches have been identified through empirical fieldwork and a literature review and are found to be quite different from each other. They are to be seen as complementary rather than competing ways to improve product development performance.

In Swedish industry, organizations use these approaches in different ways. We have observed organization having only one approach present in the organization, but also organizations having a parallel existence of all three approaches have been identified. It is impossible to say that one approach is generally better than the other ones. Under high competition and scarce resources, the prevailing approach is problem solving. What has been identified in this study is that during these circumstances an improvement initiative is better conditioned to survive if placed in a parallel organization.

However, further empirical evidence is necessary to support or contradict the application areas of these approaches. The connections to the project character of new product

development activities also deserve further attention, such as if certain kinds of improvements dominate in different project phases or which improvements are most readily accepted and implemented in subsequent projects.

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