Improving CE with PDM

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Abstract

The concept of Concurrent Engineering (CE) centers around the management of information so that the right information will be at the right place at the right time and in the right format. Product Data Management (PDM) aims to support a CE way of working in product development processes. In specific situations, however, it is hard to estimate the contribution of a particular PDM package to CE.

This paper presents a method to assess the contribution to CE of a PDM package in a specific situation. The method uses the concept of information quality to identify the gap with CE information quality requirements. The contribution of PDM to bridge this gap is estimated. Decisions on improvement actions are supported to improve readiness for PDM as well as to improve CE. The method has been tested in a real-life situation.

Key words

Information quality requirements, concurrent engineering, PDM functionality, assessment method

1 Introduction

Since its emergence in the 1980-s, the concept of Concurrent Engineering (CE) has been developed through many interpretations [Prasad, 1996; Helms, 2002]. The most commonly referred definition of CE is that of Winner et al. (1988), where it is understood as "*a systematic approach to the integrated, concurrent design of products and their related processes, including manufacture and support.*" The CE concept stresses the integration of activities between different disciplines, functions, and processes in the product lifecycle [Paashuis, 1997] and the insightful response to customer expectations [Tucker and Hackney, 2000].

While in the traditional sequential engineering approach each incremental stage is completed before the subsequent stage commences [Cooper, 1993]; the concurrent work-flow is built on parallelism [Prasad, 1996; Oehlmann et al., 1997;] and overlapped activities [Clark and Fujimoto, 1991; Wheelwright and Clark, 1992; Krishnan et al., 1997; Terwiesch and Loch, 1999; Helms, 2002]. Integration of different activities in CE is achieved by frequent, bilateral exchange of preliminary information instead of late release of the complete information [Clark and Fujimoto, 1991; Koufteros et al., 2001; Helms, 2002]. With early release of information, engineers can begin working on different stages of the problem while final design steps are evolving that might lead to avoidance of time-consuming re-work and agreement on the requirements of all stakeholders at the early stages [Eversheim et al., 1997].

Different studies mention diverse ways to achieve the benefits of CE [Gerwin and Susman, 1996, Prasad, 1996; Terwiesch and Loch, 1999; Koufteros et al., 2001]. The different solutions can be classified into *organisational* and *technical* solutions. The research of Susman and Dean (1992) and Gerwin and Susman (1996) supports our view. *Organisational solutions* are widely described in the literature and can be defined as the mechanisms applied at the organisational, group, and individual levels in a company, and include policies and practices that facilitate CE [Gerwin and Susman, 1996]. Organisational solutions mainly concentrate on multidisciplinary and cross-functional teams [Prasad, 1996; Koufteros et al., 2001; Helms, 2002], early involvement of all constituents [Adams et al., 1998; Koufteros et al., 2001], specifying parallel and overlapped tasks performance [Terwiesch and Loch, 1999], and preliminary information release instead of late exchange of complete information [Clark and Fujimoto, 1991; Helms, 2002]. *Technical solutions* consist of codification or computerisation [Gerwin and Susman, 1996], and can be divided into two groups: organizing data and information for product development within CE (generating, storage and retrieval of data); and media facilitating data management (shared workspace, planning systems, document and configuration management systems, but also paper filing systems, etc.).

Deciding on which configuration of organisational and technical solutions to use in a specific situation is, however, not an easy task. Many aspects of CE need to be taken into account, such as enabling employees to provide and use information (organisational policies), managing incomplete information within a team (group processes), managing data stores with respect to various information domains and mapping functional and technical domains (codification/computerisation), or ensuring accessibility and appropriate logistics of the flow of information for concrete tasks (task design). Information, hence, plays a key role both in organisational and technical solutions for achieving integration in concurrent engineering. Information must be managed properly to achieve the benefits of CE.

The concept of information quality is very useful for defining the requirements that should be satisfied by information management to support a CE way of working. We use the empirical quality framework defined by Wang and Strong [1996] because it represents user perspectives on necessary information qualifications. In addition, the framework incorporates both organisational and technical aspects. In this paper we present a method for assessing the information quality gap in a specific real-life situation with respect to requirements that should be satisfied in a CE way of working. We also identify the extent to which a PDM system contributes to improving the quality of information. We illustrate our approach with results from a case study in a large company producing complex electro-mechanical products.

2 Information quality in CE

By analogy with the concept of 'fitness for use' [Dobyns and Crawford-Mason, 1991; Ballou and Pazer, 1995; Wang and Strong, 1996], we define information quality as the information that is fit for use by information consumers. Using a marketing research methodology, Wang and Strong [1996] have empirically derived four user-centered dimensions of information quality (IQ): intrinsic, contextual, representational, and accessibility.

Intrinsic means that information has quality in its own rights, it must be believable, accurate, objective, and with good reputation; *contextual* implies that the quality of information must be considered within a particular task context; it must be relevant for the task execution, well-timed, complete and include appropriate amounts of data; *representational* includes aspects related to the format of the information, including interpretability, easiness to understand and use, and presented consistently and concise; *accessibility* of information emphasises ease of access and access security [Wang and Strong, 1996]. Other studies on information quality characteristics mention different IQ categories but can easily be compared with the dimensions of Wang and Strong (see e.g., [Mollema, 1991; Delone and McLean, 1992; Goodhue, 1995; Lee et al., 2002]). Because in our study we also are interested in people's perceptions of information quality in real-life situations we will use Wang and Strong's framework. Wang and Strong's framework is considered applicable to CE, where the right information should be at the right place at the right time in the right format. Achieving information quality is an important step into achieving a CE way of working.

Product Data Management (PDM) provides a way to improve the quality of information, thus supporting a CE way of working. PDM is not only a software system, but requires an integrated system (organisational and technical) to manage product and process data during the lifecycle of a product. Below PDM is briefly described.

3 Product Data Management

Product Data Management concerns the management of data that are produced by and used in various processes along the lifecycle of a product, such as development, manufacturing, maintenance, disposal, and reuse. A PDM system integrates both organisational and technical mechanisms to manage the large amounts of data during the lifecycle of a product. For example, policies and procedures are needed to manage generation, storage, access and distribution of the data, including the preliminary exchange of information. Information technologies, on the other hand, may provide efficient storage, retrieval, and administrative mechanisms to enhance consistency, security, retrieval and presentation of the data. To what extent a PDM system satisfies information quality requirements depends on the specific configuration of organisational and technical solutions.

To assess a particular PDM system with respect to its information quality potential, we need a framework to characterise the system. We use the framework defined by Pels et al. (1999) for this purpose. Pels et al. (1999) have defined three classes of objects that should be managed by a PDM system. These classes are *product*, containing data on the product that is developed, e.g., product parts and relationships, *document,* containing descriptions of product properties, e.g., geometric properties, and *process*, containing data on the status of the development process. For each object class three information management classes are defined, which are *repository management*, aimed at managing the content of information*, structure management*, aimed at managing relationships between objects, and *lifecycle management*, aimed at supporting creation, use, change, and deleting of objects as well as managing the flow of information. Together, the object and information management classes define a functional model of a PDM system. In table 1, this model is depicted.

	Document management	Product management	Process management
Object repository management	Document repository management	Product repository management	Process repository management
Object structure management	Document structure management	Product structure management	Process structure management
Object lifecycle management	Document lifecycle management	Product lifecycle management	Process lifecycle management

Table 1: Functional model of a PDM system (Pels et al., 1999)

The functional model presented above is used to characterise a specific PDM system. By relating each class to information quality, the potential contribution of the PDM system to achieving information quality can be assessed. In table 2 the potential contribution of each functional class to information quality is depicted.

	Document management	Product management	Process management
Object repository management	Intrinsic Representational Accessibility	Intrinsic Representational	Intrinsic Contextual Accessibility
Object structure management	Intrinsic Representational	Intrinsic Representational	Intrinsic Contextual
Object lifecycle management	Intrinsic Accessibility	Intrinsic Representational	Intrinsic Contextual Accessibility

Table 2: Link between information quality and PDM functionality classes

The actual contribution of the PDM system to achieving information quality in a specific situation depends on the configuration of organisational and technical mechanisms used to implement the PDM system, because current PDM systems do not yet cover all functionalities. Moreover, in practice, PDM implementations do often not yet cover the process management class (see e.g., Wognum and Kerssens-van Drongelen, 2001). The existence of organisational solutions to implement PDM functionality as well as realise functionality not covered by a PDM package needs to be assessed as well.

Below, our assessment method is presented.

4 An IQ assessment method

The proposed method aims at assessing the suitability of a PDM package to support the information management within a CE way of working. The method covers initial steps in an existing assessment method, called formal interaction analysis (FIA), aimed at creating awareness on problems with respect to information management needed to support a CE way of working [Oehlmann et al., 1997]. Our method is restricted to assessing the discrepancy between existing and desired IQ requirements in a specific real-life product development process and assessing the appropriateness of a specific PDM

system to bridge this discrepancy. Specifically, the method addresses the following questions:

- What information quality is achieved?
- What information quality is needed?
- To which extent can a PDM package help to achieve the desired requirements?

The goal of the method is to create awareness in a company about realistic potentials of an envisioned PDM package regarding accomplishing the information requirements gap for a specific CE process and support improvement decisions. The method does not focus on information content. Moreover, additional methods and tools are needed to specify and realise the desired improvements. The method is outlined in figure 1.
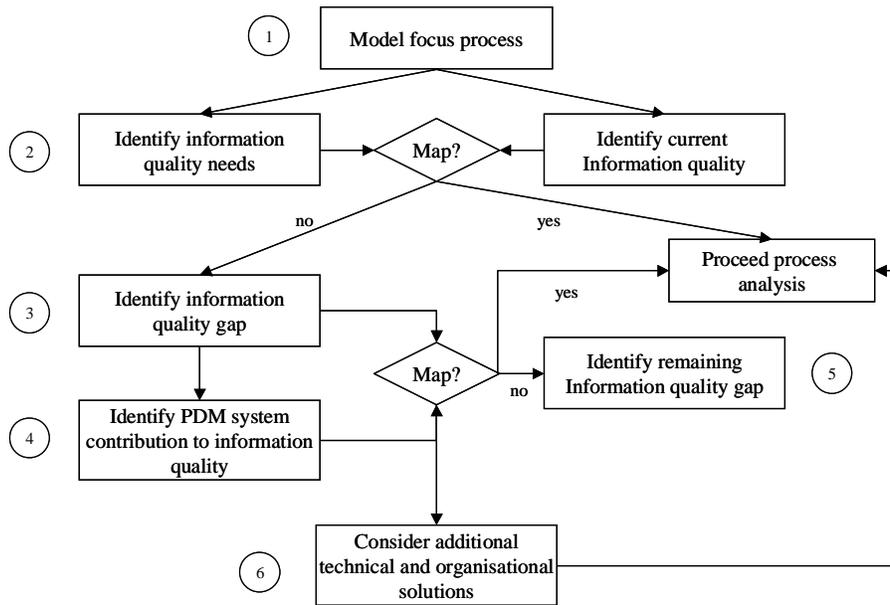
Figure 1: Information quality assessment steps

Basically the assessment takes five steps (figure 1). The first step consists of modelling the process that is our focus of analysis. Any modelling method is suited that supports identification of the information flow, such as IDEF0. Identification of the flow of information between processes outside the focus process is also necessary. The second step is aimed at identifying the information quality needs to support a CE way of working (including preliminary information exchange) as well as the information quality that is achieved in the focus process. The third step consists of identifying the gap between desired and current information quality. The fourth step focuses on the potential contribution to an envisioned PDM package to achieving information quality. The fifth step consists of identifying the remaining information quality gap. Finally, the sixth step aims at identifying additional technical and organisational solutions needed to improve information management for CE. The steps shown provide only part of an analysis and improvement process to achieve CE. The method is easy to use and understand for people in practice. A case study in which the method has been applied is briefly described below.

5 Case study

The process on which the method has been applied has been a PCB development process in a large company producing complex electro-mechanical products. People involved in the development process have been interviewed to identify desired and existing information quality. In addition, a work package manager, a CAx support employee, a process engineer, and a data manager have been interviewed.

The process has been modelled by means of IDEF0 (step 1 from the figure 1). In this model all formal and preliminary information flows have been identified. Information quality, desired as well as existing, has been assessed for all formal documents as well as for information that needs to be exchanged preliminary. Desired information quality is related to a CE way of working. In the focus process some bottlenecks to CE exist that limit or prohibit information exchange (step 2).

To accomplish step 3, the analysis of the information quality gap has been limited to intrinsic, presentation and accessibility requirements. Analysis of contextual information quality, highly important for any process analysis and improvement, requires more thorough identification of information needs and qualification than was possible for the case study at hand. For the purpose of this paper, the case provides an illustration and validation of the proposed method.

The following information quality gaps have been identified:

- *Accessibility*: some technical data generated in the design process are not accessible for detail design; technical production preparation can only access technical product data after formal approval and release; board data is stored locally on hard disk making them not widely accessible; to access technical product data several adapters are needed.

- *Presentation*: mechanical information from the design process is made available through e-mail; some documents are stored only on paper.

- *Intrinsic*: status and version management is lacking for the exchange of information between detail design and layout design; process and document status management is standard, thus limiting distinction between preliminary exchange of information and information still subject to change; preliminary information from part of the design process lack version and status information; board data lack version and status information.

Step 4 consisted of assessing the potential contribution of the PDM system Pro/Intralink. First, the functionality of Pro/Intralink was determined by matching the package with the functional model of Pels et al. (1999). Process management functionality appeared to be still limited in Pro/Intralink, as well as product and document structure viewing. Pro/Intralink contributes to bridging the information quality gap (step 5). However, additional technological and organisational solutions are needed to enable a managed exchange of preliminary information and improve accessibility and presentation of information before PDM can be implemented, but also during implementation (step 6). More process improvement steps need to be performed to improve a CE way or working requiring additional methods and techniques.

6 Conclusions

The method proposed in this paper is considered as a practical mechanism for identifying and achieving the full benefits of a PDM package with respect to CE. The theoretical basis of the method roots in the synthesis of CE requirements and information quality studies. We have presented our view on the necessary and sufficient requirements for information quality with respect to information management in CE processes.

Five basic steps have been defined to foresee the potentials of an envisioned PDM package to bridge the information quality gap for a CE process. It should be noted that we consider the method as a small step in a more encompassing process of improving a CE way of working. After accomplishing modelling a specific process, classifying the gap between the desired and current information quality requirements, identifying PDM contribution, and analysing the remaining information quality gap, there is still a need to define and implement additional technical and organisational solutions. This would require in turn further analysis of interactions, cost/benefits, etc., as has also been described by Oehlmann et al. (1997).

The application of the method to a concrete case has contributed to our understanding. We have found that identification of three out of four information quality requirements in a company was a straightforward process. The fourth class, contextual, requires a more in-depth approach as part of the improvement process. As a result it was easy to analyse the gap between the desired and existing information quality and to generate ideas for improvement.

The method allows identification of the steps for improving a specific situation to prepare for implementing a PDM package. Efficient use of such a package requires additional organisational mechanism to manage product data efficiently and consistently, as was already shown by Helms (2002). Therefore, implementing a PDM system seems to be a necessary but not sufficient solution for achieving integration in CE. Companies will benefit from the advantages offered by a PDM package for CE only after a careful analysis of the information flow, analysis of the functionalities of the system, identification of the information quality requirements gap, and improvements needed.

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