Document management guidelines for distributed project networks

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Abstract

This paper provides the project engineer with guidelines or a checklist on tasks that must be considered, defined and documented before the project can successfully implement a document management system in geographically distributed project environment. Topics ranging from configuration management, approval process, document types, user administration and document naming are covered. The underlying cases of the paper are that of CERN (European Laboratory for Particle Physics) and its latest accelerator project, together with the Nordisk Industrifond - funded Connecting Distributed Competencies (NI#: 98082) project, with a focus on distributed shipbuilding processes.

Keywords: distributed project management, product data management, networking, document management, virtual workspaces

1 Introduction

Configuration management of a large-scale and geographically distributed project has to be organised well in order to avoid conflicts between project partners during the execution of the work. In the first place, configuration management concerns policies, processes and practices which the members of the project are expected to follow (Hameri, 1995). In the second place, configuration management is a matter of information systems supporting those processes (Buckley, 1993). This paper concentrates on the policies the project management has to define to assure a successful Product Data Management (PDM) system implementation.

When establishing a PDM system for a project, the first thing to do is to stop for a while to think of its mission, its *raison d'etre*. A PDM system can be used for multiple purposes, with alternative motivations and ambitions. If the mission of the PDM project is not clear, it will be impossible to manage and the whole initiative will confront negative response from project partners and users. The more challenging the objectives the more effort has to be put into configuration planning and implementation. As for a roadmap it has proved to be useful to start with a modest implementation and to gradually expand it over time, instead of spending too much time in studying all the details (Hameri et al., 1996). The real user requirements will be found as the project proceeds and the configuration management procedures and systems are implemented. This paper gives some guidelines one should take into consideration when introducing and establishing the PDM system for a project as part of one's daily operational activities. The aim of the document is to build a bridge from the noble principles of configuration management to the PDM software used for implementing these principles. The paper provides short descriptions of the tasks needed and is intended to act as a checklist for a project manager/engineer. The following issues form the content of the next three chapters:

- Organisational issues: PDM system objectives, configuration management, project structure management, user groups and access rights

- Process issues: document approval process, change notification policy, document lifecycles and statuses, version management for documents
- Some technical issues: naming and numbering scheme of the documents, document types and file formats

It should be noted that several of these issues are interrelated, thus references to them may exist before their more detailed treatment in the paper. This is followed by summarising chapter, which documents the key questions to be answered by each project when planning to implement a PDM system. Finally, conclusions are drawn and a general policy outline for PDM system use in geographically distributed project is stated.

2 Organisational issues

PDM system is something that has an impact on the prevailing working habits, yet when implemented and adopted it does catalyse operations and makes them less error-prone (Williams & Cleveland, 1995). This improvement of operational procedures form the general motivation for each PDM system installation, but the experience has shown that introducing PDM system in an organisation is a long and difficult process. The benefits are there, yet the time to reap them varies significantly from project to project, ranging from one or two years up to five or more. Organisational hindrance and individual rigidity to adopt new ways to achieve same objectives is most common explanation for slow implementation process. A good attitude is to start small and think big. This approach favours the use of workspaces, which provide immediate ease to distributed working. These workspaces may then grow towards a full-scale PDM installation. PDM system should also be understood as a mean to communicate with distributed collaborators. A PDM system is not an archive but an active system to catalyst interaction and information dissemination among all participating parties.

Configuration management of a large-scale project has to be a managed process in order to avoid conflicts and misunderstandings between different subsystems. The

configuration management board is responsible for approving the product configuration and controlling design changes. The board controls that the proposed changes do not violate interfaces between the different project teams, makes sure that the impacts of the proposed change are properly analysed before accepting it and informs project participants. The configuration management board defines the rules for engineering change request (ECR) processing and gives the framework for the PDM system implementation planning and its operational use. Each major team or subsystem should have one person nominated as the PDM project co-ordinator, which maintains and supports the system and its services as the project evolves.

Project Breakdown Structure (PBS) is used in order to break down a project into sub-systems (Bachy & Hameri, 1997). The PBS is used for project management tasks such as budgeting and scheduling. The project structure represents a logical breakdown of a product, where each node represents a sub project or simply acts as a basket container for a set of documents and activities. At the start of a project, one can usually not define more than a high-level product structure, which will evolve over time.

The Bill of Material (BoM) structure represents the complete item structure of a product. It includes all the components to be installed in an assembly. A quantity attribute on the link indicates the number of each component type needed in an assembly, e.g. 2 wheels for a bicycle frame. The BoM structure is usually approved and frozen in a bottom-up fashion as the design of components in subassemblies is progressing. The item structure is thus a dynamic structure evolving during the detailed design phase of a project.

The management of these product structures is the base of configuration management in a project. By means of version- and variant management, and/or with the help of context-specific views on the product structure, reference structures are established at different points in time. Typically one will end up with a product structure as designed, as ordered (sent to the supplier, also called “should-be-built”) and as-built (re-entered in the system based on what actually exists at the end.) The latter one may also be called as to-be-maintained structure or Location Breakdown Structure (LBS),

which uses the physical location of each item as the basis of the structure. This means that at least three different structures is needed for complex projects:

- Project Breakdown Structure (PBS) represents a logical breakdown of the project, where each node represents a sub project or simply acts as a basket con-tainer for a set of documents and activities.

- Bill of Material (BoM) shows the item structure of the system at given time. This structure is used to store design and assembly related information along the design process.

- Location Breakdown Structure (LBS) is based on the physical location or better functional position of the items, and it links all operational and design related information of the finally assembled system.

The user groups of the PDM system are normally related to the working groups of the project. A common way of enabling better maintenance is to define roles for the project participants. Instead of associating document promotion right to a certain person the right is tied to the organisational status of that person. If the person is replaced with another person during the project, it is not necessary to search and update all documents this person has been responsible but it is enough to change the person associated with the role. Access rights are used for restricting access to the system. In general, strict access right policy tends to cause extra work for the project participants and system administrators and hinders information flow in a project. The more loose policy the project can follow the better the PDM system can serve its users.

3 Process issues

The document approval process is used to guarantee that each document passes through a formal approval process before other documents are created based on it. The approval process may vary according to the type of the documents. It has to be

light for unofficial documents, like notes and memos, but heavier and disciplined for drawings and contracts. If the change has an impact on the product design it has to go through a formal ECR-process. The document approval process has an effect on several PDM system parameters (Figure 1), among those are:

- Document statuses, i.e. document related metadata attribute that shows the legibility status of the document at given point of time during the project progress.
- User groups and user access rights, which define who has which rights in the overall configuration process.
- Document lifecycles, which define the status sequence, through which the documents pass during their existence in the project.

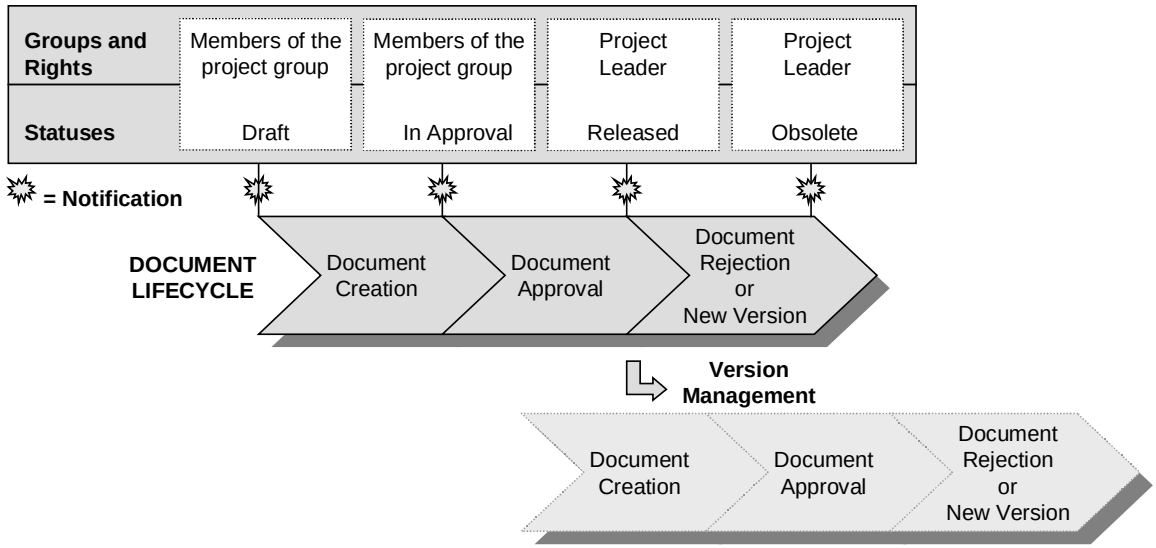

Figure 1. An example of the document lifecycle and approval process.

The document status indicates the prevailing phase during its dedicated lifecycle. Typical values the status can have are:

- Draft
- In approval
- Approved
- Obsolete

Lifecycles may differ between document types, yet too large diversity should be avoided, even large projects survive with two to four different lifecycles. The lifecycle is part of the document release procedure. It defines who has the rights to promote the document from one status to another or demote it back to preceding status in the lifecycle.

Document versioning is used to keep track of the document changes as it evolves. The version management policy defines when a new document version or even a new document should be created. Common practise is that an approved document cannot be demoted back to a draft state but that a new document version has to be created and approved. For example, project minutes should be stored in separate documents but the written memo and the presented slides should be in the same document.

In a large and geographically distributed project, document changes have to be properly communicated to avoid conflicts and misunderstandings between project participants. The experience has shown that notifications loose their meaning if used too much. Only urgent messages should be sent immediately, while minor changes should be grouped and distributed periodically. The change notification policy is needed to define the rules for the use of change notifications.

4 Technical issues

Technical issues often “steal the show” when topics related to PDM installation are discussed and prepared. It is vital to understand that the process and organisation related issues are far more crucial for successful installation. For an organisation with sound processes and disciplined working habits a PDM system provides support in terms of speeding the process and making it even more reliable (see e.g. Stark, 1992). But seldom the case is this trivial. Implementation process becomes long and costly, if people and their processes are not streamlined and documented in the quality plans of the company. Technical issues are usually easily fixed, once the rest is sorted out. Here we discuss only the document naming and numbering scheme, the document types and file formats. These serve as examples of technical topics to be decided

during the implementation process. In addition, the distinction between project items and items are discussed as experience has shown this to generate complications in companies.

The document naming and numbering scheme has traditionally tried to link documents to the project structure to ensure that the documents can later be found. The document code has carried a lot of information, among others the location of the document in the project structure. Problems have arisen when the project structure has changed over time. The information technology tools provide a cure for that problem because they allow searching the document based on the code and various document attributes over the whole project structure. Thus, it is advisable to use short and unique document identifiers instead of long and complex. The difference between document identifiers (unique keys) and attributes (metadata) must be kept clearly separated when contemplating naming and numbering schemes.

Document types (or classes) are used to separate different categories of documents. The type can also define which approval process and lifecycle policy is needed for the document. In the daily use of PDM document types provide a convenient way of filtering documents. The document type should be derived from the functional needs of the project, not from the applications used for document creation. Document types range from drawings, test results, manufacturing instructions, meeting minutes, call for tenders to simple office documents. Typically, some 10 to 20 different document types can be detected in a design and manufacturing company. Prudence should be used when document types are defined, as too detailed classification generates maintenance problems and difficulties for the end users.

The official file formats of the project have to be agreed to guarantee that documents can be distributed between the users and that they are accessible through out the project and its operational period. Different software applications use different file formats and the native formats are often incompatible with the other software applications. Especially for applications related to design and manufacturing (CAD/CAM tools) the format issues are important.

Project management must establish a clear policy on universal document formats (e.g. at CERN portable document format (PDF) for office documents and printable HPGL-

format for drawings) to support fluent communication and long-term platform independent access to the information. The native version has to be stored to ensure that the document can easily be changed if needed, while standard formats such as SGML, CGM and STEP are needed for document exchange among the project partners and for long term archiving. Thus there is a need for using different file formats for different purposes.

The formats needed depend of the document types and needs of the project. The project lifecycle and duration of different project phases are important here. A project under tight schedule and short execution time will naturally tend to take a pragmatic view and use currently available commercial file formats. If there is a need for access to product data during the lifetime of the end product, such as an aircraft, the project has to choose standard file formats in order to guarantee access to data during the maintenance phase.

5 Checklist for distributed projects

This chapter gathers all the issues treated so far by outlining a special question list, which should be answered when PDM implementation is planned for distributed project environment. Starting from the organisational issues (Table 1) the focus is first on the definition of the fundamental motivation of the PDM effort. The strategy and its premises should be negotiated through the organisation to minimise the change friction caused by ignorance.

Table 1. Organisational issues and the questions to be answered.

Organisational issues	
Mission / objectives	• What is the main use of the system? • What problems should the system solve and what problems should be handled manually? • Is it used for archiving official documents or for distributing the documents of the on-going project (workspace)? • Is the system used for product structure management? • What are the quantitative goals, i.e. improvements in throughput time, engineering change request cycles and quality defects?
Configuration management	• What is the composition/members of the configuration management board?

	• How often does the board meet? • How is each ECR documented? • Who is responsible for evaluating the ECR's? • How is the decision documented? • How is the change notification communicated? • Who is our PDM project co-ordinator?
Project structure management	• Who is responsible for defining and maintaining the project structure? • What is the natural project decomposition logic for the PBS? • What is our current BoM? • Who will manage the information between BoM and LBS?
User groups and access rights	• Who are working and contributing in the project? • Which roles do the users/participants have in the project, and to whom assign what role? • What are the safety requirements of the project?

Once the authority and responsible people have been signed, together with documented configuration management routines and project structures the detailed processes are to be defined (Table 2). A good starting point is to study the existing processes and habits prevailing in the organisation. As the aim is to improve and streamline the processes, radical changes may be inevitable to make the best out of the PDM system. As it has already been said the approach to apply here is to start with small and simple, which is gradually enhanced, as the organisation becomes familiar with the new system and operational procedures. Step-wise implementation is found to be efficient in many organisations. This means that first the rudimentary functions are installed and introduced to the organisation. This concerns functions like file loading and retrieval of documents to and from the system. In the next phase lifecycles and document statuses are introduced, and at last the higher configuration management functions like versioning and structure management are implemented.

Table 2. Process issues and the questions to be answered.

Process issues	
Document approval process	• What documents have to be approved? • Why they have to be approved? • Who submits for approval? • Who should approve them? • Can we connect the approval rights to the roles of the project participants?
Change notification policy	• In what conditions is a notification sent? • What notifications can be replaced by automatic notifications? • Who sends manual notifications? • What information is included in a notification?

	• To whom is the notification sent? • Can notifications be seen as legally binding (yes or no)?
Document lifecycles and statuses	• Who has the right to do what status change? • What are the necessary actions preceding each status change? • What are the steps for creating a document? • Where is formal approval needed? • What is needed to make a formal approval?
Version management for documents	• When to create a new document? • When to create a new document version?

Technical issues share usually the most interest from the people behind the PDM system. It should be emphasised that these issues are the simplest ones, and that already well-defined processes increase the productivity of the organisation, even without any software system supporting it. Table 3 summarises some of the technical issues that must be considered when implementing a PDM system. Attention should be paid on the existing software systems, which the organisation already uses efficiently. Radical changes in them are not welcomed, even though the moment seems to be fruitful for radical changes in the overall information technology infrastructure of the organisation. As said earlier, an approach introducing first the simple functionalities, which also provide the first immediate benefits for the user from using the system, has proven to be efficient way to introduce a PDM system.

Table 3. Some technical issues and the questions to be answered.

Technical issues	
Naming and numbering	• What is the purpose of the document code? • What other document identification attributes are needed? • What is the coding practice provided by the PDM system?
Document types	• What document types are needed? • How these documents should be separated from each other?
File formats	• What software is used for document production? • Engineering documents • Office/administrative documents • Scientific documents • What is the latest commonly used file format for each document type? • What file formats are used for viewing and printing the document? • Are there any special requirements for long-term document management to ensure access and distribution of information?

The above checklists provide the project responsible people with the first hand issues that should be considered before anything is done, especially before any PDM system is purchased. In general, the issues gathered here form a checklist useful to go through for any project and organisation, which aim to improve its document and configuration management related processes.

6 Conclusions

The paper has discussed the organisational, process and technical issues related to PDM system installation for distributed projects and operations. The resulting checklist for project practitioners stems from empirical work at CERN and among the industrial companies in the Connecting Distributed Competencies (CoDisCo) project funded by Nordisk Industrifond (NI#: 98082). At CERN a major PDM implementation commenced in 1997, which affects several large-scale and global projects forming the Large Hadron Collider due to operate in 2005. The CoDisCo-initiative has studied the configuration management processes among companies involved in distributed project deliveries. The results and experiences from these activities have formed the skeleton now summed in this article.

The processes must be defined first and then comes the system installation and implementation, not the other way around. One may think that the system empowers the change towards improved processes, but in practise this is not what happens. In cases were the PDM system drives the change process the results have been most cumbersome, old operational habits stills prevail, or even foster themselves and the system is not used correctly, or is not used at all. Improved and streamlined processes are crucial for every PDM system installation, and to support inefficient and overlapping processes with a PDM system is not rational activity. As the leader of the PDM effort at CERN said: ‘if one is to screw it anyway, with a PDM system, it can be screwed thousand times faster’.

Biography

Dr. Ari-Pekka Hameri received his Master of Science and Licentiate of Technology at the Helsinki University of Technology (HUT), in the field of production management. He was granted the degree of Doctor of Technology by HUT in 1993 for his studies of innovations and their technological impact on manufacturing companies. He has been involved in several EC-funded and other international research projects dealing with production management and logistics. He is currently director of the technology programme at the Helsinki Institute of Physics and also associated with CERN and the configuration and communication management issues of the new accelerator.

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