

## Improved project management through improved document management

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### Abstract

By drawing from field studies on three different types of business projects the paper outlines a improved document management approach. The three global cases, which comprise business process re-engineering (BPR), new product development (NPD) and one-of-a-kind manufacturing, enable to track a common set of document based operations which hold the vital information for the success of respective cases. This information reveals what is the true active organisation of the enterprise, what are the document usage profiles of the people and how knowledge-related creative processes are really performed by the organisation. In addition, the management is provided with new means to measure operational performance with better encompassing metrics. The approach and its partial implementation act as glue between various systems used within and between the collaborating companies. © 2001 Elsevier Science B.V. All rights reserved.

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### 1. Introduction

This paper intends to cast light on the management of project-oriented business processes. We aim to facilitate project-oriented business process management by the tools provided with electronic document management. The paper is divided into three parts: process management, document management and case studies. Therefore, we start our reasoning in the realm of business problems. After elaborating

business problems associated with various business processes the viewpoint is shifted towards document management. Towards the end of the paper the focus is more on practice. Three case studies focusing on business process and document management problems in one-of-a-kind production (OKP) business, on project and document challenges of global business process re-engineering (BPR) projects and, finally, on the document flow linkages of complex new product development (NPD) projects are presented.

The conjecture of the paper is constructive: is it possible to facilitate business process management with partially automated document management conventions? The economic potential of this approach may be considerable, because of the vast breadth and depth of the problems associated with management of project-oriented business processes.

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The paper reflects the experiences and plans gained in the product data management project run by the staff of Helsinki Institute of Physics, working in the environment of complex one-of-a-kind products at CERN,<sup>3</sup> Geneva, Switzerland. The approach proposed in this paper is based on empirical studies on project-oriented business processes. The BPR experiences are based on several re-engineering projects the authors have been involved in either as scientific researchers or as employees of the companies. The experience on NPD projects is based on a number of case studies in various information intensive industries. The OKP findings are also based on a multitude of research consortia representative in international OKP business. The cases presented provide examples of the problems companies have to overcome during their daily business. The information technologies used, like World Wide Web (WWW)-based document management systems, do provide quantitative data, yet to obtain measurable results on development is often difficult. Despite this and the differences of between the cases, the problems and their solutions seem to have a lot of common across the sample.

## 2. Process management

### 2.1. Business processes as unified platforms of business operations

The basic paradigm behind our reasoning is in systems thinking, with landmarks laid by authorities, such as Simon [1] and Ashby [2]. After 20 years, this trend was reinforced by business literature focusing on the relevance of business processes [3], although the concept of a process is fundamental in systems taxonomy. Understanding the coexistence between systems thinking and business processes sets up the fundamental postulate of business processes: any

operation in a business system takes place in a business process. Accordingly, the set of business processes in a business system (e.g. a strategic business unit (SBU) of an industrial company) covers all the relevant operations of a business system. Typically, the most important business processes of an industrial SBU are NPD and order fulfilment (OF) (see, e.g. [4]).

Our scope here is not to focus on the context of business processes themselves. Instead, the focus is on business processes as the standard platforms on which the business operations are instantiated. In this respect our backbone here is established by quality management literature (e.g. [5]), in particular that of quality systems [6]. A quality system presumes a set of pre-specified, documented and thereby standard business processes, on which the day-to-day business processes are to be run in order to minimise the undesired variations in the outcomes of the processes. Business process management is exercised in two levels:

- management of day-to-day business processes across the internal and external stakeholders ranging from customers down stream up to high-tier suppliers upstream;
- meta-management of business processes, i.e. management of the life cycle of the business process itself from new business process creation to obsolete business process ramp-down.

In the previous lines, we have already referred to the two typical key day-to-day business processes, NPD and order fulfilment. The phrase used in association with business process meta-management is BPR (see, e.g. [7]). A natural framework to store, share and maintain the documentation associated with the current business process platform is a quality system (see, e.g. ISO 900X — series of international standards). A good evidence of the vitality of these platforms is the hierarchical build up of quality standards. For example, the more recent environmental quality standards, such as ISO 14000 shares the similar “act according to the documented, verified and accepted set of processes” principle as the older ISO 9000 series for general business processes. The triangle between business process creation, day-to-day business process operation and the business

<sup>3</sup>CERN, the European Laboratory for Particle Physics, has its headquarters in Geneva. At present, its member states are Austria, Belgium, The Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, The Netherlands, Norway, Poland, Portugal, The Slovak Republic, Spain, Sweden, Switzerland and UK, Israel, Russian Federation, Turkey, Yugoslavia (status suspended after the UN embargo, June 1992), European Commission and UNESCO have observer status.

process descriptions within the quality system has the following structure:

1. A business process is created and maintained as a meta-management process of BPR.
2. The business process created in BPR is documented in the quality system.
3. The day-to-day business processes (e.g. NPD and OF) are run according the documented process descriptions.

These relationships between the key concepts of process management relevant in the scope of this paper are depicted in Fig. 1.

Later in this paper, we shall limit ourselves in business processes typically organised as projects. Due to the temporary, although repetitive, nature of both NPD and BPR, they both are typically organised and managed as projects. What regards to order fulfilment process, we shall tentatively also there concentrate in such cases that are project oriented in nature. A business case of order fulfilment that satisfies this condition is order fulfilment of OKP, i.e. fulfilling the customer's needs by a unique product (see, e.g. [8]). The degree of uniqueness may vary, ranging from a wild blue-sky case of “design from scratch” to a down-to-the-earth case of “configure to order”. Nevertheless, the condition of a project oriented business process is satisfied in all these cases.

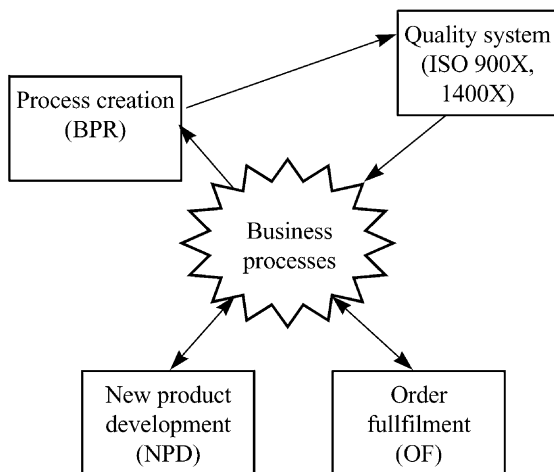


Fig. 1. Business processes as standard business activity platforms: created by BPR, documented in quality systems and run in day-to-day processes (e.g. NPD and OF).

## 2.2. Project oriented business processes

After studying 8,000 projects with various aims, like new products, restructuring the organisation, mergers, and project based deliveries, the results indicated that only 16% of them achieved the initially stated goals concerning time, budget and quality [9]. This is not a very flattering result for the management of project related activities, which close strict objectives concerning results, money to be spent and quality to be achieved. In this realm, the scope of management is not limited on traditional project management with a strict duration and one-off nature, but it includes also all management activities that fall within the following range:

- BPR projects, which usually are continuous and evolving projects aiming to improve profoundly the operational efficiency, effectiveness and efficacy, i.e. overall business performance of the enterprise. BPR projects have been aiming at the radical reorganisation of existing business processes, by improving operational performance in extensive manner. Partly because of its long and dormant existence the fresh focus on BPR from the beginning of 1990s has proved it not to be quickly passing management hype. Instead it has established itself as a kind of survival and continuous improvement dogma for many companies with its profound message on organisations capabilities to radically improve performance and change strategic directions.
- NPD projects aim to materialise a marketable idea or enhancement to an existing product into a real and error-free artefact, with all the required properties, necessary production facilities and reliable life cycle support. Successful introduction of new products has proven to share most positive implications on the company, not only in terms of direct revenues, but also in terms of image, market share and employee motivation. NPD projects have proven to share significant uncertainty and risks concerning their success along the increasing complexity of the products and competition of the markets.
- One-of-a-kind (OKP) and make-to-order based projects with production lot sizes varying from one to a few per annum form the third group of the concerned management activities. Market situation has

Table 1  
Cross process analysis of the three project oriented business processes (BPR, NPD, OKP) addressed in this paper (based on [10])

BPR	NPD	OKP	Generic Name
Idea and vision creation	Concept search	Sales	Idea
Conceptualisation	Concept screening and testing	Order engineering	Concept
Current state analysis	Business analysis	–	Analysis
Process design	Product development	Production planning	Development
Piloting	Product use/field/market testing	Purchasing and production	Ramp-up
Rolling out	Commercialisation	Installation	Operation
Continuous improvement	Service	After sales	Maintenance
Ramping-down	Roll-down	Recycling	Ramp-down

forced companies to allow certain level of delivery based customisation and uniqueness in each delivery, which has generated several problems in respect to customisation, product configuration, version and variant management, including the integration of the suppliers in the delivery process.

Following the lines of the eclectic study by Archibald ([10], pp. 26–27), we have summarised the common nominators between the different phases of the business processes addressed (BPR, NPD, OKP) in Table 1.

### 2.3. Problems encountered in relation to project oriented business processes

It is clear that all three business processes addressed here (BPR, NPD, OKP) are overlapping each other, and they may prevail at the same time in a company. Despite this, as management activities, they all share their unique approach and traditions, which are distinguishable through their individual objectives and problems they possess. The aim is to track in more detail the problems related to these activities, in order to find a common nominator and set of activities that could be used as the basis for developing an approach, methodology and possible information system specification to improve these difficult operations taking place in practically all industrial companies. According to BPR literature and especially the seminal work by Hammer and Champy [3] (see also [11] the problems are mainly related to managerial issues in different steps of project/process phase. In NPD processes [6,12–17], the problems are related more on processes and their disciplined execution, while in

OKP [8,18] the main problems lie in time-based management of delivery and supply operations. Table 2 summarises the major problems related to each sector of management during the life cycle of a project or while executing operational processes in an industrial company.

Risks related to management, organisational capabilities and close business environment are embedded in the above list. This list is fundamentally saying that the problems are often related either to ignorance, poor problem and process definition or misjudgement of the available competence. Without excluding many other root-causes for common problems, it is striking that lack of information is a common element, i.e. the listed problems tend to occur when someone has not up-to-date and coherent information as basis for his actions. This comes down to the sharing of information in the organisation. If an organisation is able to improve management and distribution of documents among the project partners, it can either directly solve or indirectly affect many of the problems that occur in the projects.

### 3. Documents and document management

The chapter above addressed the problems encountered in project oriented business processes (see Table 2). It was summarised that outside the mere business scope, these problems are regularly associated with lack or distortion of information to be shared among intra- and inter-organisational stakeholders. It becomes evident that the common denominator of project oriented business processes is related to information sharing. Information sharing will be

Table 2  
Key managerial problems during various phases of a business process; BPR, NPD and OKP, respectively

Project/process phase	BPR	NPD	OKP
Idea and concept	No clear focus Frequent change of targets Lack of support for the change process Misvalued operational goals Poor control and follow-up	Learning from earlier cases Significant variation in process conduct among different projects Lack of risk management Sharing of common project objectives	Misunderstanding customer needs and own capabilities Management of parallel processes, i.e. rigid planning Poor integration of third parties Ignorance of design baselines Poor modularity of products
Analysis	Lack of communication Establishing justification for the change project No compliance between actions and strategy	Discipline in design work Too slow organisation to manage changes Poor reallocation of changes in environment	
Development	Information dissemination Wrong scope of actions Under estimation of resources needed	Mishandling of specification changes Lack of integration with sales and channels Rigid production planning	Unclear configuration Management routines Internal delivery benchmarking hard due to uniqueness of cases
Ramp-up	Competence management Making irrelevant changes Poor information dissemination Lack of prominent measures to assess progress	Poor process descriptions Lack of measurement Supplier training and sharing product information Allocation of distributed operations	Wrong volume forecasts Mixing of manufacturing with engineering and prototyping Integration with suppliers
Operation	Ignorance of follow-up and control routines	Product compliance with initial needs Training of the personnel	Change management Controlled customisation Dissemination of information
Maintenance and ramp-down	Lack of post-mortem analysis of projects No grounds for learning	Dissemination of product information into delivery channel	Product life cycle support No process archive to establish learning routines

strongly facilitated by the use of electronic documents, which by definition encloses written, drawn or dictated information in one separate and accessible source, which can be addressed by the proprietary applications used to generate it. It is the management, i.e. the control and supervision of these documents and their evolution and exploitation that may carry the vital information for success. We acknowledge that it is another issue to verify whether the human actors in the appropriate business process have understood this information and its real value. Yet, already understanding the document flows and lifecycles, which record the true progress of the organisation, around the business processes may provide management with a fertile soil to develop and act proactively on prominent business problems. The document flows reveal who actually uses and produce information, and, naturally, who are not doing either activity in the organisation. Lifecycles record the different steps through which the document evolves until it becomes obsolete.

It has also been realised that these documents are used fundamentally in a similar manner in all project oriented business processes addressed in this paper, i.e. BPR, NPD and OKP. A proverb of ‘meta-manufacturing’ has been coined [19] to emphasise the management of all activities in an enterprise that affect the real manufacturing process through documents. This brings us close to a solution to the listed problems that hinder performance improvements in practically all kinds of organisations. By focusing on better document management and exploiting information embedded and generated during the handling of the current and the related documents an organisation may be able to indirectly improve the performance of the projects.

### *3.1. Elementary concepts of documents and document management*

The concept ‘document’ shares multiple connotations. Yet, the fundamental point is that a document carries information in some format that it could be shared, disseminated, stored and acted upon. Formally, we shall define a document as a set of metadata and data:

Document = {Metadata, Data}, where

$$\text{Metadata} = \{\text{Ownership, Authorisation, History, Status, Procedures, Links, Data\_descriptions}\},$$

Data = any attributes associated in the document.

According to this definition everything that has been stored into an accessible source is a document, be the source a drawer or database, is a document. Things that are not accessible are not documents, like non-documented discussions in the previous week. By thinking in fundamental terms and electronic document is everything that is stored in the database, as a file or data entity is in its broadest sense a document. Typical documents are meeting minutes, drawings, e-mails, specifications, tendering instructions, test result, etc. In this paper, we shall not go into details of document management, i.e. on how documents are shared effectively or how changes in them are conveyed throughout the organisation. However, some of the key concepts deserve attention also in an application-oriented paper like this focusing on process management. What makes documents and document management attractive as tools for process management is the active functionality inherent with electronic document management. These characteristics are embedded in the capabilities of metadata. Besides the traditional document related metadata (e.g. ownership of the document, authorisation (e.g. access and scripting rights) and status data the contemporary information and communication technologies enable automatic/semiautomatic maintenance of document history. What is even more interesting, is the gradually emerging object oriented nature of documents, meaning the documents may have embedded functionality in the form of procedures to be activated by predefined triggers during the life cycle of documents.

In an information intensive project, the document management and project management are closely connected together. The outcome of the project is typically a set of documents that describe either the product developed, process re-engineered or product to be delivered. If the organisation is able to define the documents that form the output and the documents needed in various intermediate steps it can monitor the progress of the project using the document management system. The document and project milestones are then directly linked and no milestone can be

approved before all documents needed have been approved. The approach does not provide means to measure the quality of the documents and correspondingly the quality of the project. However, the experiences gained in various total quality management (TQM) efforts provide a reason to assume that a punctual project is likely to produce good quality, i.e. a good process tends to produce good quality.

Documents are related to each other. An apparent feature of business processes is the process flow seconded by the corresponding document flow. The status change of a document may trigger the instantiation of another document. Or a document status change may synchronise the flow of several work procedures, i.e. document flows. This process/document flow management may be enabled via the links or structural references between the documents (an example of this is given Chapter 4.3).

The traditional administrative systems are implemented with the help of database management systems that do have data dictionary functionality to manage every single data item in the database. Document management systems do not have the means to cover and master all the data elements within the documents. Normally, no references to the contents of the documents are needed. However, there are some needs to have associations to a few critical data elements within the key documents reflecting the status of the actual real world business process.

### 3.2. Key functions of document management

Information flows in distributed business processes, organisations and operations form the starting point for our document management approach. There are three aspects of document management that prevail around the documents concerned:

- Document flow, i.e. the intended way how activities are performed. These are usually stated in flow diagrams, which define the organisational routines to be performed in order to run the operations and development efforts as unified processes in the enterprise. These flows are also associated with the goals for the overall processes. BPR, NPD and OKP have all their peculiar document flows.
- Document lifecycle, i.e. the chain of statuses through which each and every document passes

once created. This lifecycle may vary from document to document, but nevertheless, at least document life span is dictated here. This life cycle can share different status positions, various iterations and change processes. Yet, the document itself and its revisions and different versions follow physically the predefined sequence. Examples of documents with high relevance of document life cycle are meeting minutes, CAD drawings and sales forecasts.

- Document implementation, i.e. the means how the document is transferred, manipulated and controlled. Document implementation comprises the tools and information networks, be they electronic or manual. Examples of activities related to this layer are posting and mailing, all the software used to generate and share documents, and the direct transfer between people in the organisation.

In brief the set of aspects of document management above emphasises the use of the documents, the documents themselves and all the tools and media used to share them. This three-aspect model follows also the various network protocols and their layer definitions in order to establish a connection through the network.

Tracking communication and its content has been used to reveal the real organisation behind the official chart [20]. These kinds of analyses are usually based on manual labour and they provide management with a snapshot on how the business processes and communication are run in the organisation. The digitalisation of documents is making it possible to assess the performance on-line, as each transaction in the information network leaves a trace. A roadmap for generating value adding through (semi) automatic document management is surveyed, and thus foreseeable, because already today around 75% of the in-house information sharing is based on electronic media. However, communication to and from third parties is still dominantly based on conventional means, as only 18% of all document transfers are based on true networking [21].

The fundamentals of the proposed document management approach can be expressed in the following observations:

- Practically all information shared in an industrial organisation is expressed in documents.

- Most of the newly created documents are in digital format, and in many cases older documents are being digitised.
- Document usage, i.e. the generation, distribution and manipulation of documents is almost completely based on computers and networks.
- The document usage via electronic medium is traceable, which can be exploited in measurement and analysis to improve the white-collar processes in an enterprise.
- The analysis of the document processes enables to understand their real nature, which is the necessary prerequisite to be able to develop them.
- Document processes are a partial mirror image of the tacit and creative processes of the enterprise. Thus analysing them establishes means to improve these fundamentally indispensable value-adding activities of the company.

The observations above provide the logic behind the approach for generating value adding through better document management. Thus, the overall idea is to better monitor and assess the value creation in activities related to documents in the organisation. Traditionally these operations have not been evaluated on on-line basis, which the current electronic document management paradigm facilitates. This approach provides management with a complementary view on how their organisations operate and where the development efforts should be focused. It also sets frame for the proactive managerial actions, because, as pointed earlier, in most cases the fundamental reason for problems is the incoherence or lack of right and up-to-date information. On-line monitoring of the document processes enables us to take one step in the direction of verifying whether information has reached its intended subject. It is well known that lack of communication and retarded handling of information are signals of evident problems. With the presented approach these could be tracked and acted upon well in advance before the real mistakes take place.

#### 4. Case studies

The idea of this chapter is to address some crucial and interesting aspects of process management via

document management. We have extracted one conceptual or empirical case study in each of the selected process domains: order fulfilment of one-of-a-kind delivery industry, BPR and, NPD, which describes illustrative prototype of an electronic document management system. The cases do not provide comprehensive evidence that could prove all the arguments of the paper. Rather they illustrate some document related problems of the projects and means to solve these problems by using better document management systems and practices.

##### *4.1. Problems of document management encountered in OKP*

A company delivers tailored investment goods to different customers around the world. The company is technology leader in the markets and it offers new advanced product features to potential customers in order to win the contract. These product features require engineering and testing effort during the delivery process, causing significant amount of rework for the engineering department as well as for production. A common presumption was that the customer caused most of these changes. This continuous engineering for every delivery did not support coherent product configuration and modular product management. Also means to improve performance from earlier deliveries were limited as no structured archives were maintained to store the change process and delivery history. Process itself was not measured in term of operational efficiency and management followed the tradition fire-brigade tactic to tackle the projects.

The available information systems did not provide means to track the causes of the changes or to analyse their impact into the supply chain. The only available solution to find out the effects of these changes was to go through manually all the drawings of one delivery project. First, the latest modification date of a drawing was compared to the project schedule. If the date was later than the start of production the impacts of the change were analysed together with the production personnel. The causes of the changes were tracked based on the project minutes. Thus, the approach was like a post-mortem analysis of already delivered projects. It should also be emphasised that process focused strictly on quantitative information around

generated documents and their qualitative explanations.

The analysis of engineering changes was astonishing, more than 12% of the drawings had been changed after the start of production. The change requests came mostly from inside the company, only fractions of the drawings had been changed because of the customer. The project management had changed the product specification afterwards or the product development had changed the product design. The direct cost of these changes was hundreds of man-hours for engineering and production departments, plus some extra material cost. The indirect cost was remarkably higher, eating the anticipated margin from the delivery.

The company learned a lot of its own performance when the analysis was carried out. There had been no means to measure the amount or impact of the change requests before. The remaining problem was that the company still did not have any system capable of measuring these changes during the delivery projects or even afterwards. Analysing them manually proved to be too costly and difficult to be carried out regularly. If the company had means to measure these changes easily it could react to them proactively and even avoid most of the consequences in advance.

The lesson here is that without focusing on the document usage around the delivery process, one could complement the traditional understanding on how the true delivery process takes place. The gut feelings of the key personnel were strongly contradicting with the results provided by the document analysis. The results initiated a business re-engineering process in the company, which focused on defining the design process and the related document workflows to reveal the true value-adding process of the company. This was realised to be the only way to set up reliable measurement means for the delivery process and to imply certain discipline in the organisation.

#### *4.2. Relations between process and document management in BPR*

This section reflects the experiences among the authors of this paper gained in dozens of BPR projects during the 1990s. The most apparent learning platform

impacting the reasoning here is related to global information and telecommunication industries, where one of the authors have been in a privileged position of logistics chain integrator for a dominant global player in the market. In this case, the experience gained from documents used in BPR process is highlighted. The typical documentation related to a BPR falls into the following categories:

- Design documents (blue papers, white papers, process strategy, budgets, skill and competence maps).
- Work packages (WP descriptions, schedules, action plans, step models, organisation charts).
- Performance measures of BPR project (resource usage reports, progress reports, financial reports, business process measures, process assessments, risk assessments, meeting agenda/reports).
- Performance measures of the object system (business measures, financial measures).
- Associated material (e.g. training material, benchmarking reports).

The formats, i.e. the sources of BPR project related reports are highly diversified. For companies that are applying CSCW technologies (computer supported co-operative work) and enterprise resource planning systems (ERP) the documents are embedded in a few umbrella systems. Naturally, the basic office tools are applied quite extensively. The idea to enhance BPR excellence by document management is to go towards computer-aided business process assessments. The potential benefits fall into two categories:

1. Checklists of the preferred documentation necessary/sufficient for a BPR project.
2. BPR project management and BPR transfer effects under on single umbrella.

These two potential utilities build on each other in a layered way. The basic principles of document management force BPR project managers to focus on the necessary set of documents required for the fulfilment of each milestone of the project. This facilitates also BPR project progress monitoring to the planned/actual status changes. Traditional project management is a natural application domain of document management. Project management focuses on milestones, deliverables, schedules and resource consumption. More

challenging — and more rewarding — potential outcomes are provided in our second layer. It is not sufficient to focus only on the BPR development project measures, but also on the intended/actual development of the target business system. This functionality is achieved by penetrating into the context and contents of project documents (e.g. what is the value of attribute the days of supply in document “business performance”).

### 4.3. Cross document links to facilitate NPD

This case highlights how a semi-automated document management system supports globally distributed NPD project. The underlying case is that of CERN and the Large Hadron Collider-project, which will be accomplished by the year 2005. The design and engineering takes place in more than 40 different countries, and the effort progresses through thousands

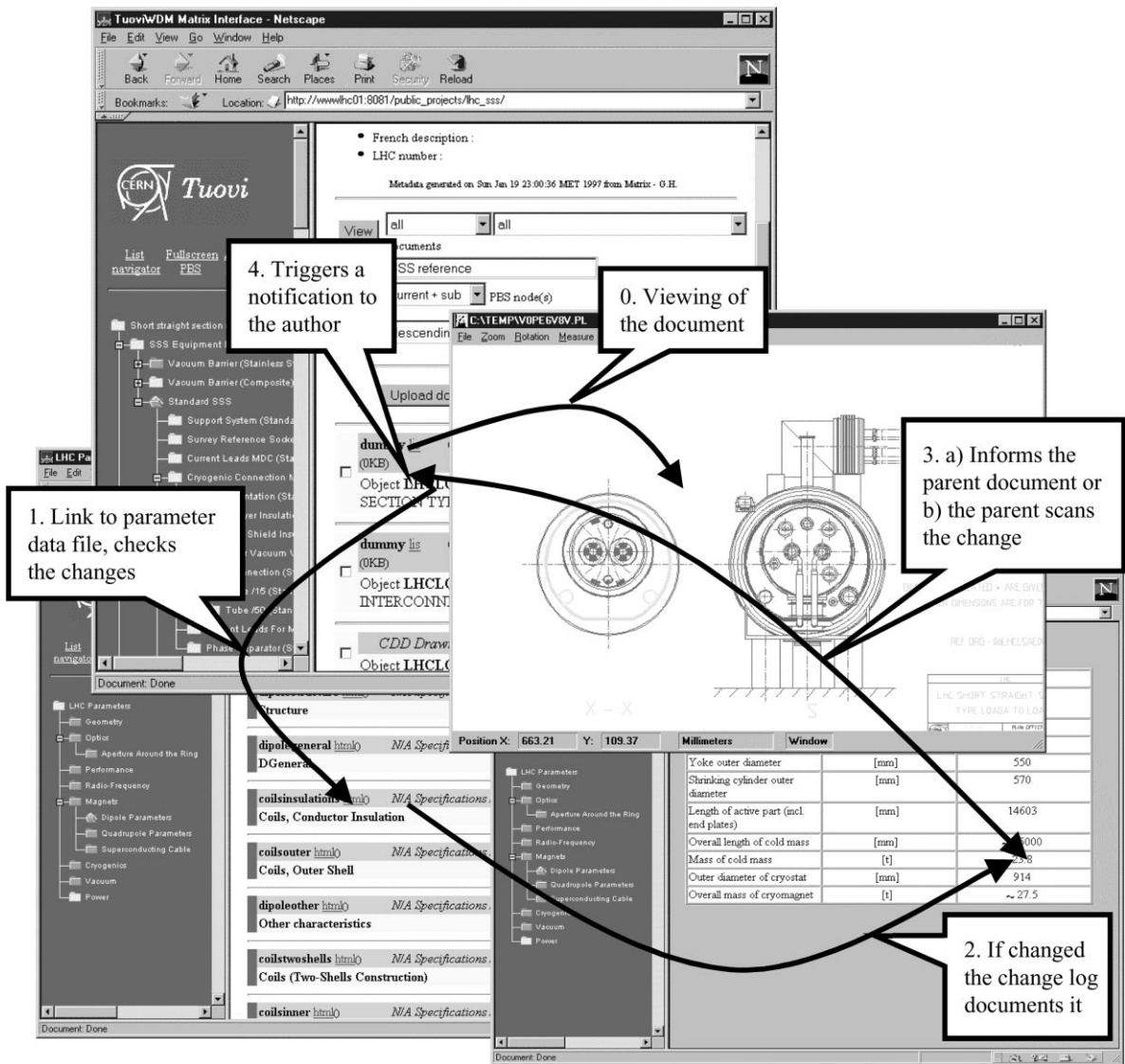


Fig. 2. Snapshots illustrating the document linking through metadata and procedures that control changes between interrelated documents, generating notification if changes occur.

of parallel and interrelated projects. As the technologies involved and objectives set presuppose novel solutions the design and engineering phase consists of continuous changes in design baseline. Managing the change information has traditionally been managed in project milestones and product configuration management related meetings. For the global research community these means have become inadequate as the changes are reported frequently and the community is globally dispersed.

To overcome this barrier and to ease fluent information sharing several projects have adopted a WWW-based document management system, developed at CERN and following in the footsteps of the initial invention of WWW at CERN. The system called Tuovi Web Document Management (TuoviWDM) provides the projects with the basic document management functions from document sharing, status management, search and user authentication. Users with different privileges have respective views on the information and the system controls and maintains the document usage history. In addition to its active stand-alone usage the system has been integrated with various commercial databases and product data management systems. The WWW with its platform independent solution is an indispensable requirement for the global community to transfer information.

To ease the NPD process and its change management problems various special features have been added on top of the traditional document management routines of the system. Document related metadata definitions have been complemented with procedures and links. The procedures execute certain tasks when certain conditions have been fulfilled. These operations may be directed with links in between the documents. A simple but effective example is illustrated Fig. 2, where a drawing document has been linked with the parameter document holding the key values of design parameters on which the drawing is based on. When the engineer loads the document in to the system he/she defines the link, i.e. on which of the existing documents the uploaded document is based on. According to the system's configuration the changes in the linked documents are automatically checked. This means that a change in the linked parameter file leaves a mark in its usage history, which the procedure in the drawing's metadata tracks and

sends a notification to engineer. This can also be performed in the other way, i.e. when the parameter file has been changed, its metadata informs all authors whose documents have been linked into it. The choice between these solutions can be described based on the anticipated load and activity in the project.

Technically this kind of linking and automatic checking of documents can be accomplished through alternative solutions. More complicated solution than the described one would base on direct links between the contents of the files. Already certain tools performing this kind of linking exist, yet they work in closed environments and do not support global activities. In smaller scale, the described procedure has already proven to be very useful and it has reduced the pressure of configuration management, as engineering changes are communicated in the project organisation more efficiently, which makes the daily operations less error prone. It is clear that the real benefits remains to be achieved when all design related documents have been linked.

## 5. Conclusions

The path towards higher productivity is not trivial. The conventional means to improve material and information flows are not always adequate, and therefore, increasingly the improvement activities have been focusing on business processes and their improvement. The article has tried to show that business processes share fundamentally the same phases and problems whether they are re-engineering, NPD or order fulfilment processes. The common denominator to many of the problems is related into information sharing and exploitation. In many cases, the information exists but is not available and when it is accessible its validity may not be coherent. Documents and their consistency, usage, proper storage and linking provide a source for improvement when business processes are to be developed.

Because of their complexity the improvement of business processes is considered risky, which also shows in failure rates of these projects. The causality, or at least the related factors behind success/failure have been elaborated thoroughly (e.g. [11,22]). One of the conclusions drawn is that the application community should provide better methods and tools in order

to turn the efforts more successful, and actually the current boom in product data management systems and better integrated enterprise systems are answering to this call. These new tools related with document management pave the way towards understanding the true organisation using the documents and the information they embed. It is not until then, when information usage metrics could be applied for the control of the creative and human interaction related operations. This would add a complementary and necessary view for the project management to act proactively and facilitate vital learning between processes.

The means are there, documents are mostly generated electronically, tools and means to manage them exist and the information has existed there all the time. Yet, managing documents and information in structured manner has proved to be difficult implement and fundamentally the success in generating value adding through better document management lies in the changing of the way how we operate. Applications and fancy technologies are only useful when they are provided to an alert, disciplined and conversant organisation. The analogy between an unused part in an work-in-progress inventory and a document waiting for approval or user is the same, they both enclose work and value which is not exploited to the extent it could be.

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