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PROCESS PLANT INFORMATION INTEGRATION IN THREE DIMENSIONS

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Abstract: The paper discusses the management of product information of complex one-of-a-kind products. Information and knowledge can be seen as important resources for design, construction, operation and modernization of process plants. The research problem is approached through three cases that form the basis for a generic conceptual model for information integration over process plants lifecycle. The model for managing and integrating information includes three dimensions: between interest groups, inside plant lifecycle and between plants or plant projects. This paper is based on a project called Novel Information Integration Techniques and Models (NIITM).

Key words: Process Information, Information Integration, Plant Projects

1. INTRODUCTION

The process industry has increasing challenges concerning environmental friendliness, profitability and efficiency. Competition has changed from local and regional to global. In this kind of business, increasing collaboration between interest groups from different phases of the lifecycle of the process plant is needed. Operating in a network becomes the driving force behind successful companies. Common feature to this networked collaboration is creation of information and its use and reuse. Systematic information management practices and procedures enable this.

The key issue is effective utilization and integration of the information that has accumulated over the lifecycle of the process plant and during previous plant projects. Typically decisions that are made in one stage of the lifecycle have far-reaching effects on the forthcoming stages and eventual flaws in these decisions are expensive and difficult to fix later [1]. Thus, by exploiting this information, the interest groups can intensify their operations and thereby meet the future expectations and gain competitive edge in respect of competitors. Effective utilization of the accumulated information requires communicating the information bidirectionally over the lifecycle, between projects and interest groups.

2. PRESENTATION OF THE CASES

The first case (Alma Software) is an IT-system provider that develops a software tool for automation design, process electrification design, field instrumentation planning and managing related information during operation of a plant. The system also provides tools for managing plant's maintenance. The main objective of the system is better usability of once produced information during plant lifecycle by integrating information management in design, delivery, operation and maintenance. The case provided knowledge about typical design tools and IT-systems that are used during plant projects and in operating plants. The case introduced an interesting approach to plant information management in general.

In the second case (Kemira Chemicals Kokkola Plants), the aim was to develop plant design information management during maintenance of a chemistry plant and thereby intensify the entire maintenance process. Also information management during the plant delivery was dealt with since information that is produced then, forms the basis for planning activities during the maintenance. The chemistry plant consisted of two units: one that manufactures bulk chemicals and other that produces small amounts of chemicals according to customer order. The studies during the case were mainly carried out in the first one. The case provided the operator view to the plant information management process during operation and maintenance.

The third case took place at Power IT, which is a part of the PVO Group. The PVO Group together with its subsidiaries operates, designs and takes overall responsibility of plant deliveries. Power IT's role is to provide information systems and tools that support these other functions. Typically, the company deals with several other companies in its business and has noticed the commonly known development areas in plant design information management. In our case study, the objective was to clarify the information management process from design to the delivery of the plant. This included defining different interest groups, their roles and requirements for information, information contents, and IT-systems. The case offered views concerning the delivery process and related information management between the (main) contractor(s) and the operator. Table 1 summarizes the major development areas and actions of the cases.

Table 1. Major development areas and actions in the cases

Case	Development areas	Development actions
1	New ideas on how to develop the product further	Based on other cases and the analysis of Alma tool, a "future requirement specification" was composed. The idea is that the document supports further development of the tool: it gives some guidelines and ideas on what areas should be developed.
2	Better information management during maintenance	Short term actions: o Several new working practices that promote cooperation and bringing the information commonly available o Intensified use of existing IT Long term actions: o Improvement ideas for IT o Improved communication during bigger projects
3	Better management of design information during a plant delivery project	Modeling the overall plant delivery project process, developing the process further and agreeing on common working practices and tools during the project. This resulted in an aim to continue with a new project during which an IT-system that supports the new practices and tools will be developed and taken into use.

3. ANALYSIS OF THE CASES AND GENERIC FRAMEWORK FOR INFORMATION MANAGEMENT

The following chapters analyze the cases and at the same time build a generic framework, which is depicted in figure 1. The objectives of the generic framework are to model the different information flows and clarify the relations between information integration dimensions. It provides one way for planning information management of plant projects and plants.

3.1 Interest Groups and Boundaries between them

The generic framework presents four types of interest groups: (machine) supplier(s), engineering office, operator and maintenance service provider. The boundaries between these interest groups may be internal or external and the strength of the boundaries may vary. This means that certain interest groups may belong to the same company (for example Kemira Kokkola Plants and Kemira Engineering in the second case) or they may belong to the same network or virtual enterprise (VE). Hardwick and Bolton [2] define VE as follows: "virtually (temporarily) united to exploit a worldwide business opportunity, a consortium of companies manufacture products together non could build alone." Since plant delivery projects require special knowledge from several areas, VE can be seen as a potential organizational way to carry out a plant project.

In the third case the organization during a plant delivery often nears VE depending of the definition of VE: the companies were not strategic partners but they cooperated on regular bases. If the interest groups belong to the same company or cooperate on a regular basis, the boundaries between them are not so strong as if they were separate firms without history of cooperation. Operating in a network results in fading of the internal and external boundaries of the networked organizations [3].

Thereby, three different kinds of boundaries can be derived from the cases: 1.) internal between different functions of the same company, 2.) internal of a virtual collaboration network (for example a VE) and 3.) external. When aiming at improved management of plant information between the interest groups, the different organizational boundaries, as well as, the nature of these boundaries should be recognized. In this way, the possible problem points in working over the boundaries can be found and the problems mitigated.

The interest groups that the framework presents are generic in this sense. The number of interest groups may vary in actual projects. In the framework additional interest groups – for example two cooperating engineering offices – would fall under the heading "engineering office". This approach suggests that these two interest groups should be treated equally in respect of the plant information. Collaborating interest groups (who have for example formed a VE) can also be taken care of by the framework: The boundaries of a VE can be set in the model so that different interest groups can form VEs. The boundaries between the VE and other companies and inside the VE can be treated similarly to internal or external boundaries. The boundaries inside the VE are internal, the boundaries between the VE and other firms are external.

3.2 Generic and Specific Plant Information and History Sets

In the framework, the content of plant information is in the roughest level divided into generic and product or project specific information (figure 1). The idea is that the generic information is something that provides the basis for project or product specific planning. The idea of generic information sets comes up in the ALMA Software case in the form of standards that support engineering and from a project information management model presented by Karvonen [4]. Also in the third case, the need to increasingly manage the experiences from previous projects is recognized. The generic information sets in the framework provide one way to do this.

If we look the difference between the generic and specific information from a supplier viewpoint, for example, the generic information forms the basis for constructing and designing a specific product. Specific information is the information that is related to this specific product. The supplier tries to keep the specific product information up-to-date over the lifecycle of the product. If something novel, and applicable also in other projects, came up during the lifetime of a specific product, the supplier may move this information to his generic information set. Thus the information can systematically be utilized in forthcoming projects. In this way, the specific information can be made common within the company.

3.3 Dimensions of Managing Accumulating Information

The following dimensions of information flows were found when studying the cases: down- and upstream between interest groups; between ongoing projects and between operating plants; from generic to specific product knowledge and vice versa. The following generic information flows depict more precisely the dimensions (letters A-E refer to the framework that is presented in figure 1).

A) Accumulation of specific information: The design of a new product and plant begins with studying the generic information that exists from the product or related products. This generic information is based on experiences from the previous projects and from the operation of plants that are taken into use. When the customer specifications are added to the generic information, the project and thus product specific information begins to accumulate.

B) Accumulation of generic information: The generic information accumulates when experiences from the previous projects or from already completed related projects or operating plants is gained and refined into such a format that it can be used to develop the generic information further.

C) Accumulation of information downstream between different interest groups: Accumulation of information downstream means that the information is communicated from earlier interest groups to later ones in a usable format. Communicating the information in this direction enables efficient utilization of the product immediately after the delivery and ensures that the product is used correctly.

D) Accumulation of information upstream between different interest groups: When the plant and its equipment are operated, plant information inevitably accumulates to the operator. Therefore, the operator soon has the best knowledge of the product he uses. This applies when information is systematically gathered and maintained during operation. Operation is typically the longest and thus, from information management viewpoint, the most challenging period in the plant lifecycle. The plant information that has accumulated during the lifecycle of a plant should be communicated upstream to the previous interest groups who then should manage to make this information into common and generic product information for themselves. When information is communicated upstream it helps the interest groups in the early lifecycle phases to develop their products according to the needs and experiences that the users of the products have. Also information about the modifications that are made during later stages of the product lifecycle help the manufacturers and designers to avoid repeating the same mistakes in their forthcoming products and projects.

E) Accumulation of information between projects and plants: Information can be communicated between ongoing projects and between operating plants directly without making it generic or it can be communicated by making the specific information into generic. The difference between these is that in the former one, the information remains specific to few cases whereas in the latter one the information adds one new layer to the generic information history set and is thus usable for all forthcoming projects.

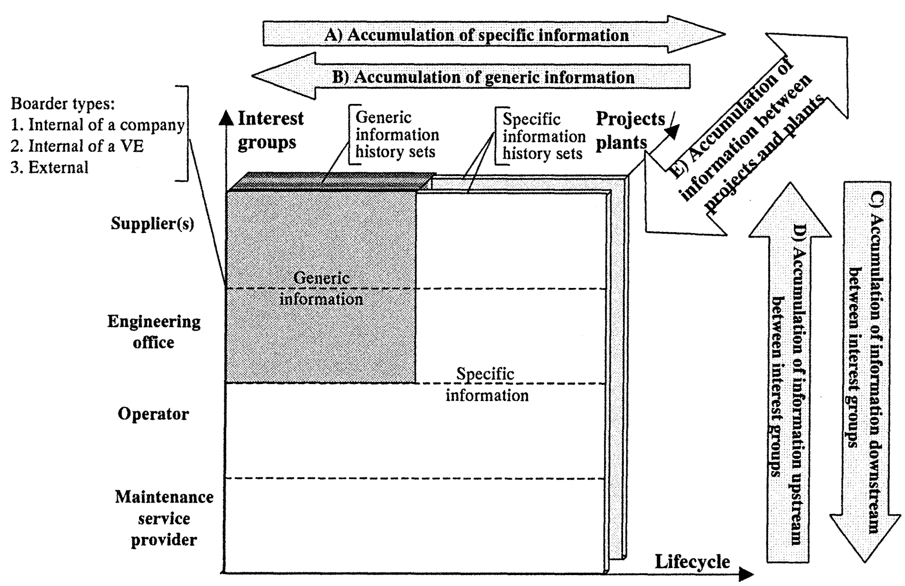

Figure 1. Generic framework for information integration over process plant lifecycle

3.4 Information Flows and Contents during the Lifecycle

Opening the framework up to a more detailed level provides a view to the actual generic information flows that were derived from the cases. The second level of the framework is depicted in figure 2.

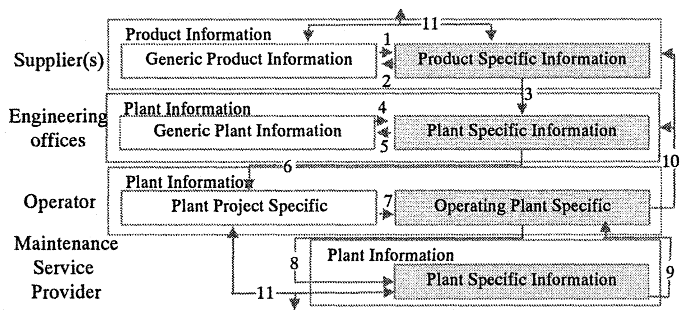

Figure 2. Generic information flows over the lifecycle of a process plant

The information flows that are numbered in the framework's second level with numbers 1 to 11 are clarified in table 2. In the table, the information content is shortly described as well as the type and dimension of the information.

Table 2. Generic contents of the information flows of the framework

No	Type of the information	Dimension of the flow	Content
1	As designed	A	Generic information gained during previous similar or related projects. Based on this generic information new specific projects can be planned
2	Accumulated as designed	B	Such specific information of some product (machine) that can be reutilized in other similar or related projects
3	As designed	C	Information about some machine that is included in a plant on reasonable level of detail and in usable form: accuracy of information is such that it can be used as a part of the plant information
4	As designed	A	Generic information gained during previous similar or related projects. Based on this generic information new specific projects can be planned
5	Accumulated as designed	B (E via generic)	Such specific information of some product (plants) that can be reutilized in other similar or related projects
6	As built	C	Information from engineering office about a specific plant including several machines. Management of information from those who have realized the plant project to the operator(s)
7	As built	A	Operator takes the new plant into use and experiences start

No	Type of the information	Dimension of the flow	Content
			to accumulate
8	As operated	C	Information from operation to maintenance
9	As maintained	D	Information about maintenance to operation
10	As operated and as maintained	D	Information from operation and maintenance to previously involved interest groups
11	As operated and as maintained	E	Information (experiences & solutions) from one plant, which is utilizable in other plants (information flow goes either via the generic information set or directly between plants)

4. CONCLUSIONS

The framework models the information management processes, identifies on generic level the typical interest groups, information flows and the contents of these flows. It presents the idea of generic and specific information together with history sets. It also stresses the different dimensions of information management. Thus the framework supports planning information management over the lifecycle of many different kinds of plants and plant projects.

The framework can also be used as a preliminary framework for designing information management systems:it gives guidelines for designing the processes that the plant design information system should support.

5. SUGGESTIONS FOR FURTHER RESEARCH

Structuring experience based information so that it can be communicated efficiently and systematically. Study how different interest groups' strategies affect on the plant information management.

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