Knowledge Management of Manufacturing Product/Process issues.

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Knowledge Management is a very wide issue to approach. The first difficulty on it is related to the understanding, definition and range of the words "Knowledge Management".
In this paper we are going to focus on the Knowledge on product and processes. Even more specifically, we will discuss about manufacturing product/processes discarding then service processes which anyway are not very different from manufacturing ones, at least in concept.

1. INTRODUCTION

During the last years (since 1999), the author and his research team are and have been involved in several research projects under the umbrella of European funded research within the field of Product related Knowledge Management in the industrial domain. The key idea behind these projects is to develop means supporting the collection of all useful knowledge on product and process throughout the extended enterprise. Keeping and re-using knowledge is of capital importance for the companies competitivity to be used in continuous improvement of existing product/processes and in new developments.

In a further step, the knowledge will then be developed into a means of fostering industrial innovations. Innovation is a critical factor in the success of industrial companies and it will mainly arise by combining ideas and feedback from all phases of the product life cycle.

2. KNOWLEDGE MANAGEMENT

As it has been said above, author's research team has developed a big activity in the field of Product/process knowledge management mostly in European funded projects. A short overview of some of these projects follows below.

The figure below will help us to understand the focus and objectives of each of the projects that will be discussed in more detail in the next point. As it may be seen in the figure, all projects deal with the Product life-cycle Knowledge Management from different aspects and using different approaches:

Specific for Small and Medium Enterprises (SMEs):

- **Know It.** Focus in the front-line decision making, that's to say the interaction with the customer in both ends of the chain, the early stages of the product definition and the product support when in operation.
- **PROMISE.** Supports the Product Knowledge Management across the Extended Enterprise introducing in that way the concept of extended enterprise, that's to say the sharing of expertise and knowledge beyond the limits of the single company.
- **FOKSai.** Extended Product Knowledge Management support system in Ambient Intelligence Domain. It introduces two new concepts: Extended Product coming to the services area and Ambient Intelligent Domain.
- **Know Construct.** Internet platform for SMEs in the Construction Industry with a twofold objective: Customer Needs Management system and Knowledge Communities Support System.

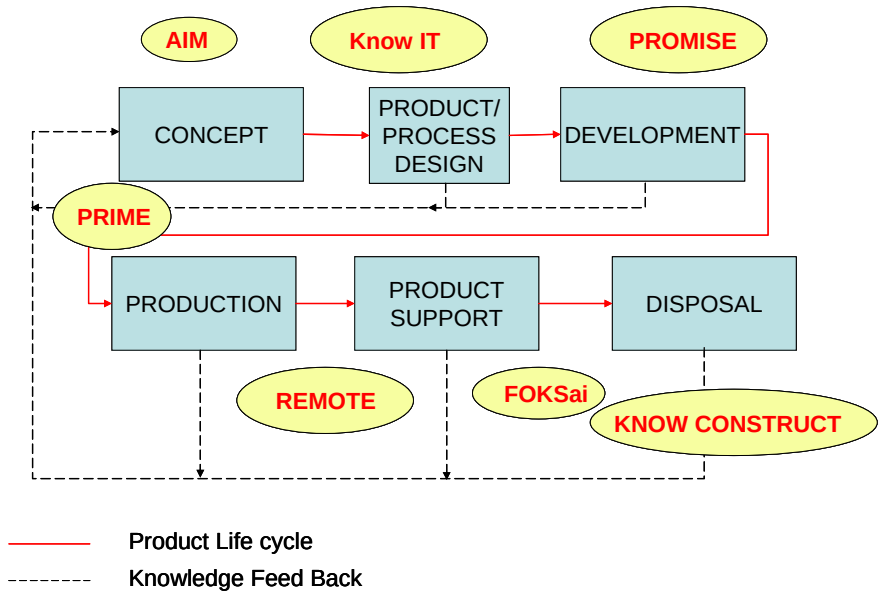

Figure 1: Overview of the Projects

Aiming to bigger companies:

- **REMOTE.** Changes the focus to the remote product support within the Extended Enterprise.
- **PRIME.** Product Integrated Knowledge Management in the extended enterprise along the product's life-cycle intended for "one-of-the-kind" products.
- **AIM:** The distinctive key issue in AIM is to develop means to make the best use of the knowledge to foster generation of innovation in new products or new processes.

We have introduced here some concepts that need further explanation:

Extended Enterprise:

New ways of working move ineluctably towards the extended enterprise. Extended enterprise concept in parallel with the Concurrent Enterprising looks for how to add value to the product by incorporating to it knowledge and expertise coming from all participants on the product value chain.

Manufacturers need to benefit from Extended Enterprise techniques by involving all actors throughout product life cycle: suppliers, customers, design, production, servicing…. They will provide their own product knowledge to enhance product development and support. This knowledge needs to be saved and managed. Loss of this knowledge results in increased costs, longer time-to-market, reduced quality of products and services. This new paradigm implies a quite new scenario: knowledge capturing and sharing, new forms of interrelationship between companies and persons, etc.

Extended Product:

The product is not anymore only a "physical" tangible entity that a customer purchases from the producer and uses at home. On the contrary, it has become just a piece of a service process including a long term relationship within several agents in the product value chain. In that approach, "extended product" shifts toward the concept of service covering important interactions among actors all along the life-cycle of the product. However, to reach a full success, a full technical support to both the product and the customer is required as the form of an appropriate product extension. To survive at the current market, industry has to provide not just a classical product but a full customer support and service. Such product extensions may range from very simple forms (e.g. different information, guidelines to customer attached to the product) up to on-line maintenance services, interactive and highly intelligent customer support systems etc.

Ambient Intelligence: We understand as "Ambient Intelligence (AmI)" those products with a degree of "intelligence" that enables them to capture signals from the Ambient and react accordingly to the way they have previously being programmed.

Current products include more and more elements of ambience intelligence (AmI). The domain is still not state-of-the art in market available products, but there is a clear trend towards products which will be fully based or include different forms of AmI. SMEs in different sectors have to carefully observe this trend to assure their long term survival at the market

3. DETAIL OF THE PROJECTS.

3.1 KNOW IT:

Practical knowledge management to support front-line decision-making in SMEs. CRAFT Project. Starting in January 2001 and ending in September 2002 with a duration of 21 months (18 + 3 month extension)

The aim of the project is to support front-line decision making in SME companies by making use of a knowledge management approach. Know IT has developed an innovative, web-based software system to help SMEs to capture, store, maintain and disseminate knowledge that supports front-line workers to make better and more profitable business decisions.

Decisions that maximise a sales opportunity or minimise the cost of a customer service request happen on the front lines. A contract that hangs upon a decision, a problem at customer site or a service request requires rapid actions, based on context and according to priorities set forth by the company management. Usually, customer support is also a huge burden for small companies like the ones participating in the Know IT consortium. SMEs need to support their staff to effectively deal with these situations.

The innovation of the Know IT project is based on Forrester Research's idea, which states that adopting frontline decision-making practices is essential for organizations to continue ratcheting up employee productivity, customer profitability and business success.

Know IT is implemented as a portal system, providing one-stop shopping for the knowledge the front-line workers need in order to make better decisions. In order to ensure that the front-line of the organization, whether on the phone or at customer site can efficiently access this information, Know IT is a multi-tier application, a tool that is powerful yet user friendly, graphic and simple to operate.

3.2 PROMISE:

Product Knowledge Management Support System, across the Extended Enterprise . (Growth). The Project started in May 2001 and ended in Fabruary 2003 with a duration of 21 months (18 + 3 month extension)

The project aim is to develop a practical extended enterprise methodology and system for comprehensive product support. This project is aimed at assisting manufacturing SMEs (from the Automotive sector and the Engineering sector) to support their customers by making use of extended enterprise technologies and knowledge management for customer/product support. The primary goal is to develop a methodology, which enables SMEs to apply extended enterprise concepts for improving product support and development.

Promise has developed a methodology, which enables SMEs to apply extended enterprise concepts for improving product support and development, and a prototype system, based on the methodology, to demonstrate the viability of an extended enterprise product support system.

The creation of a virtual platform on which manufacturers, suppliers and customers can exchange their experiences and knowledge will therefore enhance the quality of service to the customer and at the same time serve as a basis for improving the internal processes of small companies like the ones participating in

the Promise consortium. SMEs need to support their staff to effectively deal with these situations. Promise system will help SMEs to continuously empower customers, reduce the resources, improve the support of the field engineers, provide a means of encapsulating expert knowledge, reduce the number of product problems, support diagnostic analysis of customer feedback and enhance the customer-supplier relationship.

3.3 REMOTE

Remote product/customer support via extended enterprise. GROWTH Project started in March 2001 and ended in October 2003 with a duration of 30 months.

The aim of REMOTE, is to extend the manufacturers knowledge base out to the customers' site (extending the manufacturer's factory to include their customers), so that the knowledge can be used or added to at multiple remote locations (as well as at the manufacturer's site). This knowledge will be used by: Customers, and Field Operatives, (and could be used by Technical Sales Support, and Engineering Management).

The main innovations of the project can be stated as:

- The use of the modern internet/intranet technologies to improve knowledge management under the "extended enterprise concept": linking provider and customer to virtual co-operation in tackling product and service problems.
- A means of Users being able to generate their own product support systems based on the web. A means of Users being able to encapsulate company knowledge, manage and structure it into useful interactive knowledge base for use across the whole extended enterprise (product life cycle + installation, servicing, customer support, and problem solving).
- Creation of a web-based knowledge platform to share experiences between customers and support teams of the manufacturers.. New approach of embedding product-related knowledge from the end user (customer) into the information system of the manufacturing company.

3.4 AIM

Acceleration of Innovative ideas to Market. IMS-IST Project started in May 2003 and will finalize by September 2005 after 3 years plus an extension of 4 months.

AIM goal is to develop a system to support the collection of all useful knowledge throughout the extended enterprise for new and existing process and product developments, and to develop this knowledge into a means of fostering industrial innovations. Innovation by combining the ideas and feedback from all parts of the product life cycle, including customer interaction with existing products and new product ideas, customer service and field engineers, suppliers, and pooling of knowledge between multiple sites.

The project is novel as it seeks to encourage innovation creation in all people who are involved with the product lifecycle, and the production processes. It also encourages team working between people from different sites (and working off-site), and between organizations, customers and suppliers.

The project result is a customizable solution to provide the innovation system hosted on the company intranet, extranet or internet, as the customer requires.

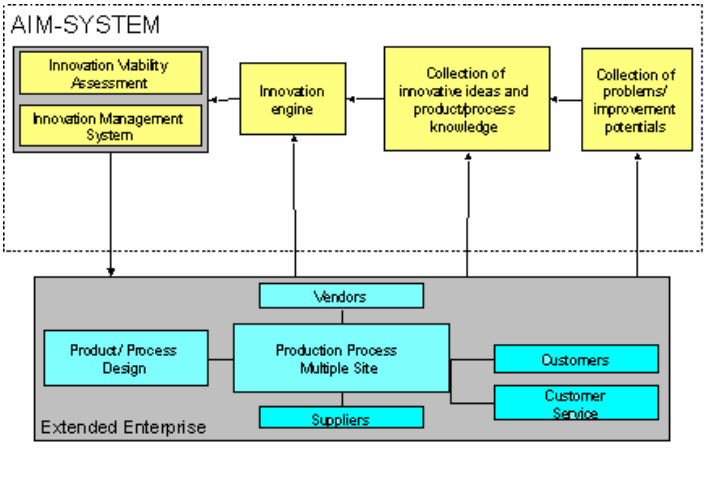

Figure 2: AIM system

3.5 PRIME

PRIME Project, "Product Integrated Knowledge Management for the Extended Enterprise", directly relates to the GROWTH programme, Targeted Research Action: TRA 1.7 "extended enterprise": the knowledge based extended manufacturing enterprise. This project also contributes to TRA1.8 "modern factory". It is a 36 months project that started on April 2002.

The **aim** of the project is to manage the knowledge generated during the industrial product life cycle to improve the development and support of **complex low volume products**. The knowledge required for the design, production and support of a complex product is not limited only to the manufacturer but also comes from all companies and individuals involved all along the product life cycle. The result will be a practical solution providing management of product knowledge throughout the product life cycle, particularly including suppliers and customers via the extended enterprise.

The main project **outputs** will be the PRIME methodology workbook detailing the developed technologies, the PRIME software system demonstrating the technologies developed, and the PRIME web site disseminating the PRIME technological achievements.

The main **objectives** of PRIME are to develop a web-based dynamic knowledge repository capable of storing and manipulating all types of product knowledge. This product knowledge repository should have mechanisms, which enables it to be linked up with existing product information systems. Moreover, this product knowledge management system is to be accessible to all actors of the extended enterprise.

3.6 FOKSai

SME Focussed KM System to Support Extended Product in Ambient Intelligence Domain (CRAFT), it is a 24 month project and started on February 2004.

SMEs offering already products with AmI elements, intend in a near future to introduce new and/or to improve their current products with even more AmI features, seeing this as their crucial competitive edge.
For such products they need a sophisticated support system. The business objective to be achieved within the FOKSai project is to provide a comprehensive solution of the support to extended products from the Ambient Intelligence domain, which will be affordable for the SMEs manufacturers.

Foksai main **objectives** are:

- Remote supervising, problem identification and solving and maintenance of heterogeneous customer systems.
- e-Supporting manufacturer's staff at remote customer site location to solve customer/product problems.
- Proper integration and sophisticated knowledge-based interpretation of the intelligent ambience information and "reactions".
- Gathering and structuring of the AmI-product and process knowledge, from the problems solutions, for the reuse in innovations introduction.
- Direct feedback from user to AmI-product/service design and development.
- Reduction of efforts/costs for searching of the reasons of problems in products containing AmI components.

3.7 KNOW-CONSTRUCT

Internet Platform for Knowledge-based Customer Needs Management and Collaboration among SMEs in Construction Industry, it is A 30 month project that started on March 2005.

The project aims to develop a common internet-based platform for SMEs from the construction sector to provide an effective combination of two general functionalities:

(a) **Customer Needs Management (CNM) System:** an innovative decision making support system regarding the products characteristics, applications and other consultancy services for SMEs' customers applying the "web enabled dialogue", and

b) **Knowledge Communities Support (KCS) System:** a system for SMEs to support an advanced form of co-operation through the creation of Knowledge Communities of SMEs in CI. The system should support the integration, management and reuse of the area specific knowledge via a common knowledge base. The platform will be owned by associations, offering to members to establish individual CNM systems and take benefit of KCS System.

The system will be used within the Associations to collect and exchange the business area specific knowledge among the members (SMEs) in a form of essential expertise, reachable anywhere, at any time. Such a system, applying the common knowledge base and KM tool, will be a low-cost solution, affordable for SME community.

It will satisfy SMEs' urgent need for a radical improvement of communication with customers and will offer an effective knowledge sharing with other SMEs as a base for further implementation of new co-operation forms. The system will be tested in project partner (and other similar) organisations from the CI. For a successful solution it is obviously necessary to establish a multidisciplinary S&T approach combining research activities in different areas, such as KM**,** particularly creation of the adequate ontology, effective forms of on-line interaction among

customers and SME (web enabled dialogue with expert/technical advisor), as well as product classification system for this sector, new forms for a representation of the CI knowledge (e.g. experience-based), investigation of efficient approaches for training etc.

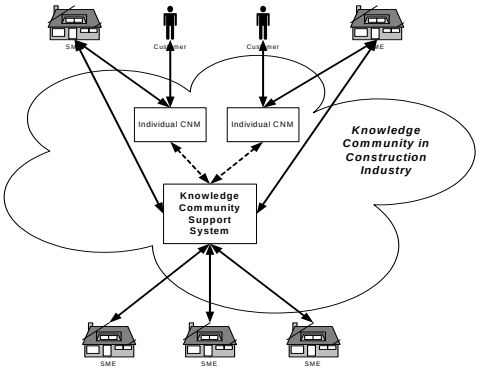

Figure 3: Know Construct System concept

4. CONCLUSIONS

A very important step toward the increase of competitiveness of European companies including SMEs, by the introduction of above mentioned concepts (Extended Enterprising, Extended Products, Knowledge Management) is done within the European projects discussed in previous points.

The scalable methodology and system implementation started by introduction of the product knowledge management support across the extended enterprise demonstrated the advantages of the approach specifically tailored to the companies' needs. At the same time a number of RTD topics was opened for future research and investigations. This number is to be enlarged even more taking into account that the direction of the "integrated economy" development will require more and more extended enterprise approaches, which are to be based on adaptive working practice and adaptive IT infrastructures. The models and the technical solutions to support a constantly changing alliances, delivering precisely formulated services in complete co-ordination across its supplier and customer base, should be developed. Surviving in the era when (in a great extent due to the fast growing IT technologies) customer expectations are very high and loyalty low, will depend very much on the speed and effectiveness of (particularly) SMEs' adaptation to this new environment.

According to the prototype testing results and partners' reactions regarding the system applicability it can be expected that the above cited needs requirements can be to a great extent fulfilled by the newly introduced extended enterprise approach and knowledge based system. Besides the system structure allows for the further improvements and advancing what provides the possibility to adapt to new forms and requirements of business practice.

From our experience on the development and implementation of the activities discussed above, we expect that those will be a good help to push companies moving towards the new paradigms of Extended Enterprise Extended

Product and Knowledge Management. We may consider that they will become a solid base on which the companies could start building their own knowledge management systems.

To support companies in keeping up the pace with technology and the market challenges, the main goal is to increase innovation and accelerate its introduction into the market. This objective will be achieved by combining a strong methodology with a supporting robust system, which will gather several methodologies already existing and applied in other areas, and help filling in a gap that exists in technology. We expect that these ideas will be a good help to push manufacturing companies moving towards increasing innovation rates throughout the new paradigms of Extended Enterprise and Knowledge Management.

Changing a company behaviour to new ways of working as in the Knowledge Management field, is always a long, difficult and troublesome process.

The first real issue is then related to a top-bottom approach starting from a sound commitment and full conviction from management. Management should bet on the introduction of these new working paradigms supported by the necessary ICT tools and start driving the organization on this way.

The best way to start with is to launch series of pilot projects sequentially or on parallel (depending on the company's capability). Pilot projects must be chosen carefully in order to maximize the possibilities of success. They are extremely important since a failure in the first trials will almost surely jeopardize further new attempts.

Achievements expected out of the implementation of this new paradigm may be listed as:

- To ensure that all useful knowledge is saved, stored and easily reusable. Not a loss of knowledge by persons withdrawal.
- Developing means of stimulating the creation of innovative ideas and collecting them from people involved with the products and processes.
- Developing ways of processing these ideas and storing them into a structured knowledge repository.
- Developing means of analysing innovative knowledge to determine which is useful, and which is not. That is, to enable the viability of ideas to be assessed.
- Developing means of delivering the innovative ideas to product and process designers for maximum effect.
- This should lead to the following **business benefits**:
- Overall improved business performance
- Improved working conditions and increase on employees satisfaction.
- Improvement on customer satisfaction
- Reduction of product innovation cycle-time.
- Reduction of time and efforts for solving product/process problems.
- Improvement of process efficiency and reduction of wastes.

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