Fostering Innovation in Concurrent Enterprising

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Abstract

Innovation is a critical factor in the success of industrial companies, and just as important is the need to get innovative products to the market quickly. Therefore, it is important to talk about "Management of product development time" because, under this new paradigm, companies able of "mastering" the development time will launch the product into the market just spending the planned time and resources and at the real moment. This will give back to the company higher market share and faster market penetration. The main objective of the Project AIM (Acceleration of Innovative Ideas into the Market) is to provide the means of stimulating the creation of innovative ideas in general, and specifically on potential product/process improvements and on problem solving. These ideas are collected throughout the Extended Enterprise from people involved with the products and processes; this knowledge will be further developed into innovations in a Project Basis process.

Keywords

Co-Innovation, Collaborative Enterprises, Knowledge Management, Virtual Enterprises

1 Introduction

In current Global Markets, **innovation** is generally one of the most critical factors for success in industrial firms. Former advantages based on aspects as costs reduction, natural resources, geographical situation and so on are no more valuable since globalization is flattening these issues and furthermore, needed natural resources are usually coming from outside. We must always be meaningful of the need of fostering innovation fighting against usual themes as: "cut your costs", "get focused". Nowadays motto should be "Innovate or lose". This new situation needs to introduce relevant changes in the way the companies are working. One of these changes has to be accomplished in the field of new products development that is the basis of the success of manufacturing companies [Sawaguchi, 2001].

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 [Levy, Rajaraman, Ordille 1996] by involving all people from throughout the product life cycle (suppliers, customers, design, production and servicing) to provide their product knowledge to enhance product development and support. This new paradigm implies a quite new scenario: knowledge capturing and sharing, new forms of interrelationship between companies and persons, etc.

Innovation is important for all companies, and just as important is the need to get innovative products to the market place quickly. Therefore, it is important to talk about "Management of **product development time**". Under this new paradigm, companies able of "mastering" the development time can launch the product into the market just spending the planned time and resources and at the real moment, meaning at the exact date when the product achieves the higher and faster market penetration. This will give back to the company higher market share and better returns.

The AIM System, as result of the AIM Project (Acceleration of Innovative Ideas to Market, IST-2001-52222), aims to answer the needs from **industrial companies** with **complex products and/or processes** with a substantial **requirement for incremental innovation** on them that need to harness the product and process knowledge of their staff, suppliers and customers using the **latest technologies**. In this line, the AIM system will support the collection of innovative ideas and relevant knowledge throughout the extended enterprise for new and existing process and product developments. These ideas and knowledge will later be developed in a collaborative way fostering industrial innovations, as Team Work will be enhanced by co-operation between manufacturers, customers and suppliers by means of the Internet facilities provided by the AIM System, "accelerating" innovation into the market.

2 Existing Theories and Work. State-of-the-Art conclusions

The AIM System consists of new and existing tools and methodologies combined for fostering innovation in products/processes. The state-of-the-art analysis consisted on a thorough literature overview and Internet search in order to provide the most extensive insight into the relevant following aspects involved:

1. 'Classical' methods and tools for knowledge management, e.g. gathering knowledge on product/processes and problems and improvement potentials.
2. Methods and tools for ontologies building.
3. Methods and tools that can be used to develop innovative ideas.
4. Methods and tools to support the innovations process- Innovation Viability Assessment / Innovation Management System.
5. Methods and tools to realise comprehensive, adaptable and user-friendly Graphical User Interfaces (GUI).

Although the main technologies mentioned are available in the market, the results of the analysis of the State of the Art conclude that:

- Practical means for developing ideas into innovations in products and processes are still missing. This will involve taking what is currently available and producing methods of rapidly taking many creative ideas, and assisting people to work together in a structured manner to develop these ideas into innovations.
- Methods and tools for capturing and structuring innovative ideas, over extended enterprise, in a way that enables the best use for product/process innovation are still missing. This is the typical idea of 'difficult to structure knowledge', which asks for high-level 'innovation' and meta classification. On one side, the structure must not restrict creativity of the people; and on the other hand, they must be structured in such a way to be easy to access and re-use.
- Providing means for team development of innovative ideas over extended enterprise is a high challenge and asks for a generic approach for development of ontologies applicable in the context of specific products/processes.

3 Research Approach

The approach followed in the AIM project to realise the System software architecture is a combination of several state-of-the-art methods, enabled by development environments, and supported by standard terminology. AIM followed a method combining the Extreme Programming (XP) approach and the "4+1" View Model. A first draft modulation of the AIM architecture was made, using the "4+1" View Model. This first model was driven by the end users' requirements, neither too specific nor too detailed. Then, during the whole duration of the

project, especially during development, an iterative process was realised, using practises from the XP approach. The testing procedure in AIM is based in the iterative approach presented in the Rational Unified Process, which also complies with XP concept, and allows detect errors as early as possible, radically reducing the cost of fixing.

The project is based on three business cases, used to ensure that the project is driven by industrial needs, and that these needs are met. The business cases use the AIM system in different ways enabling to develop and test AIM system for different scenarios, ensuring its general applicability (see Chapter 5, Findings).

In order to ensure reliable validation of the AIM methods and tools, metrics were defined to enable a quantitative assessment of the project progress and the results achieved. Some initial metrics and target values were elaborated in detail. These **quantitative metrics** include:

- Business metrics - benefits such as,
    - Reduction of product innovation cycle;
    - Reduction of time and efforts for solving product/process problems;
    - Improvement of process efficiency;
- Technical metrics – requirements upon the tools.

In order to provide **appropriate procedures for self-assessment throughout the project**, the following strategy is applied: The metrics related to technical aspects were first assessed within early prototypes of the critical issues (e.g. ontology definition, innovation engine, etc.) while however using the knowledge/information gathered in the real industrial environments.

The early prototypes installed in the industrial environment enable testing the tools under real conditions. The early prototype focused upon a relatively limited number of users within the different business cases providing limited context-, task- and role-sensitive functionality. This enables measuring the success of approaches and tools, expecting that at least 70% of the target values can be achieved. The business metrics were applied as well within the testing of early prototypes in the manufacturing environment. The results of these assessments are used to provide feedback to the full prototype development.

Finally, once applied the full prototypes in the manufacturing environments of the three end-users, the final measurement of all defined metrics will be carried out aiming at achieving all defined targets.

4 Solution proposed

The main target of the AIM project is addressing the problem of the management of distributed innovation knowledge in complex manufacturing systems. The project is novel as it seeks to encourage innovative 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 organisations, customers and suppliers. Many companies have the required corporate breadth-of-experience to improve incrementally their products or processes if they could only make best use of their knowledge resources internally and in partnership with their suppliers and customers. Stimulation of ‘Innovation’ is a means by which channel these knowledge resources. Such problems could be minimised by employing innovation methodologies and tools to support innovation during the development process.

The System is thought as a process of innovation [Zlotin, Zusman, 1999], which means that an Idea will undergo a complete cycle, in order to be collected, documented, classified and used in the AIM system. Ultimately, Ideas turn into Innovations, which is one of the main objectives of the system. This section provides a rough overview of the life cycle of an idea. Figure 1 shows the complete path that an idea undergoes in the system. This life cycle is the basis of the

innovation process, containing the activities to be realised to achieve innovations in the concurrent enterprise.

The life cycle starts with data acquisition, where ideas are collected using an appropriate graphical user interface, accompanied by knowledge acquisition methods. The users of the extended enterprise will use remotely the system to document their thoughts and viewpoints concerning the products and services of a company.

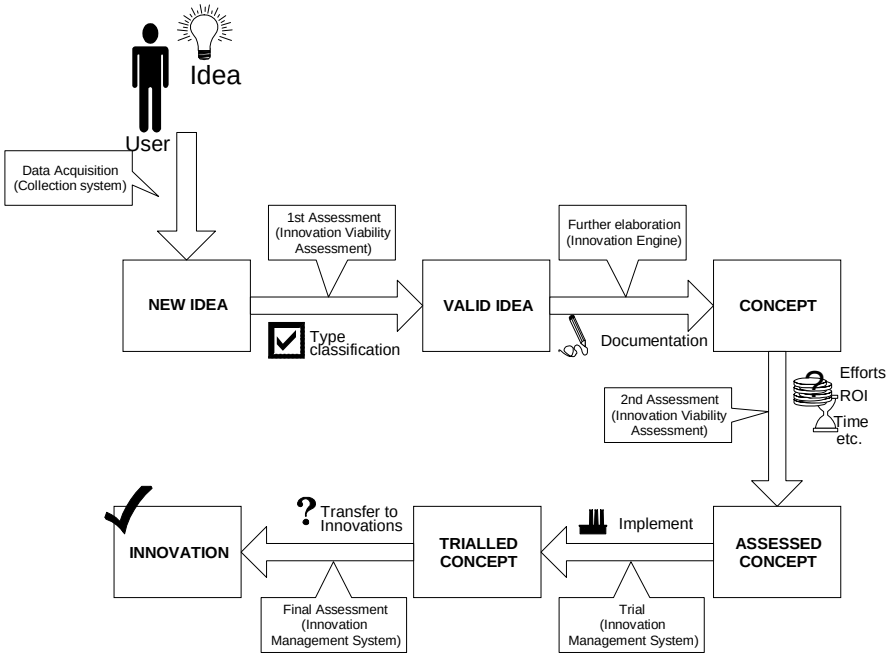

Figure 1: AIM Innovation Life cycle

The AIM system performs a first assessment of the **New Ideas**, with the purpose of making a rough classification. This classification will be an identification of the idea type, according to the information that it contains: improvement, potential cause, action or new product/process etc. The main objective of this first classification is to attribute a type to each **New Idea**, enabling its fast identification by the appropriate staff members of the company.

With all the ideas classified by type, **Valid Ideas**, a responsible staff member will develop them further, by first collecting any additional information that might be relevant for the **Valid Idea**, and further elaborate it. All the information can be useful to enable the best possible assessment. This step also includes relating the idea to any other ideas, innovations, and information stored, such as products, processes, problems, causes, actions etc. The result of this step is an idea more elaborated, **Concept**.

The company's staff members responsible for ideas' evaluation will realise a detailed assessment of each **Concept**, with the objective of supporting a decision of trying or not the idea, i.e. implementing it. Several issues must be considered here, such as material, machines, staff members, implementation cost, profit, efforts, ROI etc. The result of the assessment will be documented in the repository, together with the concept, defining an **Assessed Concept**.

If the result of the assessment expresses an expensive and unworthy implementation, the **Assessed Concept** will probably not be implemented, and this has to be documented. It is then possible to keep the concept in the repository to reuse part of its information, or delete it. When the assessment provides positive results, the **Positively Assessed Concept** is tried, and the complete development process is documented in the repository. The most important part of this documentation is the result obtained from the trial implementation, which expresses the success of the concept or not, and defines a **Trialled Concept**.

The complete documentation of the concept i.e. **Trialled Concept**, collected until this step, enables the final classification of the initial ideas. Based on the assessments and the trial implementation is possible to identify if the idea is successful, and therefore constitutes an **Innovation**.

The AIM system followed a component-based development, enabling an easy extensibility, robustness and customisation, and supporting the activities identified in the idea life cycle. Main components are:

- **Innovation Repository:** This repository classifies ideas by using a classification common to all AIM modules, and stores them for rapid access.
- **Collection of innovative ideas and product/process knowledge:** This module is based on combination of 'classical' approaches/ commercial tools together with new developments required to provide means to efficiently collect ideas, but also to collect knowledge on product and process problems for which ideas are needed.
- **Innovation Engine:** This module provides a systematic methodology for the development of ideas into innovation concepts, by sharing and working on these ideas in a structured framework. TRIZ methodology serves as a baseline approach [Kohnhauser, 1999] for this module, where the in-depth analysis of technical requirements and manufacturing failure situations is performed, structured knowledge is delivered, and graphical aids for team working and creation of Concepts are provided.
- **Innovation Viability Assessment:** This facility provides a structure (based on rapid consulting within the company of evaluation of developments and risks, combined with a multi-criteria decision support) to assist users in assessing the feasibility of new ideas at the collection stage, and innovation assessment facilities for design teams. It is important to focus on feasible, good innovative knowledge, and develop this.
- **Innovation Management System:** This is a means of providing an efficient way for planning and monitoring the use of the innovation knowledge during design activities and a structured delivery of the innovations/ideas to the process and product Design Teams.

The **main features** of the AIM System are:

- AIM enables users along the extended enterprise to introduce ideas and report problems.
- AIM enables the complete modelling of the extended enterprise (i.e. the departments, staff, processes, products, customers, innovations, etc.), in order to support an appropriate and efficient structure and classification of ideas and problems.
- AIM provides functionality to validate the ideas, classifying them by type.
- AIM includes an extensive search system for ideas, using all possible attributes as search parameters, in order to support definition, elaboration and combination of ideas and further development of innovative concepts.
- AIM supports users in the technical development of ideas, following a TRIZ-based methodology, for in-depth analysis of technical contradictions.
- AIM supports users, following a TRIZ-based methodology, in depth-analysis and solving of problems and failure situations.
- AIM supports the assessment of the ideas developed in terms of technical viability, resources, costs, benefits etc.
- AIM comprehends innovation management functionality to determine and monitor the process of innovation.
- AIM enables functionality to maintain a common ontology used in several sites, by comparing local and global ontologies.

- AIM allows on-line monitoring and access to innovation processes through web-services providing statistics on system's use and success (e.g. new ideas, status of innovation process, users, number of innovations, number of problems solved, etc.).

5 Findings

This Chapter presents findings and achievements (the integrated System and results of the Validation by the Industrial End-users in the AIM Consortium) from the validation of the Early Prototype. The tests carried out with the early prototypes had the purpose of defining flows of activities to be realised using the AIM system and allowed the end-users to provide valuable feedback regarding the AIM system. This feedback was structured in the form of improvements identified, which will be implemented for the full prototype of the modules.

Business Case 1. Cutting Tools (CTools, UK)

The business line selected for the scenario is the development of new products and cutting methods of cutting, and maintenance of cutting tools, which is the one where there is most off-site involvement of personnel, and is the one where innovation is most needed. Therefore, CTools focus on innovation generation, to achieve new products and processes, and also on solving problem occurred with cutting machines supplied to customers.

The tests of the early prototypes involved the Managing Director of CTools, the Works and Sales Manager, and one Shop Floor Tool Designer. In future tests, when the full prototype is installed, the entire shop floor will be involved. In addition, Sales will also be involved in testing the AIM system. The Works manager, supported by the Managing Director, defined the company model of CTools, and introduced it in the AIM repository, using the Set-Up tool provided. The model included several tools designed by CTools, and some problems collected in the past, with respective solutions. Afterwards, problems reported by customer were introduced in the AIM repository, using the Collection System, with the complete description. In several cases, ideas were collected to help solving these problems.

Business Case 2. MB Air Systems (MBAS, UK)

The business case area is the business of providing a complete air compressor system solution to customers, and then supporting this air compressor system. The selection of the air compressor business is because it is a key business area for the company, and that it involves (and needs to innovate and enhance this involvement) significant interactions with suppliers and customers. The main focus of MBAS business case is to collect information from customers about needed solutions. This information can be seen as problems, which need solutions provided by MBAS.

The tests of AIM's early prototype were realised by the Managing Director, one Account Manager and one Service Manager. This group will be extended during the tests of the full prototype, to include: Sales Engineers, Service Engineers, Management, Suppliers and Customers. Customers and Suppliers were indirectly involved, as they did not use the tool yet, but information provided by them was introduced in the repository by MBAS employees. MBAS model was defined by the three users involved in the tests, using the Set-Up tool provided by AIM. This model included some air compressor systems developed by MBAS and provided to several customers. In addition, some problems related to these systems were also introduced. With this basic information defined, it was possible to begin collecting problems regarding actual and future systems, using AIM Collection System. The process of solving these problems included also the collection of ideas.

Business Case 3. Ball Packaging Europe (BPE, Germany)

The BPE business case focuses upon innovation in multiple site manufacturing process based on the identified problems and potential improvements. Therefore, BPE Group is carrying out the Business Case focusing upon processes innovation.

The selected business case area is the manufacturing process of cans in two plants in Haßloch and Braunschweig. In the Haßloch plant, the process selected to test AIM system is a bottleneck machine called "Necker". This process/ machine in the production floor requires a generation/collection of innovative ideas in order to improve the processes as well as the quality of the products. Since this bottleneck machine (Necker) creates a number of complex problem/failure causes asking for complex activities to remove these causes, the AIM tools should support a collection of ideas on this production step. To solve the problems, an innovation management system is needed which gives the staff members in the shop floor, as well as engineers, a consolidated overview on problems in production and proposals of causes/actions to remove these problems. The similar process (with similar problems) is selected in the Braunschweig plant. The testing process at BPE was realised by the Process Engineers and Plant Managers and selected Maintenance Workers who defined the plant model, especially the Necker machine, using the set-up tool provided. This information was the basis to collect problems and ideas. Afterwards, problems registered in paper forms were introduced in the AIM system, using the Java client of the Collection System. In addition, ideas to solve these problems and improve the manufacturing processes were also collected. The group of users will be extended to test the full prototype.

Table 1 presents validation results obtained, where the current measures (assessment of early prototype) are compared against the objectives defined in the project start. Some of the requirements are not measurable (n.m.) and some measures are still not available (n.a.). The tests also allow conclude that the modules developed are quite satisfactory from functionality point of view. The functionality implemented was working without major problems, and in a robust and reliable way.

Requirement	**Objective**	**Assessment of early prototype**		
		CTools	MBAS	BPE
Increase the number of innovative suggestions on products from customers and suppliers by a structured web link	50%	50%	50%	n.a.
Increase the number of innovative ideas on products from employees, by means of easy to use facilities	70%-100%	60%	50%	n.a.
Collect the Corporate Knowledge from the company	n.m.	OK	OK	OK
Establish a classification scheme for product/ process knowledge to be used for further development	n.m.	Yes	OK	OK
Increase the number of implemented innovation/ new concepts of offers to customers	at least 30%	30%	30%+	-
Increase the number of innovative ideas on processes from employees within an extended enterprise, making easy the introduction of information	50%	50%	50%	25%
Increase number of innovative solutions of the identified problems within processes	at least 30%	30%	30%	10%
Reduce time and efforts to solve product/process problems	at least 25%	25%	25%	20%
Have a managed way of developing ideas into new practical concepts	n.m.	Yes	OK	-
Have a structure to record and classify ideas	n.m.	Yes	OK	OK
Reduce wastes and costs associated with problems, and supporting customers	12 %	12%+	25%+	Ca. 10%
Shorten the time needed to collect and implement new ideas in the manufacturing process	n.m.	Yes	OK	OK
IT-based collection and evaluation of problems, problem causes and ideas to remove these problem causes in order to improve the production process in the shop floor	n.m.	Yes	OK	OK

Table 1: Validation results of the early prototype

6 Conclusion

The overall objective of the AIM System is twofold: Increasing Innovation and accelerating their introduction to the Market. From Early Prototype validation through Industrial Cases, we can conclude that systematic approaches applied to incremental innovation lead to increased efficiency within innovation development process, confirming the basis and assumptions of the AIM project. Specific achievements expected out of the full implementation of the AIM system may be listed as:

- Developing means of stimulating the creation of innovative ideas and collecting them from people at the extended enterprise level involved with the products and processes.
- Developing ways of processing these ideas and storing them into a structured knowledge repository. To ensure that all the useful knowledge (innovative information) is saved.
- 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.

Leading to important business benefits on the fields of:

- Reduction of product innovation cycle-time
- Reduction of time and efforts for solving product/process problems
- Improvement of process efficiency and reduction of wastes

Acknowledgement

This work has been partly funded by the European Commission through IST Project *AIM: Acceleration of Innovative Ideas to Market* (No. IST-2001-52222). The authors wish to acknowledge the Commission for their support. We also wish to acknowledge our gratitude and appreciation to all AIM project partners for their contribution during the development of various ideas and concepts presented in this paper.

References

AIM –- IST-2001-52222: Acceleration of Innovative ideas to Market.

M. Uschold and M. Gruninger, `Ontologies: Principles, Methods and Applications', Knowledge Engineering Review, 11(2), 1996

Blake, A., Mann, D. (200) Making Knowledge Tangible. CMC and DuVersity.

B. Zlotin, A. Zusman: Managing Innovation Knowledge, 1999

Kohnhauser, V. (1999). Use of TRIZ in the Development Process. Triz Journal.

Sawaguchi, M. (2001). Study of Effective New Product Development Activities trough Combination of Patterns of Evolution of Technological Systems and VE.

A. Levy, A. Rajaraman, and K. Ordille. Querying Heterogeneous Information Sources Using Source Descriptions. In Proceedings of the 22nd VLDB Conference, 1996.

R.J. Brachman, J.G. Schmolze, An Overview of the KL-ONE Knowledge Representation System, Cognitive Science, 9(2), 171-216, 1985

Sorli, M.; Stokic, D.; Campos, A.; Gorostiza, A. "Accelerating Innovation in Practice in New Product Design", IEP Porto 2003 Conference (Portugal).

Stokic, D.; Sorli, M; Campos, A.; Gorostiza, A. "KM System to support Incremental Innovation in Manufacturing Industry", CE Madeira 2003.

Sorli, M.; Stokic, D.; Campos, A.; Gorostiza A. “Acceleration of Innovative Ideas to Market” IMS Conference, 2004 Como (Italy)

Sorli, M.; Stokic, D.; Gorostiza, A.; Correia, A.; Campos, A. "Fostering Innovation in Extended Enterprising", eCHALLENGES 2004, Vienna.