Accelerating Innovation in Practice in New Product Design

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Abstract.
This paper introduces an IMS project with the goal of developing a system to support the collection of innovative ideas and relevant knowledge throughout the extended enterprise for new and existing process and product developments, and to develop these ideas and knowledge into a means of fostering industrial innovations. The system will integrate techniques from Total Quality Management (TQM), Concurrent Engineering (CE) and Information Technologies (IT) shifting towards the required cultural changes.

The Project **AIM (ISO-2001-52222. Acceleration of Innovative Ideas into the Market)** is funded by the EC on the European side. It started in June 2002 and its main objective is to develop a means of stimulating the creation of innovative ideas in general, and specifically on problems solving and on potential product/process improvements and collecting them from people involved with the products and processes. A system will be developed to 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 into a means of fostering industrial innovations. Such a system will enable **organisational learning** by providing a means to collect, store and use/develop innovative ideas over the extended enterprise. Main RTD challenges to be faced are the combination of methods for generating innovative ideas (*i.e.* TRIZ) with "classical" methods for collection of knowledge on products/processes and their problems, and the development of specific ontologies needed to **enable efficient exchange of ideas** between different experts/actors within the extended enterprise.

1. Introduction.

The key idea behind the project is to develop means supporting the collection of all useful knowledge throughout the extended enterprise for new and existing process and product developments. This knowledge will then be developed into a means of fostering industrial innovations.

In current times is quite obvious and generally assumed that two of the most critical factors for success in industrial firms are innovation on one hand and the ability to launch a product to the market in the right moment ("Lead Time" or Launching time for new products).

Innovation is a critical factor in the success of industrial companies. Innovation is important for all companies, and just as important is the need to get innovative products to the market place quickly. People inside and outside the physical boundaries of the industrial organisation are an untapped resource for innovative ideas and knowledge.

Lead time actually covers from the product conception to its commercialisation in the market place. It obviously varies highly depending of the type of product. Usually there is an increasing need of reducing lead time in order to enable the company to increase the rate of product refreshing in the market as well as better adapting to the rapidly changing demand from the customers.

Nevertheless on the authors point of view, it is more important to use the expression: "Management of product development time" than simply looking for a time cut-off. Under this new paradigm, companies able of "mastering" the development time will achieve to launch the product into the market just spending the planned time and resources and at the *real* moment, meaning the exact date when the product is expected to achieve the higher and faster market penetration. This will give back to the company higher market share and better returns.

In summary, 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 into a means of fostering industrial innovations. It will enable **organisational learning** by providing means to collect, store and use/develop innovative ideas over the extended enterprise.

It will also "accelerate" innovation into the market enabling the companies to "master" the design time and do it shorter.

2. Results.

The project 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, and including customer service and field engineers, including suppliers, and including pooling of knowledge between multiple sites.

The paper will present findings and achievements of the project up to date and will also give guidelines on how to optimize the design process by integrating techniques from Total Quality Management (TQM), Concurrent Engineering (CE) and Information Technologies (IT).

Conclusions:
The overall objective of the AIM project is twofold: Increasing Innovation and accelerating their introduction to the Market. We expect that the project will be a good help to push manufacturing companies moving towards increasing innovation rates throughout the new paradigms of Extended Enterprise and Knowledge Management.

The project is still in its preliminary stages though by the time of the Conference (more than one year running) it is expected that many aspects will be worked on. However, main RTD challenges to be faced along it are already known and assessed. Basically they will be the combination of methods for generating innovative ideas (*i.e.:* TRIZ) with "classical" methods for collection of knowledge on products/processes and their problems, and the development of specific ontologies needed to **enable efficient exchange of ideas** between different experts/actors within the extended enterprise.

3. Contributions to the European Community

AIM addresses the problem of the management of distributed innovation knowledge in complex manufacturing systems, sometimes spreading over many countries. This problem is of a general nature, widely applicable and of essential significance in the European and world-wide manufacturing industry, both in large and small companies. Therefore, the expected results of the project are required by the EU as a whole, i.e. they are not specifically needed by just certain countries or regions.

AIM is an integrated methodology consisting of leading state-of-the-art techniques to produce a unique methodology for providing a comprehensive support for innovative product and process development. It contributes to several areas of EU policy such as:

Competition
The IST programme supports research activities supporting European competitiveness: Europe suffers from a recognised gap compared with its major competitors, inasmuch as it is less able to translate its scientific knowledge into innovation. Not only research but also innovation in respect of new concepts (e.g. eco-industries) should be fostered to boost competitiveness and productivity.
Future use of AIM throughout European companies will enable European industry to fill the competitive gap with the Japanese and North American competition, in terms of being able to develop and introduce new products to the market faster and more targeted to the market needs.
An important outcome for the project will be for users of the AIM methodology to increase their market share and, to be able to manage future product/market evolution better than before, and maintain increasing market shares.

Horizontal Policies:
The AIM proposal intends to develop a system to collect and manage innovative knowledge applicable for SMEs. One of the end user in the consortium is SME and their requirements have been strongly taken into account when specifying the AIM system. Therefore, AIM is likely to considerably contribute to the competitiveness of the SMEs, by providing them with a means to foster their innovation capabilities and shorten the time to market.

Modernisation of European Industry
The current global supply market has generated a wild competition among companies. Under this situation, organisations are compelled to devote huge resources and efforts in modernisation. Within this scope, new products design and development is a key area on which AIM will provide to industrial companies new methodologies enabling them to develop new products including differentiating performances at very low prices. This is the only way for the companies to become really competitive.

4. Extended Enterprise

Extended enterprise concept aims 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.

The novelty of the approach is to focus on product knowledge, which is not managed today, and which comes from suppliers, customers and employees (and tacit or informal knowledge generated by internal staff) involved in the development and support and use of products. It represents the next evolution of product information systems, taking standards and practices forward to support co-operative working and partnerships.

The key idea behind the projects presented here is to develop means supporting the collection of all useful knowledge throughout the extended enterprise for new and existing process and product developments. This knowledge will then be developed 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 customer's new product ideas; service and field engineers; suppliers and knowledge pooling among multiple sites. Innovation is a critical factor in the success of industrial companies.

5. AIM

The Project AIM: Acceleration of Innovative ideas to Market (IST-2001-52222) has started in June 2002. It runs under IMS programme with partners from Australia, Korea, Europe and Switzerland (considered as non-European region within the IMS scope).

The project 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, and including customer service and field engineers, including suppliers, and including pooling of knowledge between multiple sites. Innovation is a critical factor in the success of industrial companies

The objectives of the project are:

- To develop a means of stimulating the creation of innovative ideas and collecting them from people involved with the products and processes. Specifically to increase the number of innovative suggestions, concepts and new designs by 50% in all user companies.
- To develop a way of processing these ideas and storing them into a structured knowledge repository. To ensure that all useful knowledge (innovative information) is saved.
- To develop a 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.
- To develop the best means of delivering the innovative ideas to product and process designers for maximum effect.

This should lead to the following business benefits:

- Reduction of product innovation cycle-time by at least 30% (specifically for SME business case no. 1, and business case 3 for engineering services, and business case 5 electronic industry)
- Reduction of time and efforts for solving product/process problems by at least 25 % (all business cases)
- Improvement of process efficiency by 15 % and reduction of wastes by 12 % (specifically within manufacturing process in business cases no. 2 and 4).

The key idea behind the project is to develop means supporting the collection of all useful knowledge throughout the extended enterprise for new and existing process and product developments. This knowledge will then be developed into a means of fostering industrial innovations.

The project fits into the objectives of both IST (II.1.2 Knowledge Management) and Sustainable Growth (Targeted Research Action 1.7 "Extended Enterprise") programmes and directly addresses the IMS technical themes: Corporate technical memory and "Virtual / extended enterprise issues".

6. Innovation

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 organisations, customers and suppliers.

The accelerated pace of technological development continuously increases time and market pressures on manufacturers' capacity to innovate new products and designs and to develop the manufacturing processes that produce these products. The relentless race to develop new, higher quality products, simultaneously reducing time to market, reduce product cost, improve quality is a major challenge for all companies. Many companies lack the financial capacity either to invest in the latest technology as it reaches the market or to hire specialists to integrate new methodologies and systematically to improve their products.

Many companies have the required corporate breadth-of-experience to improve their products, improve their 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 these knowledge resources could be channelled.
Major difficulties for innovation are related with two main topics (which will be addressed by this project):

a) Intangibility of the inventive knowledge. The inventive capacity is usually considered more as an inherent property of the genius than something that may be learnt. Intangibility makes the inventive knowledge difficult to accumulate and transfer. Emerging theories say that the capacity for innovation observed in some inventors is not more than an instinctively applied methodology for abstraction, which gives sense to the words "inventive knowledge" (or "innovative knowledge"), defined here as "the knowledge necessary for finding solutions at any abstraction level". Therefore intangibility will be overcome by establishing rules, methodologies and tools for abstraction and concretion of problems, allowing to accumulate them and their solutions in a hierarchical database with the abstraction level as hierarchy separator.
b) Individualisation of the innovation process. Investigations performed during the last 20 years have demonstrated that innovation is better achieved by working in team. In the first conceptualisation steps the working teams should include the best experts in several fields available world-wide which is completely impractical for many manufacturing companies. Due to this problem, innovation thinking is usually tried by individuals on their own, which becomes almost impossible in the current stressed and time limited working environments.

Such problems could be minimised by employing innovation methodologies during the development process and incorporating tools to support innovation along the process. However, even when enterprises try to incorporate new methodologies, many problems appear due to human- and methodology-specific factors. Human factors include problems of encouraging and convincing people to use new and innovative methodologies. It is noted that new methodologies, however enthusiastically received, are frequently discarded in favour of familiar methods shortly after they are taught and personnel trained. Implementation of new methodologies is also frequently inefficient in time-management terms due to complexity, dependence on worker experience and interpretation, as well as processing of results. Methodology factors: available engineering methodologies are frequently theory-overloaded and do not integrate well with one another, if at all. In the chain of methodologies there is lack of transparency in planning, cost, technological and quality data's.

7. Approach

7.1 AIM system

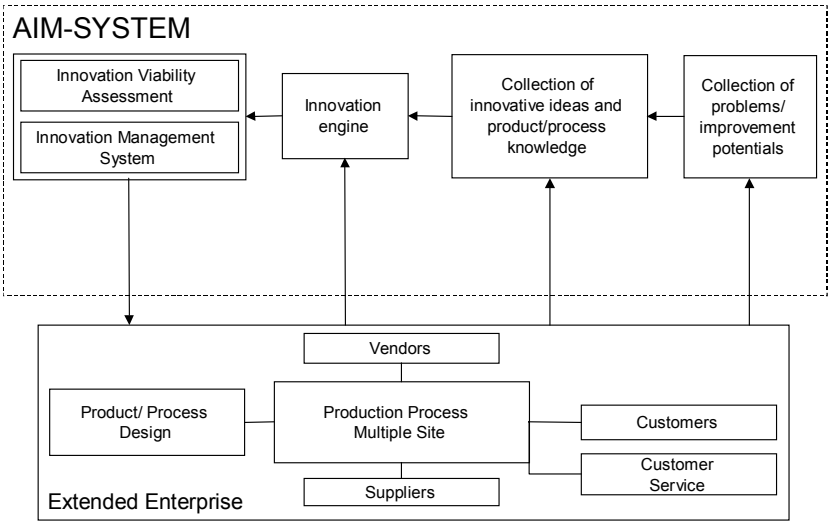

Figure 1. AIM basic concept

Figure 1 shows the basic AIM approach. AIM system will include methods and tools (modules) for collecting innovative ideas and knowledge on products/processes. The system will also contemplate another important source of innovative knowledge coming from problems and potential improvement points. The system will also support assessment on these innovative ideas and help to manage them in order to provide the best way of using them for innovative product and process designs.

In summary, 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 into a means of fostering industrial innovations. It will enable **organisational learning** by providing means to collect, store and use/develop innovative ideas over the extended enterprise.

7.2 Functional approach

The main functional elements of the AIM system appear in the following figure 2. A brief description of them can be found below:

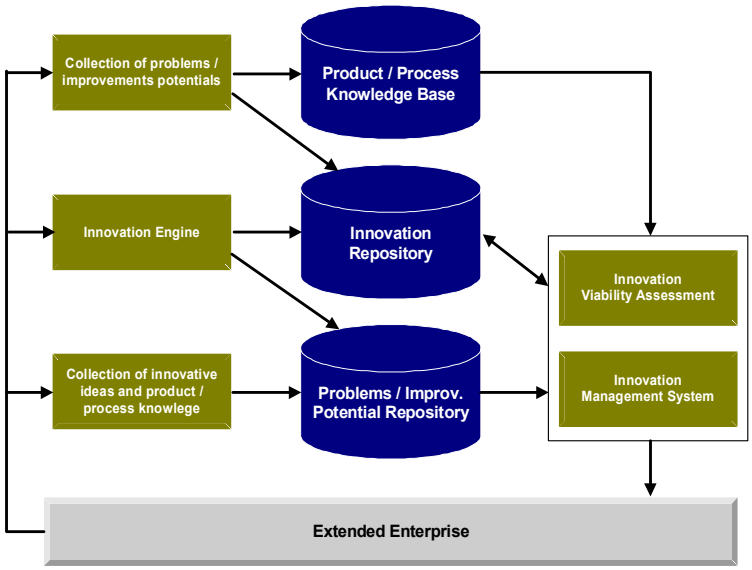

Figure 2. Functional Approach

- **Innovation Repository**: This repository will classify ideas using an 'innovation' meta classification, and will store them for rapid access. The overall meta classification of the (innovative) ideas and innovations will be defined as a basis for all AIM modules. The problem is how to enable appropriate classification for different specific products and processes, as well as within a specific company concept. This will include: Product/process knowledge base, Problems/Improvements potential repository, (Innovative) ideas and Innovations.

- **Product/process knowledge base**: This knowledge base will include all relevant information and models as well as experience-based knowledge of products and processes related to the information systems available in the enterprise.

- **Problems/Improvements potential repository**: This repository will include knowledge on problems and potential improvements regarding products/processes. This will cover knowledge on problems identified, their reasons and/or ways which were used to solve them in the past.

- **Collection of innovative ideas and product/process knowledge**: This module will be based on combination of 'classical' approaches/commercial tools together with new developments required to provide means to efficiently collect innovative ideas, but also to collect knowledge on product and process problems for which the innovative ideas are needed. This module will include an appropriate user interface to introduce ideas and knowledge on products/process and about the identified problems.
- **Innovation Engine**: This is a collection of methods oriented to finding innovative solutions following a systematic methodology. This is the facility that provides a structured means for **the development of ideas into innovation concepts**. The ideas collected within previous module and stored in the repository will be further developed. This will involve taking the most appropriate parts from state of the art methods for innovation development approaches as well, and developing these into a specification for the development of an innovation engine, which can be used to develop thoughts and ideas into innovative solutions. This will be the means by which raw, creative ideas can be organised and developed by sharing and working on these ideas in a structured framework. The specific requirement is to provide robust solutions to be applied in the industrial environment.
  TRIZ methodology is likely to serve as a baseline approach for this module. TRIZ, Theory of inventive problem solving, is a recently developed methodology giving a more systematic and technological approach promoting not only idea generation, but also a consistent comprehensive method to convert ideas into feasible concepts. See an extended explanation on the following paragraph 9.
  AIM will combine TRIZ with all useful knowledge on the specific business of the company together with other tools as Rule Based Reasoning or Case Based Reasoning (RBR/CBR) applications. This will provide all resources needed by expert hands for inventively solving almost any kind of problems.

- **Innovation Viability Assessment**: This facility will provide a structure (based on decision-tree criteria) to assist users in assessing the feasibility of new innovative ideas. Innovations which cannot be turned into reality, for commercial or socio-economic benefit are of little use. It is important to focus on feasible, good innovative knowledge, and develop this. This facility will involve taking the state of the art innovation assessment methods and specifying a solution to provide viability assessments of ideas at the collection stage, and innovation assessment facilities for design teams.

- **Innovation Management System**: This will be a means of providing structured delivery of the innovations/ideas to the process and product Design Teams. This module will assist graphically the work of the Design Teams in designing new process and products in the companies. It will also provide an efficient way for planning and monitoring the use of the innovation knowledge during the design activities.

This architecture will be finally deployed following a multi-level architecture based on Internet technologies. Integration with other tools inside each enterprise will carefully be studied and adapted to specific needs.

8. Business Cases

The project will be based on several business cases, one from each user. These will be used to ensure that the project is driven by industrial needs, and that these needs are met (by validations and assessments of the results at strategic phases of the project). These business cases will be focused on innovations for product development and innovations for process developments. The business cases will therefore use the AIM system in different ways, e.g. while some business cases will be oriented to directly collect innovative ideas and knowledge, in some the motivation for collection of ideas will be realised via identification of problems/improvement potentials asking for innovative ideas. This will enable to develop and test AIM system for different scenarios, ensuring its general applicability.

8.1 Business Case 1: Product innovations in SMEs

This business case concerns rapid product innovation in an SME, developing new innovative products internally by getting everyone involved, including field engineers working with customers to generate product ideas. This business case will focus on providing a structured and rapid approach to product innovation, so that the time to market is reduced. This is extremely important for most companies, particularly SMEs which have to produce innovative products for the marketplace, and where it is essential to have a minimal time to market.

8.2 Business Case 2: Multiple site process innovations in high volume manufacturing

This business case will focus upon innovation in multiple site manufacturing process based on the identified problems and improvement potentials. The end-user is a large multiple site company producing high volume products. Currently, many innovative ideas from employees are not used since there is no system to collect such ideas, assess them and deliver them to process designers. In order to collect information on problems in production, for which innovative ideas are needed, the integration and expansion of the IT-Systems implemented in production will be applied. The extension of the systems should mainly be concentrated on knowledge-based methods for the improvement of the production & quality data analysis, providing faster problem causes identification. The special challenge of this business case is that it will address manufacturing process distributed over multiple sites. The industrial partner has several plants in Germany and Europe, but also in US and other regions. Several sites will be involved in this business case. The goal is to collect problems/improvement potentials and innovative ideas from these multiple site manufacturing plants, i.e. to provide means to put together ideas from actors in different plants. The teamwork on developing the ideas across the multiple site will be supported by AIM system as well.

8.3 Business Case 3:Product and process innovations in engineering services and customer and supplier focus

A medium size company, being part of a larger industrial group is a system provider to industry

and is strongly oriented towards sales, service, marketing and after-market.. The company is working closely with their suppliers/partners. Therefore, a system for collecting of innovative ideas from both employees and suppliers is an urgent need. The business case scenario will involve collection ideas internally and at supplier sites. Specifically the benefits from collecting ideas at supplier site could be high, taking into account a high interest of suppliers to provide ideas to improve services with their products.

9. TRIZ. Innovative Problem Solving

TRIZ is the Russian acronym for Innovative Problem Solving. Altshuller, inventor of the methodology, started his work in Russia in the early 50's. His assumption was based mainly on the idea that the born inventor should follow a kind of intuitive methodology, so then if this method could be represented by a standard logical system it will help anyone to be more inventive and able of generating a higher number of good ideas in shorter time.

TRIZ is a methodology that by using schematic representation of problems and reducing the psychological inertia guides the developer to the abstract solution. Basic principles of TRIZ are the ideas of:

- **Out-of-the-box.** Systematic analysis of the problem helps to identify the real problem, change the mind and approach it from innovative (non traditional) "out-of-the-box" perspectives.
- **Contradictions**. Any problem encloses at least a contradiction. Traditional approaches look for trade-offs with a good balance between confronted parameters. On the contrary TRIZ claims (and demonstrates on practice) that the contradiction could be solved just by eliminating it.
- **Ideality.** TRIZ solutions look for ideality: performing the objectives of the system at the minimum costs, in the extreme the system could even not exist.
- **Resources.** Supporting previous idea, TRIZ begins by looking for all available resources (existing, hidden or non-existing but that could be "invented"). The use of these resources could allow the inventor to find cheaper and more effective solutions.
- **Systems Approach.** In-deep analysis on where to approach the problem for. What is identified as a problem is often just the mirror of the hidden problem. Analysing the System, sub-system and super-system could guide the inventor towards the more effective solutions.

10. Conclusions

The overall objective of the AIM project is twofold: Increasing Innovation and accelerating their introduction to the Market. We expect that the project will be a good help to push manufacturing companies moving towards increasing innovation rates throughout the new paradigms of Extended Enterprise and Knowledge Management.

The project is still in its preliminary stages and the main RTD challenges to be faced along it are already known and assessed. Basically they will be the combination of methods for generating innovative ideas (*i.e.:* TRIZ) with "classical" methods for collection of knowledge on products/processes and their problems, and the development of specific ontologies needed to **enable efficient exchange of ideas** between different experts/actors within the extended enterprise.

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 involved with the products and processes.
- Developing ways of processing these ideas and storing them into a structured knowledge repository. To ensure that all 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.

This should lead to the following **business benefits**:

- Reduction of product innovation cycle-time by at least 30%
- Reduction of time and efforts for solving product/process problems by at least 25 %
- Improvement of process efficiency by 15 % and reduction of wastes by 12 %

11. Acknowledgement

Authors express their acknowledgement to the other members of the AIM project consortium and to the European Commission supporting the project.

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