Classification of Ideas in an Industrial Innovation Management System

A Knowledge-based Approach

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Abstract: This paper is going to deal with innovative idea classification methods applied in the European research project, called AIM, Acceleration of Innovative Ideas into the Market (IST-2001-52222), which runs under the Intelligent Manufacturing Systems Program (IMS). After a short description of the relevant market trends in the field of manufacturing, the paper will introduce the AIM project concentrating on the idea and innovation management. The main concepts of the AIM system will be described pointing out the necessity of idea classification. The most widespread classification methods will be introduced, and analyzed if their concepts can be applied for idea categorization in this project.

Key words: innovation, ideas, classification, knowledge-based approach

1. INTRODUCTION

Many companies have the required corporate breadth-of-experience to improve their products and processes, but they 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. If the companies could only make best use of their knowledge

resources internally, and in partnership with their suppliers and customers, they would be able to respond more effectively to the new market challenges. Stimulation of innovation is a means by which these knowledge resources could be channelled.

New system are required, where ideas and innovation can be stored, evaluated and managed in an efficient and appropriate way, to force all participants of an extended enterprise to improve the efficiency and economy of the processes and product in a manufacturing system.

2. THE AIM PROJECT

The European Project AIM [1], Acceleration of Innovative ideas to Market (IST-2001-52222), has started in June 2002, and runs under the Intelligent Manufacturing Systems Program (IMS).

The goal of the project 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 innovation. Innovation by combining the ideas and feedback from all parts of the product life cycle, and including customer service, field engineers, suppliers, and pooling of knowledge between multiple sites. Innovation is a critical factor in the success of industrial companies [2].

2.1 Ideas and Innovations

AIM intends to provide a system to manage ideas and innovation within industrial enterprises. Therefore, it is necessary to clearly define and distinguish between the terms “Innovation” and “Idea”.

Innovation is something new that was introduced in an environment, i.e. a new product, a new way of realising a process etc. The concept of being “new in an environment” is very relevant since it is also possible to talk about something known and experimented in other fields but never used in a specific one. Therefore, an innovation represents the final stage of a development process, representing the result achieved and implemented successfully.

In AIM project an *Idea* is a set of knowledge that describes a possible action to be implemented to overcome a problem, to provide an improvement, or to reach an innovation. These ideas can represent different types of knowledge: technical, empirical etc. Every innovation starts with an idea, a rough concept describing something to be implemented. In these cases, the expression “innovative idea” can be applied, to describe a concept

that is new, not contemplated yet in the area, and that can lead to a successful innovation.

2.2 Knowledge-based approach

It is possible to store knowledge in many kinds of expert ways, but this does not make it real for people who need it. It is common sense that, unless we actually do something with this knowledge, it becomes insubstantial for us a mere record of what is passed.

When managing knowledge, representing “Ideas” or “Innovations”, it is essential to keep in mind that the gap between knowledge and its respective use has to be eliminated. This means that the knowledge has to be stored and managed focussing its use.

In AIM System the ideas will be evaluated in two phases that structure the information (ideas) in such a way that enables functional and financial assessments, supporting users in assessing the feasibility of new innovative ideas. These phases are:

- *First Assessment*: a rough classification, identifying the type of these "Ideas" collected throughout the extended enterprise, classifying them either as potential improvement to product/process, potential cause for problems identified, actions on productive units where the problems occur or new product/process.
- *Second Assessment*: once new "Concept" is developed and previous to its implementation, an assessment based on strategic policy is done: implementation cost, materials to be used, equipment, profit expected, corporate efforts, Return on Investment etc.

These assessments use the following methods and tools:

- Decision Trees are used as tools for helping developers to choose between several courses of action, as they provide a highly effective structure within which it is possible to lay out options and investigate the possible outcomes of choosing these options.
- Reasoning tools, such as Rule-based Reasoning (RBR) and Case-based Reasoning (CBR), are used to propose the level of priority of each idea, as their rules can be established gathering information about the business objectives and users satisfaction.
- TRIZ tools and method [3] are used to achieve the generation of innovative ideas, enabling to "get-out-of-the-box" to find real "new" breakthrough ideas with a considerable degree of innovation.

In AIM System an Innovation Repository stores all the information that describes products and processes, as well as all the necessary information

related to these components. The first part of this Corporate Knowledge base (CKB) can be seen as a core component or as necessary auxiliary information to describe problems, ideas and innovations, which constitute the main objective of the AIM's Innovation Repository. In addition, the CKB is also used to save the results provided by the AIM tools, such as possible error causes or proposed actions to eliminate an error, classification of ideas etc.

The Innovation Repository includes:

- Product/process knowledge base: all relevant information and models as well as experience-based knowledge of products and processes.
- Problems/Improvements potential repository: knowledge on problems and potential improvements regarding products/processes. This covers knowledge on problems identified, their reasons, and/or actions that were used to solve them in the past.
- Ideas and Innovations: all ideas and innovations will be stored using the meta classification. The overall meta classification of the ideas and innovations is defined as a basis for all AIM modules. The classification is adjustable to specific user needs.

We have created a meta-model that defines the structure to be used in storing all the information that describes products, processes, problems, ideas and innovations.

The Innovation repository will classify innovations using an ‘innovation’ meta classification, and will store them for rapid access. The problem is to enable appropriate classification for different specific products and processes as well as within a specific company concept.

3. CLASSIFICATION OF IDEAS AND INNOVATIONS

In general terms, classification creates a type of metadata, which provides essential information about the content. Metadata and classification are part of the discipline of information architecture, whose focus is to organise the content.

3.1 General classification objectives and some possible methods

Good, internal classification has generally two key objectives:
1. To organise the knowledge-base (containing ideas, innovations, etc.) in such a way that maximises its ability to communicate knowledge.
2. To allow the users to quickly find specific parts (certain innovations, patents, etc.) of the knowledge-base.

Classification experts tend to focus on organising complete documents, books, music and other content. They classify for two reasons [4]:
1. To organise the content so that it can be found quickly.
2. To place the content in context so that it becomes part of a cohesive body of knowledge.

One of the most widespread classification schemes is the *dichotomous system*. This type of classification divides the objects always into two subsets on the basis of whether each object has or does not have a particular property. That makes a hierarchy of classification which groups all objects into increasingly narrow categories.

There are two ways to represent the dichotomous classification, in other words constructing *dichotomous key* – either by a spider (tree) diagram or by a paired statement key (linear key).

To make a *tree diagram* key, first a characteristic must be defined, which some of the objects have but none of the other objects have. Then the break down of each group should be continued based on another characteristic that some objects have and others don't, until all the objects are identified separately.

The following trivial example easily demonstrates the dichotomous key, represented in a tree diagram in case of inventing new vehicles (see *Figure 1*). Jus to provide a simple model the new vehicle can be a plane, ship, train or a car.

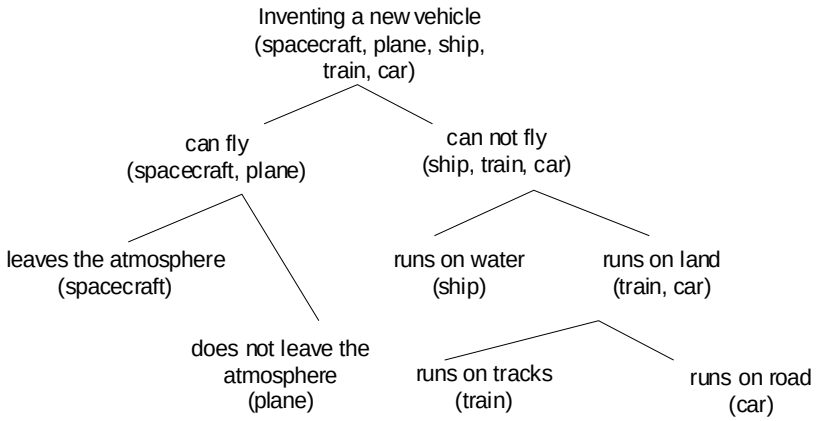

Figure 1. Tree diagram example

To make a *linear key* representation of the model provided above, the same set of characteristics should be used as by tree diagrams, but the description of the information is a different:

– each pair of characteristics should be numbered, as 1a, 1b, 2a, 2b, etc.
– each characteristics should be listed one below the other,
– instructions of where to go to next are listed on the right hand side,
– once the object is identified the name goes on the right hand side.

3.1.1 Faceted Classification

Faceted classification is a bottom-up scheme. Here, each object is tagged with a certain set of attributes and values (these are the facets), and the organization of these objects emerges from this classification, and how a user chooses to access them.

Faceted classification is also called analytic-synthetic [7], named after the two main processes involved in the composition of a call number. These two processes are:

1. Analysis: breaking down each subject into its basic concepts.
2. Synthesis: combining the relevant units and concepts to describe the subject matter of the information package in hand.

A facet is a "clearly defined, mutually exclusive, and collectively exhaustive aspects, properties or characteristics of a class or specific subject" [5]

As an example, faceted classification of innovative ideas can be used as follows. Facets can be defined like “Related Generic (Product Part, Process, Production Unit)”, “Problem to be solved”, “Suggested Solution”, “Value of

Innovation”, etc. Users of the system might look for solutions related to a certain product, and want to start the search there, other users might value conscious, and begin with the estimated value of the innovation.

Faceted classification allows for exploration directed by the user, where a large dataset is progressively filtered through the user's various choices, until arriving at a manageable set that meet the users' basic criteria. Instead of sifting through a pre-determined hierarchy, the items are organized on-the-fly, based on their inherent qualities.

Faceted classification isn't inherently innovative. In fact, objects tend to have a fixed set of facets by which they are organized [8].

3.1.2 Colon Classification

The Colon Classification scheme is based on the faceted classification [7]. It starts with a number of main classes, which represent the fields of knowledge. Each class is then analysed and broken down into its basic elements, grouped together by common attributes, called facets. In colon classification there are five main groups into which the facets fall, these are called fundamental categories, represented by the mnemonic PMEST in an order of decreasing concreteness.

- Personality - what the object is primarily "about". This is considered the "main facet".
- Matter - the material of the object.
- Energy - the processes or activities that take place in relation to the object.
- Space - where the object happens or exists.
- Time - when the object occurs.

There are also facets that are common to all the classes. These are called common isolates. The same facet can be used more than once. Notations, such as numbers and letters, are used to represent the facets, while punctuation marks are used to indicate the nature and type of the facets. The notation for each facet is separated by a colon, hence the name of the system.

Es an example let us suppose that we have an invention that is about "Controlling forces between non-magnetic bodies in magnetic liquid" [6]: The call number can be: *M 421:61:17* that represents *M for Magnetics, 421 for Forces, 61 for Non-magnetic bodies, 7 for Controlling and 17 for Magnetic Liquid.*

Colon Classification is general rather than specific in nature. Through the use of facets, it can create complex or new categories. It has main and generalized classes represented by a mixed notation of Arabic numerals, and

Roman or Greek letters. In addition, there are four floating tables that correspond to subdivisions such as form, geography, time, and language.

The classifier's job, therefore, is to combine the available terms that are appropriate in describing the information package in hand. According to [9], Colon Classification is widely used in India, but is becoming complex and difficult to use.

4. IDEA CLASSIFICATION IN AIM

The goal of meta classification in AIM system is to ensure a rapid access of ideas and innovations in the Innovation Repository. Classification can help in selecting the ideas and innovations and store them in an appropriate way that helps in searching and retrieving them.

In AIM system it is important to set up a clear, easy to use and extensible classification method that can be used in the extended enterprise. Most people, when thinking about organizing objects or information, immediately think of a hierarchical organization; a top-down structure, where you start with a number of broad categories that get ever more detailed, until you arrive at the object. In such structures, each object has a single home, and typically, one path to get there. This is how things are organized in "the real world", where each item can only be in one place. For these reasons the dichotomous classification method seemed to be the most appropriate one in the AIM system, with which we can provide an usable tool for the users to classify their ideas. Another reason for choosing this well-known binary classification method was the size of the expected model, and this way we looked for avoiding computational problems.

To fulfil the above requirements we have created a **hierarchical meta-classification** schema based on dichotomous method represented by a **tree diagram** (see *Figure 2*). In this diagram *generic* means the business objects of the existing system, like product parts, process steps, or production units to that an idea can be related.

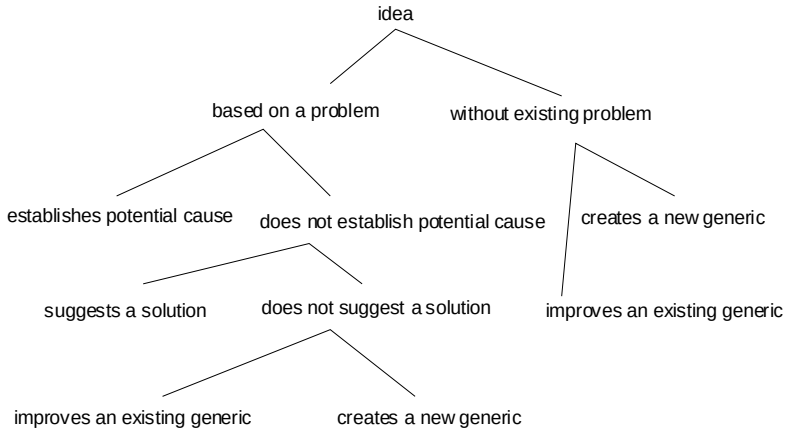

Figure 2. Hierarchical meta-classification of innovative ideas

Based on this decision tree the classification can be made rather easily. The decision maker has to only decide if an idea owns a certain property (e.g. based on a problem) or not. Further classification depends on the generic that is different in every business case. The generics can be represented in tree structure as well, from where the individual components (like certain product part) can be selected.

The above decisions can be made at different levels of the system. It is very much dependent on the qualification and access rights of the user. Normally, the basic user of the system has only to provide his/her idea without any classification of it. More advanced users can provide a classification of the idea together with its description and other properties. Expert users will have the rights to classify their own or others' idea, as well.

The initial assessment of the ideas is done completely manually using the same user interface where the ideas were entered. Later on, in other turns of idea assessment the ideas are labelled as *valid idea*, *concept*, *innovation*, etc.

The classification of ideas can be done by individual experts or in teamwork, as well, when so-called Evaluator Teams formed by experts to establish each individual idea's category.

These decisions are sometimes fairly simple (e.g. *is it based on a problem?*) but sometimes rather complicated (e.g. *does it create something new?*).

5. CONCLUSIONS

This paper introduced some general classification methods, and showed the application possibility of the most suitable one in the frame of the European project AIM.

The chosen hierarchical dichotomous classification method, and its tree diagram can help in assessing innovative ideas, before storing them in the innovation repository.

Rapid prototype of the system is under development, where all the theories will be proved.

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REFERENCES

1. AIM-IST-2001-52222: Acceleration of Innovative ideas to Market. From 1/06/2002 to 31/05/2005.
2. M. Sorli, D. Stokic, A. Campos, Antonio S., M. A. Lagos: Fostering Innovative Ideas and Accelerating them into the Market, European Commission's IST Programme, eBusiness and eWork, The Key Action II Annual Conference, January 2003, http://www.cheshirehenbury.com/ebew/virtulahtml/sorli.html
3. Kohnhauser, V.: Use of TRIZ in the Development Process, Triz Journal, June 1999.
4. McGovern, Gerry: Information architecture: learning how to classify, http://www.gerrymcgovern.com/nt/2002/nt_2002_09_02_classify.htm, September 02, 2002
5. Maple, Amanda: "Faceted Access: A Review of the Literature." <http://www-sul.stanford.edu/depts/music/mlatest/BCC/BCC-Historical/Bcc95/95WGFAM2.html> (16 March, 2000)
6. Innovation WorkBench Software System, Version 2.2.0, Ideation International, Inc. 1998,
7. Ranganathan: Ahead of His Century, http://www.slais.ubc.ca/courses/libr517/winter2000/Group7/index.htm
8. Peterme: Innovation in Classification, http://www.peterme.com/archives/00000063.html, Posted on 09/23/2001
9. [Foskett]: Foskett, A.C. "The Future of Faceted Classification". In The Future of Classification, edited by Rita Marcella and Arthur Maltby. Aldershot, Hants, England; Brookfield, Vt.: Gower, 2000.