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**Author(s):**

Elspass, Wilfried J.; Pereira, M.A.

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# An Advanced Knowledge Environment for Product Innovation

A.W.J. Elspass & M.A. Pereira

*Research Group for e-knowledge in Engineering, Centre for Product Design, Swiss Federal Institute of Technology, Zurich, Switzerland*

**ABSTRACT:** The collaboration of universities and industrial partners is a major prerequisite for the realization of an advanced knowledge environment for product innovation (AKEPI). A knowledge network is established, which is an essential part of the overall framework. In this network knowledge is built via collaboration among users (lecturers, researchers, industrial partners), via various forms of interaction. A knowledge pool, organised in a database, is the basis of the system, enabling users to compile personalised forms of utilization (online courses, electronic books, portfolios, etc.). This is achieved by a high level of modularisation and structuring of the content, using a content management system with cross media publishing functionality. Based on a socio-constructivist approach, the system will promote the acquisition of knowledge on the basis of users' experience and via shared activities. A highly interactive environment with advanced communication tools will foster the realization of virtual innovation projects by project teams. This platform will, therefore, effectively serve for the purposes of degree acquisition, continuing education in enterprises, and the promotion of collaboration between universities and industry.

## 1 INTRODUCTION

The constant development of information technologies generates an enormous flow of information. Global communication networks like the Internet enable the almost immediate exchange of information without limits with respect to place and time. However it is not the information alone, but the knowledge and capability to evaluate, judge and make use of this information which can assure a competitive advantage and foster the learning process. Numerous companies, enterprises and educational institutions are aware of the importance of knowledge as "the fundamental resource".

Within the knowledge domain of Product Innovation, high quality knowledge and expertise is spread across different universities as well as among communities of practice in industry. This paper discusses a pioneering project, which proposes an advanced knowledge environment for product innovation (AKEPI), aiming to generate a common knowledge pool for European universities and industry partners, where resources, expertise, and ideas can be exchanged. The AKEPI project seeks to answer two important needs:

- firstly, to foster collaboration among European universities and
- secondly, to promote a better integration between universities and industry.

The need for such a project is discussed as well as its main aspects, such as the AKEPI concept, content, structure and functionalities, as well as issues related to its development.

## 2 BACKGROUND

### 2.1 Product Innovation

Product innovation, which essentially means the definition, development and production of new products and their successful launching to the market, is the driving factor for a powerful, competitive economy and the prosperity of society. Therefore, the education of professionals at universities and the continuous professional development of engineers in the wide field of product innovation are of central importance.

Knowledge about product development and product innovation has both, an enormous width in topic variety and a considerable depth regarding the needed know-how (see Figure 1). An online knowledge pool, which is comprehensive and contains high-quality resources, collaboratively generated by universities and industry could become a valuable resource to universities and industry.

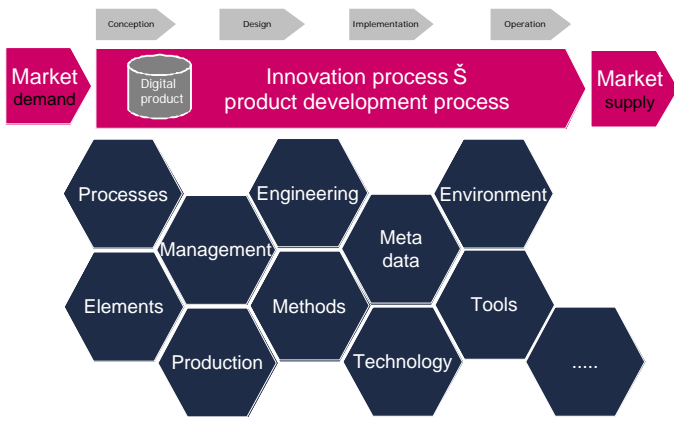


Figure 1: related subjects in product innovation and development (Elspass 2002)

## 2.2 Need for collaboration among universities

An analysis of the present education programs and offers of different universities in the area of Product Innovation shows the following situation:

- the specific knowledge is extremely distributed among the different universities,
- the different curricula have distinct focuses with respect to specific subjects and themes.

For instance, there are several good courses in innovation management, development methods, engineering tools, engineering and structural analysis, and rapid prototyping design. However, the subjects are often presented in kind of isolated view, driven by the specific know-how and interests of the teacher. These differences can have a negative influence on the exchange of students and on the development of collaborative work, for example. However, the difference has also its richness. Making these differences clearly accessible and open to collaborative use and debate can improve creativity and generate further developments in educational practices as well as in research. We believe that the use of networked technologies can be of immense help in this positive process, facilitating the collection of and access to content, allowing for collaborative exploration and development of it.

## 2.3 Need for a better integration between universities and industry

The rapid technological development and the need to cope with an increasing amount of information generate a difficult situation for both: professional courses at universities and the industry. University teachers and researchers have to be constantly updating their knowledge on newly available technologies and products. The same happens to professionals from industry. The research developed at universities needs the support of industry, not just

financial, but also to test ideas in practice. Industry can also benefit from having the opportunity to present their products to students, who will be future professionals and probably work with their products or in development teams in industry. Therefore, it is obvious the potential which a collaborative networked learning environment could have for both, universities and industry.

Via the use of a networked environment, the following topics, which are relevant to universities and industry, could be addressed:

- new requirements for degree earning and continuing education,
- increasing globalisation and mobility,
- increasing need for speed and flexibility,
- facilitation of access to information, including functionalities such as filtering and compression,
- promotion of easy access and update of knowledge for academic and industrial users,
- need for cost reduction and increase of cost efficiency,
- need for improvement in learning quality.

## 3 AKEPI

Attempting to answer this demand for a better integration between universities and industry and the need for collaboration among universities, this project will generate an Advanced Knowledge Environment for Product Innovation (AKEPI). Its characteristics are described next.

### 3.1 Concept

AKEPI will be a knowledge network built via the collaboration of European universities and industrial partners, having as its main users: lecturers, researchers, students, and professionals from industry.

With the overall goal of establishing a network of competence in the field of product development and innovation, AKEPI aims to:

- generate a knowledge pool in Product Innovation;
- promote collaboration and exchange of experience and information among users;
- collect users' experience;
- collect the results of users' interactions with the environment (contents and tools) and with other users (collaborative activities);
- allow for individual forms of utilization of the environment and of the content;
- promote collaboration among European universities, supporting common research and courses, as well as students' exchange;
- promote integration between European universities and industry, supporting research, development, and courses;
- promote continuous professional development opportunities for professionals in industry and universities.

The AKEPI conceptual model will be only be completely defined during the project development, taking into consideration findings from the first stages of the project. However, we can already cite central aspects, which shall be determinant in further developments, such as the pedagogical model and the user interaction model.

### 3.1.1 Pedagogical model

Aiming to generate a networked collaborative environment, we favour a socio-constructivist approach, where the acquisition of knowledge is based on the users' experience and collaboration. Within this approach, it is important to provide a choice of activities within a secure environment, where users can develop individual and social cognition (Pereira, 2001, Crook, 1996).

Dealing with the education of practitioners represents also a higher demand for the development of critical and reflective abilities. The constant exposition to an increasing amount of information and to technological developments generates new demands on individuals. They need to develop the ability of critically select the most appropriate information and of taking immediate decisions to efficiently respond to the changing scenarios of practice. Therefore, principles of 'reflective practice' (Schön, 1983 & 1987) and 'critical pedagogy' (Freire, 1985) are also to be considered.

Combining these issues, the Critical Socio-Constructivist pedagogical model (Pereira, 2001 – see Figure 2) shall be adopted. This model has the following characteristics:

- a learner-oriented approach;
- the development of individual cognition, with emphasis on active and independent learning (via exploratory and highly interactive activities) – metacognition – reflective practice;
- the development of systems of cognitive activity: social interaction and collaborative learning
- critical & collaborative reflection;
- the construction of flexibly structured learning environments, which allow different learning experiences – within learning organisations;
- the development of learning as situated in real context, not just in terms of associating learning with real-world contexts, but also developing in the learners and other agents involved in the learning process, the consciousness of the social and political context where the learning experience takes place.

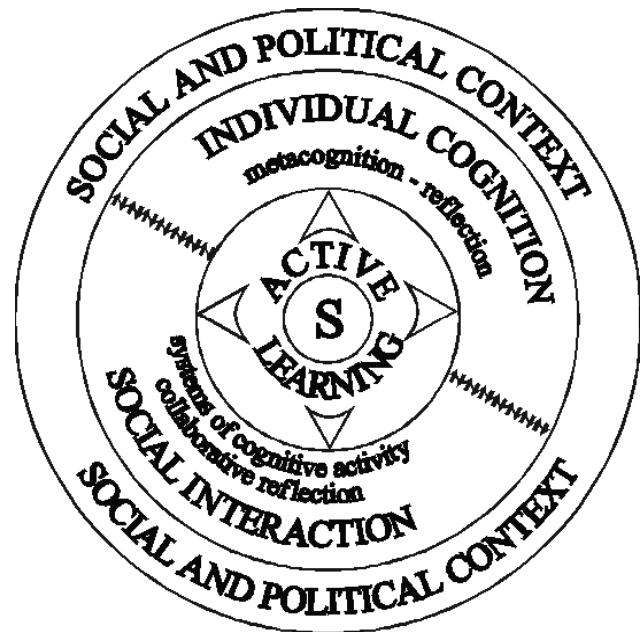


Figure 2 – Critical Socio-Constructivist Pedagogical Model (Pereira, 2001)

### 3.1.2 User interaction model

The way the user interacts with the content and with the environment as a whole has significant importance, if more than providing reliable information, we want to promote learning. The learning content needs to be accessed via a coherent navigational approach, within a coherent user-interaction model.

Based on the pedagogical model above, the system shall promote the following types of user interaction:

- Interaction with content
- Interaction with other users
- Interaction with tools

The user-interaction model allows the description of the visual appearance of the system, including user interface elements, information shapes and organisation. The user-interaction model will guide the design of the environment, determining:

- the organization of the content presentation;
- the character of the different parts within the learning environment;
- the hierarchy of information;
- the forms of navigation through the environment.

Findings from a consistent investigation of users' needs and contexts shall be used to generate the ultimate design of the knowledge network platform, but the user interaction shall be organized into at least two basic levels:

- an upper level that divides the environment into easily assimilated areas, where specific activities will take place, using analogies and metaphors which help users to associate them to real world activities – these areas can be associated to different types of learning, for example: collaborative learning, learning by doing, and so on. Gen-

eral tools for exploration of the whole environment should also be available.

- a second level which allows users to navigate into the specific spaces, interacting with content and tools to realize the specific activities and learn from them.

In this second level of interaction, a user-tailored exploration of the content should be allowed. The user should be able to choose among possible paths and the information should gradually unfold, presenting different degrees of complexity. Embedded in the forms of navigation there should also be options to facilitate the access of the content according to users' preferences, such as:

- users who prefer having an overview of a sequence of information, before choosing to go deeper into a specific part of the content would be able to choose to see all the "overview" parts of a series of content "sections", for example.
- Other learners are more visually oriented and they should have the option of browsing all the images of a learning theme, looking at pictures, diagrams, and simulations, for example before deciding to go deeper into a subject.

### 3.2 Content

The AKEPI content shall be:

- generated by users, via individual and collaborative interactions;
- organised into a database
- modularised and structured according to worldwide accepted standards and managed via a content management system
- available in different media formats (e.g. HTML, PDF, video)
- easily accessible by members of the online community via a web-based interface
- easily uploaded and downloaded by members of the online community via a web-based interface

The content will be generated by users during the interaction within the environment, but also from existing material and expertise of partner universities and industry.

An example of an important part of the knowledge in the area of product innovation and development is concerned with processes and methods. An essential issue of the knowledge pool will be the description of contents related to a unified process and methodical model. The methods for the efficient support of the product innovation process will be presented in a homogeneous manner. Each method will be complemented with valuable documents, references and hints for the application.

Other examples of content which shall be available in the AKEPI environment are:

- a formalized explanation and definition of the product development through descriptive process models,

- innovation cases leading users to learning targets based on real world or constructed case studies,
- check lists,
- interactive formulas,
- intensive use of multimedia,
- exercises, which could be automatically corrected,
- communication and discussion platform among users (learners, teachers, researchers, professionals, experts) to motivate users for a new topic or to lead to the views of applications
- links to secondary information and to selected companies.

### 3.3 Structure and functionalities

Main features of the AKEPI environment will be:

- a knowledge pool – containing shareable resources, in a well-structured and reusable format, organised into a database or distributed databases;
- a collection of tools for individual and collective use (e.g. portfolio, conceptual map, whiteboard, forum);
- a collaborative online community composed by university and industry participants.

The AKEPI environment shall be web-based to facilitate accessibility at any time and place, compatible with the most used browsers and platforms, and available for use in two levels: via universities and companies intranets, and via the Internet.

A highly interactive environment with advanced communication tools will foster the realization of virtual innovation projects by project teams among other shared activities. This platform will, therefore, effectively serve the purposes of continuing education in European enterprises and the promotion of collaboration between universities and industry.

### 3.4 Project development

Diverse expertise is required in the area of research and development to successfully carry out such an ambitious project. Therefore, a striking cooperation among several universities and industrial partners is needed. This broad collaboration will also facilitate a wide and fast industrial acceptance of the learning environment and the use of the knowledge pool. The European dimension of the project will ensure the involvement of the best competence in setting the proposed knowledge pool for product development and innovation. The already mentioned enormous width and depth of this knowledge domain demands such a wide collaboration.

The project will be subdivided in several work areas as described below (Elspace, 2002):

Work area 1: preliminary investigation and users' involvement:

- investigation of the specific organizational context, pedagogical approaches, and technological

infrastructure of each partner institution to determine the best approach for integration.

- investigation and analysis of users' needs and expectations (university and industry),
- evaluation, development and application of new teaching and learning media and tools.
- Integration of new learning methodologies into industrial workflows.
- conception of a technology which can be used in a classroom, in a modern learning laboratory using new teaching technology, networked with the outside industrial world

Work area 2: concept development

- application of the pedagogical model with the identification of appropriate learning scenarios and activities.
- development of the system conceptual model (identification of main features, functionalities, activities, and content).
- conceptual knowledge structuration.
- conceptual layout of the cross media publishing integration.

Work area 3:

- *implementation* structuring of knowledge topics into content-related and didactic knowledge units.
- realization of the required IT-infrastructure with corresponding database definition, content management and cross media publishing.
- realization of the knowledge pool with its corresponding knowledge units for individualized and flexible use, but also conducive to cooperation. Focus on engineering fundamentals with respect to the conceptual layout, design, realization and operation of systems and products, embedding of case studies from industrial partners.
- integration of state-of-the-art tools of knowledge management and transfer for teaching and learning.
- featuring active, experiential, and collaborative learning with wide use of e-learning technologies in disciplines which are interwoven and mutually supporting.
- design and development of a user projects' area partly managed by the virtual collaborative environment.
- constant improvement through a robust evaluation process.

## 4 CONCLUSIONS

This paper presented the advanced knowledge environment for product innovation (AKEPI) – a knowledge network to integrate universities and industry partners in a common effort to build a knowledge pool and a space for interaction and learning.

The main concept and features of AKEPI were discussed as well as how it shall be developed.

Based on a pedagogical model which encourages individual and social cognition, via reflective practice, it shall be an environment which offers different learning possibilities and several collaborative instances.

As diverse expertise is required in the area of research and development for the successful development of this project, the close collaboration among partners in industry and several universities is paramount. As they will be the ultimate users of the AKEPI environment, their active involvement on all the stages of the project will be essential to guarantee a broad and fast acceptance and use of the learning environment as well as the richness of the knowledge pool.

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