

Global E- Business Education in Industrial Engineering-Meeting the Needs of the Networked Economy

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Research in Progress

The educational system is currently facing new challenges because of the dynamically expanding e-business deployment. This is especially vital for industrial engineering as an applied interdisciplinary discipline. To cope with these challenges, several European research initiatives are trying to update the content of curricula responding to industrial needs. This paper first presents the findings of the EU-IST research project BRIDGES by discussing and comparing e--business trends and challenges in the EU and the USA. Then, challenges for education in E-Business are elaborated. Those challenges are picked up by the EU-IST/ IMS project GEM in order to create a new curriculum for a master degree in Manufacturing Strategy. It will cover technology and business topics and especially consider digital business. Finally, an initial concept of a short course covering essential aspects of production based on digital business is discussed.

Introduction

E-business has brought up many new challenges to educational systems applied in industrial engineering. This development goes along with many new educational requirements to either train the workforce or teach young students and graduates. So far, the education of industrial engineers is limited with respect to the real needs of the industry that faces problems of integrative nature across the traditional disciplines¹, such as:

- working globally in a multicultural environment
- working in interdisciplinary, multi-skill teams
- sharing of work tasks on a global basis
- sharing information and knowledge to foster organisational learning
- working with digital tools for communication
- working in an virtual environment

Since tasks are becoming more complex, the educational demands increase in future

¹ Thoben, Schwesig 2002

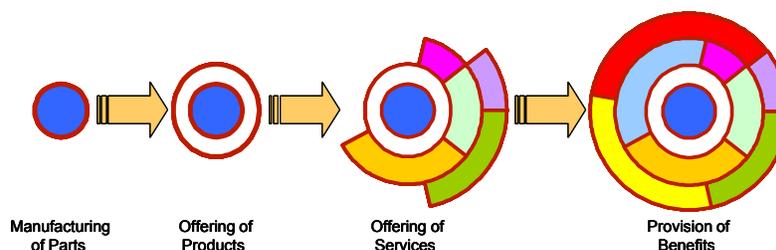
workplaces. Consequently if today's engineer envisions to meet the expectations of the global industry he or she is forced to patch up his or her individual educational program. This patchwork of different programs provided by different institutions such as universities and colleges forces every employee to select the right programs to keep the knowledge up-to-date. Unfortunately miscellaneous approaches and methods make this selection process difficult which results in an immense investment, extraordinary effort and duration for every individual.

Accordingly, it is not possible to get a proper education of high quality that meets the industries needs at affordable costs with an appropriate effort. The adequate qualification has to be given by practice, and by training of new techniques and actions in a practical manner with consideration of the modified working conditions. Thus, there is a strong need for new training and education approaches, enabling engineers to co-operate in a global environment ² ³. Hence, the question is how the industries demands and the learner's demands can be satisfied. In order provide an answer to such a question develop such an approach, this paper firstly describes e-business trends creating new challenges for the education of engineers and then discusses the development of a curriculum for an e-business related master course. The focus is on both the content of such a masters course and the learning approaches to teach such content. Finally, the very first concept for a short course covering essential aspects of production based on digital business are discussed will be discussed.

Discussion of e-business trends and challenges in the EU and the US

E-Business has been identified as one of the most important factors driving new enterprise strategies. Many new companies have now successfully started their e-business in the midst of the "dot.com" phenomenon. In 2001 the Internet economy collapsed and realism became the main driver of the further developments. In parallel, extended concepts created new challenges for engineering. The concept of extended products has been introduced by Thoben et al, 2001 and focuses very much on the extension of products towards the provision of benefits (to the customer).

Extended products shall deliver the answer to the continuously growing customer expectations. Consequently, to compete in the competitive global market place, manufacturers and suppliers have to come up with novel ways of forming alliances to sell their products and services. The main novelty of this concept is interlink core products with additional services very closely to make the over-all package (which could be just the solution to his needs) more attractive to the prospective customer. Figure 1 shows explicitly how the products has evolved in the last couple of years.



² Windhoff, Hoheisel (1999)

³ Hirsch, B. E.; Thoben, K.-D.; Hoheisel, J. (1998)

Figure 1: The extended product concept: Changing the Focus: From Manufacturing of Parts to Provision of Benefits (Thoben et al 2002)

The E-Business leaders are not the organizations that launch a super web site or even those who deploy the most sophisticated Internet-enabled technology. E-Business leaders are organizations, that align their people and internal business processes to gain the maximum leverage from the Internet technology and tap into the vast potential of E-Business⁴⁵. Models such as shown in Figure 2 indicate today’s challenges for industrial organizations when applying e-business.

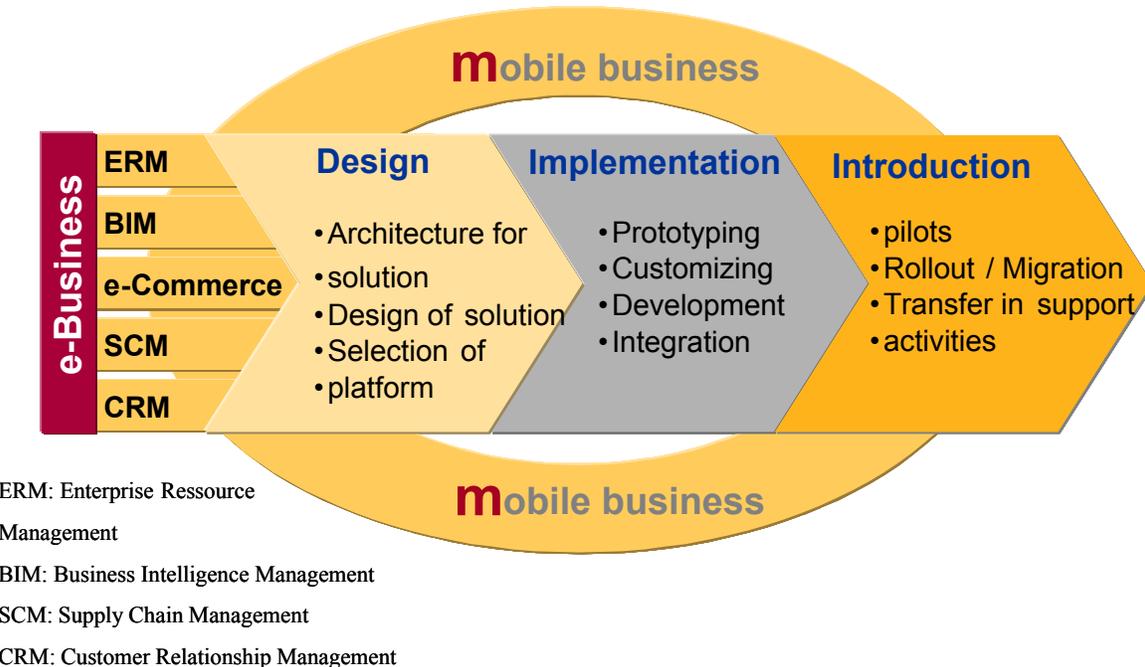


Figure 2: E-Business-solutions for business processes

E-Business in Europe is forecast to grow at a compound rate of 132% over the next four years. Over 60 million Europeans are expected to purchase goods on the Internet by 2004. In addition, internet banking is also growing dramatically. In many cases, the costs are coming down and the loyalty of the customer base is increasing⁶.

In future, devices similar to the mobile phone could be set to evolve into virtually the only essential item needed outside the home. Such devices will ultimately replace the pagers, PDA (personal digital assistant), music “walkman” and finally your wallet. The results of applying E-Business solutions will also change business operations in many organizations, especially in terms of supply chain management (SCM). Almost every industry has established some form of Internet E-Business presence. So where is E-Business leading and how will it evolve? Common future applications and strategies include information and communication technologies that will re-shape business strategies and provide E-enabled supply chains.

⁴ Kalokota 2001

⁵ Timmers 1999

⁶ Merz 2002

Before discussion of the synthesis between the EU and US, some introductory remarks are necessary. After researching the trends in the BRIDGES project⁷, several issues become clear:

- A comparison between EU and US trends is difficult because there is a different level of information available. The strong market research organizations dominate trends making in the US. Their European affiliates do not deliver such high degree of precision for the European market
- Trends in the US are made in big companies whereas Europe is based on many different SMEs (small and medium sized enterprises). Consequently trends must be different because the respective enterprises face different economic situations.

Common E-Business trends in Europe and the USA

The following synthesizing aspects have been identified as trends in both the EU and US⁸:

- Usage: E-Business will be used throughout the value chain. Customers will be enabled to conduct all their business over the web, and many will use wire-less/mobile technology for business transactions.
- Strategy: E-Business strategies will give partners in the supply chain strategic competitive advantage over competitors. A reduction in human intervention in the ordering process will also ensure fewer errors.
- Personalization: In the future all E-Business web sites will know their customers and provide interactive personalized web communication.
- Instant fulfillment: Most E-Business experiences do not provide instant gratification. E-Business sites in the future will direct the customer to stores/organizations closest to them so that the product can be picked up in minutes. Other E-Business web sites will have the product delivered from a local affiliated business partner the same day.
- Custom pricing: Custom pricing provides a challenge for all businesses. Product prices on E-Commerce sites have the capability to become dynamic. Each customer could pay a different price based on many factors. For example, the number of products the customer has previously bought.
- Intelligent agents: The introduction of intelligent agents will become more prevalent in industries in the future. Agents will find the best products and best prices for customers. Currently consumers use agents to find the best price for a computer or printer. Companies will use agents in place of human purchasing agents to obtain the best price.
- Web services: The collection of software standards known as "Web Services" is still evolving and not yet ready for widespread usage . However, it is predicted that there will be a take-up of Web Services for integration purposes and on select pilot

⁷ www.bridges-eu.org

⁸ Higgins, P., Eschenbaecher, J. (2002) Bridges – Deliverable D11.

Diverging E-Business trends in Europe and the USA

The identification of diverging trends is again a very difficult task. Nevertheless some lessons learned out of the analysis conducted so far can be highlighted.

- Customers want anywhere/anytime service via multiple channels - web, call center, agent, etc. The US started already in the beginning of the 1990's with call centers and electronic supported telephone systems. This has been adopted in the last 5-6 years in Europe. Meanwhile the high penetration of Internet in some European countries indicates that the interest in automating functions has been increased dramatically. Especially business models in mobile commerce indicate the readiness to make it most easy for the customer to get everything is of higher importance for the Europeans.
- Insurers-which have suffered substantially in 2002- are now pushing non-high value customers to e-channels for service. This is again one exemplary trend in Germany and some other European countries. The stability and reliability of the insurance systems in Europe seem to push such e-services more strongly than in the US

Challenges for education in E-Business

After analyzing the trends stated before it is obvious that these trends cause some educational challenges which need to be addressed in industrial engineering curricula. The following bullet points present again a selection of main findings:

- The development of extended products and services is a major challenge which needs to be addressed in industrial engineering
- Enterprise modeling, product modeling and simulation
- Collaborative Business and enterprise networks as major driver for innovative products and solutions
- Distributed innovation and change management

This section has shown many trends and challenges regarding the development of e-business all over the world. Part of these challenges have been picked up in the GEM curricula shown in Figure 3 of the next chapter. Universities and colleges are challenged to prepare master courses and training schemes in engineering which take up this industrial requirements and translate into teachable course modules.

Development of a curriculum for a e-business related Master Course

The previous chapter discusses trends about similarities and differences in e-business in the U.S. and Europe which do have an impact on the Manufacturing Strategy curriculum. The main reason can be seen in the globalization of the economy. So far, engineering courses in the US and in Europe are different according to various aspects. Whereas in European universities

it is of instance almost common that in some lectures the student will sit together with 500 students in undergraduate level, this proportion may be different in the US. Therefore, the learning outcome differs as well. However, the workforce has to be able to work in different environments e.g. the USA and Europe. Future education has to provide a qualification that does meet the needs of worldwide industry. Thus, in international collaboration a world standard curriculum will be developed. To achieve this goal, the project has been divided into six steps within three phases that form the process model of the GEM Project:

The GEM project (Global Education in Manufacturing⁹) will provide a new training scheme for engineers by developing a new curriculum covering technology and business - a Master degree in Manufacturing Strategy focusing on subjects such as e-business and extended products.

- Phase 1: Definition of the industries needs
- Phase 2: Development of a draft curriculum
- Phase 3: Verification and development of the final curriculum

Based on an international survey among about 600 companies from Europe, USA, Asia and Australia, the industrial needs both for their actual and future training and educational have been investigated. Initial results show, that capacities in interdisciplinary team building, and working methodologies where processes, communication and other business activities are carried out using ICT-tools are gaining importance. Additionally, capacities in knowledge management are becoming more relevant. According to the overall comparison between fields of competencies, it is interesting that today management capacities like innovation management, productivity improvement and strategic planning gain importance. Within the following 5 years, individual capacities like teamwork capabilities and interpersonal communication skills seem to become more important.

The outcome of a worldwide internet inquiry on existing master programs manufacturing engineering is going to be used to get an overview about the content of the existing curricula in manufacturing and then provides a basis for the development of a draft curriculum.

After having studied the industries' needs, the second phase starts with the development of an appropriate training delivery mechanism. Based on the industries needs and the content of teaching of the existing curricula investigated earlier, a curriculum at post-graduate level will be drafted. According to the IMS steering committee meeting, the conducted surveys and the results of the BRIDGES study on trends and challenges it is envisaged, that this curriculum for manufacturing strategy may contain about 7 modules; which cover the following topics illustrated in Figure 3.

⁹ www.sintef.no/gem

Manufacturing Strategy Curriculum				
Module A Development of extended products	Course A1	Course A2	.....	Course An
Module B Digital business along supply chain	Course B1	Course B2	.....	Course Bn
Module C End of life planning and operation	Course C1	Course C2	.....	Course Cn
Module D Business op. and competitive strategy	Course D1	Course D2	.....	Course Dn
Module E Intelligent manuf. processes	Course E1	Course E2	.....	Course En
Module F Intelligent manuf. systems design	Course F1	Course F2	.....	Course Fn
Module G Enterprise and product mod. and sim	Course G1	Course G2	.....	Course Gn

Figure 3 First proposal of a modular structure of the curriculum

This number may be expanded. These modules should focus on aspects that are future oriented for the manufacturing industry to promote a paradigm shift from traditional manufacturing to e-business.

The part of the curriculum to be developed in Europe will be focusing the creation of the modules A, B and C. Thus, the GEM project has recognized the significance of digital business within the education of engineers. Since After having created a draft curriculum, a short demonstrator course with the duration of 5 days , the so called demonstrator course, will be developed. It will cover essential aspects of the production based view on digital business

Requirements for the GEM demonstrator Course

The requirements that have been mentioned so far comprise three different categories of needs, that have to be addressed in the demonstrator course. The first one deals with pedagogic requirements. Since usual teacher-input teaching results in the fact that just 50% of the taught content is afterwards remembered by students, it is necessary to think about more efficient ways to mediate the knowledge and skills¹⁰.

But knowing specialized knowledge is not enough. In addition, engineers need to know how to apply this specialized knowledge in a working situation. They need to have experience about the interrelations and the consequences of their actions. The isolation of such performance skills and specialized knowledge can lead to the inability to act properly within real life situations¹¹. According to the combination of knowledge and performance skills as well as the inadequacy of isolated teacher input teaching, the GEM demonstrator should be built on the basis of active learning. Active learning and especially game based learning enables the students to gain the mentioned experience in simulated complex real life situations and

¹⁰ Däumler 1982 S. 14

¹¹ Graf 1992

additionally meditates knowledge more sustainable than teacher input teaching. Studies have shown, that 90% of the content was remembered by the students after having experienced the content in a simulation game.¹²

The second category of needs results from the new challenging work situations, that engineers have to face. Consequently, the demonstrator course has to address the following experience-oriented elements in order to prepare the students for this future:

- working globally in a multicultural environment
- working in interdisciplinary, multi-skill teams
- sharing of work tasks on a global basis
- sharing information and knowledge to foster organizational learning
- working with digital tools for communication
- working in a virtual environment

The third group of needs covers content-related knowledge and skills, that evolve out of the e-business trends and of the GEM project in manufacturing strategy.

- the development of extended products
- end-of-life planning and operation
- digital business along the supply chain
- enterprise modeling, product modeling and simulation
- collaborative business and enterprise networks
- distributed innovation and change management

The mentioned three categories of requirements provide a basis for the proposal of an initial concept of a demonstrator course. The requirements are illustrated in Figure 4.

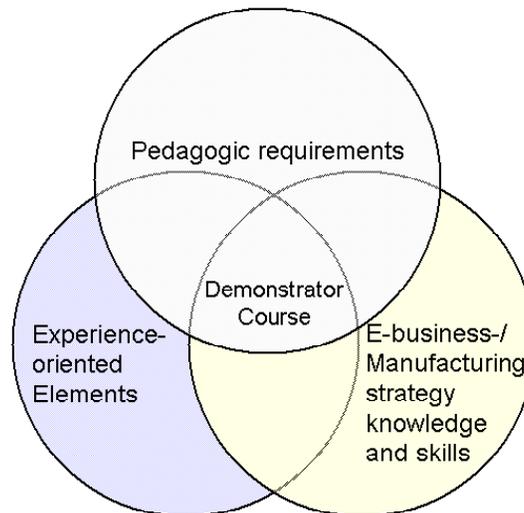


Figure 4 requirement categories for the GEM demonstrator course

¹² Orth, 1999

A Concept for the GEM Demonstrator Course as a solution

Following the pedagogical needs, it is planned to develop an internet based group simulation game that will use virtual distributed working environments. The main goal of the simulation game is the mediation of relevant competencies to actively participate in future distributed working and learning environments by addressing the three categories of needs identified.

The key process of the game will be the joint experiencing and shaping of each phase of the of the life cycle of an extended product. In at least four different stages, the players will undergo the virtual conception, production process in collaboration with other colleagues from one virtual company and then with other virtual companies. Then, the product will be virtually sold using digital business methods. Finally, as the product will be disposed, knowledge about end of life management approaches will be mediated and used. Depending on the participants, it will be able to simulate working processes in interdisciplinary, multi-skilled teams. The conception process will imply the use of product modeling approaches.

But since knowledge has become the central factor of production¹³ and the half-life period of knowledge decreases, the companies management more and more evolves into knowledge and learning management¹⁴. Thus, it is important to especially consider the objective concerning knowledge sharing and organizational learning. have to regard the concept closer in order to identify game eligible elements of organizational learning.

In order to regard organizational learning in a sophisticated manner embracing the main levels of action within an enterprise and to identify game eligible elements , we interpret organizational learning from a multi level perspective¹⁵ that comprises individual-, group-, organizational- and inter-organizational learning. In the different stages, the unequal distribution of information will require the participants to use specific approaches of organisational learning to acquire the knowledge needed to produce the extended product. The involvement of the latest wireless learning technology will allow a simple implementation of the game in various environments. Apart from that it will enable the students to work with digital tools for communication and thus to gain realistic experiences of future forms of learning and collaborative working. This initial concept is illustrated in Figure 5.

¹³ Schüppel 1996, p.183

¹⁴ Geissler 1995, p. 364

¹⁵ Inkpen, Crossan 1995,p. 598; Nonaka 1994

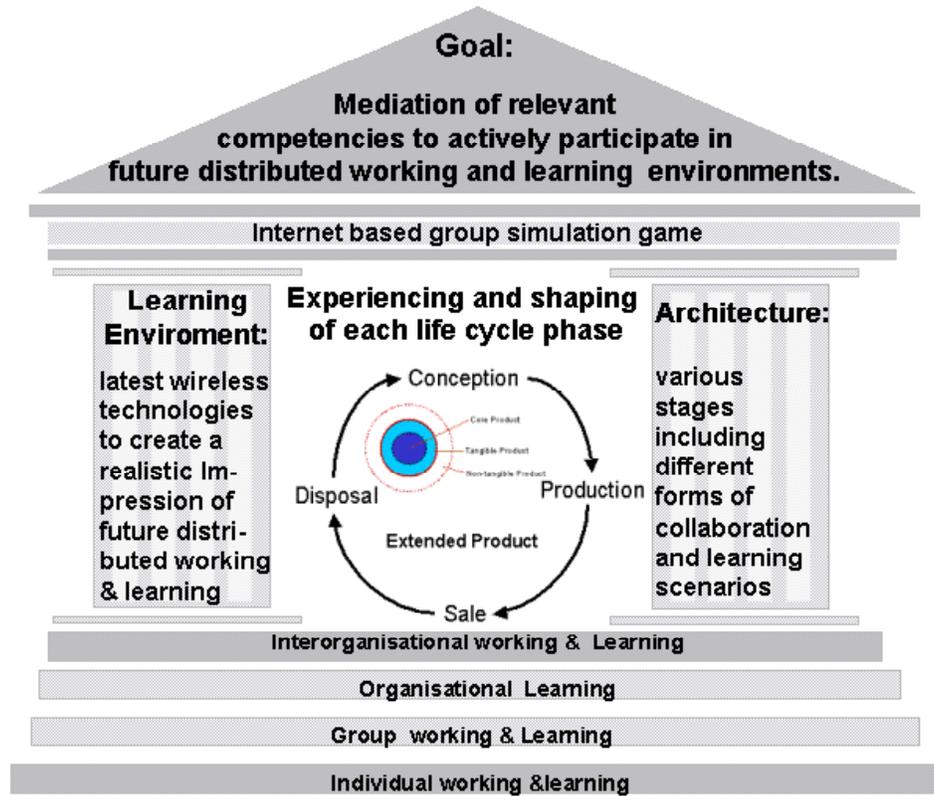


Figure 5 Gaming approach for the GEM demonstrator course

Conclusions

The main message of this paper is to illustrate the industrial needs towards the development of right educational means in industrial engineering. E-business in combination with extended products have created many of this new educational challenges which have been identified in the research work of the BRIDGES project. The identified challenges have been picked up by the GEM project in order to create a masters course for manufacturing strategy. The content of such course has been sketched. Finally, an initial concept for the development of a short course covering essential aspects of production based on digital business are discussed. It uses a gaming approach in order to simulate complex real life situations and thus meditate the required performance skills and specialized knowledge to work and learn in future working environments.

Acknowledgements

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