

Project no IMS01010
GEM – Global Education in Manufacturing

Final report to IMS SC



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The GEM project

The GEM project (Global Education in Manufacturing) was endorsed by IMS on January 24th, 2002. The project successfully completed its activity on November 1st 2004. The following IMS regions have been involved:

- Australia
- EU and Norway
- Japan
- Korea
- USA
- Switzerland

In total there has been 27 partners from 20 countries. 75 industries have been connected to the project as industrial associates with the role of ensuring industrial relevance of the curriculum.

There has been one project in each region with the same work package structure. However, EU and Switzerland have worked jointly within one project (GEM-EUROPE).

The overall objectives of GEM have been to:

- Define and understand the needs of the manufacturing industry for training and education in manufacturing strategy on a global basis to comply with the concept of digital business and extended products.
- Develop a framework (detailed specifications) for a manufacturing strategy curriculum focusing both manufacturing and business administration topics. Selected elements will be tested in all IMS regions applying a modern IT-based delivery of training and education (web-based multimedia solutions).

The GEM curriculum is defined as a number of courses within seven knowledge areas. The knowledge areas are listed in table 1.

Each regional project has had main responsibility for some knowledge area. GEM-EUROPE has covered knowledge areas A; B C and G. GEM-Australia has covered knowledge area D, GEM-Japan knowledge area F and GEM-Korea knowledge area E. GEM-USA has not covered any knowledge area due to insufficient funding.

Each region has been responsible for:

- Develop all results and documentation for their respective knowledge areas.
- Develop demonstrators to test pedagogic approach.
- Develop demonstrators for their modules to be tested in several IMS regions.
- Exploitation and dissemination within their area.
- Secure industrial relevance in their region.

Table 1 GEM knowledge areas and learning objectives

Manufacturing Strategy Curriculum	Learning Objective
Knowledge area A Development of extended products	Make the student familiar with the concept of extended products and introduce the student to effective tools for such development.
Knowledge area B Digital business along supply chain	Introduce the student to the concept of supply chain management and provide knowledge about electronic commerce and work.
Knowledge area C End of life planning and operations	Introduce the student to modern environmental and recycling technology. Train the student in decisions on product end of life.
Knowledge area D Business operation and competitive strategy	Expose the student to modern thinking in productivity and competitiveness. Train student in business operation decisions.
Knowledge area E Intelligent manufacturing process	Give the student a good knowledge of manufacturing processes and their application in intelligent manufacturing.
Knowledge area F Intelligent manufacturing systems design	Introduce the student to the concept of intelligent manufacturing and to integration aspects using ICT.
Knowledge area G Enterprise and product modelling and simulation	Train the student in modelling and simulation and its applications intelligent manufacturing systems.

The GEM project has been executed according to a plan comprising eight work packages as indicated in table 2.

Table 2 GEM overall workplan

Phase	Phase title	WP	WP title
1	Definition of the industry's needs	1	Extended enterprise training needs
2	Development of draft curriculum	2	Training delivery mechanism
		3	Draft curriculum
3	Verification and development of final curriculum	4	Develop demonstrator and evaluate concept
		5	Revise curriculum
		6	Exploitation and dissemination

Attainment of objectives

GEM has met its objectives in full. The definition of the industrial needs have been achieved through an international survey amongst industry for their needs for training and education in the field of manufacturing strategy. This survey has obtained 556 responses from 22 countries. The respondent was asked to indicate for a number of topics:

- The importance of the topic for the work performance today
- The importance of the topic for work performance in five years
- The need for further education

The curriculum has been specified as a number of courses retained in a database. This database is accessible on the internet and allows any university to design their own curriculum based on the GEM template.

The innovation of GEM is twofold:

- A new, first ever curriculum for manufacturing strategy at masters level to be delivered internationally to meet the future needs of the digital business and extended products and to be accepted as a world standard
- New pedagogic approach and delivery by ICT to meet the needs of on the job training and education and to combine theory and practice

GEM has experimented with different pedagogic approaches and has obtained good experience with application of ICT. The curriculum is intended to be delivered to two types of students:

- Ordinary students pursuing a degree at a university (on-campus students)
- Students in industry with a need for training on the job (off-campus students)

Implementation of the GEM results

GEM has been a complex project with many partners spanning over different cultures. However a viable network of universities has been developed, especially in Europe where also the integration of the new members of EU has been successful.

In Australia the curriculum has been taken up at the University of Melbourne. Both in Japan and Korea, the curriculum is being implemented. In the US there is interest in future cooperation to implement the curriculum. In Europe The GEM alliance has been formed with the ambition of cooperation to implement the curriculum.

Education in engineering is important. Therefore in a time when such engineering is receiving less attention (which again represents a threat to the future manufacturing industry), the importance of a consortium with a proven record of good and wide cooperation to give a new dimension to manufacturing education should not be

underestimated. The consortium should be encouraged to seek new opportunities to work together within the IMS framework. Although GEM has been successfully completed, there is still a road to go in order to reach the goals of IMS to have a new curriculum adapted by leading universities on a wide scale.

The GEM Alliance formed in Europe represents an interesting way of cooperation at university level to fulfil the objectives of IMS. The training is based on the “hybrid model”:

- Two plenary sessions; one at the beginning and one at the end
- A number of virtual sessions in between; each session to be carried out within a given time window
- Plenary sessions to provide learning through interaction between students and by extensive use of industrial experts
- Virtual sessions to include varied activities such as readings, video lectures, slide-shows, assignments and tests
- An optional project assignments going over the whole learning period to be executed in small groups and to be based on real life problems in the students’ companies.

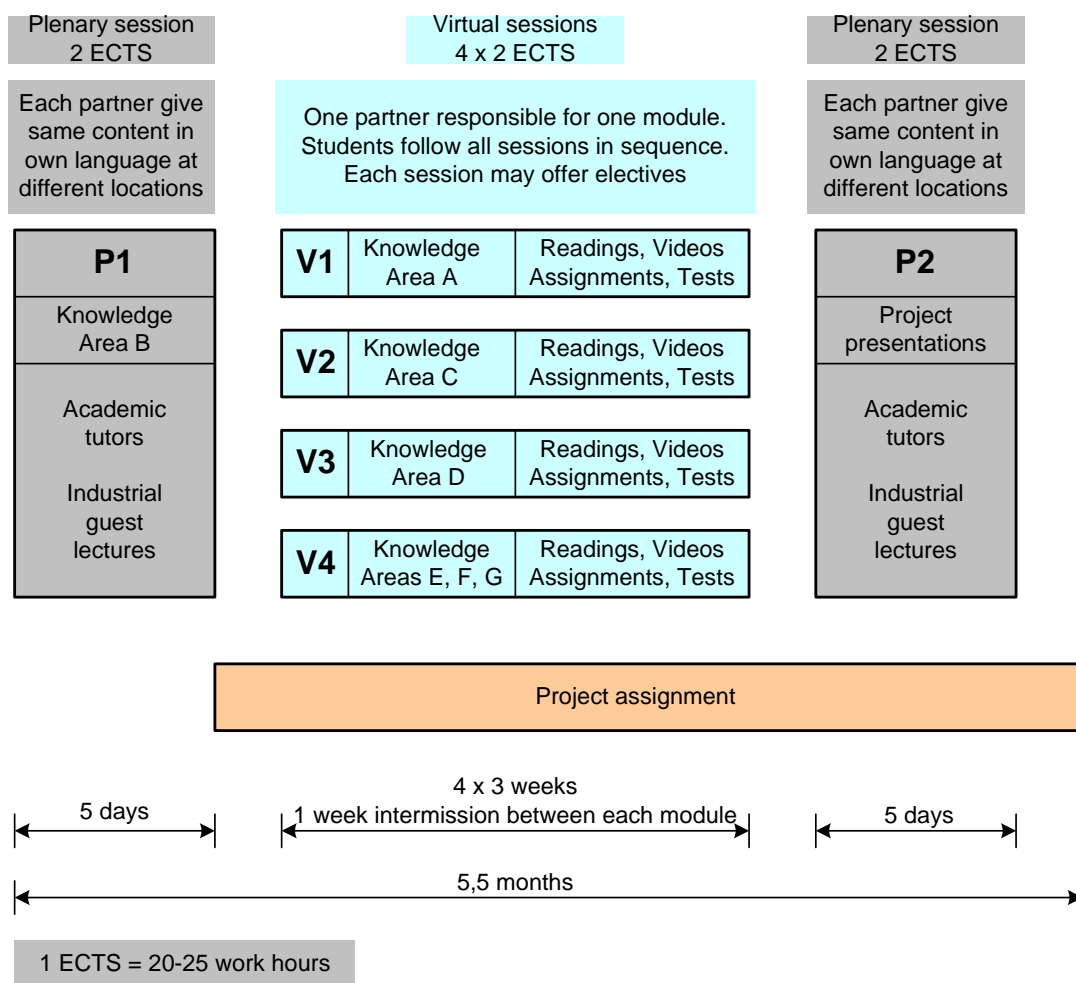


Figure 1 Model for training at engineer update level

Figure 1 shows an example on how the hybrid model can be used to implement industrial training at the engineer update level.

In order to stimulate other universities to take up the results of GEM, the GEM web-page with the curriculum database will be maintained for a period of at least six months after the project has finished. For the same reason, some of the partners will continue to disseminate results of the project at conferences and meetings.

The road ahead

The main focus on GEM has been to develop specification for a curriculum. Although the partners engaged in the project have started implementation efforts, there is still a strong need to boost exploitation and dissemination activities.

It is recommended that IMS keeps education as a priority area and that further activities are initiated to exploit the results of GEM and if necessary, initiate research and development for new implementation and learning models that can facilitate take up and dissemination. New learning models can include use of serious games, virtual laboratories, virtual mentoring and others. Wide dissemination can be obtained by using e-work and collaboration technologies that are available either commercially or through regional research activities within IMS.

To explore such possibilities and to develop an agenda for research, it is recommended that IMS establishes a working group of experts.