World Transactions on Engineering and Technology Education
Vol.2, No.2, 2003

Innovative user-tailored master level courses in mechatronics

Gustavo Belforte†, Dante Del Corso† & Emanuela Ovcin‡

Politecnico di Torino, Torino, Italy†
Consortium for Research and Continuing Education (COREP), Torino, Italy‡

ABSTRACT: The Asia IN-MEM Project, co-funded by the European Commission, aims at creating and delivering a set of master level courses in the field of mechatronics. Courses, developed by an intercontinental group of institutions, make use of innovative ICT-based multimedia and teleteaching approaches. Particular attention is given to a learner-centred approach using the development methodology for interactive educational multimedia, which is realised in the European project 3DE and based on a pedagogical theory focused on learning styles. Educational support is offered through Internet delivery, for each course, of packages of different educational material, ranging from a mere transposition of lecture notes, to solved exercises, texts of past examinations, details on laboratory exercises, and free-distribution educational software (eg demo versions of some simulators). True added value regarding paper-based material is given by interactive parts, such as virtual laboratories and animations used to enhance the learning process efficacy. Web services, like newsgroups, FAQ repository, glossary and chatroom are used to promote communication between teacher and students, as well as among students. Self-assessment tests and exercises for immediate verification can be directly linked to theory parts.

INTRODUCTION

Education is indeed one of the most essential human rights, since it is only through education that people can fully participate in modern society, enjoying its benefits, accessing information, services, etc. At the same time, our fast growing society needs a well-trained workforce and specialists to maintain its growth. An increasing amount of education, both in quantitative and qualitative terms, is therefore constantly requested. For any country, a well-educated population is an important asset that must be cultivated. Unfortunately, the educational system in every country requires a long time for it to be built up and demands large investments and energies.

However, in recent years, the new information and communication technologies (ICT) have provided tools that can dramatically change the learning process. It is not exaggerated to say that these new technologies will induce in the learning and teaching patterns more significant changes than those related to the invention of printing, photography and movies. ICT-related innovations can revolutionise learning approaches and methods with respect to classical learning based on lectures and paper material. The reasons for this are as follows:

- ICT permits the use of a huge amount of material that can be stored on electronic support at very low cost, and retrieved not necessarily in sequential order. Such material can include movies and animations.
- ICT allows interactivity, thereby increasing learning effectiveness.
- ICT allows for customisation to individual learners (eg the possibility to choose different learning patterns and styles);
- ICT permits long distance synchronous and asynchronous communication between educational participants (ie learners and instructors).

If fully exploited, these innovations represent a wonderful opportunity to upgrade the education process, thus easing the learning effort. In fact, they allow for the introduction of new important features in the learning organisation that can, therefore, be flexibly personalised according to the learner's needs. When educational material is provided through multimedia equipment, learners are no longer bound to follow the same pattern in terms of time scheduling of teaching activities (lectures, etc), so they can learn when they want and where they want. Also, the interaction with the instructor can be over distance. Even more important is the fact that learners can learn at different speeds and access learning material in a personalised way, with a high level of interaction between instructors and teaching tools.

At Politecnico di Torino, Torino, Italy, as in many other universities, multimedia-based teleteaching methods and opportunities have been investigated over the last few years. As well as several other developments in the field of distance learning, Politecnico di Torino has led two projects, funded by the European Commission, in the field of multimedia-based education. Such projects are the focus of this article and include:

- *The 3DE Project*: this aims at developing methodologies and tools for multimedia-based teaching, and relies on pedagogical theory that is focused on learning styles [1];
- *The Asia IN-MEM Project*: this aims to create and deliver a set of master level courses in the field of mechatronics using the methodologies developed in the 3DE Project [2].

THE ASIA IN-MEM PROJECT

Asia IN-MEM is a project co-funded by the European Commission under the heading ASIA Information and Communication Technology (Asia IT & C). The Asia IN-MEM Project targets the creation and delivery of a set of self-

consistent and coordinated master level courses in the field of mechatronics. The set of courses, developed by an intercontinental group of institutions, makes use of innovative ICT-based multimedia and teleteaching approaches. The focus is on the latest *learner-centred* environments that allow for personalised contexts and reusability of educational material, thereby improving the quality of education and reducing development costs and time. In order to achieve these goals, the Development Methodology for Interactive Educational Multimedia was adopted; this was realised in the European project 3DE (IST-1999-10697) [1].

By delivering the courses (primarily to Vietnamese master level students), the information on actual potential problems, resulting from using solutions developed in Europe in an Asian context, will be gained, while also satisfying various important educational needs in Asia. The institutions involved in the project, besides Politecnico di Torino, are the Royal Military Academy (RMA), Brussels, Belgium, and the Fachhochschule Augsburg (FHA), Augsburg, Germany, from the European side while the Asian partner is the Asian Institute of Technology (AIT).

The courses to be prepared that belong to the AIT curriculum are as follows:

- Automation Technology;
- Deterministic Decision Models;
- E-business for Technology;
- Image Processing and Pattern Recognition;
- Kinematics and Dynamics of Mechanisms;
- Robust and Adaptive Control;
- Selected Topics in Control.

Courses have a duration of about 30 hours and will be delivered twice within the project in the AIT campus in Hanoi, Vietnam. The second offering will be an upgraded version of the first one, at least with regard to the multimedia material.

An important activity of the project is the evaluation of the multimedia development tools and the educational impact achieved, so that feedback is provided on both the methodology and tools used. The results of such an evaluation will primarily take place and be publicised during two meetings held after the first course delivery and at the end of the project.

The objectives of the project can be summarised as follows:

- To utilise some of the latest products of the European research into the field of educational multimedia so as to develop and deliver highly demanded master level courses in the field of mechatronics, especially as there is a strong need for skilled labour in Asia, particularly in Vietnam.
- To test some innovative solutions for multimedia teaching material preparation and to assess their efficacy.
- To test the portability within the Asian context of some of the latest ICT European products and to state whether they can be immediately applied to an Asian context, or if they require some adaptation.
- To strengthen existing links between European and Asian universities/institutions for long-lasting cooperation, while also networking to stimulate their wider participation in innovative educational projects using multimedia and teleteaching tools.

All of this should serve to increase awareness about the use of multimedia tools in education, while also improving the levels of mutual comprehension and the degree of cooperation between institutions from different countries with different cultural backgrounds. It is hoped that such cooperation will also foster the adoption of common regulatory approaches and ICT standards.

THE 3DE PEDAGOGICAL APPROACH

3DE is a research project within the European Union IST Vth Framework Programme [1][3]. Its goal is to define, design, build and make a usable developmental environment for interactive educational multimedia packages, which can construct, either in an automated or guided way, courses that are customised for the needs of each learner. Such courses will achieve higher effectiveness due to improvements in the pedagogical design and learner-centred customisation.

The 3DE system makes the creation of a different *version* of each course feasible. The process starts with a careful analysis of a learner's competences and preferences, expressed by a set of learning style parameters. These parameters then drive the course construction, which is automatically carried out by the 3DE system for each learner. These custom courses are automatically built from a library of *micromodules* (logically indivisible learning units), which have been previously prepared by an authoring group, with specific features for the various learning styles. The course compilation takes into account the specification of final educational/training goals and the results of a learner's competence/preference analysis. In this way, courses are no longer designed for a *class* of students, but instead fine-tuned for each learner from the results of a learning style preference analysis, taking into account the personal entrance competence, skill level and learning goals.

The use of engineering methodologies reduces the design and development time, while the learner-centred personalisation cuts the time required to learn. This improves the effectiveness with respect to current computer-based teaching and training packages, and reducing the total effective cost.

The pedagogical design is centred on the selection of the learning style model and the related learning style test. Various models have been evaluated in order to select the most useful for 3DE purposes. The final choice was for Kolb's and Honey and Mumford's models, since they concentrate on the learning process, which is the most essential level of learning styles [4]. Learning is mainly related with perceiving and processing information, and the selected models measure these characteristics. Honey and Mumford's learning style names and style descriptions have also been used in the 3DE learning style profiling, due to their easier vocabulary. More details on pedagogical design can be found elsewhere [5].

A 3DE Learning Style Questionnaire is utilised to classify users' learning styles. The reference learning styles are activist, reflector, theorist and pragmatist, which are elaborated on below:

- Activists are active learners. They like to discuss the things to be learned and work actively on the subject in a group. Activists like diverse tasks, new experiences and problems from which to learn.
- Reflectors also learn from new experiences, but they do not want to be actively involved in them. Reflectors like to

observe situations, research the subjects and make analyses and reports. They need time to produce new ideas and theories based on their new experiences.
- Theorists like to have learning materials offered in their context: models, systems or theories. They analyse things deeply and like to listen to, or read about, interesting ideas that emphasise rationality and are well argued.
- Pragmatists like to study things that have practical advantages and they like opportunities to implement what they just have learned. They value high face validity and real problems, and also enjoy chances to practice techniques with feedback from experts.

To keep all of the information collected from the learning style test, and instead of identifying only a prevalent learning style, as in other models, the results are expressed by normalised parameters for each of the four basic styles (A, B, C or D). The numbers identify the components of the learning style vector, and the learner is identified by the (A, B, C or D) tag. The parameters are stored in the 3DE database and are fed back to the student with some explanations. They can also be viewed later from the *Learning Style* menu.

Also, the learning styles of each learning unit are represented by similar parameters that are included in the metadata of the learning units. Since it is very difficult to evaluate the precise parameters for each learning unit, conventional values of parameters are assigned to the main and the secondary learning style. An *Author Guide* to the global use of the 3DE system, especially the pedagogical aspects, is available via the Internet [6].

PEDAGOGICAL CONTENT AND METADATA

In 3DE, the micromodule is a small unit that contains not only the information that the learner uses as learning resource, but also some *metadata* concerning the micromodule itself. A metadata unit is a set of information that fully and adequately describes the relevant characteristics of a learning object in order to facilitate search, evaluation, acquisition and the use of learning objects. The purpose is also to facilitate the sharing and exchange of learning objects by enabling the development of catalogues and inventories, while also taking into account the diversity of cultural and linguistic contexts in which the learning objects and their metadata will be exploited.

The Custom Course Compiler, the core of the 3DE system, uses metadata to pick the right micromodules for each course. This process is based on learner profiling and the student's personal choices. At minimum, metadata should contain information about the name of the course, course description, course provider, course extent, author, date, curriculum level, learning style it supports, what part of learning environment it is and when it was last updated [7].

Several kind of metadata are available in the international panorama, which belong to different initiatives that are working to standardise them; two of the most diffused ones are IEEE and Dublin core metadata [8][9]. The metadata specification used in the 3DE project is the IEEE Learning Object Metadata (LOM), since every item is optional and, in any case, the set of attributes *comprises* the Dublin core set.

The IEEE LOM base schema is divided into nine categories, as follows:

- General;
- Lifecycle;
- Metametadata;
- Technical;
- Educational;
- Rights;
- Relation;
- Annotation;
- Classification [8].

Their overall number is about 80. However, not one of these attributes is mandatory to be filled.

The data-element *learning style* is added in the *educational* category. Here, authors can indicate the parameters for the four learning styles that have been declared for the micromodule.

A metadata tool (see Figure 1) has been developed to ease the completion of mandatory metadata, and to save the huge time required to complete each metadata description. This software can be set so that recurrent metadata are automatically filled (eg data of the author can be automatically filled after the logging of the author in the system).

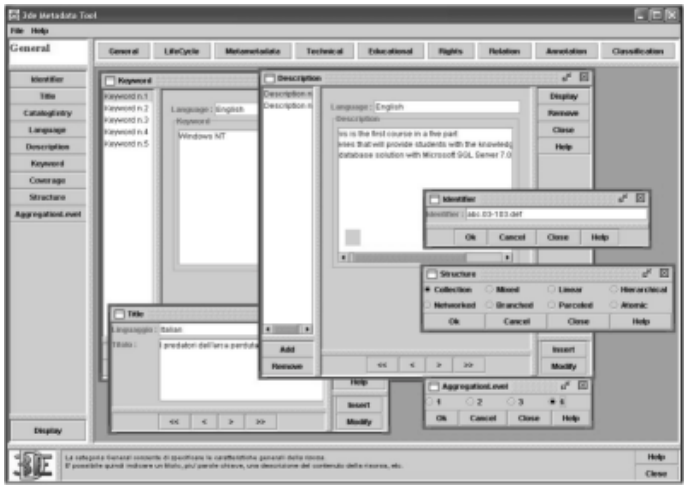

Figure 1: Screenshot of the metadata tool.

In order to allow easy interoperability and reusability of the educational material, IMS content packaging specifications have also been adopted for 3DE themes and courses [10].

STRUCTURE AND TOOLS OF ASIA IN MEM SITE

Access to the ASIA IN MEM courses is made through the ASIA IN MEM Website (see Figure 2).

Each course has the same layout and structure, as shown in Figure 3, with the following features:

- Homepage of the course with course description, calendar and references;
- The index of the content of the whole course is always present on the left side of the page; this also gives information regarding the user's position in the course;
- Glossary;
- FAQ section;
- Newsgroup on the subject;
- Notice board;
- Access to the 3DE Learning Style Questionnaire.

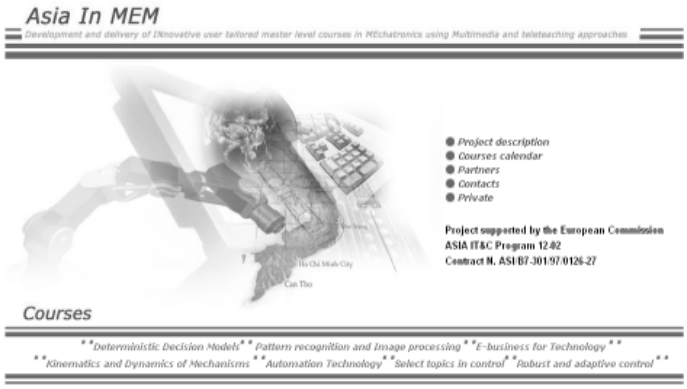

Figure 2: Screenshot of the ASIA IN MEM Website.

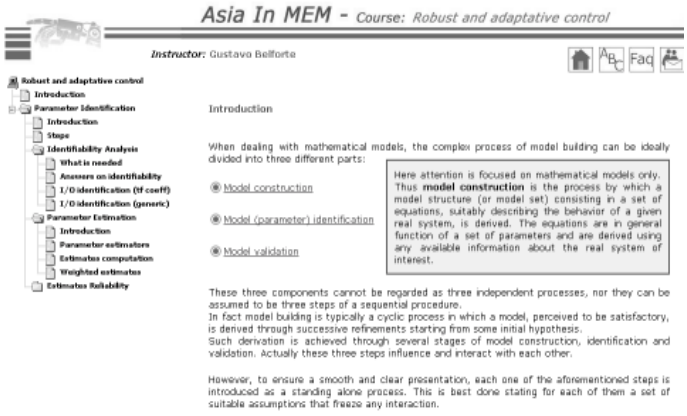

Figure 3: Typical layout of a course.

The educational material presented in the courses is not just a pure transposition of text and figures: true added value with respect to paper-based material is given by interactive parts, such as virtual laboratories and animations used to enhance learning process efficacy. Web services, like newsgroups, FAQ repositories, glossary and chatroom are used to improve communication between both teacher and students, as well as between students themselves. Self-assessment tests and exercises for immediate verification of concepts can be directly linked to theory parts.

The contents are organised in micromodules according to the 3DE methodology, with each of them indexed through a metadata set coded into an XML file that is compliant to IMS specifications [10]. In this way, micromodules can be reused in any platform that supports international standards; they can also be loaded into the 3DE system to allow personalised delivery according to the learning style of the student.

CONCLUSIONS

In this article, the main features of two projects funded by the European Commission and led by Politecnico di Torino in the field of multimedia development for innovative distance education have been presented. These projects are the 3DE and the Asia IN-MEM projects that should be considered as being complementary to each other.

In fact, the 3DE Project aims at developing tools for the preparation and management of Web-based interactive teaching material and courses, including relevant multimedia content. The envisaged approach and technique is primarily directed to provide multimedia content developers with tools and procedures that permit the creation of learner-centred multimedia materials. With such materials, the teaching path can be assembled for each single learner by automated tools in the way that seems more favourable for each student.

On the other hand, the Asia IN-MEM Project targets the preparation of a set of seven courses that make use of multimedia material developed with the tools and procedures studied in the 3DE Project. Therefore, it can also be used as a test field for 3DE methodology. The seven courses in the field of mechatronics are going to be offered twice to Asian students (mainly Vietnamese) on the AIT campus in Hanoi, as well as possibly in Bangkok for some of the courses. In this way, the following goals should be achieved:

- Delivering some highly required higher education in advanced technological fields;
- Testing the 3DE Project's products and evaluation of its practical use;
- Collecting information about the use in Asia of advanced technological products developed in Europe;
- Increasing the use and the knowledge about multimedia and teleteaching-based learning;
- Strengthening the level of cooperation between European and Asian higher education Institutions.

At the time of the submission of this article, only two of the courses have been offered once, and the remaining five were still in preparation; it is therefore not yet possible to draw significant conclusions. However, the feeling is that the awareness about the potential of multimedia and teleteaching-based learning should be increased. In fact, it opens new and exciting opportunities that can significantly improve the learning process by easing and shortening it.

The first impression on the tools prepared in the 3DE project is that they allow a very effective and promising preparation of multimedia material. However, the effort required for the materials' preparation is still quite consistent and may be incremented at some time, if different learning styles still need to be considered further. Nevertheless, the benefits for the learner seem to be important.

REFERENCES

1. 3DE Project (2002), http://www.3deproject.com
2. ASIA IN MEM Project, http:\\www.asiainmem.org
3. EU Fifth Framework Programme (2002), http://europa.eu.int/comm/research/fp5.html
4. Honey, P. and Mumford, A., *The Manual of Learning Styles.* Maidenhead, Berkshire (1992).
5. Salojärvi, S., Kvist, T., Del Corso, D., Ovcin, E., Ossola, P. et al, *Educational Design*, 3DE Project, Deliverable 1. April (2001).
6. 3DE Author's Guide, http://www.3deproject.com/ccchelp/guide_fr.htm
7. Del Corso, D., Ovcin, E., Morrone, G. and Gianesini, D., The 3DE custom course compiler: an engine to assemble custom Web courses. *Proc. FIE 2002 Conf*., Boston, USA, (2002).
8. Robson, R., IEEE Learning Technology Standard Committee (LTSC) (2003), http://ltsc.ieee.org/p1484
9. The Dublin Core Initiative (2003), http://purl.org/DC/
10. IMS Content Packaging Specifications (2003), http://www.imsproject.org/content/