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Adaptive Virtual Higher Education Space for Engineering Modeling

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Abstract: -. Things in engineering have dramatically changed. A long period of development of product related engineering methods from the manually prepared drawings to the integrated virtual spaces resulted advanced application of contemporary information technology. Engineers are moving into communities organized for product lifetime management (PLM) on the Internet. The authors made efforts to develop higher education for engineering into a level where virtual technology can be delivered as a life long learning of engineers engaged in product lifetime management. They developed approach, concept and initial methods as an implementation of Internet portal based computer modeling for group work of engineers in higher education. Virtual information technology is considered as a methodological background of a mixed on-line education, advanced distance education, and modeling assisted campus education. In their earlier, publications, the authors introduced several issues in model-based definition, description and management of student profile based courses. Teaching content of a virtual course is organized around six different aspects of engineering modeling as virtual technology, shape centered modeling, virtual manufacturing, virtual reality, group work of engineers, and CAD/CAM systems. In this paper, preliminaries of the reported work are followed by an outline of essential issues in course modeling as modeling environment for construction of classroom model, the proposed classroom model, and virtual laboratory. Next, adaptive course model is explained by initial conditions for definition of a course model, conflicts during definition of a course, and communication inside a course model. Finally, construction of a course model is introduced by essential construction entities and restrictions for construction.

Key-Words: - Distance higher education, Virtual classroom, Modeling of higher education courses, Teaching of virtual engineering, Internet portal based collaboration.

1 Introduction

Engineering modeling in its advance form is applied to establish complete description of information for a group of products. That description is developed by a group of engineers. Engineers are typically working in organization of extended companies where computer system for engineering at a company is extended to participants who are not with that company but involved in that project. The main essence of the approach to the virtual classroom courses by the authors is to join modeling and portal system of an engineering modeling environment. They follow the trend of getting higher education closer to industry. At the same time, this is the only way to establish a laboratory for students allowing access to leading industrial engineering technology.

Conventional form of distance education is telecourse. Advanced form of distance education provides course over the Internet. Learning activities are conducted electronically via Internet so that students need web browser to access the Internet. It is applied among others to navigate through, and help to find, organize, and cite teaching content. Communication skills of both students and teachers are improved. Complete degrees, diplomas, and certificates can be delivered according to accreditation status and student demand. High number of courses can be available individually and in any allowed combinations. Advanced application of leading information technology brings students and teachers together from less or more locations. In the background, multimedia based digital document sharing helps learning and teaching. Sometimes on-line education is combined with conventional telecourses. Virtual classroom is not a new concept. However, fantastic development of computers and software for information processing has produced a new situation where new advanced computer technology is waiting for efficient application in this area.

As a background of the reported work, the authors established and published an engineering specific modeling of virtual classroom in recent years. Essential issues in that modeling were functional model for virtual classroom, integrated classroom model for computer description of curriculum, teaching processes, credits and students, and modeling of customizable and configurable courses by structural, contact, assessment, content and handout features. In the proposed virtual classroom methodology, different aspects of teaching of virtual engineering in virtual classroom were considered

[1] and virtual classroom analysis based methodology was established [2].

In this paper, preliminaries of the reported work are followed by an outline of essential issues in course modeling as modeling environment for construction of classroom model, the proposed classroom model and virtual laboratory. Next, adaptive course model is explained by initial conditions for definition of a course model, conflicts during definition of a course, and communication inside a course model. Finally, construction of a course model is introduced by essential construction entities and restrictions for construction.

2 Preliminaries

Internet portals for advanced distance learning are often called as virtual classrooms. Existing virtual classrooms have been established for various purposes and programs in higher education [3]. Virtual classroom related research and teaching program development projects are around topics of cyberspace based campus and learning community as well as issues about classroom [4]. Virtual classrooms offer services similar as of campus based universities but their purpose is not simply a solution to replace them [5]. An advanced e-learning service is shown in [6] in the form of virtual university.

To highlight the difference between the proposed and earlier advanced distance learning, conventional distance education, conventional virtual classroom, and the proposed model based virtual classroom were compared by the authors in [1]. Considering numerous constraining effects, arbitrary courses can be defined and described in advanced models using resources as generic teaching functions, programs, and materials. Flexible configuration of on-line and off-line teacher contact is a great value of that modeling. Modeling gives an opportunity to change to virtually composed multimedia teaching materials. All functions are under the control of course management. Models handle linked outside sources. Deep searches also can be integrated.

3 Essential Issues in Course Modeling

Teaching content is organized in a virtual course around aspects of engineering modeling as virtual technology, shape centered modeling, virtual manufacturing, virtual reality, group work of engineers, and CAD/CAM systems. Course manager handles modules of the teaching programme. A module involves topics. A topic consists of topic related procedures for handling of principles, methods, relationships, questions, materials and instructor activities. Also links to other topics and the outside world can be handled.

Essential entity of the course is topic. Topics and features are constrained to describe relationships and prerequisites. Otherwise, sequence of teaching and learning of topics is arbitrary. Programs for groups, even individuals can be customized by selection of relevant topics, replacing features within topics or adding extra modules or topics.

Course model supports activities for its construction. Specially configured browser, interface and interoperability tools, as well as model construction tools are available for the construction of course model (Fig 1). Interface and interoperability tools provide communication with knowledge sources, teaching environments and modeling procedures in the outside world. Model construction tools involve classroom, feature, student profile, and adaptive toolkits. Student profile based results are stored as classroom model instances. Valuable resources for construction of classroom models are classroom model feature libraries. As simple but efficient knowledge description and integration tools, rules and checks are emphasized-

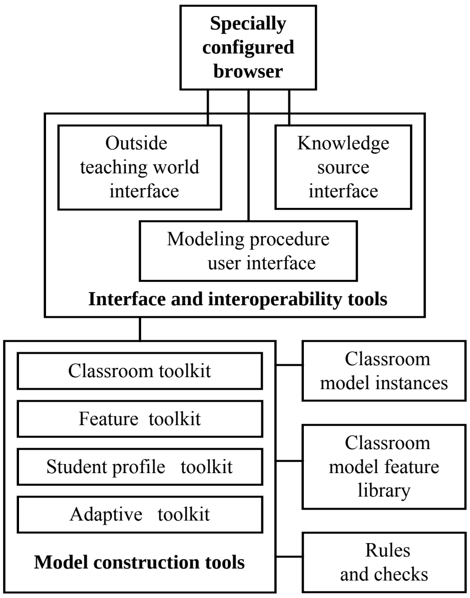

Fig 1 Modeling environment for construction of classroom model

Modeled course objects are configured according to purposes and activities of an Internet based distance education (Fig. 2). Course model is constructed by using of course features, as Fig. 4 will explain it. Features represent higher education objects according to demand of teaching, learning, and administrative practice. Procedures are available for students and teachers as software tools for definition and creation of course features, construction and application of course models, and managing of classroom functions. Data sets are established to collect reference courses, feature libraries, course instances, and feature instances. Teaching in higher education is based on well-organized content. For that reason, curriculum must be represented by courses, core studies, modules, blocks and topics.

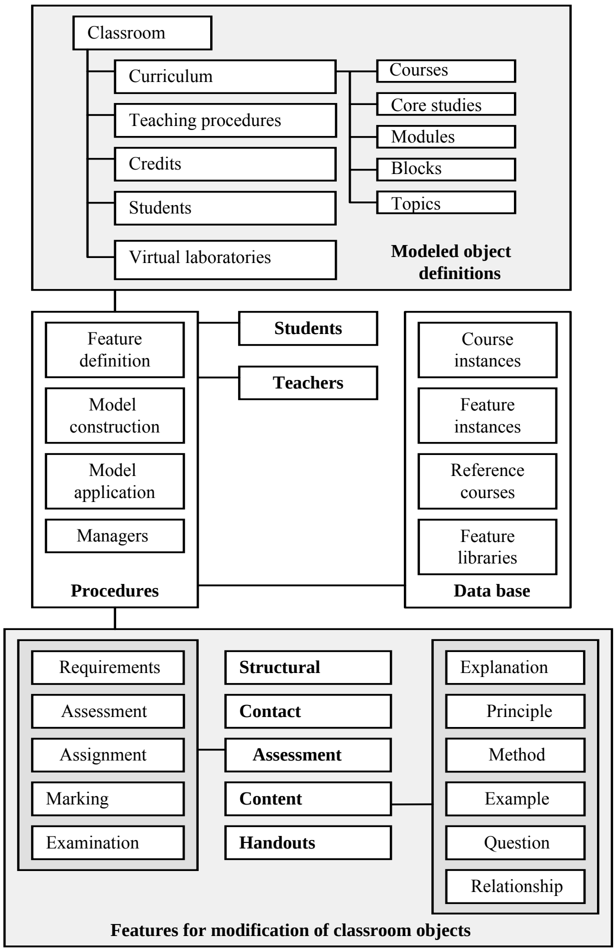

Fig.2 An outline of the proposed classroom model

Participants of a project from different geographical sites access virtual engineering modeling systems. When students access engineering modeling systems in a similar way, virtual laboratories have been established. Its concept can be seen in Fig. 3. Internet portal and appropriate workstations are connected in a wide-area network system according to the schedule and participants of virtual laboratory hours. Virtual laboratory may extend into a campus, to computers of students, teachers and virtual classroom system in an area, or it may be implemented as a global system. Product data and multi site management functions assure important services to maintain effective and safe operation of classrooms in case of computing resource intensive virtual laboratories. Project and student profile databases are also developed at portal systems. Workstation functions are arranged for virtual laboratory, virtual classroom, student, teacher, and other linked workstations. Students access assignment from the workstation configured for course management and use their own, downloaded or on-line accessed modeling software. Software at workstations is installed and configured according to its demanded functionality. It is an important objective to establish related virtual classroom and group work engineering environments simultaneously.

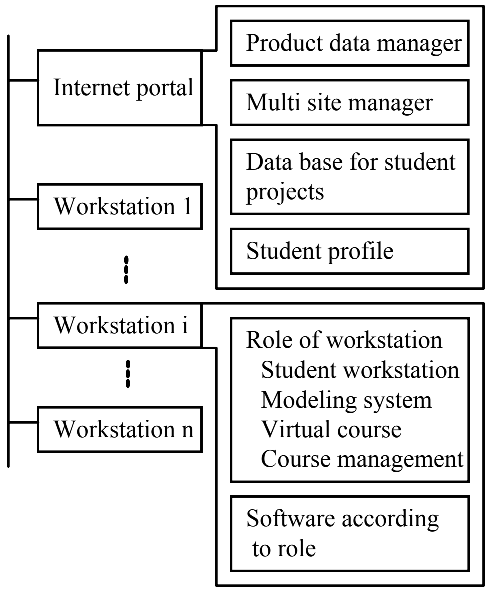

Fig. 3 Virtual laboratory

4 Adaptive Course Model

One of the innovations in the proposed modeling is an extended application of the feature principle. Its first implementation was widespread application of form features for modeling of parts in mechanical systems. Traditional pure geometric way of element definition and composition of complex shapes did not allow description of application specific shape information. By application of the feature principle, engineers can define shape elements according to their technical meaning then apply them to modify an earlier shape.

Implementation of the feature principle allows construction of a course model by definition or selection of a course instance as an initial model. This model is modified by a series of course modification features. Initial conditions for the construction of course instance can be predefined in the form of reference structures, associativities, and constrained connections (Fig. 4). Constrained connections are forced modifications. Mapped course features (CF) modify base course feature (BCF). Reference interface (RI) is provided by the BCF. Modifications by course features are defined by reference connections (RC) [2]. A previously connected CF also can be modified.

Construction of a course model can consider a lot of human intent and capability related restrictions and options. In other words, stored knowledge can produce information suggesting more or less restriction of application of a course modification feature or can help to reveal alternatives. Fig 5 outlines conflicts and their handling. Any modification by feature is conflict analyzed before execution of that modification.

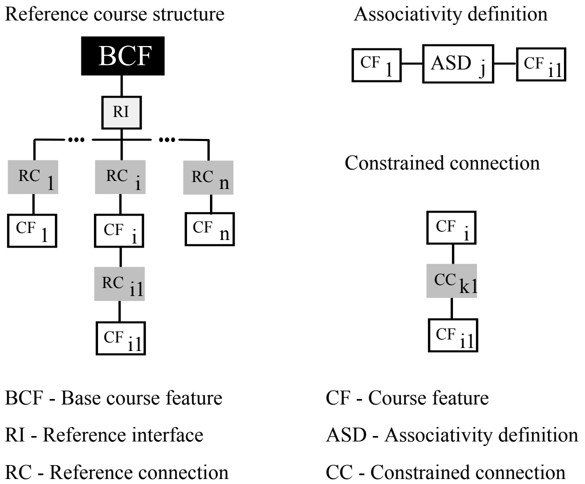

Fig. 4. Initial conditions for definition of a course model

A conflict may be capability or human intent originated. Besides capacity of humans and technical environment, capability information can be also originated from restricted applications, results of analyses, threshold knowledge, experience, and schedule. Because an engineering decision is a resultant of less or more different human intents, breaking of human intent is a frequent cause of a conflict. Human intent can be represented in a course model for later application and development of that model or it can be on-line communicated during development of the model.

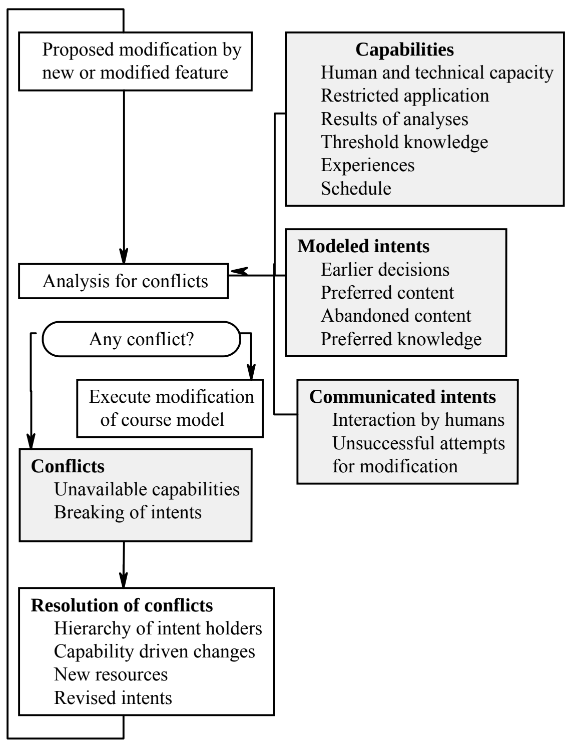

Fig. 5. Conflicts during definition of a course

In practice, complex and labyrinthine capability and intent information must be harmonized. It seems impossible to survey all influencing effects at a decision. This is why the reported research places emphasis on this problem. The first task is to collect conflicts. Then iterative attempts are made to resolve them by revising intents, changes for better fitting to capabilities, or including new resources. If necessary, impact of conflicting human intents or allocation of existing resources can be decided on the basis of intent holders and decision makers, accordingly.

The next very important aspect is communication within course modeling and between course modeling and the outside world. Inside communication connects humans, resources, procedures and course model instance (Fig. 6). Summarizing the above-explained entities, course model instance consists of a student profile, a base course feature, a sequence of modification by course features, and a set of associativity definitions to relate attributes of features and student profile information. Communication is controlled by associativity definitions within a course model instance assuring course model for an actual application. Knowledge, teaching and technical resources represent implementation of a course model in institutional education. Procedures generate and apply course model entities.

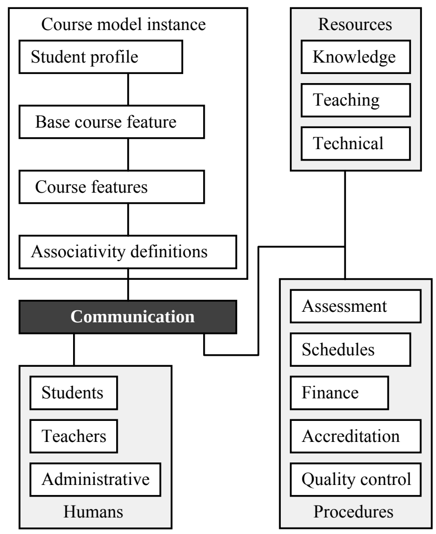

Fig. 6. Communication inside a course model

The above outlined course structure supports adaptive course modeling. This is the main importance of the application of interconnected model entities with type and application specific sets of attributes. Associativities define dependences amongst attribute values by simple relation, equation, rule, check, network or measure. While, the first five defines new entities or modifies attributes of existing entities, the sixth concludes some measure about course. Adaptive modeling utilizes connections by associativities at automatic modification of the model. Constrained associativities represent relationships within the course model and between course model and its associative environment.

5 Construction of Course Model

A course model is constructed for a student course profile. Profile can be mapped to an individual, a any group of students within accessible area or selected IP codes along the Internet. Course under construction may be a generic or an instance one.

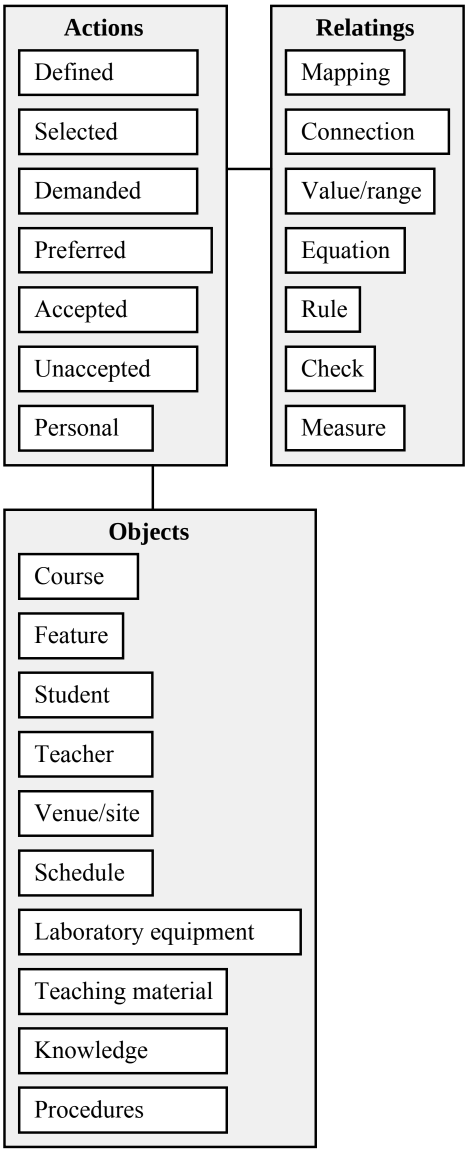

Fig. 7. Essential construction entities

According to an actual task, construction process can be initiated for creating a new course, modify a course or joining to an existing group. In the practice, the third one means joining a student or a group of students with specific absolved teaching program in other organization or course. Joining new members may bring some demand for modification of course instance. New demand driven improvement of the course can bring benefit for other members of the extended group.

In a simplified schema of construction of a course model in Fig. 7, objects are related by human controlled actions. Classes of course related objects are course, feature, student, teacher, venue, schedule, laboratory equipment, teaching material and knowledge. They are defined, selected, demanded, preferred, accepted, unaccepted, or personal-affaired by humans while relationships are established amongst objects. Humans and procedures do relating. They use techniques as mapping, connection, giving values, creating equations, rules and checks, and making measures. For example, different sets of attribute values can be mapped to entities.

During construction of a course model, restrictions posed by limited access, constrains, and dependencies are to be considered (Fig. 8). Restrictions may apply for humans as course, teacher, student, knowledge, link, site, date and time, and country. Choices and lists of entities are free to modify and extend as a consequence of application of the feature principle.

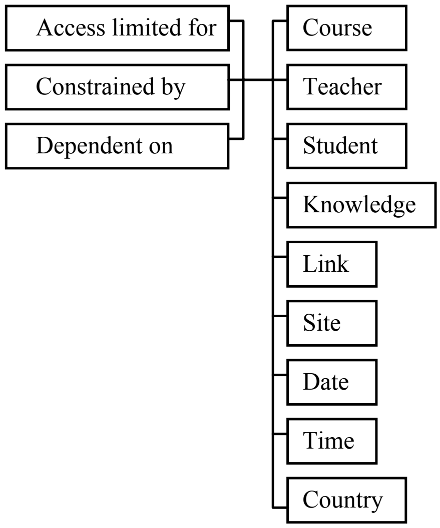

Fig. 8. Essential restrictions for construction

6 Conclusions and Future Research

Some recent results in development of virtual course related methodology in modeling for Internet based advanced distance education are introduced in this paper by the authors. Course instance is defined according to a profile for a student or a group of students. Essential entity for definition of a course in its modeling is topic. Relationships and prerequisites are described as constrains. Programs for groups, even individuals can be customized by selection of topics, replacing features within topics or adding extra modules or topics. A lot of human intent and capability related restrictions and options can be considered at construction of a course model allowing definition of correct model for an application. Implementation of the feature principle allows construction of a course model by definition or selection of a course instance as an initial model. Any modification by feature is conflict analyzed before execution of the modification. During construction of a course model, objects are related by human controlled actions. Internet portal and appropriate workstations are connected in a wide-area network system according to the schedule and participants of virtual laboratory hours.

The proposed course structure supports adaptive course modeling. This is the main importance of the application of interconnected model entities with type and application specific sets of attributes. One of the most important objectives of future research in this project is more to know about adaptive course modeling. Other topics of future research are methods for resolution of conflicts including effective handling of complex and changeable situations, and procedures for communication within a course or amongst a set of mostly independent courses.

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