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Course Modeling for Student Profile Based Flexible Higher Education on the Internet

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Abstract: Higher education courses are increasingly created as student organized collections of interrelated modules. At the same time, frequent change of subject matter and knowledge in its background must be handled. Above and other factors created and recognized a need for efficient computer based course management. Conventional computer aided teaching methods are not suitable to organize, manage, and communicate the comprehensive course information any more. The authors considered an analogy with well- organized computer descriptions of interrelated objects in the form of comprehensive integrated models in product engineering. Modeling and management of information serve engineering activities during lifecycle of product. Relevant advanced characteristics of integrated product descriptions are process orientation, definition of application oriented building elements called as features, and assistance of decisions by knowledge representations. The authors considered higher education course as one kind of product and proposed a course model. They focused to integrating student, teacher, and institute demand driven characteristics of modeling. Model is developed for application by course procedures. While conventional virtual education systems concentrate to computer mediated distance education, the authors considered arbitrary mix of campus and distance styles of education. In this paper, the authors first give an introduction in their approach to classroom modeling by a comparison of conventional distance education, conventional virtual classroom, and the proposed model based virtual classroom. Next, functional elements of the proposed course modeling and components of virtual classroom are explained. Conflicts as consequences of inappropriate capability or breaking of human intent are analyzed. Following this, initial conditions for definition of course module and construction of course module using modification by features are detailed. Finally, future work for implementation of the modeling in an experimental system composed by professional product lifecycle management (PLM) system, configurable virtual teaching environment, its virtual classroom extension and virtual classroom extension to the engineering modeling system is concluded.

Keywords: Virtual classroom, Model of higher education course, Feature driven model construction, Conflicts at course definition
Categories: J.6, J.7

1 Introduction

Computer networks on the Internet provide an efficient solution to the problem of performing basic communication between teacher and student in distance education. Campus based courses also utilize local and wide area computer networks. Increasingly complex higher education courses are characterized by vast amount of changing information, many interrelations with outside information sources, and growing demand for efficient communication. Advanced modeling and sophisticated models have established an information technology intensive way to solve similar problems in product engineering. The authors of this paper considered higher education course as very special product and made an attempt to implement some advancement from the very flexible product modeling methodology in modeling of courses. Engineering applies modeling to organize vast amount of strongly interrelated product and process information. Virtual higher education needs computer methodology of similar purpose for description and relation of objects.

As a contribution to introduction of modeling in higher education, the authors introduced a line of modeling methods for interrelated description of course objects during recent years. Main issues of that modeling were explained and detailed in [Horváth, 01], [Rudas, 04] and [Horváth, 01].

In this paper, the authors first give an introduction in their approach to classroom modeling by a comparison of conventional distance education, conventional virtual classroom, and the proposed model based virtual classroom. Next, functional elements of the proposed course modeling and components of virtual classroom are explained. Conflicts as consequences of inappropriate capability or breaking of human intent are analyzed. Following this, initial conditions for definition of course module and construction of course module using modification by features are detailed. Finally, future work for implementation of the modeling in an experimental system composed by professional product lifecycle management (PLM) system, configurable virtual teaching environment, its virtual classroom extension and virtual classroom extension to the engineering modeling system is concluded.

2 Background

Application of networked computer systems has brought a great change in higher education by electronic teaching materials, communication using web pages, and course administration by purposeful software systems. In recent years, virtual classrooms were organized around well-equipped Internet portals, utilizing the dynamic development of Internet technology in advanced distance learning [Kellog 01]. Existing virtual classrooms have been established for various purposes and programs in higher education [Tschang 99]. Virtual classroom related research and teaching program development projects proceed around topics from cyberspace based campus and learning communities as well as issues about classrooms [Rena 99]. Virtual classrooms offer services similar to campus based ones. However, their purpose is not simply a solution to replace campus courses [Teare 99]. These systems are difficult to configure because high number of course related object types, associative attributes of objects, and high amount of imported and frequently updated information must be handled. Modeling techniques offer methods for associative description of arbitrarily complex course and to create and handle transparent information environment for humans engaged in teaching, learning, configuration, and administrative processes. Perhaps the highest value of modeling is simple handling of multiple and personalized teaching program variants. Other main benefit of modeling is that its application requires correct information about teaching resources, student demand, and constraints.

In order to give an introduction in approach to classroom modeling by the authors, Figures 1-3 compare conventional distance education, conventional virtual classroom, and the proposed model based virtual classroom. Teaching functions, teaching programs, teaching materials, and teacher contact activities are characterized in these main stages of evolution of computer-based higher education. Efficient communication between teachers and students is a primary objective in all stages. Conventional distance learning uses written and mediated teaching material packages and campus arranged consultations (figure 1). As an alternative to manual course administration, separated software is applied.

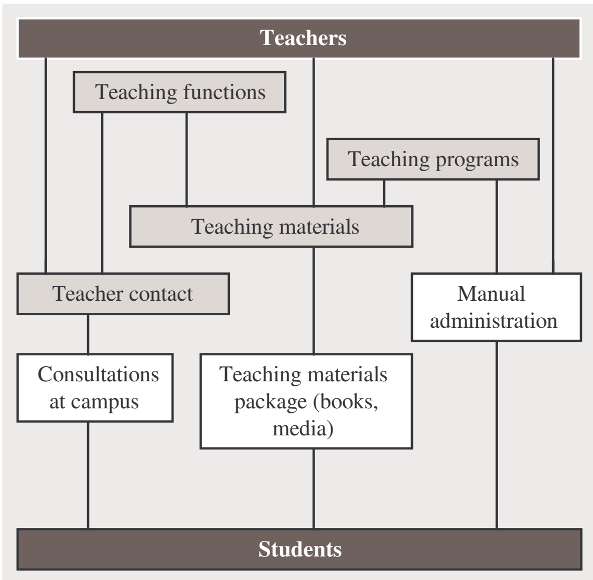

Figure 1: Conventional distance education

Conventional virtual classrooms utilize less or more organized Internet portal functionality (figure 2). Computer programs may be applied for some teaching functions. E-mail contact, live chat, on-line lecture, and other services are available according to capabilities of the computer system and agreed service providing. Teaching materials are downloaded or browsed. Interactive teaching materials enhance the quality and effectiveness of teaching. A large step towards computerized higher education is established. However, the creation and maintenance of data sets and site processes are time and work consuming. The information environment is not transparent enough for the flexible handling of variants and changes.

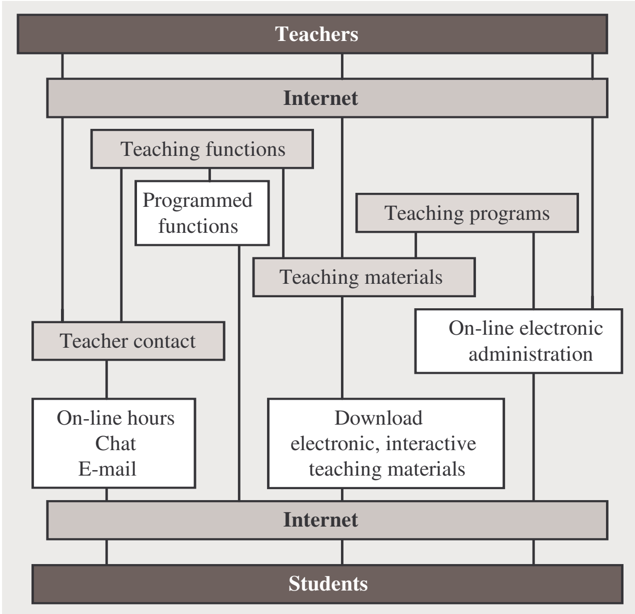

Figure 2: Conventional virtual classroom

The virtual classroom proposed by the authors integrates generic functions, programs, and materials as teaching resources (figure 3). Instances of these resources can be composed into arbitrary course model. Flexible configuration of on-line and off-line teacher contact procedures and good opportunity of content-based composition of teaching materials are provided. All functions are under the control of course management. Application of linked outside sources and deep searches are integrated as required. The main improvement is a change from handling of simple course data to the description of content and relationships of course objects.

Course model supports activities for its construction and application. Purposeful modeling, browser, interface, and interoperability software tools are integrated. Interoperability provides communication with knowledge sources, teaching environments and modeling procedures outside of the system.

3 Course Model Structure and Entities

Main functional elements of the proposed course modeling are outlined in figure 4. Modeling starts with definition of classroom objects to be described. Procedures are available for essential modeling activities such as feature definition, model creation, model application, and management. Generic (reference) and instance course object and knowledge descriptions are stored in course data. Virtual classroom establishes modeled courses and consists of curriculum, teaching procedures, teachers, students, and virtual laboratories. Curriculum as an organized learning experience describes content of a degree program, provides conceptual structure and time frame to get that degree. It is composed of organized learning experiences in different areas of an education, called courses. A curriculum is composed by using of existing courses. Alternatively, courses can be elaborated according to predefined curriculum.

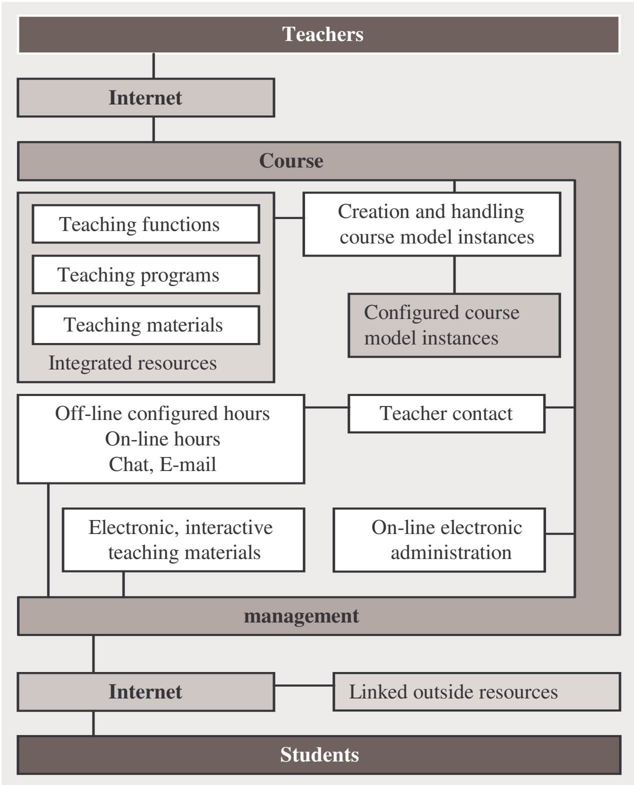

Figure 3: The proposed virtual classroom

Course data sets are organized for reference and instance courses, modules, and features. Teachers, students and linked outside world humans and objects communicate with the classroom system using more or less complex Internet and collaborative functionality.

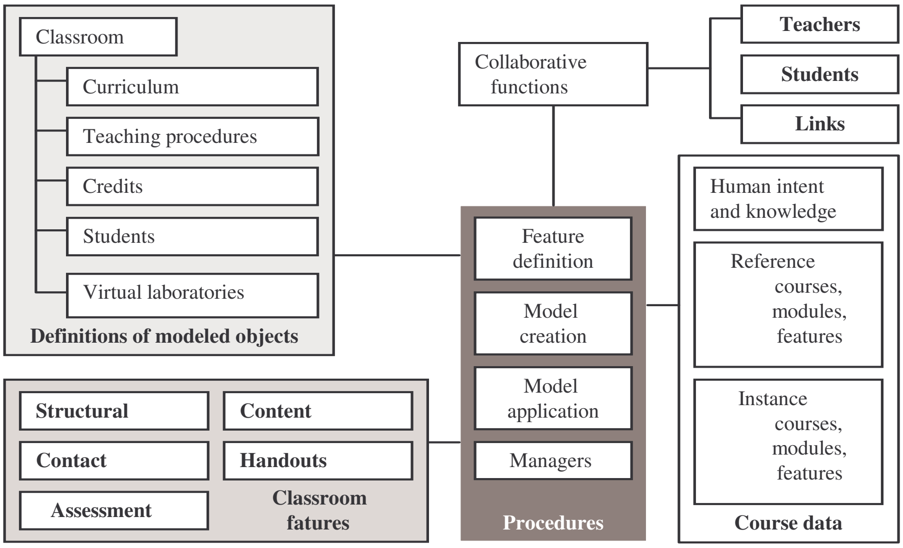

Figure 4: An outline of course modeling

Essential components of a virtual classroom are detailed in figure 5. Teaching procedures are organized for curriculum. At the same time, students select elements of curriculum and collect credits for degree. Curriculum arranges a choice of modules, blocks, and topics in courses. As for its structure, course is a sequence or network of modules. A module consists of blocks while a block involves topics. Essential knowledge can be organized in core studies composed of modules or blocks.

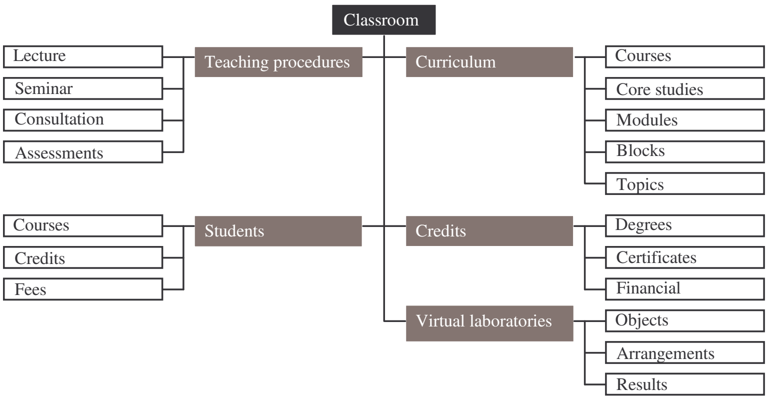

Figure 5: Definitions of modeled objects

Teaching procedures are lectures, seminars, consultations, assignments, and assessments. Credit information describes degrees and certificates as defined by their requirements. Student profile consists of course and its elements, credits, and tuition fee information. The fifth component of virtual classroom is virtual laboratory for distance laboratory hours using modeling and model based analysis environment. Software modules, arrangements of model objects for analyses and, results of student work including assignments and degree works compose a virtual laboratory.

Modules are optionally grouped in tracks (figure 6). Sequence of modules in a course model instance is constrained by precedence conditions called as prerequisites. Module is created as a sequence of purposeful modifications by classroom features. Technically, this procedure is organized for modifications of an initial object called as base feature. Figure 6 shows an example of modification by structural features[1]. In some extent, it is an analogy with engineering modeling where application of features as building elements of models is a prevailing method.

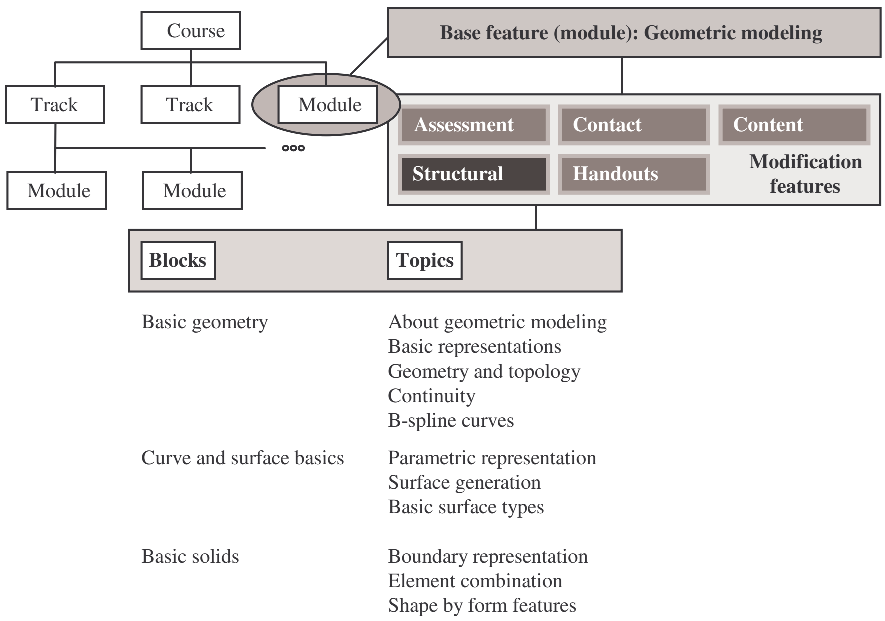

Figure 6: Structural module modification features

At the definition of a course and its elements, more or less human intent and capability originated restrictions and options are to be considered. Demands by students may be in conflict situation with decisions by teachers or capabilities of an education system. Other typical conflict may be between teachers or experts in teaching content. To achieve a conflict free solution, any definition or modification of course model elements is undergone to conflict analysis. Course model supports handling of conflicts mainly by associativity definitions.

A conflict may be caused by breaking a capability of an education system or intent of a human (figure 7). Besides capacity of humans and technical environment, restricted applications of resources, results of analyses, threshold knowledge,

[1] For more details about features and feature modeling techniques see chapter 4.

experience, and scheduling are also sources of conflict situation. A decision is often composed by intents of different humans; attempt to breaking of human intent is frequent cause of conflict situations. Capability related conflicts are resolved by modified solution or including new resources.

Process to reveal human intent related conflict requires information about human intent in course model. Because acceptance of knowledge is more or less human dependent, knowledge is considered as human intent except for threshold knowledge. Human intent related conflicts might be very special in higher education because different teaching methods, opinions, accepted and refused explanations, etc. are normal. Resolution of an intent originated conflict may be result of a compromise or hierarchy of intent holders. Intent may be accessed in model or it is communicated during definition of a course.

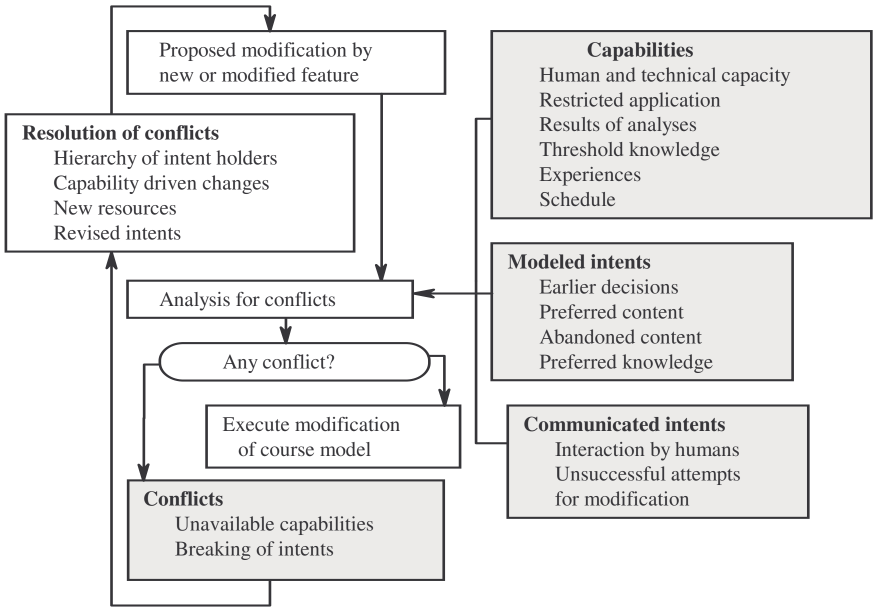

Figure 7: Conflicts during definition of a course

4 Construction of Course Model Using Modification by Features

One of essential techniques in the proposed course modeling is construction of module by course modification features. Feature is a flexible entity in the course model. It is defined as an identifiable element of a module according to its application, attributed and represented according to its content, and applied for modification of a course module. Arbitrary pairs of features can be connected by associative links. They can be added, replaced, suppressed, and deleted in the module structure to improve and complete of modules including definition of module variants.

Initial conditions for definition of a course module can be given as reference course structure, associativity definitions, and constrained connections (figure 8). Reference structure is a predefined generic module. Constrained connections act as forced modifications and describe prerequisites, etc. A base module feature (BMF) is modified by a series of course features (CF). For this purpose, a reference interface (RI) is provided by the BMF. Reference connections (RC) connect CFs to the module. RC also can be defined for modification of a previously connected CF.

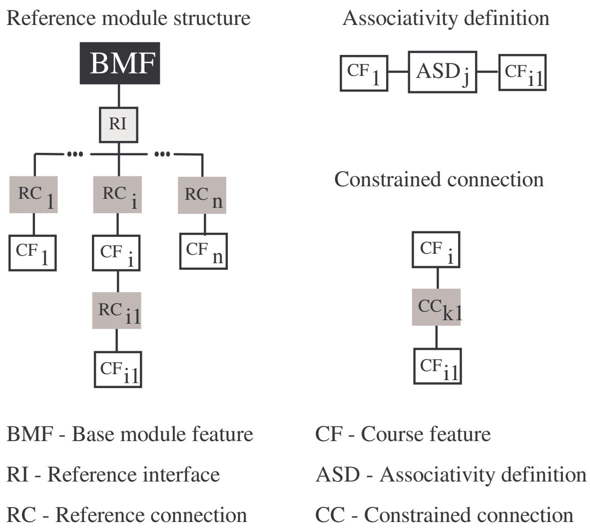

Figure 8: Initial conditions for definition of a course module

Application of module modification features is explained in figure 9. BMF *Geometric Modeling* is modified by block *Advanced representation.* This block is the first one on the list of blocks at the moment. The main difference between a simple mapping of a list of module elements and the proposed modification by features is the organic integration of the features in the information structure of a module. Block *Advanced representation* is modified by topic *Blending functions*. A lecture contact and an examination assessment feature modify this topic structure feature. Content of lecture *Spline blending function* is configured using modifications by content features.

An extendable choice of predefined classroom features is available for modification of modules. Figure 9 shows sets of structural, contact, assessment, content, and handout classroom features. Each set has a distinct purpose. Structural features modify structure of module by introducing new blocks and topics. Contact features establish contact activities between students and teachers. Consultation and discussion are inherently interactive, while lectures, laboratories and seminars may be also interactive. A content feature contributes to teaching content of a module by purposeful explanations, description of principles and methods, representative examples, putting questions with or without answers, and relating things by relationships. Assessment features complete module by description of requirements, composition of assessment, assignments, marking schemas, and examinations. Handout features include or link materials, instructions, and literatures.

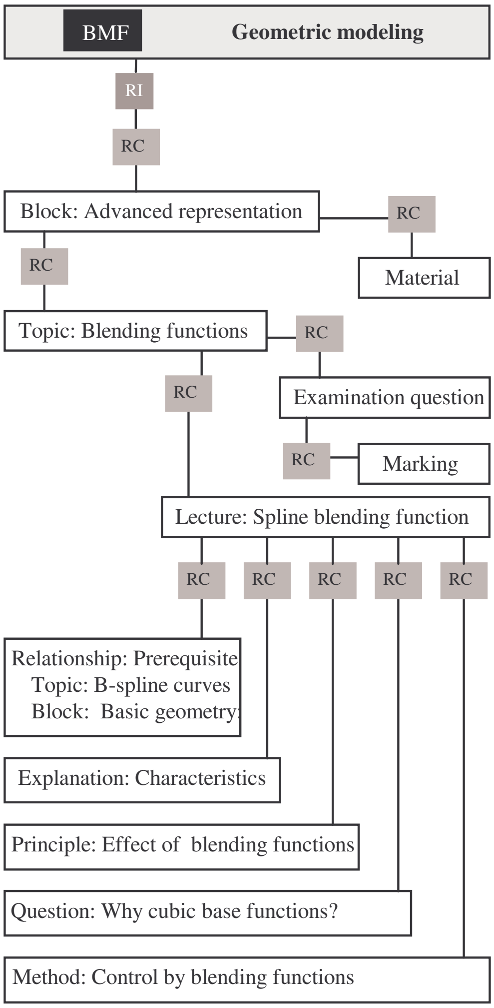

Figure 9: Example structure of a feature-based module

5 Conclusions

Higher education is increasingly characterized by high amount of frequently changed information, many interrelations with outside information sources, need for flexible configuration of courses, and growing demand for efficient communication. To cope with this challenge, well-organized description and processing of course information is necessary. For this purpose, the authors elaborated a content-based and information technology intensive methodology for higher education courses in the form of course modeling. Functional elements of the proposed course modeling are definitions of modeled objects, procedures, classroom features, course data, and collaborative functions. Curriculum, teaching procedures, students, credits and virtual laboratory compose virtual classroom. Acceptance of knowledge is more or less human dependent so that knowledge is considered as human intent except for threshold knowledge. In the proposed course modeling, module as main structural unit in a course is constructed by identifiable elements called as module modification features. Feature is defined according to its application, attributed and represented according to its content, and applied for modification of a course module. Reference course structure, associativity definitions, and constrained connections serve as initial conditions for definition of a course module instance. Sets of structural, contact, assessment, content, and handout classroom features are predefined according to local specifics. Although the authors consider higher education of computer modeling for engineering, the proposed virtual classroom modeling is also suitable for organized information handling in many other areas of education. While primary area of application of new virtual methods is inevitably distance education, extensive modeling is a chance of integration campus and distance forms of education.

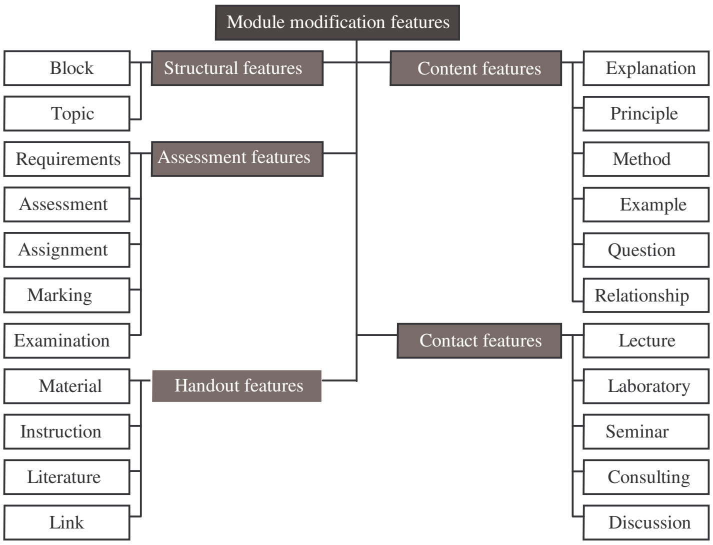

Figure 10: Course model composed by features

6 Future Work

Course modeling approach and method by the authors have been developed on the analogy with product modeling. Its implementation at the Institute of Intelligent Engineering Systems, John von Neumann Faculty of Informatics, Budapest Tech is being prepared for teaching of virtual engineering. A laboratory system for product lifecycle management (PLM) system using integrated software product of Dassault Systemes composed by engineering modeling, product data management (PDM), group work, and Internet portal functionality for comprehensive product related engineering has been established for education purpose in Laboratory of Intelligent Engineering Systems (LIES). Using this laboratory, students work in an environment similar to as in industrial engineering systems. Portal organizes groups of students for project work. The proposed classroom modeling will be integrated with the PLM software using application development and configuration functions. It is easy to configure to remote access of laboratory software. Contribution by industrial companies to teaching programs can be done simply by joining to the portal.

Professional PLM system at LIES and its planned virtual classroom extension is outlined in figure 11. Product modeling program products have functionalities for development of models, analysis of modeled objects, planning of production, model database management, configurable user interface, and application programming. Product data management (PDM) and Internet based group work functionalities are in close connection with functionality of the portal specific software.

Engineering purposed virtual classroom environment would use configurable virtual teaching software. New elements to be developed as implementation of the proposed modeling to this system are virtual classroom extension to the industrial modeling system, and virtual classroom modeling extension (VCME). VCME will utilize functions available in modeling, virtual teaching and Internet software. As an alternative, it can be developed as an independent virtual classroom system working under the control of a portal. Virtual classroom is intended as an integration of a configurable virtual teaching environment, its virtual classroom extension and virtual classroom extension to the engineering modeling system.

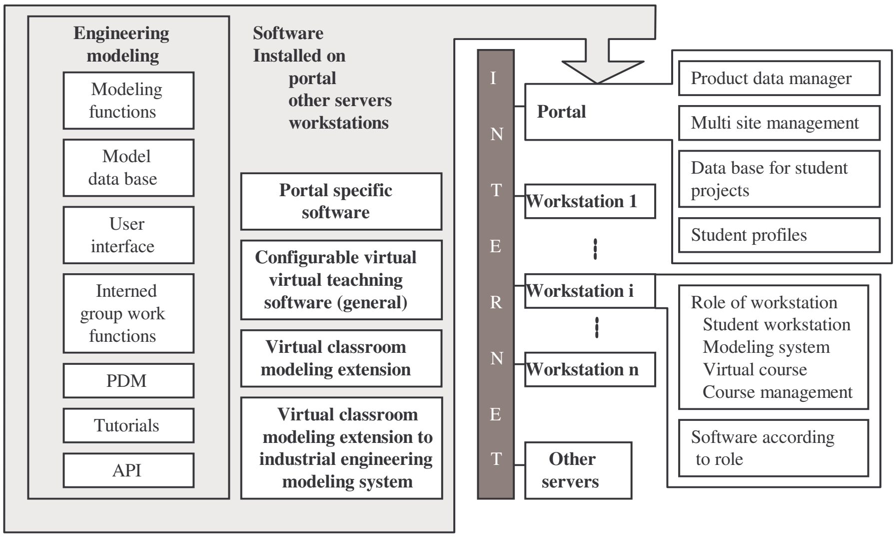

Figure 11: Implementation in Internet communicated modeling environment

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