Modelling the virtual campus.

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Abstract

The challenge facing TeleLearning and Distance Education is to support the essentially autonomous knowledge building process by the learner, while at the same time, emphasizing the very important collaborative dimension of learning. This challenge cannot be met without information technology and without the integration of all the useful synchronous and asynchronous technologies in a coherent architecture. We call such an architecture the Virtual Campus. A review of five LICEF's projects related to this architecture will be presented. Then, applying an object oriented modeling technique, we outline the modeling process, defining the actors of the Virtual Campus, their roles, the processes they are involved in and the computer tools they need to perform their roles. Upgrading tools and methods to support the Virtual Campus will open up and extend the traditional classroom in a very "real" way. It will hopefully contribute to learners persistence in distance education, thus extending the social and economic usefulness of TeleLearning.

Keyword Codes: K.3.1, I.2.4, D.1.5

Keywords: Computer uses in Education, Knowledge Representation Formalisms and Metheods, Object-oriented Programming

1. INTRODUCTION

Télé-université of Quebec is the second oldest distance university, having started its activities in 1972, shortly after UK's Open University. Twenty-two years after, nearly two hundred thousand students have followed its courses. While still making extensive use of low-tech but reliable technologies such as mail, telephone and cable-TV, Télé-université has progressively integrated new training technologies as soon as they became available to its students: PLATO system for Computer assisted instruction in the seventies, TELIDON videotex system and VIDEOWAY interactive television system in the eighties and, since

1988, email and teleconferencing environments. This last system has been used by over a thousand students in Quebec and in some international activities.

Télé-université's *Laboratory for Cognitive Computing and Training Environments* (LICEF) has begun in 1991 its research activities on TeleLearning methodologies and tools. We will present here a synthesis of the research achieved by the laboratory in the last three years, concentrating on the Virtual Campus project which constitute the integration framework of most of the research being conducted at the laboratory.

At first, we discuss some traditional TeleTraining models, as well as some new developments in Distance Education technology. Then, we present an overview of the Virtual Campus model we have started to develop. Using an object oriented modeling technique, we go on to define the actors of the Virtual campus, their roles, the processes they can be involved in and the technological tools that will facilitate their interaction in the Virtual Campus. We finally discuss our pedagogic and technological orientations.

2. TOWARDS NEW TELELEARNING MODELS

Distance education has been in operation for decades in government agencies, universities and large companies. We do not pretend here to a synthesis of such a rich past and present achievements. Our goal here is to present two contrasting categories of models: real-time synchronous systems and asynchronous or delayed interaction systems. Then we will outline the major concepts and principles of the Virtual Campus Model we are proposing.

2.1 TeleLearning models

The *synchronous models* aim at liberating learners from distance constraints, while emphasizing real-time group activities in the typical way of a traditional classroom. The classroom becomes a tele-classroom or a virtual classroom [1-2]. Learners have to be present at the same time, but they can be at different locations, sometimes at great distance. Historically, radio and television have been used first to ensure real-time distance communication. In the radio or television course, the teacher present information and knowledge and is broadcasted by a radio or television station or through a cable network. Some limited interaction possibilities can be added using open lines so the learner can ask questions and receive answers from the teacher.

With the development of computer assisted telecommunication, new synchronous TeleTraining tools are now available such as telephone conferences or audioconferences, and, with the developement of the information highway, videoconferences. Collective software or groupware enable learners and trainers to share the same computer screen on each of their workstations. Real-time team work at a distance is then possible, for example collaborative writing of a document or team work on science simulations. Finally, videopresence brings screen images of the participants in a classroom, recreating the work team or the discussion group, at a distance.

On the other hand, *asynchronous models* liberate learners, not only from distance, but also from timetable constraints. They put more emphasis on autonomous and individual learning activities, but group learning activities are also possible. Historically, this approach has first taken the form of correspondence courses. The learner receives by mail a kit of learning material, for example a learning activities guide, written documents, audio or video cassettes, educational software. In more recent systems, more emphasis is made on the role of a trainer or a tutor, intervening at a distance, calling student by phone to discuss their progress and difficulties and securing time periods where he can be reached for questions.

With the development of computer assisted telecommunication in the last five years, new asynchronous tools are now widely available. Fax, electronic mail and file transfer of data and documents facilitate group work and interaction between learners or learners and trainer, at moments chosen independently by the participants. An especially useful collaborative learning tool is the computer assisted teleconference. Using a teleconference software, it is possible to create a virtual work team or a discussion group where participants will exchange text and soon, audio and video messages, at the moment they choose. The trainer then becomes an animator, making sure that the teleconference will follow an agenda and process each subjects in an productive way.

These two models have each their advantages and drawbacks. We share with other research projects [3-4] the goal to integrate synchronous and asynchronous learning activities in a new coherent model.

Asynchronous models have unquestionable practical advantages because they free learners from distance as well as timetable constraints, while facilitating autonomous as well as collaborative learning. They also possess a sound pedagogical value, developing the learner's responsibility in his/her knowledge building process.

Many studies have shown the pedagogical inefficiency of the knowledge transmission model dominant in the traditional classroom. To this effect, synchronous tele-classroom models can make the situation worse if they are limited to broadcast the professor at a distance in a certain number of rooms or on the individual workstations of a large group of learners. In this case, it can be even more difficult to question the teacher or to interact with other learners, than in the traditional classroom.

On the other hand, asynchronous models have often limited themselves to individual learning, neglecting the interaction between learners that is essential to knowledge and know-how acquisition. This situation can be compensated to a certain extent by using computer assisted teleconferencing. However, the exchange of rather short text messages has its limits and can be adequately complemented by real time teamwork and discussion group sessions. These synchronous activities will be more efficient if they extend individual or asynchronous group activities.

2.2 The Telecommunication Multimedia Project

New TeleTraining models and tools are actually being developed in Quebec within the context of the Telecommunication Multimedia Project. This large project totals 27 millions canadian dollars investments from the government of Quebec and the participating organizations. Five companies and Télé-université have a partnership in the project. Partners exchange their results and some of their computer tools and methods.

The goal has been set to develop the transmission capacities of digitized multimedia information over networks from ISDN to T1, and to applied these new functionalities to

TeleTraining. A multimedia hub, enabling multipoints communication on ATM networks is being developped by one of the companies. Another company has achieved a beta version of a video modem card to be installed in microcomputers, enabling the integrated communication of data, voice and real-time video. These companies are also developing exploitation software to facilitated the use of their hardware for new application functionalities such as multimedia document transfer, real-time screen sharing and annotation, videopresence, synchronous and asynchronous video conferencing.

To this effect, LICEF and three companies cooperate in the development of a TeleTraining workbench grouping most of the computer tools that can be used in TeleTraining environments. These partners have defined a common software architecture at the end of 1994. Throughout 1995, they are cooperating in the development of the tool set. Afterwards, each partner will be free to use part or all of the tools directly or to integrate them in their own development system. Télé-université's system, developed by LICEF is named "The Virtual Campus".

2.3 The Virtual Campus, a network of actors and resources

The Virtual Campus rests on the interaction of different actors with resources on a network. These actors meet to participate in learning events: curriculum programs, courses, learning units, or single learning activities.

Figure 1 illustrate the multidirectionnal links between the actors and the resources. The network gives them access to one or more server giving access to multimedia documents, learning tools, files containing individual of teleconferencing messages, as well as documents resulting from individual or group activities. Other resources are available on-line to the learner: a trainer taking care of pedagogic assistance, animation, and progress assessment; content experts providing specialized knowledge; pedagogic managers taking care of the logistic and administrative aspects of training; and instructional designers responsible for the definition and revision of the learning events and the didactic resources available in the system.

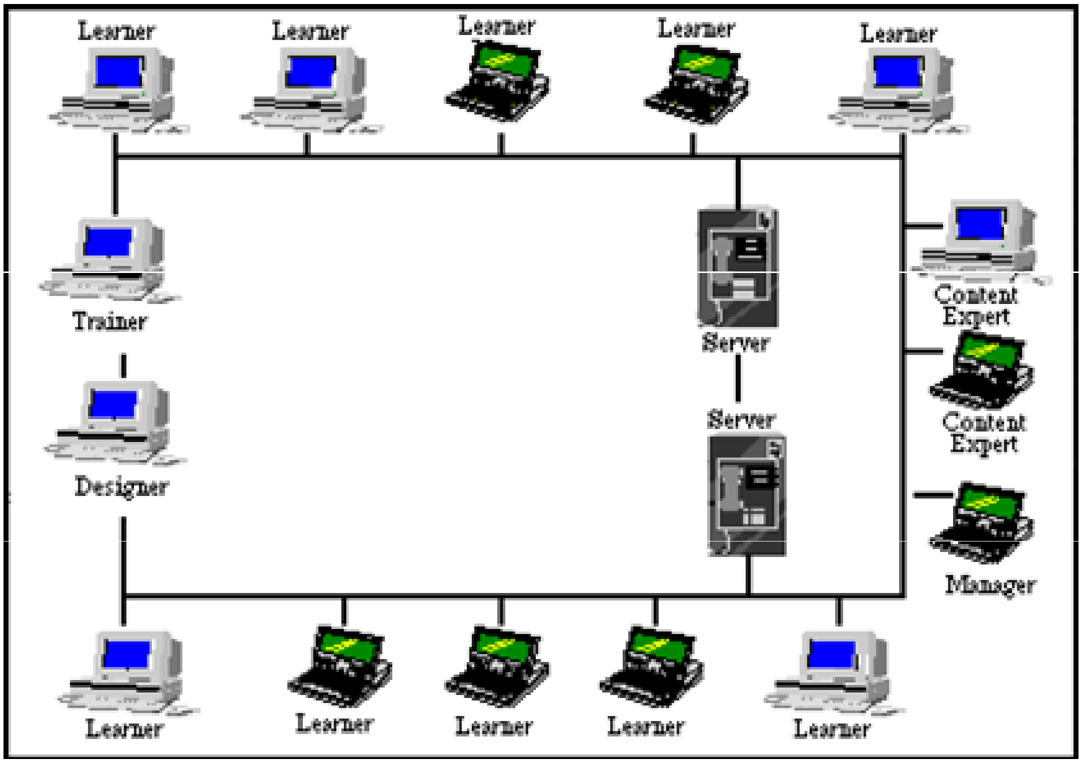

Figure 1 - Actors networked in the Virtual Campus

The actors in such a network are:

— the *learners* undertaking activities through which they construct and acquire new knowledge and new competencies;

— the *trainers* who intervene to answer questions; to suggest the consultation or use of certain documents or tools; to communicate information; to regularly assess the learners progress; to adapt the technological system to the particular needs of a group of learners;

— the *content experts* providing new knowledge from time to time, making presentations or answering questions from the learners or trainers in their field of expertise;

— the *managers* coordinating the implementation and the delivery of the training system to the groups under their responsibility;

— the *designers* that define, develop, validate, revise and make available the different components of a learning system to the other actors.

2.4 The Virtual Campus as a computer system

From a computer science point of view, the Virtual Campus is a system with many software components that enable the actors to play their role in a TeleLearning computerized environment. We now present some of these systems.

The learner's HyperGuide give him access to a net of learning activities or tasks. The different components provide links to multimedia documents and tools distributed over the telecommunication network, to on-line advisors, and to distance collaborative tools for team work, discussion groups, tele-presentations and tele-assistance.

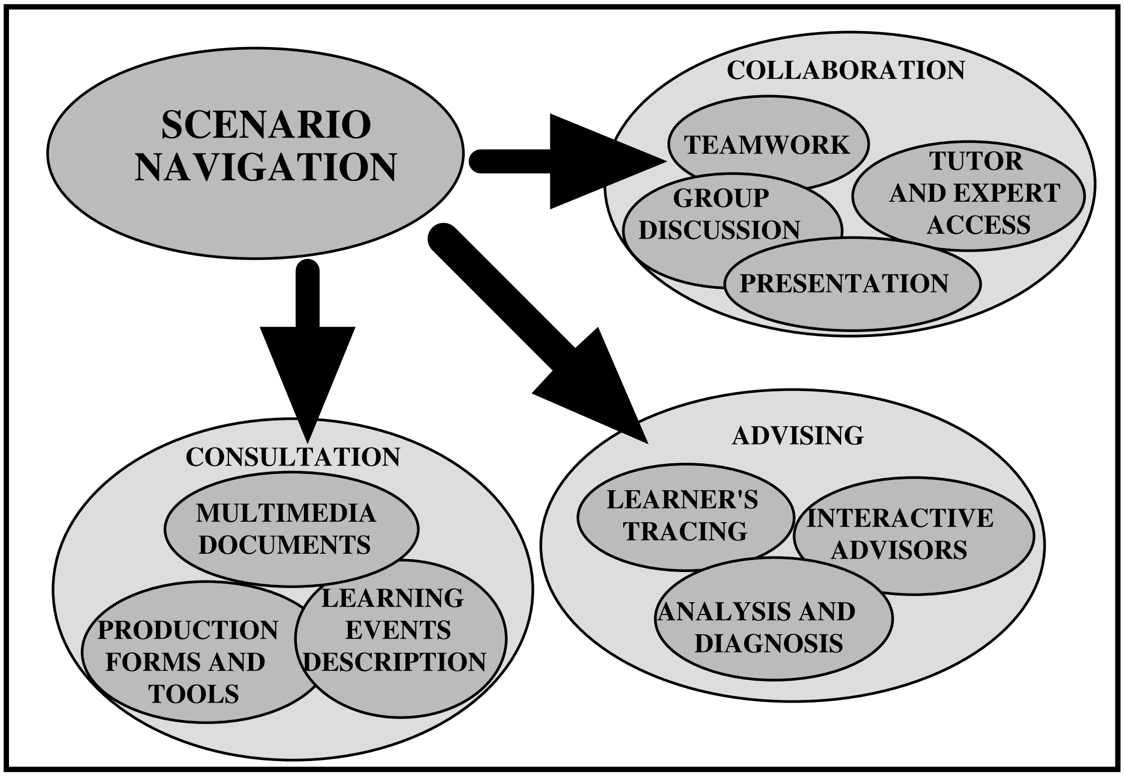

Figure 2 - Components of an HyperGuide

—*Navigation and production component.* An hypermedia software serves as an interactive road map describing the learning tasks. It also gives the learner access to all the resources available locally or at a distance: content experts, co-learners, multimédia documents, production tools, help and advisor agents, also providing feedback to self evaluate his progress and reorient his activities if necessary.

—*Documents and tools component.* Driven by the learning tasks, the learner will need to access multimedia documents on the network, including those he will produce or obtain from co-learners or resource persons. This component will provide search facilities to find out documents or tools that are useful for a certain task.

—*Collaborative components***.** Collaborative activities at a distance can take many forms. Computer assisted *tele-discussion* can be achieve through asynchronous teleconferencing or synchronous videoconferences. *Tele-teamwork* between co-learners is possible using groupware and videopresence. *Tele-presentations* are made available in real-time using videoconference, or can be "canned" for future display when needed. *Tele-*

assistance and monitoring by the trainer provide individualized advice, in real-time, or using asynchronous tools such as text, audio or video email.

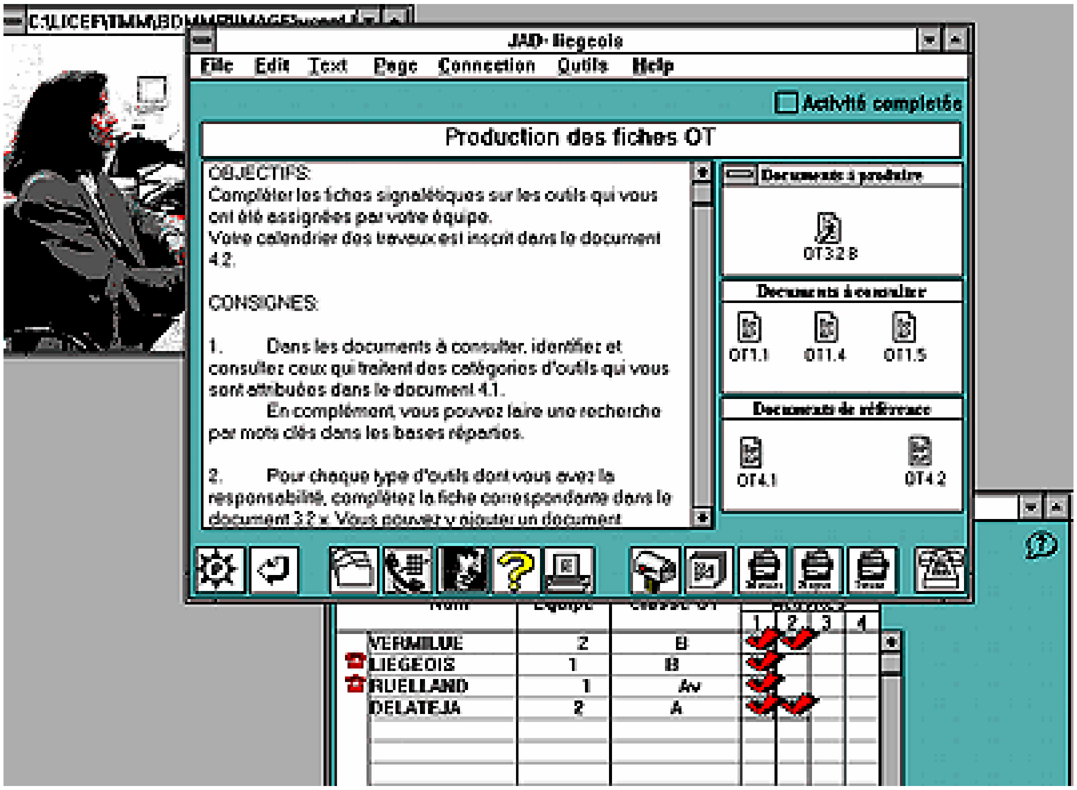

Figure 3 - Example of a learner activity and a groupware tool
in a Virtual Campus environment

—*Intelligent Help and Advising.* The HyperGuide software also provide the learner with on-line intelligent help and advising. These functionalities are indispensable to help the learner find the information, the documents or the tools he/she needs throughout the enormous mass of possibilities available on the network. Essentially, a structured trace of the learner's interactions is compared with a model of the learning tasks to provide advice on his/her path between tasks, on his/her acquisition of knowledge and on his/her interactions with other actors on the network.

Trainers, content experts and managers HyperGuide

Trainers, content experts and managers all have important roles to support learners acquire knowledge and skills. They fulfill their role using their own specialized HyperGuides.

— The trainer has a copy of the learner's HyperGuide with additional tools that enable him to access to a synthetic view of each learner's and team's progress, to provide assistance and pedagogic guidance to learners as well as animation to discussion groups, and to evaluate the learners achievements.

— Content experts also need additional specialized tools to present information and answer questions on the knowledge domain.

— Finally, managers will need special tools to monitor the learning system and also to manage inscription, evaluation and certification of the learners.

Designer's workbench

Such a system can only work if the designers can have their own support system to produce and deliver the appropriate HyperGuides to the other actors. Essentially, two other software systems are needed:

—A *network exploitation system* (NES) provide software access to the communication capacities of the network such as multimedia mail, screen sharing and annotation, audio and videopresence, synchronous and asynchronous teleconferencing, multimedia document base edition and access.

—A *development support system* (DSS) facilitates the integration of these low level communication tools on the network with other local or network tools to produce and deliver the HyperGuides to the different actors of the Virtual Campus. The DSS is organized in a certain number of editors that produce each component of the HyperGuides, together with an instructional design advisor to support decision making by the designer with regards to the particular training needs of the target population.

2.5 Summary of related research

The implementation of the Virtual Campus architecture is of course a long term endeavor, demanding the solution of many research problems, both in the educational and the technological fields. In this section we summarize the result of the research work undertaken at LICEF related to the Virtual Campus project.

A first operational HyperGuide.

From 1991 to 1993, a three year project [5] has resulted in the definition of an integrated model adapted to TeleTraining. On this basis, a first HyperGuide has been developed, tested and delivered for one of the courses at Télé-université. This project has demonstrated the feasibility of the concept presented here since the environment is actually used by a hundred students in a real life context, giving them access to credits within one of the university's regular program.

On the other hand, this first TeleLearning environment has been developed with limited funding for a public that has limited technological access, so it presents limitations in many respects. First it uses programming tools such as HyperCard and ToolBook that are useful and versatile, but not very performant. The environment do not give access to on-line multimedia documents. The communication tools are limited to electronic mail, textual teleconferencing and file transfer on the usual telephone network, using low rate modems.

The environment provides some contextual help but no intelligent advice. There are no special tools for trainers, content experts or managers. Finally, no special tools have been provided to the designers: while conceptually generic, the learner's HyperGuide has been programmed specifically for the particular domain content.

Teleconferencing

In the last two years, another LICEF team has been working at the design of teleconferencing environments and analyzing their content using a system called ACTIA [6]. This system uses linguistic analyzers, developed previously at the ATO•CI center of Université du Québec, to model the content and the interaction in a teleconference. The project aims at creating tools to help learners and trainers find information in the messages, and to provide a a diagnosis of the interaction within the conference to help the moderator.

In its actual state, ACTIA gives its resulting analysis only to the trainer and this output is limited to certain types of interaction and content. In other words, the system do not yet provide general tools to the learner in its collaborative learning activities. Also the analysis results have not been linked with an advisor system to directly support the learner.

Distributed multimedia document base.

Also in the last two years, in cooperation with the multimedia lab at the Université de Montréal, another team has explored the question of editing and accessing a distributed multimedia document base [7]. A distributed catalog system gives access to text, sound and video documents, distributed on different microcomputers on an heterogeneous network. The system proposes different modalities for real time consultation or transfer of documents, depending on the transmission speed available on the network. A pedagogic scenario including numerous consultation and transfer activities has been designed and experimented.

However, the system is too much dependent on the Macintosh platform and the "remote control" application that has been used. Also, the system has been tested only on a local Ethernet network and a distant low rate link between two local networks.

The didactic engineering workbench

Since the beginning of 1993, in cooperation with the DMR group, the Héron laboratory at Université de Montréal and CRIM, LICEF has undertaken the development of a didactic engineering workbench [8-9]. The workbench can be used in any delivery modes: classroom, self training, task integrated training and distance learning. It can also be used with any pedagogic strategy or media. When the project ends in December 1994, a task support system for instructional designers will be made available. It embeds an intelligent advisor using pedagogic expertise to help designers analyze the learning context and needs, to build a model of the content and to assign it to learning events, to choose the strategies and the media, to define the learning instruments and to finally plan the development of the learning system.

The system covers the analysis and design phases, but not the development, validation and delivery phases. Furthermore, it is not adapted to the specific context of TeleTraining, nor to the use of telecommunication multimedia documents and tools. In other words, the workbench gives us part of a designer's support system but it cannot yet generate the TeleLearning environment needed for the Virtual Campus.

Advisor editor

At LICEF, a team has developed a first version of a tool called ÉpiTalk [10-11] that enables a designer to add an advisor system to an existing application. This system has been used to build the Didactic engineering workbench's advisor system, together with another advisor for a scientific discovery application. ÉpiTalk provides the designer with a graphic interface to specify his view of the application in the form of a task tree, to define computer objets to capture the interaction of the users with the application and to generate advisor agents. Each of these agent has a private rule base that can trigger advises when certain trace conditions are met. Another interface enables the designer to define the rules which embed expertise in the application's knowledge domain.

While it has been designed for stand alone as well as collaborative application, it remains to be seen if ÉpiTalk can be efficiently used for the advisor components of the Virtual Campus. Research work on this aspect has just begun in fall 1994.

3. MODELING THE VIRTUAL CAMPUS

In order to integrate these partial results, the definition of an architecture for the Virtual Campus has been undertaken, in collaboration with other partners in the Telecommunications multimedia project. The goal is to better understand interactions between actors and resources in the system and to define tools to be integrated in the different computer components of the Virtual Campus.

The modeling method we have used is derived from the Jacobson's object oriented software engineering method [12]. It consist at first in describing actors and their roles in the Virtual Campus. Then these roles are defined by modeling processes (use cases) in which the actors get involved. This leads to a first model where the main objects interacting in the processes are described with their attributes, methods and links to other objects. Once this is done, functional specification of tools enabling the actors to play their role can be outlined. We will now illustrate this method, thus defining more precisely some of the aspects of the Virtual Campus model.

3.1 Definition of the Actors and their roles

The actors represent everything that interact and exchange information in the system: persons, pieces of software or documents. Some are information transmitters while other are receivers. Most are sometime transmitters, sometimes receivers. More precisely, the actors are essentially defined by their roles, that is by the way they interact with other actors into processes. In the Virtual Campus, we distinguish five actor categories: learner, trainer, content expert, manager and designer. The following table defines these actors by their main roles.

ACTORS	ROLES
Learner	• Navigator • Advice user • Explorator • Learning activity achiever • Evaluation activity achiever • Self-evaluator • Communicator • Social actor • Team worker • Teleconferencer
Training	• Technological support • Pedagogical support • Progress evaluator • Group animator • Progress monitor • Advisor • Gathering information for the manager
Content expert	• Knowledge transmitter • Knowledge organizer • Knowledge updater • Knowledge counselor
Manager	• Delivery planificator • Implementation decision-maker • Group formation controller • Operations director • System's validation organizer • Revision organizer • Progress evaluation manager • Learning system evaluation director • Network administrator
Designer	• Pedagogic scenarist • Pedagogic planner • Media integrator • Didactic instruments producer • Knowledge model-builder • Learning system planificator • Interactive advisor producer • Document and tools base producer • Collaborative tools selector

It is important not to confuse actors with users of the Virtual Campus. The users are physical persons who can change role, becoming sometimes learners, sometimes trainers, content experts, managers or designers. This distinction give much flexibility to the model and opens the door to innovative pedagogical approaches. For example,

—the roles of the learner actor can be assumed, not only by physical learners, but also by trainers, especially when a trainer calls upon the content-actor to obtain knowledge he does not already possess;

—the roles of the trainer actor can sometime be played by co-learner or even computer software as it is the case for an interactive advisor component;

—the roles of the content expert actor car be assumed by on-line or "canned" content experts, and also by document or software mediating content for the other actors;

—the roles of the manager actor car also be assumed by the trainer or designer if a person occupies more than one function in the learning system, which will often be the case; it can also be played momentarily by the learner if he/she has the possibility to personalize a proposed pedagogic scenario to his own needs;

—finally, the roles of the designer actor will in general be assumed by different persons in a team whose members will change at different phases such as context and needs analysis, pedagogical design, production, validation, delivery and diffusion; some of these roles can also be assumed by a trainer or a manager to adapt the learning system to a group's particular needs; they can even be played by learners as a pedagogical tactic where the learner is asked to plan training as a mean to better understand a knowledge domain.

3.2 Roles and processes

Each of the preceding roles can be seen as a group of processes that an actor can execute. Each process is a set of actions or operations that a user can perform while interacting within the Virtual Campus. A process is one of the way to use the TeleLearning system. The set of all processes define what the system is used for, why it is developed, what are the different ways to use the system.

A user can achieve one or more tasks by employing one or more processes. Unless the process is defined as sequential, there are no constraint on the order of execution of operations within the process. In particular, some operations can be executed in parallel.

As an example, the following insert show how we define one of the roles described previously for the learner-actor, concerning his navigation in a pedagogic scenario. The following text has been elicited through interviews of a knowledge engineer with three pedagogic experts. The other roles of the five actors have been defined in the same manner.

Learner-actor - Navigator Role

Goal

To circulate through the learning activities of the pedagogic scenarios of a learning event to achieve its learning objectives.

Context

The navigation process through a learning scenario is a central activity to the training program that a learner has undertaken. This is essentially an individual process, but a team of learners can also be considered as a learner and be assigned to a team scenario. In any case, this process starts when the learner opens the HyperGuide to the screen where the scenario graph is displayed, giving access to particular scenarios for each learning unit, and finally to learning activities.

Process preliminary description

- The navigator access the scenario displaying the activities in a learning unit, or the learning units in a course.
- If the navigator sees a course scenario, he can select one of the learning unit and open its scenario where the activities are displayed
- The navigator selects an activity he wants to explore or achieve. When he opens the activity, the system verifies if the scenario constraints such as prerequisite activities, are respected.
- If no constraint is violated, the inputs, for example documents to consult or the tools to be uses, the output, for example productions to make, and the assignment for the activity are presented to the learner.
- When adopting the Decision-maker role of the manager, the learner (or the team) will define its own personalized scenario by adapting the scenario proposed by the designer-actor.
- The system will keep a trace of the learner's interaction with the environment for the interactive advisor and to facilitate diagnostis by the trainer-actor.

3.3 Object description for role processes

Each of the texts describing an actor's role is a specification of the actor's needs with regard to this role. It is a preliminary step to the modeling of the objects involved in the processes defining the role and their interrelations. The set of all different path using related objets is another way to define an actor's role. Figure 3 presents a schema of the objects involved in the navigator's role just outlined, showing the most important links between them.

The schema on figure 3 uses the graphical notation of the OMT modeling method [13]. Each node has three sections: the name of the object, its attributes and its methods. For example, all four kind of learning events have a name, a type and at least two methods to present themselves and to give access to their components.

On the schema, there are three kind of links between objects: the heritage link (is-a-kind-of) represented by a triangle, the aggregation node (has-for-components) is represented by a diamond, and special links are designated by a term referring implicitly to the actor's role, such as "consult" or "triggers". The dot "•" means that the link points to a list of objects of the class, instead of only one of these objects.

On the following diagram, lets start with the object representing the learner,.

—The learner navigates through a pedagogic scenario which is a component of the log journal that the learner can consult at any time. This scenario is itself composed of learning activities and links between them.

—The learning activity, just like the learning unit, the course or the curricular program is a kind of learning event, each defined by one or more learning objectives, which are composed of a knowledge part, a skill part and a competency level part.

—The activity is composed of a production assignment. There are three kinds of assignments. Each one identify one or more reference to documents the learner can access, giving him the assignment text, the documents he will consult or, the tools he will use.

—While navigating between the learning events and documents, the learner will produce events that will be registered in his trace journal. This journal contains the trace sequence of all the events produced by the learner. The trace can satisfy the conditions of one or more of the rules associated by the designer to the learning event, thus triggering an advice to the learner. This advice is not imperative and the learner is free to use it or not.

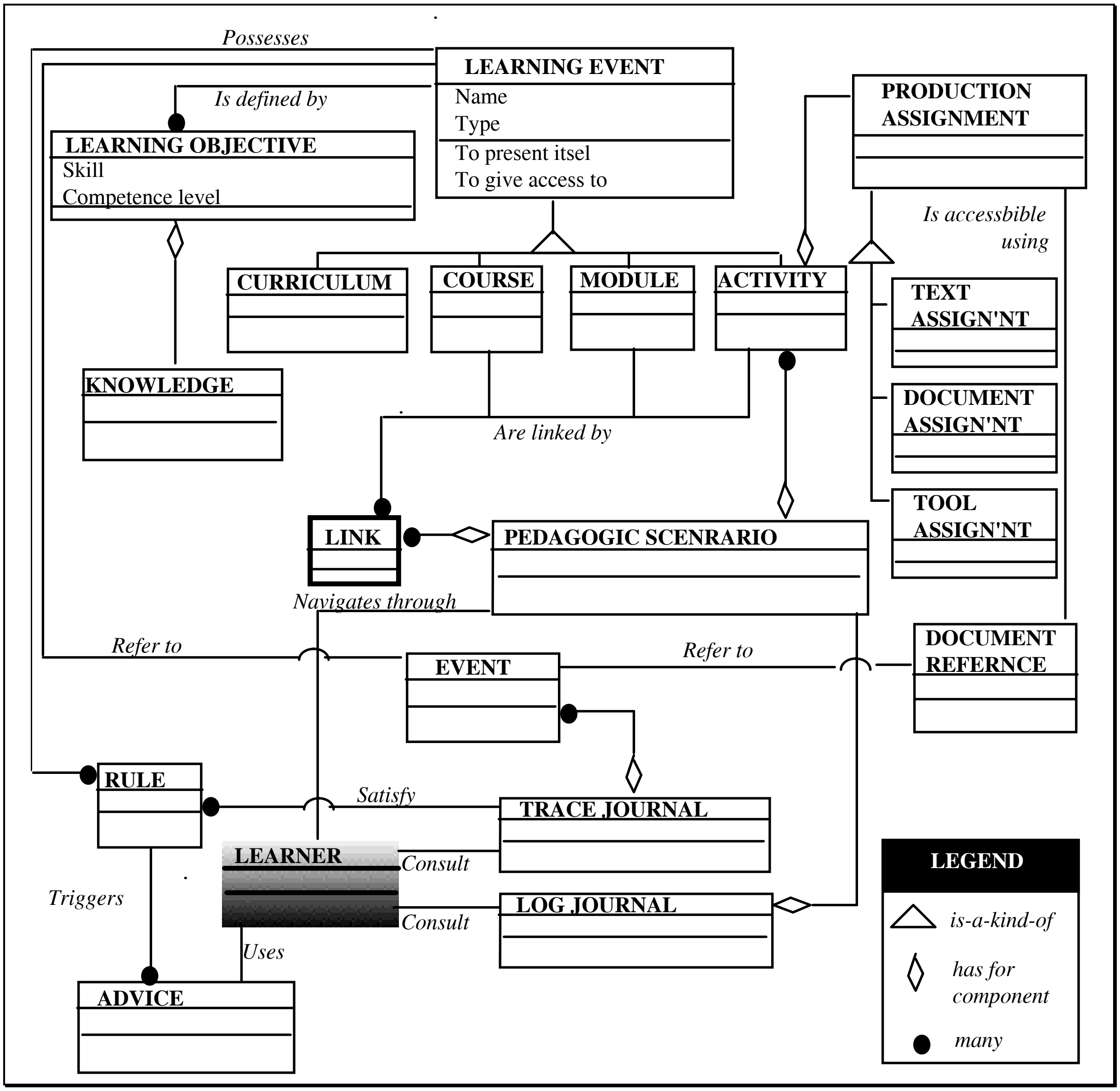

Figure 4 - Model of the objects involved in the navigator's role of the learner actor

3.4 Functional specifications for tools in the TeleTraining workbench

The specification of the objects and their interrelation leads to the definition of tools necessary to each actor to perform their different roles. Using definition such as the preceding one for the navigator role, we can proceed to establish the functional specification of a certain number of tools: a scenario editor, a learning activity editor, an evaluation activity editor, a navigation driver, a navigation advisor, etc. As an example, we now present some of the specification of a central tool, the scenario editor.

THE SCENARIO EDITOR TOOL
1.0 Goals: —The main goal of the scenario editor is to support the designer in the task of designing and delivering pedagogic scenarios in a graphical way, and in collaboration with other designers. —A secondary goal is to offer to learners and trainers a subset of scenario edition functionalities to personalize a pedagogic scenario to their own needs. —Finally, a far reaching goal is to develop functionalities to integrate design component from a didactic engineering workbench, directly into a pedagogic scenario.
2.0 Definition: A pedagogic scenario edition tool
3.0 Used by: designer ; learner ; trainer
4.0 Functional requirements: —*Scenario creation* —*Definition of participants* in the design process with their role and privileges. —*Selection/creation of components of the pedagogic design:* graphical functionalities to bring on screen learning events as nodes of a graph, to move them, to create, destroy or copy links between learning events, to reuse component of other pedagogic scenarios. ...
5.0 Processes - utilization cases: • the designer assembles a pedagogic scenario from a design document • the designer modifies the structure and content of an existing pedagogic scenario ...
6.0 Functions: scenario creation; design document interpretation; interactive graph edition; configuration of a learning environment.
7.0 Properties • edition of n pedagogic scenarios simultaneously supported • collaborative scenario edition by a team • drag&drop, copy/cut/paste, group/ungroup of learning events ...
8.0 Input-Output*:* • input: pedagogical design document, partly defined scenario, other scenarios, specifications of learning events, knowledge model for a learning event • output: scenario being designed, completely designed scenario, personalized pedagogic scenario, trace event.

4. PEDAGOGICAL AND TECHNOLOGICAL GOALS

We will now underline the pedagogical and technological objectives that lie at the basis of the Virtual Campus project.

4.1 Knowledge processing by the learner.

The most fundamental goal is to provide knowledge intensive activities in the Virtual Campus. As proposed in a 1986 OECD international conference [14], the development of knowledge processing skills should be at the center of training and education in the information society. Education is about knowledge building by the learner. This can only happen in learner-centered knowledge rich environments.

4.2 Task centered learning for continuity between work and training

The Virtual Campus model makes possible close interaction between work and training activities, because the learning scenarios are task centered, the activities being organized around projects taken in real-life activities. The learning environment can naturally become a work environment, and use to pinpoint useful knowledge when needed in work activity.

4.3 Just-in-time information

In task centered problem-solving environments, information is always available and can be obtained by the learner when he needs it to progress in a project, achieve a task or solve a problem. The Virtual Campus is designed to offer maximum support to the learner by providing numerous information sources locally and at a distance. It also offers intelligent assistance to help the learner find the appropriate knowledge and information.

4.4 Personalized and collaborative learning

Learning is at first an individual activity requiring that the learner be given a large degree of autonomy. The activities in the Virtual Campus provide such autonomy. Not only can the learner navigate through the learning events and information sources in a pedagogic scenario, but he can also adapt, alone or with the help of a trainer, the scenarios to his particular learning situation. But learning requires also collaborative group activities where knowledge being constructed by a learner can be compared with knowledge built by other learners. This is where multimedia telecommunication technologies can be the most useful.

4.5 Distance and time-free learning

Many TeleTraining applications limit themselves to broadcasting the teacher to the learners. This can be useful from time to time, but it does not fully exploit the learning possibilities offered by the information highway. To do that, collaborative distance activities must be supported, not only in real time, but also in delayed asynchronous activities. In that way learners will be able to collaborate in locations and at moments they will choose, increasing coordination between their work and training activities.

4.6 Trainers and content experts

Unlike the first wave of computer assisted instruction, including the more recent intelligent tutoring systems, the Virtual Campus model embed trainers, content experts and managers as indispensable components of the system. Multimedia telecommunication is fully used to facilitate contact between resource persons and the learners to provide knowledge content, pedagogic guidance and management support.

4.7 Modularity, versatility and continuous knowledge update

The modularity of the architecture of the Virtual campus makes possible its application in diversified context such as TeleTraining in the workplace, home distance education, or campus courses to large groups. It will also facilitate the reuse and continuous update of knowledge, learning activities and didactic instruments embedded in the learning system. This is an essential feature to cope with the extremely rapid knowledge evolution in the information society.

4.8 Technology integration

Three complementary technologies must be closely integrated in the Virtual campus to help fulfill to the pedagogic and social needs just outlined. Cognitive modeling is necessary to represent knowledge in the system, and to build intelligent tools and advising components. Interactive multimedia will give the learner control over presentations and tools he needs to achieve his/her tasks. Telecommunication is indispensable to enable collaborative learning activities and access to information and knowledge from distant persons and databases.

By integrating closely these technologies, the Virtual Campus tries to solve a very important productivity problem. The development of computerized training systems demands a variety of skills and the integration of many tools, making the task more and more costly and difficult. Our approach will integrate existing productivity tools such as text, graphic, video or multimedia editors, as well as groupware, teleconferencing and video conference software in a common framework. The Virtual Campus development system will provide the glue, using links created by the designers between learning activities, documents and tools in a pedagogic scenario.

It is our hope that these efforts, combined with other projects, will contribute to achieve the great potential of the information highway for better education, social democratization and economic growth.

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