Methodology to DMITS: Distributed Multimedia Intelligent Tutoring Systems

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Abstract

This methodology provides a method for designing and developing multimedia applications and for incorporating it into nets and videoconferencing. The main virtue of DMITS is that it serves as a theoretical foundation and a method that provides procedures for the three basic tasks of these applications: the acquisition and representation of information/knowledge, the translation of concept networks into multimedia objects and the integration of these multimedia objects, and finally distributed multimedia.

The methodology of DMITS is based on RESMUL (Semantic Networks in MULtimedia environments; Brugos, 1993, 1996), and MITS (Brugos, 97, 98), which sought to focus on the representation problems and the inheritance property in Semantic Networks when concrete hypermedia objects are used, such as images, voice, text, etc. The special uses of mutimedia objects means readapting the KnowledgeBase and Interface modules, etc. Then MITS (Multimedia Intelligent Tutoring Systems) seek to integrate ITS in multimedia lines by analysing and defining the functionalities of the multimedia objects. Multimedia objects are thus distributed analysing the functional use of every one for application The core of this approach is supported by the role of the images in concept formation and, in general, in communication processes, a kind of theatrical presentation (scenarios), just as it is postulated by the iconic communication (Ch.S.Peirce). Of corse the semantics of the images constitute a natural base for intuitive communication. On the other hand, this proposal cooperates both to Distributed Multimedia (networks) and the Quality Of Services (QOS) required.

Key Words: Intelligent Tutoring Systems (ITS), Computer Asisted Instruction (CAI), Knowledge Representation, Semantic Networks, User Interface, Human Computer Interaction (HCI), Multimedia, Hypermedia, Hypertext, Distributed Multimedia, Machine Learning, Semantic Image Analysis, Videoconferencing, Video on Demand (VoD).

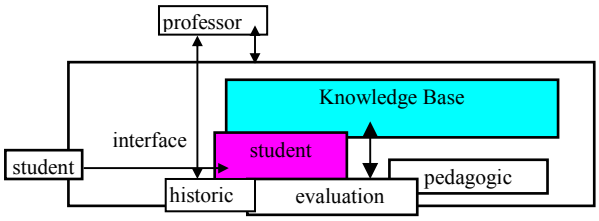
1. Introduction.

On the one hand, the current problems of the ITS are obviously their integration in a multimedia environment, because Knowledge Base and interface modules are principaly and radically changed by the use of multimedia objects like direct knowledge, and they should be integrated in the system. And on the other hand, besides standalone multimedia, there exists distributed multimedia that support communication among users: networks and videoconferencing. The International Telecommunications Union (ITU) identifies four basic distributed services and applications: conversational, messaging, retrieval and distribution services. In our hypothesis the last two services are more related to the contents of multimedia applications and the first two to videoconferencing and video on demand. However, as our method deals with integrating all multimedia resources, all the services are involved. Our aim is to integrate all the items and multimedia techniques in an ITS rather than the opposite. Therefore it is the ITS which have to be rethought in relation to ditributed multimedia. The opposite is usually the path which is followed: supplying the distributed multimedia with the ITS features. In the second half of the 80's computer-assisted instruction was rethought by incorporating Artificial Intelligence (AI) and the term ITS began to be used (Dede, 86; Kearsley, 87), Nevertheless the use of AI techniques had alredy been proposed and applied (STUDENT) by Carbonell "AI in CAI: an AI approach to computer assisted instruction", 1970, Ch. Dede, "A review and synthesis of recent research in intelligent computer-assisted instruction" 1986 and others. The invasion of multimedia, especially after Macintosh (1987) with his version of Hipertext (Hypercard) and GUIDE, begins to demand a change in interfaces (communication) and in the bases of knowledge of ITS, almost at the same time as these begin to be developed. Without doubt, the ITS come from a fusion of mature techniques of Expert Systems and the very models of assisted instruction (CAI),tutors and training systems, especially in what concerns the model of the pupil, but also, obviously, in the bases of knowledge. In this sense, Multimedia already meant a certain understanding of the bases of knowledge ditributed through the mutimedia items which they represent and of the interface which provides communication through the scenarios which the user navigates on.

The following diagram shows the main models of a tutor:

a) Knowledge Base
b) Student model

c) Teaching strategy
d) Assessment
e) Trace of sessions
f) Interface
g) Module of teacher
h) Module of student



Sketch of ITS arquitecture

For our purposes we will concentrate on the method of interpreting the Knowledge Base in terms of multimedia items and on how the interface can help in this aim.

2. Methodology.

Our MITS proposes a method for the:
a) knowledge adquisition and representation,
b) knowledge flow diagram to navigate
c) knowledge translation into multimedia objects
d) multimedia object integration
e) presentation
f) usability
g) distributed multimedia

There are three basic stages that support the formative prototype: **knowledge acquisition and organization, concept translation to media and media integration, and distributed multimedia.**

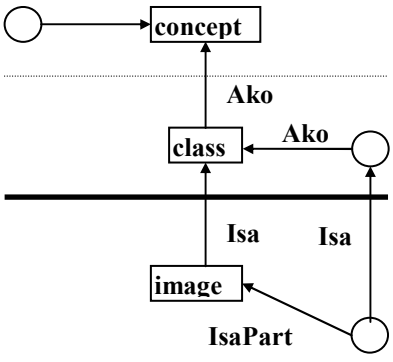
The knowledge, the pedagogic strategy and the evaluation form are picked up from expert domain. This is carried out it by means of protocols and documents, and takerecords and videofilms. The knowledge protocols establish a layout for the knowledge presentation of experts, looking for the possible more graphic and plastic form, for example, outlines, slides, transparencies, graphics, images, etc. The evaluation module represents a minimal subset of the Knowledge Base. Towards decomposition method in goals-subgoals (end-means) a path is settled down (top down) that should be continued between Knowledge Base and Evaluation Modules, the inverse one follows path bottom up. This path provides a strategy adapted to the student-user's profile by means of the student's pattern, preferences, individuality and errors. Genetic programming (algorithms) and fuzzy logic provides system control,and adaptation to the student, overcoming the difficulties of a causal model based on differential equations. Improvement also modulates explanations and personalised help adapting it to students. The Knowledge Base is established as a concept graph, for example, an extended semantic network: a acyclic directed graph interpreted by means of the multimedia objects. These objects are used as perceptive things. The classes worth/necessary for application are called the relevant conceptions. An instance is a relation between an image area and a relevant conception, often events, and its model is a concept with properties, that when they are perceptible we call attributes (real world features). So concepts have attributes and instances have attribute values. Thus we have relationships between classes, perceptive properties, and numerically testable (structural) relationships. The hierarchy forms a three-dimensional structure of parts, gen/specializations, and individualizations. A part is a relationship that decomposes a concept into subconcepts which represent conceptions of the same level of abstraction.There are primitive concepts and primitive actions.

Knowledge can be organized by RESMUL hierarchical structure:

1) Conceptual Subgraph (intensional classes)

2) Class Subgraph (extensional classes)

3)Perceptual Subgraph (individual objects; instances)



1.**Conceptual Subgraph**: the concepts correspond superclasses of every class and classifie intensionaly the class subgraph, i.e. every global (whole) image and its parts, and also its properties and relationships. Its nodes correspond to concepts (intensional classses).
2. **Subgraph of 'classes of parts'**: parts are classes ones that belong 'physical parts' in which an image has been partitioned, so that every part in an image will have respectively an unique class from that is an exemplar in this subgraph. This procedure allows to decide which will become the *minimum of classes* of individual objects that the subgraph becomes, and so will not have empty classes. This subgraph classifies extensionaly the perceptive subgraph
3. '**Physical'** or **perceptive Subgraph**: Global (or whole) image and their parts and relationships between themselves; so as their perceptives or 'mensurables' properties. Their nodes of its skeleton (objects) corresponds to images, therefore are **constants**. A image here represents exactaly an individual object (named by a proper noun).

The three subgraphs are built by means of knowledge envolved whithin images starting from **physical subgraph**. Also they reflect the grades of abstraction/concretion and generalization/specialization of the process. Objects of conceptual and class subgraph consist of normal (distribute) sets but objects of perceptual subgraph consist of collective sets. In normal sets inherintace is performed through transitive close of subset (or inclusion) property, however in collective sets inheritance is based on restrictive axioms of whole/part theory (Lesniewski)

The graph is realized starting from the classification level of the named global images in classes, for example, an image of the cathedral of Oviedo (could have different associated views), etc. in Cathedral class, and so for any other global image.

Total or Whole image becomes a prototypical image of a object, and could consist of a set of images completing global vision of a thing (a sequence), and, at least, a prototypical image which gives cause for a script of events-images. In any case, every image is a physical singular object.

The level of classification also has a minimal initial case, which is that of **a unique prototypical image** classified within its class (for example, Oviedo cathedral into cathedral). It is initial in the sense that we say "give me an example of the concept". For certain purposes a very useful case is when one has a design-scheme or model which reproduces the essential elements of a thing.

The relationship between the named global image and the class that it falls in is **Isa,** i.e., set membership ('to belong to'), and works between individuals and sets (or classes). Literature about Semantic Networks and Data Bases was often confused (Brachman has noted many formal mistakes).

Perceptive Subgraph contains objects-images, and its relationship to Class Subgraph is a Object-Class relationship, which can have cardinality.

Bottom-up follows **Subgraph of Classes** and Conceptual Subgraph, and the basic relational skeleton (those which propagates the inheritance of properties from classes to concepts) are the **Ako** relationships**,** or set inclusion. Also there will be **Pro relationships,** which assign properties for classes and concepts. The graph is often a tree having so an origin node, the Superconcept of all the concepts in Conceptual Graph, and maximal grade of generalization. Thus, a bottom up **generalization** approach and from top to bottom, a **particularization; abstraction/concretion**:GEN-SPEC.

As often, when concepts of a graph come from **production rules** (conditionals), a superconcept should appear on *action-part* in rules. Simetricaly, minimal concepts (those classifying individuals), will only appear on *part-condition* in rules. The rest of the concepts will be between those two layers in the hierarchy. The tree may be balanced forming a pyramid (Brugos, 1992).

Under the node named 'image' (individual global image) there are nodes, whose skeleton is established by **IsaPart** relationship, but could even be these **Prof** relationships (relationship or 'physical' properties, such as for example, 'to be left/right of"', 'over', etc. This set of nodes constitutes the named Perceptive Graph also hierachized, providing the reconstruction of a global image and its partitions from its parts: ALL-PART relationships. Thus level by level it can go raising through hierarchies of parts.

For the Physical Graph, this approach seems to **NALIG**, (vide, for example, Understanding scene descriptions by integrating different sources of knowledge, F.Giunchiglia,Int. J. Man-Machine Studies, 1992, 37, pp.47-81). This group began in Padua near 1984 and then in Edinburgh. And also it's very near to a german group (**Sagerer, G., Niemann, H.,** 1997**)**

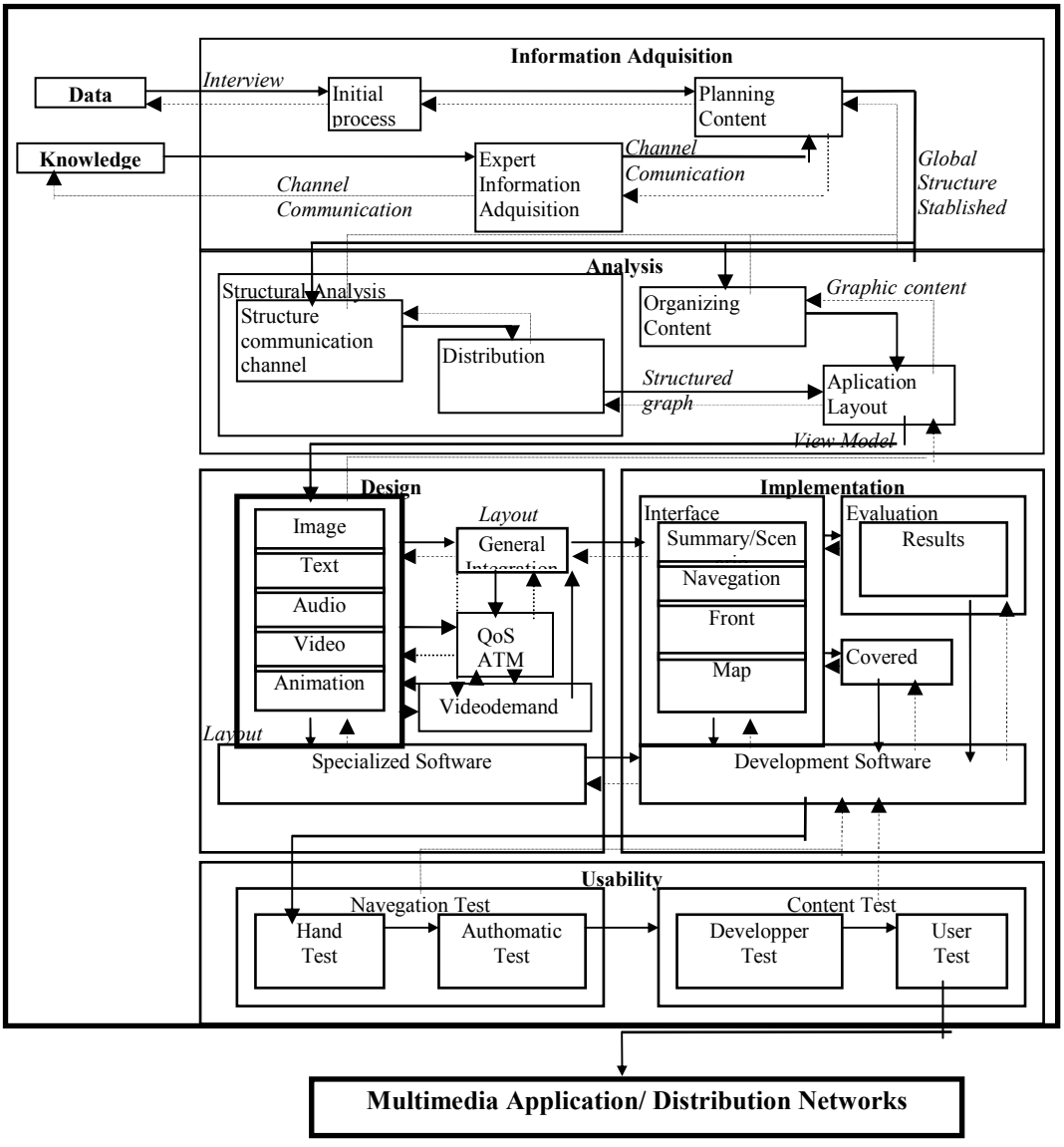
Graph of Classes of Partes links to Conceptual Graph from a concept which cover global image, of course is a kind of this concept related by Ako. Minimal graph corresponds to the parts of a global image, i.e. that its skeleton is the same as that IsaPart provides. Its importance consists to allow parts as classes of parts (or concepts) assigning them properties or describing features, and, on the other hand, allow classification of the parts of different images with parts in common, i.e., can filter the

common parts of different objects. Obviously, this possibility provides the distinction between essential parts and accidental parts to find the 'essentia' of a concept or its definition.

So, we could have sets such as:
1) Parts of image;
2) Spacial Relationships between parts;
3) Physical Properties of parts (or of exemplars);
4) Reconstruction of an object from its parts.

Thus Semantic Networks (RESMUL), and an Index, and flow diagram, transition diagrams or statecharts, can be used to facilitate, on one hand, the task of knowledge organization and communication with the domain expert, and on the other, the navigation through an entire application, and the last distribution through networks. [Brugos, 93, 95, 97; Sagerer, 97;Neira, 97]

3. The main methodical sketch.



3.1. Knowledge collection.

Knowledge is acquired from experts through filmed/recorded meetings, including videoconferences and the networks which establish communication channels with the said experts. To make this possible a draft of terms and an index of knowledge command are drawn up to facilitate communication with the experts and standardise the information.

The knowledge, the pedagogic strategy and the evaluation form are picked up from expert domain. This is carried out it by means of protocols and documents, and videofilms. The knowledge protocols establish a layout for the knowledge presentation of experts, looking for the possible more graphic and plastic form, for example, outlines, slides, transparencies, graphics, images, etc. The evaluation module represents a minimal subset of the Knowledge Base. Towards decomposition method in goals-subgoals (end-means) a path is settled down (top down) that should be continued between Knowledge Base and Evaluation Modules, the inverse one follows path bottom up. This path provides a strategy adapted to the student-user's profile by means of the student's pattern, preferences, individuality and errors. Genetic programming (algorithms) and fuzzy logic provides system control,and adaptation to the student, overcoming the difficulties of a causal model based on differential equations. Improvement also modulates explanations and personalised help adapting it to students. The Knowledge Base is established as a concept graph, for example, an extended semantic network: a acyclic directed graph interpreted by means of the multimedia objects. These objects are used as perceptive things. The classes worth/necessary for application are called the relevant conceptions. An instance is a relation between an image area and a relevant conception, often events, and its model is a concept with properties, that when they are perceptible we call attributes (real world features). So concepts have attributes and instances have attribute values. Thus we have relationships between classes, perceptive properties, and numerically testable (structural) relationships. The hierarchy forms a three-dimensional structure of parts, gen/specializations, and individualizations. A part is a relationship that decomposes a concept into subconcepts which represent conceptions of the same level of abstraction.There are primitive concepts and primitive actions.

An index can also establish expert/designer understanding of the domain.

The general structure of the requested information is similar to this, supposing that the chapter was the X-th and the section the Y-th:

X.Y.1. Approach
X.Y.1.1. Summary
X.Y.1.2. Lists of topic concepts
X.Y.1.3. Index
X.Y.1.4. Introduction
X.Y.1.4.1. Definition
X.Y.1.4.2. Justification
X.Y.1.4.3. Status quaestionis
X.Y.2. Position
X.Y.2.1. Main explanation
X.Y.2.2. Global approach
X.Y.2.2.1. Subapproach 1
X.Y.2.2.2. " 2
.....
X.Y.2.2.m. Subapproach m
X.Y.3. Conclusions
X.Y.4. Examples
X.Y.4.1. Hypothetical example
X.Y.4.2. Real example
X.Y.5. Evaluation method
X.Y.6. Parallel relationships

We shall now explain certain points of the structure about proposed knowledge. X.Y.1. Approach: *this section tries to advance the insight that will be*. X.Y.1.1. Summary: *paragraph that summarizes the contents of the section.*

X.Y.1.2. Lists of topic concepts: *it defines the specific concepts of the done topic. To propose the definitions whose interpretation is basic for understanding the section, keeping in mind the user's formative level, selecting only the concepts that are supposed unknown.*

X.Y.1.3. Index: *an index that shows the structure of the development of the section.*

X.Y.1.4. Introduction*: introduction that will offer an initial, global vision of the section.*

X.Y.1.4.1. Definition: a *brief definition of the main concept of the section.*

X.Y.1.4.2. Justification: *to explain the importance of the section within the course and within the chapter.*

X.Y.1.4.3. Status quaestionis: the *current vision of the topic and the previous vision*

X.Y.2. Development*: the necessary theoretical explanations, supported by text/vision/sound.*

X.Y.2.1. Main explanation: *an introduction to the global approach developed in the next point*

X.Y.2.2. Global approach: this has the structure of the "Particular Index" seen before. It consists of m points that we denominate subapproachs and which correspond to the titles of each subpart where the content of the section is developed.
"Approach" provides a global vision with subparts. "Position" develops content of the section, and it follows the "Particular Index" proposed by the teacher. "Conclusions" tries to serve the student initially when not having a teacher to contrast own conclusions. All topic will have a series of examples. The teacher proposes a "Method of Evaluation". "Parallel relationships" facilitates navigation for the whole application.

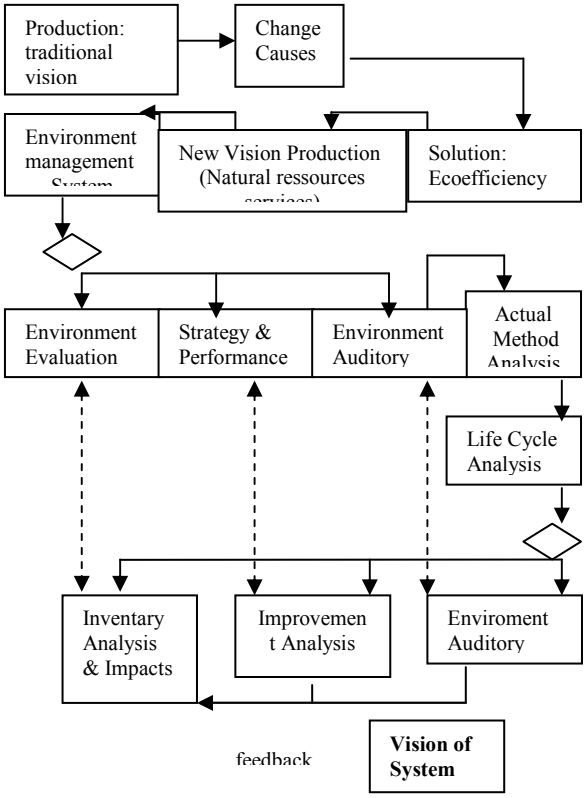
This index serves the designer as much as the expert and user, and this approach should reflect the general structure of domain presentation for the expert. What it cares about here is not the relationships among the concepts, that is to say, the flow of the knowledge, but the formal structure of the organization of the knowledge domain that the expert has. It is also useful to control that we are representing from the expert's complete approach, and that the interface shows at this site. In the case of several experts, this outline has to recover basically all its different visions. This is necessary because the expert has organized his knowledge in a complex way, which is difficult to predict, and he must be able to check that it is reflected from his vision, then for this reason, it should be edited in an intelligible way for him.

3.2. Knowledge flow diagram to navigate

Once the knowledge has been collected, it is organised progressively in an extended, semantic network, or in other words, in a non- cyclic directed diagram which contains roles and partitioned objects such as images and graphs. Sets with these objects are called collective sets as they behave differently to distributive or normal sets. The extended semantic network must be interpreted and translated to multimedia objects and must contain all the expert knowledge sought.

Once we have represented the fundamental concepts and their relationships in a concept graph, the following task is to design the concept flow diagram. This diagram follows the concept flow of the data domain, according to the expert's presentation, and within a scenario accorded to ussers.

This way we obtain the necessary information to determine the actual navigation for the application. Transition diagrams or statecharts can also be used An example for a possible flowchart for the domain of the "Environmental Management" :



3.3. Multimedia objects translation and integration.

A) Main fonctions of multimedia objects (aims).

The knowledge represented in the semantic network is translated to multimedia objects which have the following functions:

a) Text
b) Still (fixed) images
c) Syncronic images (with movement): animations and video sequences
d) Voice and sound
e) Filmed videoconferences (Video on Demand: VoD)

The general principle consists in representing each concept graphically. So each concept must be described with images or graphs giving "prototypes" of its most representative examples, creating an unchangeable description, its script, such as in the making of icons. The essential features which show examples according to the point of view and aims of the expert must be selected. In order to do this examples are collected, classified and classed according to the essential significance of their content. The image, therefore, forms the mainstay and must contain the essential knowledge in all its features and parts.

Still images i.e. scripts, represent nodes on the semantic network, or rather a bunch of nodes.

The text should be explicit and reinforce some of the features and properties of the images so that they have a rather expressive and rhetorical nature. In the case of networks and also in that of videoconferences, those taking part may carry out many of the tasks involved. "Horizontal" communication is established among the participants and the facilitator is given important information which allows more relevant interventions to come to the fore following the criteria of the metateacher.

The animations represent relationships and processes within the concepts, or, in other words, their functional character. Therefore they must show the essential time sequence a process follows and as such, are of great importance in the representation of concepts.

The video sequences have a functional character subsidiary to the animation of processes and relationships, in actual fact they are the realistic version of the animation. They also manage to situate the user in the real context. Taken as filmed videoconference sequences they complement the explanations of the concepts and their relationships, just as the expert or teacher does when he/she explains a concept: he/she uses material meant to show and express a concept, but the important thing is the inner representation i.e. the model which the expert has in mind. The same occurs in live videoconferences where the whole teaching system is put at the service of the expert or teacher, at least this is how it is seen by those taking part. The idea of the teacher or metateacher in our videoconference system is that the whole teaching system be at their service and not the opposite.

Sound is used not only in a rhetorical way but also significantly, as it provides a means of interactive communication between the system and the user mainly by drawing attention to certain actions of both the user and the system, confirming them and helping to create an interface scenario.

The voice is used fundamentally as an aid, in situ, to guide the user and to reinforce interaction. However, in the case of videoconferences it has an even more fundamental function, as it explains and reasons upon the content of the concepts put forward and also constitutes the means of communication between the exponent and the participants. However, as we have already said, we must not lose sight of the general principle that the centre is still graphic representation which plays the role of virtual reality.

The videoconference which is filmed and distributed through video on demand substitutes the live videoconference, putting the filmed sessions of a previous course at the disposal of those who require them. But in our case these filmed sessions will also be used as longer or shorter video sequences, but in short only sequences. Following this approach they will be used with a similar function within the education system. Therefore frames and sequences must be selected and edited for their incorporation in the field of education corresponding to the command of knowledge, or a multimedia presentation.

B) Multimedia objects integration.

Integration is carried out following the norms of the supremacy of graphic representation over all others, exactly the same as when we talk of real world situations in a virtual way. So all the objects cooperate to make a more intelligible image, even sound. We must overcome the idea that verbal communication belongs exclusively to the telephone, although the idea of the videoconference certainly arose as a means to accompany the telephone, making communication more real, but always situated in a fixed space. We must not forget that with multimedia, we are trying to move about and live in a virtual space simulating the reality that exists in our minds. The centre is the communication of ideas through

"harmonious" objects, where said objects acquire a symbolic representation, as in iconic communication. The participant, or user, not only speaks and writes to communicate but he also handles objects; he physically interacts.

So it can be said that the multimedia objects fit around the images, each one carrying out its appointed task. These objects have to be prepared in such a way that they contain the necessary information about their roles and about which other objects they are associated with, either wholly or partially. Therefore, each image must contain in its format all the features necessary to carry out its function of expressing a concept and of relating to other concepts expressed through other images. In synchronous objects the duration and order of the frames are included in these features, together with the main parts. For example, in the action of parking a vehicle each frame must refer to the action of "parking", to the place within the sequence of the action of parking, to the moment in time, to the object contained therein, to the relationship with the other essential objects contained in the rest of the frames etc. The object "voice" must also include these features, such as the duration of the frames they correspond to, including some of the main objects contained in the frames as well as the concepts to which they refer. In this way multimedia objects are constructed containing the necessary objects about their relatioship with other objects and the concepts they exemplify not only to be mutually integrated but also to facilitate the package which is needed for distribution on networks and for communication systems in general. In other words, codfying/decodifying, compressio/decompression and packaging in ATM cells (with a size of 53 bytes) all become easier. So the order in which they are sent will not substantially affect the deployment and use of the objects made by the user. The aim is to facilitate the modular nature of the multimedia objects as well as the so-called Quality of Service (QoS).

In conclusion, the design, the putting into effect and the integration of the multimedia objects will be carried out adhering to a format which fulfills the demands of MPEJ, MHEJ, and ATM convenient for distribution on networks, including its use in a videoconference system and vice-versa as far as the videoconference is concerned. This can be either live or on demand because, within the education system, this is regarded as an object more. In the case of Multicast Backbone (MBone), within the Bay Area Gigabit Network (BAGNet), where IP over ATM metropolitan-area network is tested as the channels of image and sound are separate, the procedure is even more obvious. In this way, MBone tool set is used for multicast audio and high quality video, which employs 30 frames and a resolution of 320x240 pixels (for example, LLNL, Stanford University, Apple, UCB and Xerox-Parc).

4. Distributed multimedia.

This follows the prototype constraints and interface properties, especially the usuability attributes observing task users in action [Hackos, 98]. Norman's seven-stage cycle establishes these seven steps: forming the goal and the intention, specifying and executing an action, perceiving and interpreting the state of the world, and evaluating the outcome.

Video on-Demand (VoD) allows users to decide what to view and when to view it. The ATM (Asynchronous Transfer Mode) Forum defines AMS (Audiovisual Multimedia Service) VoD as an asymettrical service that uses several connections to transfer encoded video from video server to client, typically STT (a set-op terminal) or PC. The decoder in the STT reasembles, decompresses and decodes the streams. It then converts the video signals to analog signals for presentation on a screen. User-Network Interface (UNI) signaling is employed to stablish the video connection between the client and server, which is a point-to-multipoint connection. [Wu, 9]} Through a server of VoD (WEB) can be provide static information to future users about a course, that should be dynamically achieved during videoconferencing sessions. Thus the users can prepare their questions, and the tutor the answers. The courses can be restrict to specific users when this were required.

On the other hand, Distributed Multimedia (networks) requires a Quality Of Services (QOS) of five major elements: a QOS specifation mechanism, control to admitte application without affecting QOS of the other applications, QOS negotiation between application and system, resource allocation and schedulind, and traffic policing, i.e. traffic throughput, transmission delay, delay jitter, transmission reliability and synchronization. That is the temporal relationship which is peculiar to multimedia information, and (inter/intra media) *synchronization* is the problem for generation and replay, rather that in orchestrated (time-independent or discrete) but in live (time-dependent or continuous) applications. Multimedia over a network is *distributed*, at best on Asynchronous Transfer Mode (ATM) and BISDN (Broadband Integrated Service Digital Network) networks (SONET) rely on new integrated circuit switches, since fixed-sized cells are easier to handle than variable-sized cells. MPEG-4, scheduled for November 1998, experiments with wavelet compression, and MPEG-7, for November 2000, that will support interactive multimedia distribution in a multivendor client/server environment prepared by the Multimedia and Hypermedia information coding Expert Group (MHEG) [Lu,96;Raghavan,98;Wu,98]

5. Basic videoconferencing and VoD System

The videoconferencing is incorporated into the system beginning with the analysis of actors and basic elements that take part in the act of teaching with this method: i.e. the organisation of courses, the classes, the intervention of participants, consultations with the teacher/metateacher (experts in the subject) or with the arbitrator, etc. There are the main characters in the activity of teaching/learning who overcome the drawbacks which distance and time produce. Looking for a practical side, we propose the main activities and requisites to carry out Video on Demand (VoD) designing a totally feasible system with the available means and introducing the most relevant aspects for our intentions and in accordance with our proposal for applied and theoretical/conceptual research.

Other aims will not be taken into account here: aims such as the production of multimedia products to be applied and distributed or the mechanisms which provide the whole system with the possible intelligence to communicate interactively with users and are at the service of the arbitrator of sessions and the metateacher, a very relevant figure in our hypothesis.

It is of great interest that our videoconference system be designed according to our theories (DMITS), that it should work and that its performance as Video on Demand be taken into account, as this is the most effective way of considering the system and its use.

A) The initial aims are workable with means within everybody's reach.

- To provide access to the courses being organised to anyone who may be interested.
- To allow, at all times, communication between student and teacher both during the course and after this has finished.
- To provide participants with material on the subjects being taught.
- To give information about bibliography and references of interest for the present course.
- To facilitate the whole or part of a session which may be needed for reference or study.
- To avoid unnecessary journeys.
- To provide consultations without the need for travelling to the centre.
- To make exchanges among participants available without interrupting or disturbing the normal development of events.
- To allow other activities to take place at the same time as one receives information.
- To have up-to-date centralised information available at all times for users of the systems.

The two figures of **client and host** will constitute the two main groups of the system. The clients will be the users who the system to apply for one or some of the services on offer. The host will be in charge of offering the said services.

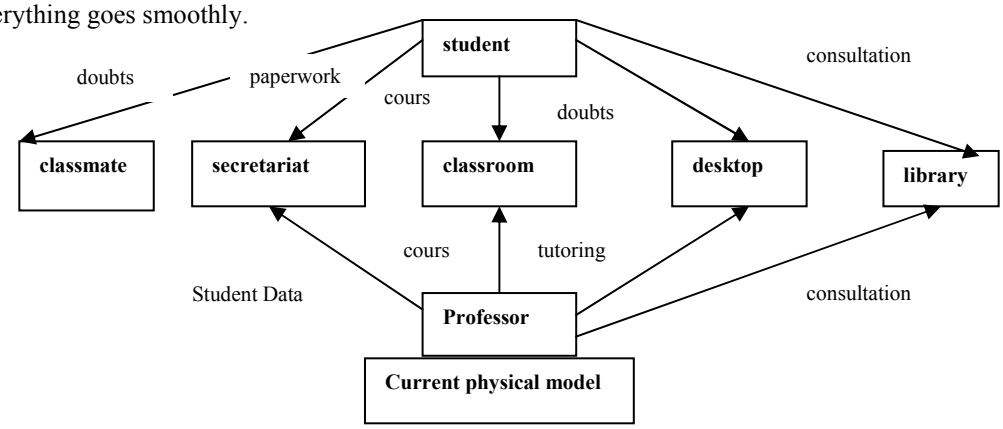
Users of the system are:

Pupils, i.e. those persons who are going to receive and take part in the training courses offered by the system. These are the clients and those who will benefit from the information distributed.

The teachers are the people in charge of giving tuition based on the contents offered by the system for training courses. There will be two types of teacher; the teacher who gives tuition and the metateacher who directs it. Tuition will be given in the form of videoconference sessions.

The organiser is the person in charge of the preparation of the contents and the organisation of these. This person is responsible for everything that happens related to the courses.

The arbitrator will be present throughout the sessions to control their development and make sure that everything goes smoothly.



Here we are not going to expound the techniques which allow the system to behave in an intelligent way. Neither are we going to dwell on its capacity for deduction about accumulated knowledge nor on the behaviour of the pupils and their assessment, in short, on the intelligent adaptation of the system for the users.

The future participant will be able to obtain information on the courses which are going to be held by going to the centre where they will take place, from publicity, from other people, etc. Once he has been informed and has decided to take part, the future pupil will get in touch with the secretary to carry out the necessary proceedings to enrol. Once his application has been accepted, the pupil will be informed of his timetable, the starting date and the allocation of classrooms.

Throughout the course, both pupils and teachers will need to go to the centre.
During a class a reasonable number of questions may be asked, but once the class has finished, doubts must be solved in tutorials at the given time and place, in other words, returning to the centre.

The same applies to dialogues between the pupils-they must take place ouside the classroom.

The same also applies to the use of the library to consult books of reference.

In all cases it is clear that this teaching model (which is the most common) requires many hours and some means of transport. Therefore it is very costly.

Problems derived from the present model:

- Physical limitation on the number of students who attend a course.
- The cost of transport to the centre where the classes are held.
- The cost of transport to use the library.
- The cost of transport to carry out the enrollment proceedings.
- The cost of transport to attend tutorials.
- Similarly, the cost of transport for teachers.
- To the cost one also has to add the number of hours employed, which in the case of the employees of a firm would mean hours of straight productivity.

The **needs** of the present model:

- Courses must be organised in such a way that the expenses produced by attending be kept at a minimum so that all types of pupils may take part.
- Courses must be offered which are given by teachers/experts who live elsewhere without this meaning long journeys or a loss of time.
- Communication between those involved must exist, overcoming all types of obstacles.
- To permit communication between students and teachers at any time without adhering to a rigid timetable, and so separating the student/teacher communication from the place.
- To organise courses in which several experts can take part regardless of where they may be , and to give inter-disciplinary courses.
- To make the development of a course independent from the physical location, which limits the number of people who can attend and is closed.
- To avoid workers on training courses having to leave their place of work, making the training course and their jobs compatible.
- To reduce to the minimum degree the need for journeys and the loss of time, so associated with the present system.

A system must be devised to overcome these problems.

B) The **functional requisites** can be broken down into two blocks which correspond to the two main modules of the system:

a) Requisites of the client:

- To simplify the process of application to attend one of the courses offered by the system.
- To be able to attend any course, regardless of where this is being held and where the student may be.
- To be able to recover, at any time, the whole course in which the student has taken part.
- To have didactic material relevant to the course which may be consulted at any time.
- To make bibliography and works of reference available.
- To facilitate student/teacher communication both during the course and after its conclusion.
- To facilitate communication between the students.
- To facilitate communication with persons not even related to the course.
- To allow access to information of all kinds, regardless of whether this is relevant to the course.
- To provide a schedule, with dates, of the courses to be given.
- b) Requisites of the host:
- The system must automatise all the application for enrolment process.
- To give the courses in such a way that they reach all parts of the country.

- To permit the total recovery of the courses given, but checking that this is only made possible to authorised students.
- To organise the courses in such a way that they are available to anyone who may be interested, in theory to an unlimited number.
- To maintain the information of the sessions which make up the courses given.
- To maintain the information of the didactic material which complements each course.
- To maintain the rules and regulations which must be obeyed when taking part in the course.
- To plan and maintain the information concerning the courses to be given in order to be able to present a schedule to anyone who may be interested.

The **non-functional requisites** are:

- To guarantee security in the access to the courses so that only authorised students have access.
- Similarly, access to video courses must be guranteed. By this we refer to courses which were given previously and may be consulted at a later date, but only by authorised students.
- To provide security in the access to the different didactic material which complements the course.
- To control the development of the course through videoconference sessions, checking that all the participants are carrying out their allotted tasks.
- To make the information reach all the participants, wherever they may be.
- To eliminate the loss of time involved in journeys made both by students and teachers.
- To guarantee the maintenance of the information which the system handles in such a way that the user always has up-to-date information at his disposal.
- To make security copies of the data in the system regularly: of the courses to be given, of the users or clients of these courses, of the right to access of each one and of the complementary didactic material.
- Quality of service (QoS) must be guaranteed, especially as far as multimedia material (image and sound) is concerned.
- To minimise the cost of organising and carrying out training courses.
- To develop a system for PC's.
- All these requisites have the same priority.

Alternatives:

a) With regard to the client's software:
1) The host provides the necessary software which cannot be changed by the client.
2) The client acquires his own software, which will be suitable to take part in the courses.
3) The host provides the software which he considers necessary, but , at the same time, allows the client the option of using his own software.

b) With regard to the transmission of information.
1) All the contents of the syllabus are transmitted on the communication network..
2) The contents of the syllabus are limited to those persons who are authorised to attend the courses, with two options:

- Unicast technique: the host sends a copy of the information to be transmitted to each of the clients.
- Multicast technique: The host sends only one copy of the information to be transmitted.

c) With regard to security copies:
1) The system must automise the process of making security copies of the information maintained by the system.
2) The host must make security copies manually when the system considers this convenient.

d) With regard to recovering received information:
1) The information received can be recovered through the videoconference by means of video on demand.
2) The information received can be stored by each client and personalised as he wishes.

Each of these alternatives has advantages and drawbacks, but one must be chosen.

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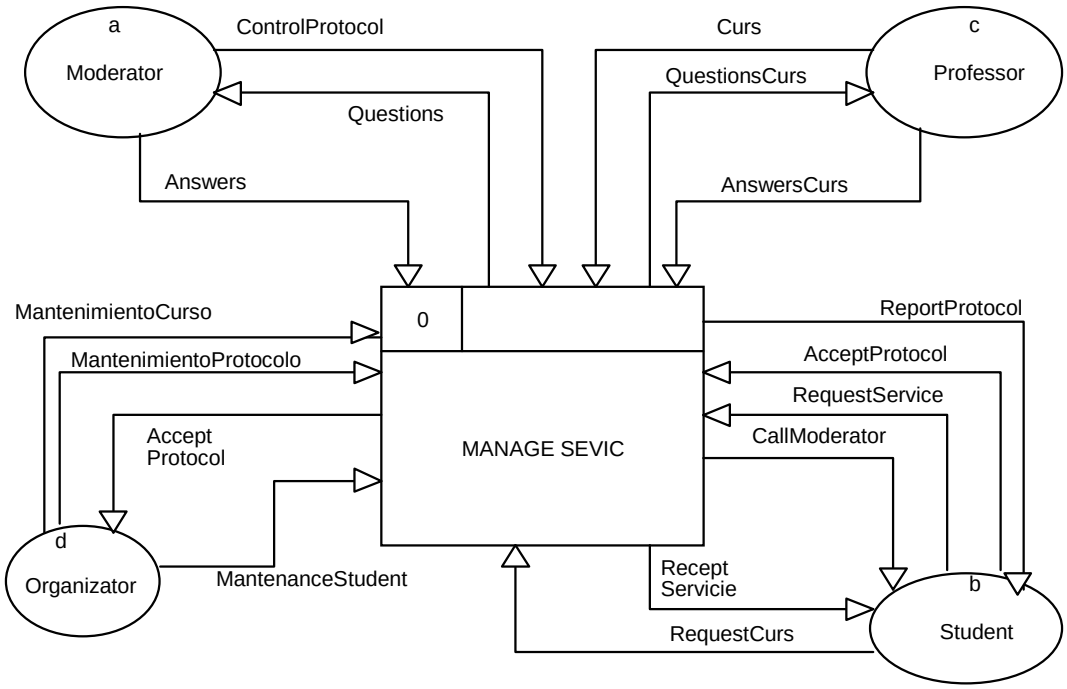
C) System description.

This system carries out all the necessary tasks so that the education system fulfills all its aims: giving classes, recovering them, allowing communication between teachers and students, maintaining the norms of behaviour, maintenance of all the information which the system handles, controlling access and answering all the demands made by the different clients.

Here follows a diagram of the context and subsystems of the system.



C1) Description of components

C1.1) Description of terms

C1.1.1) Term ORGANISER

The organiser is the person who organises the courses and as such, is responsible for the following:

- Contacting the persons who are going to teach the subjects included in a given course.
- Compiling the didactic material which will be put at the students' disposal before the beginning of the course and which will be available on a web page.
- Searching for and compiling bibliographic material related to the course to be given and which will be of interest to the student. This must be prepared in such a way that it is available for students on the web page prepared for such events.
- Establishing the rules and regulations which the participants of the videoconferences must obey in order to obtain a suitable level as far as the reception of information is concerned.
- He will be in charge of receiving applications from students who accept the norms of taking part in the course.
- Accepting students or participants on the course he has organised.
- Once the course has finished he will be in charge of discharging the students and withdrawing the courses.

Needless to say, the Organiser need not be maintained for all the courses to be given in the SEVIC system, or in other words, each course can have its own organiser who will be in charge of carrying out everything related to the staging and development of the course. He will also be in charge of selecting and compiling suitable material to offer the students or users of the course organised by him.

C1.1.2) Term **TEACHER**

The teacher will be the lecturer who teaches the subject of the course, either totally or only the part which has been assigned to him . The method used will be the videoconference. In his teaching tasks or obligations the following will be taken into account:

- He will teach the course subject assigned to him.
- He will answer all questions which may arise during his teaching of the subject assigned to him.
- He will answer all questions and solve any problems which may arise after the course has reached its conclusion.

It must be stated that the teacher is in no way obliged to be in the place where the course is being held, a feature of the course which also applies to the participants and is one of the greatest achievements of an education system which uses the videoconference to give its classes. Besides, there is also the metateacher, who supervises the work of the teacher and of the participants, studying the subject in depth and gathering the most interesting questions.

C1.1.3) Term **ARBITRATOR**

The arbitrator must always be present when lectures are being given. Among his tasks are the following:

- Following the progress of the participants on the courses and checking that the rules and regulations are obeyed so that the videoconference sessions do not lose any of their high quality.
- Granting or denying permission, when necessary, so that the participants do not unnecessarily interrupt the lecturer.

This figure is totally independent from the course being given and may be repeated as time goes by without the quality or the development of the subjects being given being affected in any way.

C1.1.4) Term **STUDENT**

Finally we have the figure of the student who represents the participants in the course. The student has his rights but also his duties:

- The main duty of the student lies in respecting the norms laid out in the rules and regulations and he must promise to adhere to these before being able to take part in the course.
- He must respect the arbitrator's decisions during the training sessions through videoconferences.
- He must provide all that is required of him when he enrols for a course.
- With all the previous points in order, the student is in a position to make his requests.

Obviously there is no limit to the number of courses which a student may attend, but the formalities must be carried out for every one of them.

C1.2) Description of main files

The main files are the following:

C1.2.1) **PROTOCOL**

This file has the information which is related to the rules and regulations which must be respected on taking part in a course which is to be given through a videoconference

C1.2.2) **PUPILS**

This file holds the information which is required of the pupils on enrolling for a course. Apart from the usual personal details, the pupil's E. Mail address will be required as a means of contact with him, both for the organiser and the other pupils who will be on the same course.

C1.2.3.) **CLASSES**

This file will hold the information of courses previously given through videoconference sessions which can be consulted by authorised users.

In one part the complete course will be filed and in another there will be information to identify the users who have access to these recorded sessions.

C1.2.4.) **INFORMATION**

The information file holds didactic material which refers to the courses to be given.This will allow the users to have a syllabus of the classes they are going to receive throughout the course. Both the information relating to the courses and information which restricts access only to authorised users will be stored.

C1.2.5.) **DATABASE**

This file will hold information which may be interesting and relevant to a specific course which is to be given. Thanks to this file the users will be able to make cnsultations about the subject which is being dealt with both before the course begins and while it is in progress. As with the other files there will be informationabout the courses and information to restrict access to authorised users only.

C1.2.6.)**AUTHORISATION.**

This file will hold the authorisation for access which each participant of the courses in progress has regarding the services provided by the system, especially as far as videoconference sessions are concerned, as these do not have to be identical for all users. The file will hold details of the students with the authorisation they have for a detemined course and at a determined time.

C1.2.7.) **REQUESTS**

The requests file will take in the requirements of the participants on the course. Thanks to this file the requests will be dealt with according to their order of arrival. Obviously the details of the request made and the details of the person to whom the request is made will be stored.

C1.3) Description of processes.

Here the proceses of the system will be described in great detail. The processes can be divided into two large modules: on the one hand we have the module of the client or the user who requires the services of the system, and on the other hand we have the module of the host who will be in charge of providing the services required by the clients.

C1.3.1) **Client** management process

This process, as its name states, will be in charge of carrying out the management of all those processes which are related to the figure of the client, which in this case is the same as the pupil.

When a user wishes to take part in a course he must make the necessary application to attend the course. In return he will receive a document listing the terms which he must promise to accept in order to be admitted on the course. He will also receive information about the details that are required of him and information about the course he is interested in.

On agreeing to the terms, the user must provide the system with his personal details as well as his Email address-the means of communication of the education system being presented here.

Once all these proceedings have been completed and the student has been admitted in the system, he will be assigned his authorisation to which he is entitled (the users do not necessarily all have the same privileges).With his authorisation he can then make his requests to the system with the guarantee that his requirements will be dealt with.

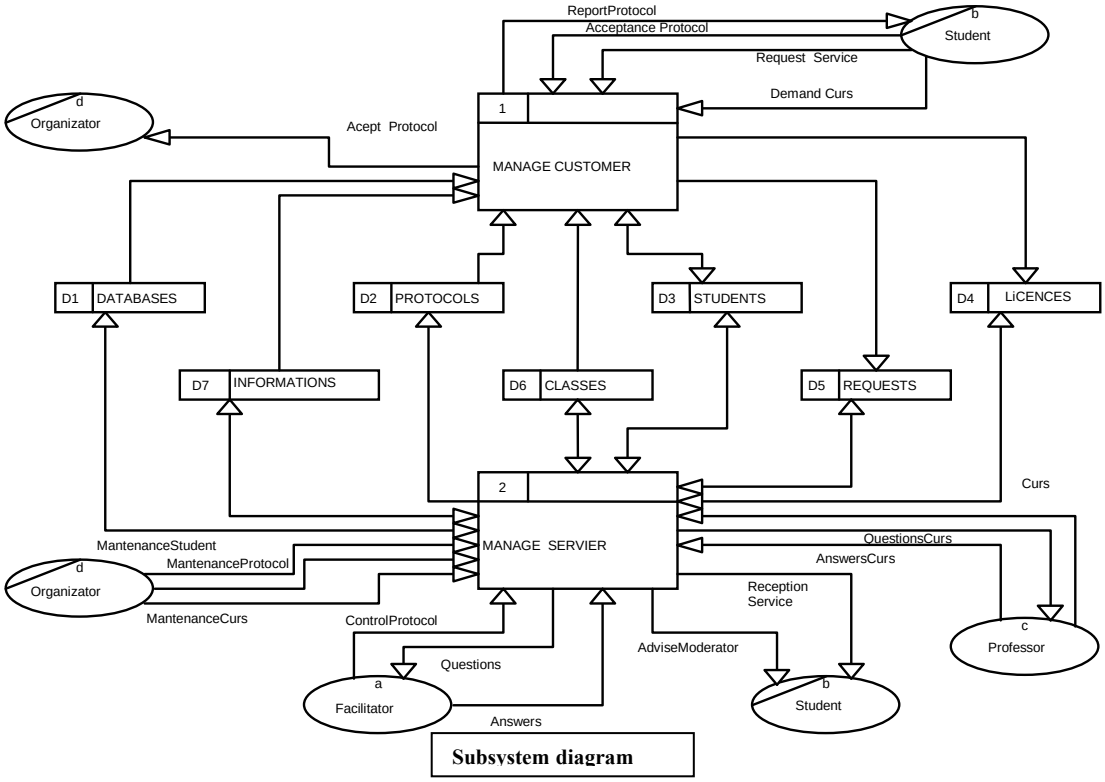
C1.3.2) **Host** management process

The host module will be in charge of carrying out the maintenance of the pupils. He will receive their acceptance of the terms and their personal details and will admit them on the course. He will also alter these details if he is informed of any changes and, of course, he will cross them off the list on conclusion of the course. He will also carry out the maintenance of the established terms which the clients must accept and respect to be able to take part in the videoconference courses.

Similarly he will carry out the maintenance of the didactic information and other information which may be of interest for the course. From this module new information will be introduced, other information will be modified and other information will be eliminated in order to provide the user with the most up-to-date information possible.

This module will also be in charge of controlling the terms and checking that the norms , mainly those related to classes through videoconferences, are being obeyed. He will carry out the necessary measures to avoid interference if any of the participants does not adhere to the terms.

Finally, and also from this module, the different requests made to the system will be dealt with. As the users make their requests they will be dealt with according to their order of arrival. Before providing the service which has been requested, a check must be made to see whether the person has the necessary authorisation and if this is the case the request will be satisfied.



Subsystem diagram

This videoconference application has an easy user interface to configure it by means of a titlebar and iconic tool bars with buttons:

- file, videoconferencing, mail, navigator tool and help;

- icons for operations.

Conclusions

This paper continues to expound on the subject of our researchs into the integration of ITS (Intelligent Tutoring Systems) and TITS (Training Inteligent Tutoring Systems) and CAI (Computer Aided Instruction) within Multimedia surroundings, following the line set out years ago by RESMUL, MITS and DMITS in a videoconference environment. Oviedo University has been a pioneer in Spain in incorporating CAI, ITS and MITS in university teaching trying to achieve not only the training of computer scientists in these techniques and research , but also trying to find a connection applied to teaching centres and the training of workers of firms whose network is surely the most complete.

The main approach lies in reinterpreting CAI and ITS in multimedia environments (MITS); understanding multimedia in the widest sense of the word. This includes Distributed Multimedia, in other words on networks, and therefore also using the resources of videoconferences. So both modules and models (e.g. of the student, of the teacher, of the tutor, of the interface, of assessment) as well as the multimedia objects (receivers of knowledge), are produced bearing in mind their distribution through the available media.

The present paper incorporates the videoconference into this context, beginning with the analysis of the actors and basic elements that take part in the act of teaching with videoconferences, i.e. the organisation of the courses, the classes, the interventions of the participants, the consultations with the teacher (expert in the field) the arbitrator etc, who are the main characters in the activity of teaching and learning, but overcoming the drawbacks which distance and time produce nowadays. Looking for a practical side, we propose the main activities and requisites to carry out Video on Demand (VoD), designing a totally feasible system with means within eveyone's reach and introducing the most relevant aspects for our intentions and in accordance with our proposal for applied and theoretical or conceptual research.

Other aims will not be considered in detail here; aims such as the production of multimedia objects to constitute applications and be distributed nor the mechanisms which provide the whole system with the necessary intelligence to communicate interactively with the users and are at the service of the arbitrator of the sessions and of the "metateacher", a very relevant figure in our thesis. We will concentrate mainly on the outline of the integral method.

As far as the system of videoconferences is concerned, what interests us here is that it be designed according to our theory and that it work and that its functioning be considered in the form of Video on demand as this is the most practical way to consider the system and its use.

A instruction system must be able to incorporate **desabled** peaple. To make this possible suitable economic interfaces must be avalable by means of sons and ultrasonic sons, radio waves, to brain paralytics, tactile wrist to deafs and blinds, allowing access to PC's and Internet, implementing tools to develop characteristic languages of this population (SPC, BLISS, etc.), creating author languages (Inteligent Tutoring Systems and Training Systems) in order to professors can incorporate instruction (by example, "global instruction", entertaning plays, etc. , training management, job, etc.

We believe we have managed to formulate a reasonable, feasible proposal which fills us with optimism and hope and we are sure we will be able to continue developing the system progressively until we obtain full integration of MITS methods, i.e. our research and experience in Intelligent Tutors in Distributed multimedia environments.

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