Knowledge Transfer in the Field of Telematics, in a Didactic Communicational Context Realized with Hypermedia Support

Abstract: This paper describes part of a university research project which aims to construct a design method involving interactive multimedia products for knowledge acquisition. The purpose of the method is to design truly interactive multimedia products (Vidalenc, 1997), and thus to introduce a new form of writing. This is built up by adopting a constructivist paradigm that is based upon a systemic view and upon a network approach such as proposed by the sociology of translation (Caillon, 1986). All our reflections are indeed based on the differentiation between two levels of information: an internal level and a sensitive level (Bouzidi and Vidalenc, 1997). However we have chosen a common model, the object oriented model, which allows us to represent the elements belonging to each level. In order to prove the validity of this proceeding, a prototype is under preparation. It is founded on the transposition of a course, which deals with telecommunications and networks, into a multimedia teaching tool. To be able to build up the prototype, taking into account the usual steps (writing the requirement schedule, choosing the necessary technology, modeling, design, implementation and evaluation), and after that, to be able to measure the conception method, a stage of analysis and assessment of the present course is necessary. The analysis of the course must allow us to identify the conditions of the knowledge transfer and provide components for the requirement schedule of the hypermedia product. This is the main subject of our reflections.

1. Project, its ‘Episteme’, its Methods

1.1. The Object Model

The object model proposes several schemes that permit the representation of information and seems to be useful in the context of a design method for a didactic hypermedia product. The object model makes the Modeling of the prototype easier as soon as we start to create the very first objects that are autonomous. Moreover everybody taking part in the construction of the product is able to add his own objects, and activate them without changing the previously established construction.

The first term to explain is the word «object». An object is an abstract entity that is autonomous and active. It can be described by a set of properties each defined by a list of values, and can exchange signals with other objects of its environment. When an object receives a familiar signal, it launches the corresponding script; consequently there are several «signal, script» pairs associated to one object. And then this object is able to send a signal to another object. An object becomes real at the moment it occurs; it is then unique, identified by a number. Each of its properties is given a value, and it can interact with its environment.

A class can represent a common description to several objects or other classes, i.e. a list of properties and «signal, script» pairs. It constitutes a structure which allows us to share characteristics and which represents the prototype of a certain number of elements. Classes or objects can inherit the characteristics of other classes. However each object can have its own characteristics different from and prevailing over the common description.
There exists also another kind of relation between classes and objects. It is a «compound-component» relation called aggregation, which allows us to create classes made up from ingredients (for instance a car is a class made up from wheels, an engine, etc.) These classes are different from mathematical sets composed of similar occurrences. In the case of aggregations there is no inheritance of characteristics but the mark of a hierarchical and united link between objects and classes. The relation is quantitatively defined. We have also an associative relation, already used in the case of the relational model, which is able to specify links between different objects or object classes.

We consider the hypertext model as a kind of inexplicit object model. It employs close concepts specialized in interface objects: information nodes, screens, text fields, images or buttons. There are also frames of shared properties like the background in HyperCard. More generally, a hypertextual link is only a form of a particular script (a script for moving towards a node) launched upon the click signal sent by an interface object. Figure 1 shows some objects identified during our analysis of the domain of telephones.

1.2. The Two levels' Conception Method

Our method for the development of hypermedia products is based on splitting up information into two levels: an underlying level of conceptual information and a surface level of perceptible information. Conceptual information of a domain has to be discerned (seen, read, heard, etc.) through perceptible information channels. During the process of modeling, the associations between conceptual objects on the one hand, and perceptible objects on the other hand can take different shapes (hierarchy, scenario, etc.). Therefore, there will be a kind of duality regarding particular representations.

In our models, information is structured with objects, and thus restored autonomous and reactive. We are seeking to identify objects, properties and scripts, as much as the links between them. But the two levels are not distinct worlds. The benefit from structuring into two levels stands precisely in the links we can find between underlying objects and perceptible objects. Figure 2 shows the two levels and the relations we can immediately observe between them.

Figure 3 points out the organisation of a multimedia product as we imagine it. The reader's access is confined to the surface level and is forbidden all kind of modification, while the author's access is made to handle both of the two levels. According to the hardware and the software chosen, first we have to build author's soft tools, and then, with the help of these, we shall produce the objects by the common effort of the research group. Afterwards, the product will be proposed to different kind of users playing the role of the reader or the author.

1.3. A Network Situation

A network is a meta organisation gathering together humans and non-humans. We regard the course and the hypermedia product as a network. When we analyse the course we do not cut it into parts but link together all the entities playing a role in the situation. This principle is inherent to our hypermedia conception method.

We try to grasp interactivity in all its forms, we do consider the course situation as interactive situation. Our analysis does not assess the course only as a written document recited by the teacher. We also examine the new learning situation brought forward by hypermedia. For example, we find it useful to allow the user to add his own information in order to acquire knowledge in a more efficient way.

For the hypermedia product we are planning to set up a system of interface parameters by taking into consideration the user characteristics, the social and cultural representations and, in general, the interactive situation. Our two level constructions will facilitate this system
of parameters by preserving common objects and only varying some properties and associations. Actually, for the construction of a hypermedia product, it appeared necessary to analyse the Human - Human context of a course, with its Human - Support - Human alternative, in order to examine the issues it brings up. As a matter of fact, the new Human - Computer context cannot be a simple transposition of conceptual contents.

2. Methodological Principles Sustaining Analysis and Evaluation of the Course

2.1. A Method that is Non-contingent on the Domain

Our wish is to develop an analysis method, as in the case of the product conception method, which should not be inherent in a particular domain of learning or abilities. Whatever the knowledge domain to organize may be, we should be able to apply it. We are seeking methodological invariants, valid at least for the transfer of a course onto a hypermedia platform.

We have examined Didier Paquelin's research (Paquelin, 1996) that aimed at building a hypermedia conception method to help learning. By observing a learning situation, he focuses on the reactions of the learner who must resolve a problem using hypermedia. It is a kind of learning by doing. Thus, Paquelin's conceptual model identifies different spaces; a space of problem solving tasks, a space of mediation, a space of objects (the knowledge corpus of the domain) and a space of subject (the learner).

He uses conceptual mapping as a tool for forming the space of objects as much as for permitting the discovery of a solution by learners. Five types of concepts are identified; meta concept, concept of state, concept of transformation, concept of intervention, elementary concept (see figure 2.2 p. 88 of Paquelin's article). According to the author «this identification and categorization do not get a universal value, they are in accordance with knowledge corpus. Each concept owns a state and is defined by a text which can be complemented by icons. For every concept a range of values is settled». An example of using conceptual mapping is thus proposed by the author. It represents an «Earth to Soil» project, the goal of which is to induce the learner to control the components of the fertility of land. It is necessary to redefine the typology of concepts for each new domain. Concepts are connected by a conditional reasoning between an «uphill slope» concept and a «downslope» concept. For example: \( \text{IF} \) the Ph level is small in the soil, \( \text{THEN} \) the root absorption decreases. Two important points distinguish this method from ours.

The identification and the categorization of the concepts do not own a universal value. They depend on the knowledge corpus. As far as we are concerned, we are seeking the invariant in the methodological process, particularly referring to a course style in our study, and more generally, in those cases when knowledge transfer is at stake.

For Paquelin, the meta-concept is the pedagogic target at the root of the application, in some way the result that determines a descending analysis process towards elementary concepts. Thus he talks about hierarchy and oriented links which allow us to define an «uphill slope» concept and a «downslope» concept. And as we have just seen it, he determines the algorithmic sequences (\( \text{IF} \ldots \text{Then} \ldots \text{Else.} \)) in our view this kind of modeling typically lies on a processing approach with a high level of contingency. The object model that we chose presents a much more independent approach that combines data and processes in an encapsulation logic. Next to a contingency related to the domain, we can find in Paquelin's theory a contingency that is related to his objectives: problem solving skills.
2.2. A method Built on the "Object - Pedagogical Function" Relation

The theory developed by Maia Wentland and Eddy Forte (Wentland and Forte 1997) is much closer to ours. They presented the HIPOCAMPE project, in which we found particularly interesting their proposal of a pedagogical modeling of a knowledge domain relying on a reference book or handouts and trying to find the essential concepts treated in an explicit definition in the text and the so-called simple or required concepts not having their definition in the text. According to the authors, the definition of each concept has to be expressed with the help of relations between other concepts so that the user understands it better.

Beyond the definition of the concept itself, the authors propose a model for the different arguments of each concept. These arguments are determined by their pedagogical function in connection with the concept. Wentland and Forte present three big functions of the arguments, broken down into more precise roles: familiarisation (introduction, simplification, comparison, recall, digression), clarification (observation, demonstration, description, reformation), reinforcement (illustration, justification, discussion, recapitulation, corroboration).

Each concept is characterized by its number, its etiquette, its style, its nature, its type, its extent of complexity and its topographical mark, as well. All these form a conceptual network of the domain. This method was applied to different domains without any difficulty concerning the transposition. The distinction between essential concept, required concept and argument is close to our distinction between object, prerequisites and didactic sequences. Let us consider, however, some significant differences.

Our object perspective allows us to identify quite precise properties. Thus the understanding of the inheritance-specialisation relations can be translated by a family property. Also our didactic sequences are different in several points from their arguments. They employ a functional classification by a temporal aspect of learning (familiarisation, clarification, reinforcement) that appeared to contain some ambiguities. For example, we found that the resemblance by analogy that is situated in the function of familiarisation might have been also put in the function of clarification. Moreover, in their model the arguments are associated with only one concept, whereas our sequences can be independent and some of them can even manipulate several objects.

2.3. Research Principles Based on the Distinction between Actual and Possible Situation

We are planning a product which can be used in two ways. With its help students can complete the notes of the attended course, and also distant (in time or in space) users can study in an efficient way. Thus it is not the aim of our project to transpose a course delivered in oral or visual form literally. In the case of the first type of users we would have redundancy and in the case of the second all interaction necessary for knowledge acquisition would be impossible. Our analysis is presented as a diagnosis that is explained below.

- What appears in the actual course.

In order to apprehend the nature of the actual course an analysis of the current support and of the verbal contents is necessary. The analysis of the current support is essential as much as concerning its form and its contents as its use. In fact, observing the use of the support can help us to understand better the potential uses of the hypermedia product, and also the pertinence of certain schemes and figures.

The analysis of verbal content is organised around two main aspects: (1) we can try to find the different sequence types that can be identified, and also (2) the conceptual objects or manipulated physical objects, as well as their properties, methods and relations. A strict observation of the time of comprehension, of reaction or answer is going to be equally
essential for the characterisation of the pertinence of the explanation provided to different audiences.

- What is not included in the actual course.

We are going to make use of the interactivity and the individualisation of the use of the product. It is going to allow us, among other things, to answer the questions and satisfy the needs of each learner in an individual way, as well as to integrate acquisition balances which make it possible for the learners to locate their new knowledge and shortages, and to help the users to correct their own mistakes.

3. Analysis and Evaluation of the Actual Course

3.1. Observation

The object we start with is more complex than a traditional course and henceforth proposes several sophisticated multimedia and interactive mechanisms. In fact the teacher has contructed a visual aid, which at one and the same time is printed on paper and handed out to the students, and projected on a screen during the lessons. For this purpose he has used the soft Powerpoint which is a CAP (Computer Assisted Presentation). The use of the support implicates for students to take notes below the printed screens.

The phase of observation has taken place during December 1997. Several observers attended the course which was recorded on tape. A few of them have taken notes like students, others have watched interactions. A sample was set up using a questionary which was intended to appreciate knowledge of the students. in order to observe the use of the support and the rebuilt capabilities, some annotated support were recovered at the end of each lesson. In that case, our intervention consisted in analysing the way by which capabilities connect with themselves and the way by which the learners and the teacher interact.

In order to estimate the value of the product and to improve it, a second period of observation will be organized. Afterwards, a new questionnaire will be applied. Several schemes from the support will be proposed to the students so that they may annotate them during unannounced tests. This process will be repeated after a while, to complete the analysis finding the possible changes. The discriminant criterion seems to us coming from differences between audiences, as the teacher and the support are always the same. At last, we will submit our analysis to the teacher's reactions, and we will ask him to compare the context of the course, his pedagogical objectives and the control he has chosen.

3.2. Modeling

In a first stage, the modeling process is mainly oriented towards the real situation. As we indicated before and similar to the approach of Wentland and Forte, who distinguish arguments and concepts, we focused on objects and pedagogical sequences (also called didactic). We aimed to characterize pedagogical sequences building up a classification and to identify objects emerging from the speech, associating them with a certain number of properties.

The identification of pedagogical sequences proceeded in a constructivist way: as soon as they were identified, a taxonomy was worked out and became fixed on a three level tree. The first level allowed us to distinguish explicative sequences, interactive sequences and structural sequences, at this time it is used by the research group members to enhance the quality of the CD-ROM analysis grid. The second and the third level answer to a will of itemizing the sequences (see Figure 4). It is at the third level that the instances of the discourse are drawn up.
The identification of the domain objects, considering the thread of the course, takes place in a widely preestablished frame. Effectively, the adoption of the model object as a methodological choice, leads finally to produce a classic modeling as OMT, OOD or equivalent. And in order to collect the independent objects, we had to create a kind of locating grid to find the properties as Figure 5 shows it. In the end, the transcribed text of the course is annotated with identified objects, their associations, and the pedagogical sequences stirring them up. This linear exploration of the course takes us to identify undefined concepts or ideas which take place in the discourse. These are the concepts we classify as prerequisites. We can cite as examples: X25, OSI, Internet, Ethernet, prime numbers, CCITT, impedance.

3.3. The conditions of transposition

The transposition presents three objectives. The first one consists of restoring the exhaustive content of the teacher's course as well as in translating the pedagogical mechanisms used by the teacher. The second runs in an enriching ambition that can be expressed by way of the identification of implicit notions and of the most efficient pedagogical sequences. At last, the third one stays in the capture of opportunities proposed by a multimedia system. Having adopted these principles, the different models we have previously described, propose some answers in the following way:

- The restitution of the course is realized through the identification of the objects and the classification of the didactic H-H sequences. A validation which uses criteria of pertinence and efficiency and allows a hierarchical construction, is achieved by the analysis of notes and the examination of the tests (contents, interview with the teacher concerning the expected results, examination of the students' answers, interviews with the students concerning what they thought about the tests) together with a subsequent evaluation carried out by the members of the research group.

- The enrichment of the product is based on the methodical identification of prerequisites in the whole recorded discourse (concepts, undefined notions), it is also based on the study of the exercises and controls to identify missing but expected knowledge. Finally, it is also founded upon the examination of the annotated supports to identify prerequisites considering the deficiencies of the understanding. Moreover, a diachronic approach is introduced in our network of objects (Callon, 1986) by repeating the whole process (recording and analysis) with other groups of learners. These iterative processes aim at the improvement of both didactic sequences and content.

- At last, the exploitation of the opportunities of multimedia tools resulted in the construction of the evaluating method of the CD-ROM. It allows us to focus on the possibilities of transposing the marked didactic H-H sequences, and it enhances the universe of possibilities, finding new sequences in relation to the H-C situation.

In conclusion, with the help of our method which is built by adopting a constructivist paradigm and a synthetic point of view, we have taken up the elaboration of a hypermedia product which is mainly oriented by user's requirements. We have turned aside from the single constraint of a change of support.
Figures

<table>
<thead>
<tr>
<th>phone</th>
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<tbody>
<tr>
<td>phone number</td>
<td>type : draw</td>
</tr>
<tr>
<td>model:</td>
<td>color: none</td>
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<tr>
<td>conditioning: 2 parts</td>
<td>spatial coordinates:</td>
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<tr>
<td>shape:</td>
<td>activation</td>
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<tr>
<td></td>
<td>activate &quot;phone&quot; object</td>
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</tbody>
</table>

Figure n°1: Some objects identified

INTERNAL LEVEL

En 1876, le premier téléphone ayant fonctionné est celui de l'américain Graham Bell.
En 1876, Elisha Gray présenta un prototype convaincant.
Le premier central téléphonique est mis en place aux États-Unis en 1878.
En 1929, la visiophonie à titre expérimental.

INTERFACE

story

<table>
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<tr>
<th>type : text to read</th>
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<tbody>
<tr>
<td>police : times</td>
</tr>
<tr>
<td>taille : 12</td>
</tr>
<tr>
<td>spatial coordinates:</td>
</tr>
</tbody>
</table>

• take dates and creations about phone in "invent" objects
• compose history text
• make the text appear

SENSITIVE LEVEL

Figure n°2: Some relations between the 2 levels of our method

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Séquences explicatives
- Définitoires et Définitions
- Analogiques
- Illustratives
- Graphiques ou Schématiques
- De reformulation immédiate paraphrasique

Séquences interactives
- Rhétoriques / de captation
- De commentaire synchronique de planche
- Enchaînements: question/réponse/développement
- « Subjectives » d’opinion
- « Utilisation d’objets supports »

Séquences structurelles
- « Plan »
- De reformulation synthétique
- De rappel/appel

Figure n°3: Organisation of our futur multimedia product

Figure n°4: Our didactic sequences
- FONCTIONNEMENT
Processus de transformation du signal analogique en signal numérique et d'acheminement de celui-ci.
- FAMILLE
Mode de transmission / phénomènes de numérisation
- HISTOIRE
Numérisation du réseau téléphonique
- OBJETS ASSOCIÉS DU DOMAINE
transmission analogique, modem, techniques de contrôle d'erreurs
- OBJETS ASSOCIÉS HORS DOMAINE
- USAGE SOCIO-ÉCONOMIQUE
convergence technologique: TV, CD, Audio, Ordinateurs ...
- PRÉREQUIS
numération binaire
- OBJECTIFS
accélération vitesse de transmission et fiabilité
- NIVEAU D’ANALYSE
- SÉQUENCES D’UTILISATION

Figure n°5: La transmission numérique, one of our objects and its properties

References