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Designing pedagogical hypermedia : An information-centered approach.

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Introduction

Tutoring systems represent one of the new answers offered in order to fulfill the new needs engendered in the field of education. There is a need for more research to integrate such solution into real applications. In order to submit solutions for the design of pedagogical hypermedias, we adopt an approach based on the study of the specificity that the support carries. Whereas textual documents rely on spatial representation [Goody 79], "numeric information are computable, and only computable" translated from [Bachimont 00]. The internal representation of information in a computer is not linear, and this delinearization determines the design of numeric documents since a new way of representing information has to be adopted.

After having studied basic concepts (information-unit, internal structure, external structure) to deal with non-linearity, we describe a design approach based on the integration of four surveys (pedagogy, information modeling, drafting and edition). Finally we conclude introducing the advantages such an approach could bring for the design of Intelligent Tutoring Systems.

An information-centered approach

Because of the non-linearity of the information representation in a numeric support, we propose to model an hypermedia as a graph, *i.e.* a set of nodes and links between them. The first implication of such a representation is that that the reading depends on the way the nodes are accessed (*i.e.* computed). Indeed, a node is a computation-unit. Since books or videotapes impose the reading process (one page or sequence after the other), numeric supports do not: the reader is expected to build by his own a proper linearity. Therefore, there is no guaranty on what the user has accessed before, and what he will access then, while reading a computation-unit. We submit the following hypothesis in order to deal with this problem: the information representation in hypermedias should be based on **information-units** corresponding to computation-units. We define an information-unit as a node of the graph, which reading is necessary and sufficient in order to understand a concept. This implies that information-units are indivisible and independent from other units.

Two questions emerge from this representation: How to manage the interaction between the set of media that compose an information-unit ? How to manage the interaction between the set of information-units that compose an hypermedia ? The **internal structure** of an information-unit represents the explicit logical structure of the different kinds of media that compose it and the relationships between these media (see example Figure 1). The **external structure** of an information-unit represents its explicit conceptual links with the other information-units that compose the hypermedia (see example Figure 2).

```
<!—Information_unit.dtd -->
<!ELEMENT information_unit (exposition | exercise | question | evaluation | theme)>
  <!ELEMENT exposition (title, contents)>
  <!ATTLIST exposition type (definition | methodology | example) #REQUIRED>
    <!ELEMENT title (#PCDATA) >
    <!ELEMENT contents (principal, redundant*, complement*, illustration*) >
      <!ELEMENT principal (written_text | didactical_image)>
      <!ELEMENT redundant (written_text | didactical_image | speech | animation)>
      <!ELEMENT complement (didactical_image | speech | film | interaction)>
      <!ELEMENT illustration (image | music | sound_effect)>
  <!ELEMENT exercise (title, contents)>
  <!-- etc -->
<!-- etc -->
```

Figure 1: Example of internal structure (XML formalism)[1]

[1] This example and the following are extracted from a pedagogical hypermedia we realized and used for the teaching of the basis of algorithmic.

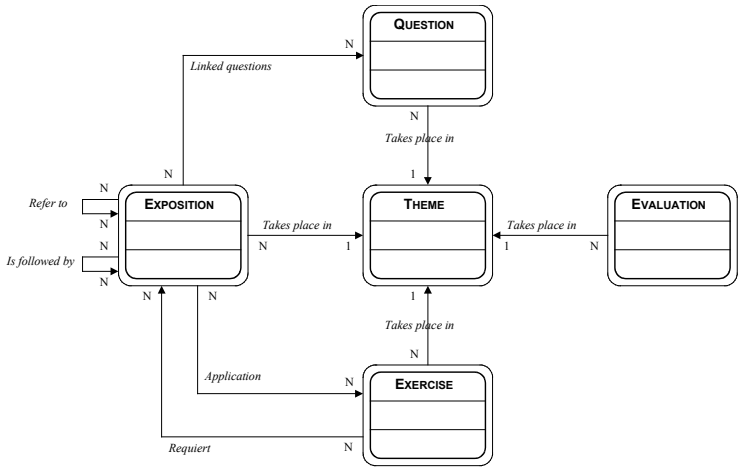

Figure 2: Example of external structure linking different Units of information (OOA formalism)

A four-levels design method

Having adopted the previous concepts, we identified four distinct functions in the design process:

The **pedagogical survey** comes first, its purpose is to explicit the pedagogical process in order to identify the role the hypermedia can play within it. We submit a methodological tool in order to help the expert. This tool is based on the description of the process in term of discrete pedagogical acts[2] [Ghitalla, Boullier 99]. The organization of these acts constitutes a model that can be easily used to focus on the aspects that the hypermedia can partially or totally manages.

The **information survey** translates the model of the domain (the pedagogical acts organization), in order to build the information structure and model the hypermedia. This step becomes quite easy since we identified an equivalency relationship between a model of acts and an object-oriented model.

The **drafting survey** uses the information structure in order to write the contents following it. We provide a set of tools in order to assist on managing the multimedia context (such as classification of the media, elements of choice between them, elements of concurrence managing between them, etc. [Crozat 98])

The **editing survey** realizes the human-machine interface, in order to make possible the manipulation of the information by the user. Through our previous researches [Crozat & al 99a][Crozat & al 99b][Crozat & al 99c][Crozat & al 99d] we built an ontology of multimedia learning software interfaces. We presently propose to use this ontology in order to guide the editing process.

Perspective: From structured hypermédia to Intelligent Tutoring Systems

The researches we have summed up in this paper are a submission to manage multimedia information on a numeric support, in order to use it in a pedagogical context. Whereas it could be applied to others domains, it seems particularly relevant in the field of education since information and its manipulation remains a central difficulty. The interest of such an approach is increased when introducing artificial intelligence to the system. The intelligence of a tutoring system can be seen as the automatic guiding of the student in the hypermedia, depending of a dynamic model of the training. If this hypermedia is structured, it can be easily related to a student model and manipulated by AI engines, in order to infer the best information at the best moment for a determined student.

Further works could be oriented toward the combination of the design methodology we described along with the introduction of intelligence in the management of the reading scenario. For instance the disturbing agent presented in [Piché & al 98] could be generalized to several kinds of hypermedia. Having a structured hypermedia, one can imagine to add such an autonomous agent. Therefore the modeling of its interventions is facilitated when based on the existing explicit structure of the hypermedia. In one hand the information structured in the hypermedia can be reused in order to help in implementing an AI engine, and in the other hand AI engines can be reused on distinct structured hypermedias.

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[2] Examples of pedagogical acts : formulate, develop, demonstrate a concept, do an exercise, discuss, …

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