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Writing multimedia pedagogical hyperdocuments: For an integrated design environment

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Introducing computers in education can be an opportunity for teachers to invent new pedagogical process. Multimedia learning software is not the universal solution to all the instructional problems, nevertheless it comes with its specificity and imposes new ways of thinking pedagogy.

Three main approaches can be distinguished to design multimedia numeric documents. Documentary approach is based on logical structuring of documents. Multimedia approach intends to exploit potentials of each kind of media, along with possibilities of dynamic interaction with users. Pedagogical approach search to solve local didactical problems by computer mediation.

We advocate for the integration of these three fields in one single way of thinking. We shall present a methodological environment we are building in order to assist designers from specifications to final evaluation.

Keywords: **Instructional design, Development methodologies, Multimedia.**

1 Introduction

Knowledge transfer takes an increasing place in our societies. Different ways of teaching appear, concerning more and more people, beginning earlier and earlier and ending later and later. We do need new tools to answer this new demand. Learning software could be particularly useful in case of distance learning, along-the-life learning, very heterogeneous skills in classes, children helping,... Our thesis is clearly not to pretend that software could replace teachers or schools. However, in specific cases, new supports are particularly advantageous, and can be integrated in the classical teaching process. Nevertheless, close to this new policy, we have to take into account that today's learning software are not so much used. There is no reason why this support should not find its role along with the books, the traditional teaching methods in schools or firms. Thus we think that its relative failure is due to the poor quality of the current products, compared to what they could offer and what the users expect them to offer.

Using computers in education implies inventing a specific way of writing multimedia documents. The experience accumulated in the domain of text drafting enables pedagogic actors (mainly professors and students) to have an efficient use of this well-known support. Numeric documents do not have such a practice to refer on, that is why people who want to design numeric support have to create original way of writing.

We propose to distinguish between three main approaches, the first one centred on documentary discipline, the second one on multimedia and the third one on pedagogy. This

distinction will lead us to suggest integrating this three ways of thinking into one single methodology. To end with we shall describe the environment we submit and the application we make on it.

2 Documentary, multimedia or pedagogical approach?

2.1 Structured documents

The documentary approach is based on the organisation of information and structuring of documents. Framework of these environments began in industrial context, where the control of the structure is essential in order to manage large quantity of information. Generally these approaches are based on the **separation between the logical structure and the physical one**. Authors define logical structures and draft following it, and editors use this structure in order to present information to the readers. This approach provides many advantages in our context: Separation between authoring and editing jobs, reuse of documents, helping in structuring redaction, better possibilities of manipulation of the information, low cost edition for several different supports and way of presenting information, ...

The recent studies upon hyperdocuments point out the duality they introduce. In one hand the delinearization of the reading process makes possible new range of knowledge manipulation. In the other hand this delinearization provokes a risk of lost in the hyperdocument, permitting not the sense constitution by the reader [2]. Some principles to assist in writing non-linear documents begin to appear. For instance the use of granular autonomous information is a way of reducing risks of lost, for two fundamental reasons: There is no links inside the text so the reading will not be interrupt by navigation jumps ; The grain does not require having previously accessed such or such part of the hyperdocument to be understood so several meaningful paths are possible [5].

Two main ways of doing structured documents are developed: grammar-based languages and databases management systems. SGML standard is a description language for generic structures. It enables the drafting of tagged documents following a Document Type Definition (DTD). The DTD defines the allowed logical structure of the document [28]. XML standard is an SGML language implemented in order to propose a more simple language for Internet environment [24]. ARIADNE project [15] propose an European shared database of documents to be used in instructional context, in order to enable reuse and lower costs of documents production. The project provides authoring tools and indexation principles that permits a documentary management of the produced documents. Several others local experiments intends to help authors communities to shared documents by formatting, indexing and stocking them in databases, such as SEMUSDI initiative [14].

2.2 Multimedia documents

The bases of multimedia approach is to search the reason why using numeric documents instead of normal ones. For each specified problem this approach tries to find the supplements the support could bring. It particularly tries to benefit from the **dynamic aspects** (i.e. simulation, adaptation to the user, solicitation of user's action, ...) and from the **multimedia potentials** (i.e. introducing visual or sound representation when it can bring a different and complementary vision compared to what classical textual documents already offer).

Authoring tools (like Macromedia Director) provide larger and larger technical possibilities to realise these objectives, whereas they do not provide methodologies to

manage the new potentials and particularities. The research in this domain is oriented toward three main directions: Guidelines to avoid errors in making multimedia software, project methodology to deal with the complexity of the development, and specific authoring tools to control the realisation in particular framework. Guidelines have been largely developed in the usability domain, for instance the large set of rules proposed by Jean Vanderdonckt [29] or the INRIA research [27]. Several works also propose management methodologies for multimedia production, introducing concepts of multimedia story-board, for instance [25], [22]. Some people are also providing project management to deal with their local productions [16].

2.3 Pedagogical documents

The last approach we wanted to illustrate is oriented toward the use of computers in order to **solve an identified didactical problem**. This approach is generally based on pedagogical design innovations to improve traditional teaching, especially around the particularly hard-to-teach aspects of a curriculum. Several efforts are made to have the traditional pedagogy go forward, thinking problems of knowledge generation, sharing, appropriation and application [23]. In this context of invention of original way of teaching, computers are used as a mean to transform, more than a goal to purchase. Multitudes of examples are available in literature, for instance [4] [26] [7] [1].

3 Doing multimedia pedagogical documents

3.1 Integrating the three approaches

Whereas the specificity of paper documents is the spatial representation of information, the specificity of numeric documents is the calculation the computer does on these documents: “The numeric information is calculable and only calculable”, translated from [3]. Written text enabled the spatial representation and the persistence of information with time, whereas oral information was intrinsically ephemeral. Thanks to these new possibilities, new knowledge that could not be formulated by oral appeared (for instance tables make it possible to point out relationships that can not be described orally) [19]. Numeric documents also bring new potentials of information representation, based on dynamic calculation. Our purpose is now to understand how to inscribe information on this support in order to benefit from its specificity. Therefore we would be able to manipulate calculation as a mean to facilitate interpretation and appropriation of the information by the learner.

This position we adopt implies that:

- We need logically structured and annotated documents in order to control their manipulation inside a complex hyperdocument.
- We need multimedia methodologies in order to benefit from the support potentials (multimedia and dynamic interaction) and deal with readability of multimedia documents.
- We need pedagogical design principles and experiments in order to provide useful tools that profit from the support to improve the training process.

The corollary of theses three requirements is our proposition to use a **documentary approach for the exploitation of dynamic, interactive and multimedia documents in an innovating pedagogical process**.

Some examples begin to appear illustrating this unified attitude. We already quote the ARIADNE project, as a mainly documentary one. In fact the project is more complete and reaches a certain degree of integration of the three complementary aspects. Along with the database and the indexation tools, it provides authoring tools that permit a rapid production of multimedia documents (mainly text and video) and make it possible to realise simulation or interactive exercises at low cost. A deep pedagogical research is also at the base of the project, having identified important aspects for the integration of computers in educational process, such as need for communication between learners and with tutors, need for stimulating active participation of the learners, need for motivating them, ...

Other example of recent integration is the elaboration of SMIL standard, a XML-based formalism (DTD) to create and run multimedia presentation. It benefits from several documentary advantages (compared with proprietary authoring tools) in scripts description, such as readable textual source files, use of normalised and shared formalism, possibilities of distributed source files, totally Web compatible, computer sciences skills needless for authors, ... Nonetheless, in our context, a pedagogical adaptation of SMIL DTD would be relevant to achieve the integration of the three components of pedagogical multimedia documents.

In our university the Praxis project (directed by Nicolas Salzmann) links pedagogical and documentary approach. The project assists teachers in inventing New Pedagogical Process (NPP) in order to determine the evolution of their own curriculum. If this evolution requires the introduction of computer aspects in their courses, then they are given authoring tools (based on LaTeX language) to write (or re-write) their documents taking into account numeric specificity and producing granular documents. A shared database (broker) assists them in reuse of contents, documents distribution, documents maintenance, ...

3.2 Toward one single environment

Our purpose is clearly to integrate documentary, multimedia and pedagogical approach in one single methodology. We are developing a design environment for multimedia learning software that largely benefits from previously described strengths of each separated approach. This environment is still in an experimental phase, nevertheless we wanted to end this paper by giving the main aspects of it.

Pedagogical intentions stating: This first step aims at assisting the teacher in charge of the curriculum to state on the pedagogical context he have, and the pedagogical objectives he wants to achieve. We want to use works on pedagogic act definition [17] in order to propose a formal language to the teacher so that he can describe his pedagogical process. Having described his particular process he could then decide if and how the introduction of numeric documents could be useful.

Authoring phase: Having determined the frame of use of numeric documents, the teacher shall write these documents. He then has to be helped in writing the script of the document, including the structure of the hyperdocument, and tools available for the learner to manipulate this structure (reading and rewriting tools). Together with this work, the author has to determine the categories of node the hyperdocument will have (exposition, exercises, simulations, ...) and the logical structure these nodes should have.

Multimedia charter for edition: Once the documents' structure defined, the way these documents will be edited can be set. Our environment shall give recommendations and rules to either implement automatic edition or guide manual one. The guidelines are mainly based on usability of the interface and presentation of the media.

Requirements and quality insurance: The first three steps constitute a set of specifications the actors have to follow in order to produce the adequate pedagogical hyperdocument. Our environment enables the production of a document that summarises all the requirements. This is useful in two ways. It permits to forecast if the initial project is reasonable, for we can compare the choices made by the actors to generally better choices. This drives them to either modify their choices or justify them systematically when they are original or context-specific. The other advantage is that the document can be used to regularly control the realisation.

Evaluation of final product: To end with we use an evaluation tool that organises a set of questions in a criteria-based structure, so that we can underline strong and weak point of the learning software. This last step is essential to estimate if the product can finally be used with large chances of success. Of course only the experimentation of the support and the validation *in situ* can determine if it improve teaching or not. Our methodology can not do more than giving a set of tools to gather the elements that should make possible this improvement.

4 Conclusion

Our submission for design of multimedia learning software is both to integrate documentary, multimedia and pedagogical approach; and to integrate the realisation steps from pedagogical requirements to final evaluation. The environment we previously described does not really exist as a whole, but as a collection of separated tools more or less operating. We dispose at the moment of a pretty ended evaluation tool, EMPI [11][12]. We are finalising guidelines-based prototype to write the requirements documents. We are testing databases structures that could easily support various kinds of documents and relationships between them (script). Our previous research [10][13] provides us a lot of elements we can use to guide in authoring and edition process. We miss the formal elements to help in the stating of pedagogical intention, however we already made some experiences and tries.

The whole principles of our methodology are actually tested and illustrated through learning software we are realising to teach bases of algorithmic in our university.

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