

Changing Interaction Paradigms in Annotation Environments

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Abstract: Implementation of novel learning scenarios frequently implies the adoption of new interaction paradigms provided by new media. Changes on media bring several issues to educational metaphors, such as deciding which characteristics should be maintained, removed and improved. This paper discusses these issues by means of a case study comparing evolving scenarios for the annotation metaphor: from paper-based to hypertext and virtual reality.

Introduction

The design of innovative educational environments involves providing novel learning scenarios, which most of the time requires the support of new interaction paradigms. We start from the aspect stated by the following hypothesis: changes on the medium enable the introduction of new interaction paradigms and further opportunities to improve educational metaphors.

By using "metaphor" we mean the transposition of the meaning of one thing to a different one. For instance, the "text metaphor" supposes a place with visual information (words, graphs, etc.). "Paradigm" is understood as a model for relationships among metaphors and rules responsible to turn them into concrete entities. In other words, a metaphor implies a model (paradigm) and a paradigm is not easily grasped without metaphors (Winograd 98). Metaphors and paradigms exist only over a medium that provides perceivable features. In parallel, media inexorably affect the corresponding interaction paradigm, because each medium is identified by a proper set of rules, which defines possible paradigms. In the case of hypertext paradigm the decisive importance of media in defining the corresponding paradigms is shown. This paradigm was described by Vannevar Bush (Bush 45) to be implemented on microfilm medium, but it really succeeded when a more adequate medium was adopted (the digital text).

Therefore, the adoption of new media requires a careful study of how they affect the current paradigm. A second problem is then stated: how to deal with metaphors in consequence of changes on paradigms and media? Which characteristics should be maintained, eliminated and improved in the new implementation of the metaphor?

The first difficulty is the different features of source and target media, causing trouble to see beyond well-known metaphors and use all the functionality of the target medium (Halasz & Moran 82). For example, considering a word processor as a typewriter would not make it clear that there could be facilities such as "copy" and "paste". This problem is particularly serious in the shift of computer applications towards a 3D paradigm, because we tend to use 2D desktop-like metaphors of current systems to guide the development of 3D interactive environments. In order to decide on features that must be supported by new metaphors, a careful study of how media affect new interaction paradigms is necessary.

The next section presents a discussion about different interaction paradigms within daily practices. These ideas are then analyzed by means of a case study on different scenarios for the annotation metaphor. This metaphor usually appears in text-based educational environments (Adriano et al. 99, Davis & Huttenlocher 98, Harger 96), but it lacks appreciation for some new media, like 3D virtual environments.

Interaction Paradigm Ruptures

The rupture of interaction paradigms has been a recurrent fact throughout the history of many artifacts for knowledge transmission. A good example was the advent of the medieval *codex* (sewn paper pages, not much different from the current books), substituting the parchment of antiquity. Among the consequences of this change, there was the possibility for readers to work simultaneously with several books and make annotations on them. Such facility was not feasible with the parchment because readers had to use both hands to keep it opened (Chartier 97). Even though soundly benefic, some historical changes were not immediate and a lot of years are needed to overcome the natural resistance to the new interaction paradigm. Thus, in order to minimize resistance and provide adequate paradigms for new media, it is necessary to understand how current metaphors are affected.

In search for paradigm ruptures within daily practices, Michel de Certeau, in an anthropological study (Certeau 90), identified the following ruptures in modes of describing places: place vs. space, map vs. trail, frontier vs. bridge. These ruptures obey the following patterns: from personal to unpersonal, from biased to unbiased, from transient to permanent and from static to dynamic. These patterns distinguish different uses for the narrative metaphor. The word metaphor (from the greek *metaphorai*) denote "public means of transportation", which is the sense applied to the narrative and annotation metaphors. The former conveys the speaker to the described places, while the latter helps the reader move among cores of ideas in a text.

According to Certeau, a *place* is a referential, static, and permanent organization of things. On the other hand, a *space* is perceived when vectors of direction, velocity and time are used. The "city *place*", for example, is composed of streets, parks and buildings, while the "city *space*" involves the circulation of people and a sum of every citizen's instantaneous impressions. Similarly, the "text *place*" is the stylistic design of paragraphs, phrases and figures. The "text *space*" is the interaction with the written word, like annotating, discussing and summarizing. A similar analysis, but with interchanged terminology, was made by (Harrison & Dourish 96). According to them, a place is a space with some additional features, like social meaning and cultural knowledge about individual roles.

The distinction between *trail* and *map* stems from narratives of *space* and *place*. *Trail* was the prevailing paradigm in medieval descriptions of geographic extensions, which involved cities where to visit, stop, rest and pray. Nowadays, the *map* paradigm prevails, describing regions by global landmarks like meridians, names of cities, roads, etc. Annotations on paper compose a total and reduced vision of a commented text, which corresponds to the *map* paradigm. The *trail* paradigm imposes the traverse of links in order to obtain an annotation.

Narratives of region demarcations inhabit the paradigms of *frontier* and *bridge*. A region is a meeting of actions and there are as many regions as the number of possible inter-actions. The *frontier* delimits the static division among parts, like geographic references (rivers and mountains). The *bridge* separates by the opportunity of interacting or crossing, like the narrative of Columbus' navigation to the Antilles. As with the case of hyperlinks in a hypertext, an annotation-place is a *bridge* between two regions, the annotation and the text. On the other hand, annotations on paper are ruled by the *frontier* paradigm.

The ideas of Certeau seem very appropriate to guide our case study about changing interaction paradigms for the annotation metaphor, which is the topic of the following section.

Case Study: Annotation Metaphor

Annotations are contents appended to a text; they have well-defined boundaries and are resultant of some cognitive effort. Removing an annotation inflicts no damage to the corresponding text. Annotation-places are responsible to structure groupings of annotations, provide contexts and define interaction paradigms. Annotation-places are also superstructures holding relevant metadata about annotations.

The learning scenarios for this case study were built in CALM (Computer Aided Learning Material) (Adriano et al. 99), a recommender-like system developed at the University of Campinas.

Text-Based Annotations

A learning scenario in CALM starts with a student selecting learning goals. A learning goal is a set of subjects of interest, which are mapped to topics recommended by the system. The student sets a specific goal by choosing one topic to accomplish. The learning goal is accomplished by doing delivered study units. A study unit is composed of a topic, a list of related topics, some tests and exercises, which are defined according to the student's learning goal and a history of previous interactions.

Annotations are made during the study unit. In the context of a study unit, three interactive learning scenarios based on annotations were investigated: *commenting*, *authoring* and *discussing*. The first one corresponds to annotating to raise a doubt or include a link to another point in the material. In this scenario, the underlying text being annotated is self-contained with respect to the specific objective it intends to accomplish. Therefore, the original text is not modified. Two annotation-places support this scenario: *bridge* and *in-line* (Fig. 1), a and c, respectively.

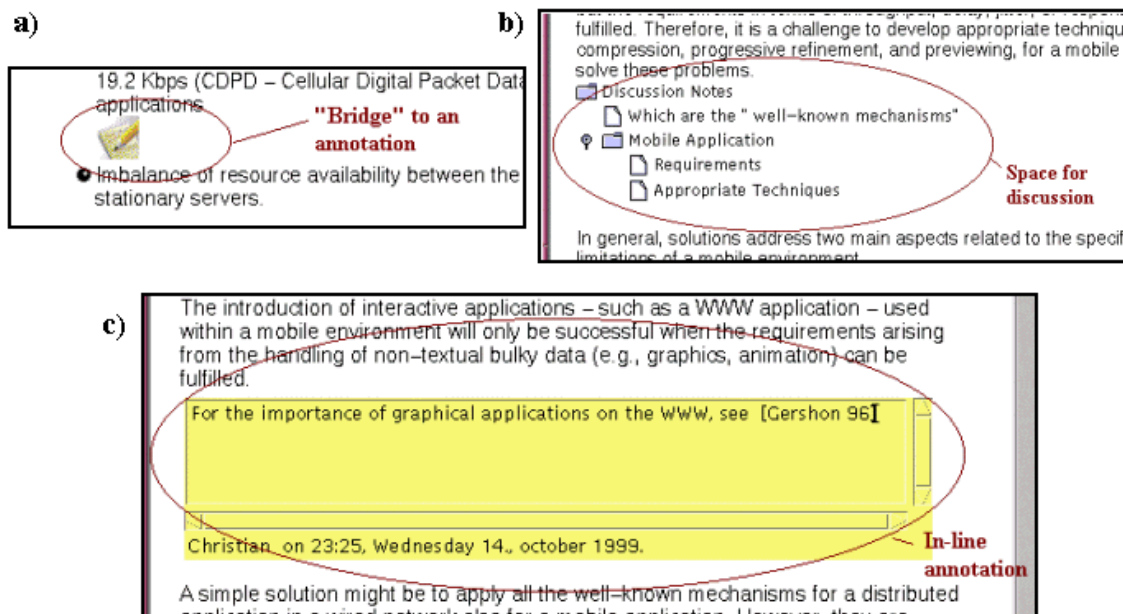


Figure 1: Three annotation scenarios in CALM.

Annotations on paper use the *frontier* paradigm that distinguishes annotations by a colored pen or a handwriting style. The *bridge* paradigm cannot be established over paper medium. The *frontier* paradigm is adopted in the digital text by means of the *in-line* annotation-place (Fig. 1), c. Shifts between these paradigms depend on the necessity to reduce the stylistic pollution (excess of annotations) or to undermine the difficulty of navigation (excess of links). This scenario demonstrates the necessity to modify features of a metaphor according to media changes.

The second scenario is the collaborative authoring by means of *in-line* annotations. This scenario requires a total vision of the work (the vision of author). Insofar, it is paramount not to miss the distinction between what is annotation and what is text. The association of two paradigms, *frontier* and *map*, obtains the desired vision. These paradigms support an appropriate annotation-place that not only provides version and date information, but also displays the annotation contents within the commented text. The *frontier* paradigm displays the annotation distinguished from the text contents and the *map* paradigm organizes the annotations under an authoring vision. Since text on paper already supports both paradigms, this scenario demonstrates the necessity to maintain features of a metaphor when changing the medium.

The third scenario comprehends the discussion by means of annotations (Fig. 1), b. A newsgroup-like annotation-place was implemented to organize the annotations hierarchically. The text is the motivation of discussion and it must not be modified. Therefore, this new accomplishment of the annotation metaphor could not be done over the hypertext paradigm that would mean inserting hyperlinks in the text. The annotation-place for discussion permits the insertion of annotations without modifying the text. This annotation-place shares the paradigm of *trail* with the hypertext, but they diverge with respect to the paradigms of *place* and *space*. A "*space* of discussion" is necessarily dynamic, while the non-modifiable hypertext defines only a *place* (static). This is an example of an innovation in consequence of changing the medium, since the paper medium cannot support such scenario.

Virtual Reality Annotations

A motivation for the shift towards a 3D paradigm would be the need to introduce more appropriate and novel interaction among metaphors in a learning situation. For learning situations in which interaction is greatly based on real objects, a text based-scenario becomes too cumbersome, due to highly descriptive narratives of positions, appearance and movement. Virtual reality based learning can bring convenient interaction and visualization features (McLellan 96).

Moving the annotation to a 3D environment would impose at first a creation of a 3D metaphor for the annotation-place. Which are then the implications of having the annotation-place as a 3D metaphor?

As in the case of text-based annotations, it is necessary to investigate how the 3D spatial notion affects interaction paradigms in order to decide about features of annotation metaphors. The ideas of Certeau were also shown to be an appropriate strategy to define interaction paradigms in 3D environments (Jensen 99).

The implemented learning scenario is a virtual reality model based on VRML (VRML 97), combining a 3D paradigm with the world metaphor. The consequences to the annotation metaphor and the annotation-place are numerous. First, annotation-places are connected to objects that provide richer context to the annotations. For example, a grocery shopping list will probably be placed on the refrigerator door or on some other agreed place in the kitchen. Second, relations between annotation-places can be drawn more easily, based on the objects they are attached. Third, the expected readers of the annotations can be selected by these different relationships. For example, a virtual classroom may have an annotation place on the entrance door, available to every one at school, a group-available annotation-place on the blackboard, and also a private one on each student desk.

We implemented an illustrative prototype of an annotation-place located on a refrigerator door. Such place enables addition, removal and edition of annotations that are located all over the door. When moving the mouse over an annotation, its author name, date and keywords are displayed. A click on annotation displays its content in an editable dialog (Fig. 2).



Figure 2: VR-based annotations.

The implemented 3D-annotation environment corresponds to the commenting scenario discussed in the previous section. Regarding the paradigm ruptures described by Certeau, the 3D annotation is dynamic in every aspect. It is considered a *space* due to the interaction opportunities for editing, removing or adding annotations. The paradigm of *bridge* is present in the links relating the post-it like object and the annotation contents. The *trail* paradigm was used because it is difficult to offer a total vision of textual information (*map*) in 3D environments.

Conclusions

Thinking of annotations as metaphors subjected to paradigms, and these latter as direct outcomes of adopting and combining media, is a complementary approach to investigate the effects of changing paradigms when designing interactive learning scenarios. Annotations on paper and the classic 3M post-its are well-proofed successful implementations of the annotation metaphor. Moving them to digital media is still a challenge that needs further understanding on how actors in an educational environment perceive spaces and places for annotation. Corroborating these ideas, there is some work investigating effects of interfaces for annotation (Wohjan et al. 98), student learning improvement by use of annotations (Armel & Shrock 96), and architectures for annotate-capable documents (Phelps & Wilensky 97).

The 3D prototype was an interesting experience and opened the possibility for innovative uses of annotation-places such as: audio and video annotations, 3D annotation-places for authoring and discussion, and annotation-places defining a specific text format (e.g., via XML - Extensible Markup Language with an appropriate style definition).

The study of paradigm ruptures can also be applied to other educational metaphors, such as interface agents, user avatars, 3D spatial notion, etc. When interaction paradigms for certain metaphors become clear to designers of educational environments, new media will be better used and the risk of rejection to changes will be reduced. Therefore, it will be given a further step towards the definition of a more general paradigm to be used in the transmission and manipulation of knowledge in the digital era.

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