Introduction

Digital libraries (DL) technologies have benefited during the last decade from the impressive increase of digital data capture, storage and transmission capabilities along with the consequent fall of their cost. The widespread use of the World-Wide Web (WWW) also enables digital libraries to meet a very large, international, population. Started in October 1993 on the first French Web site, the *Association des Bibliophiles Universels* (ABU, http://abu.cnam.fr) reaches today thousands of books downloads daily. It has become, and still is, one of the most active French-speaking cultural website. Born in January 1998 from a partnership between the library of the CNAM, the research centre for history of techniques and the computer science research laboratory, the *Conservatoire Numérique* (CNum, http://cnum.cnam.fr) was put online in January 2000. Three hundred reproductions of old scientific and technical books are accessible on the web site. These digital libraries are accessible online with a WWW-based interface and a standard architecture.

According to emails sent to the webmasters, these straightforward WWW services seem to meet users needs. For ABU, texts are easily and quickly accessible (100kb is sufficient to encode a whole book without any compression algorithm). To access the CNum, only a low computational power for the users workstations is required. The digitalized books pages to be downloaded and saved in GIF file format are compatible in size (100kb) with an average dial-up internet

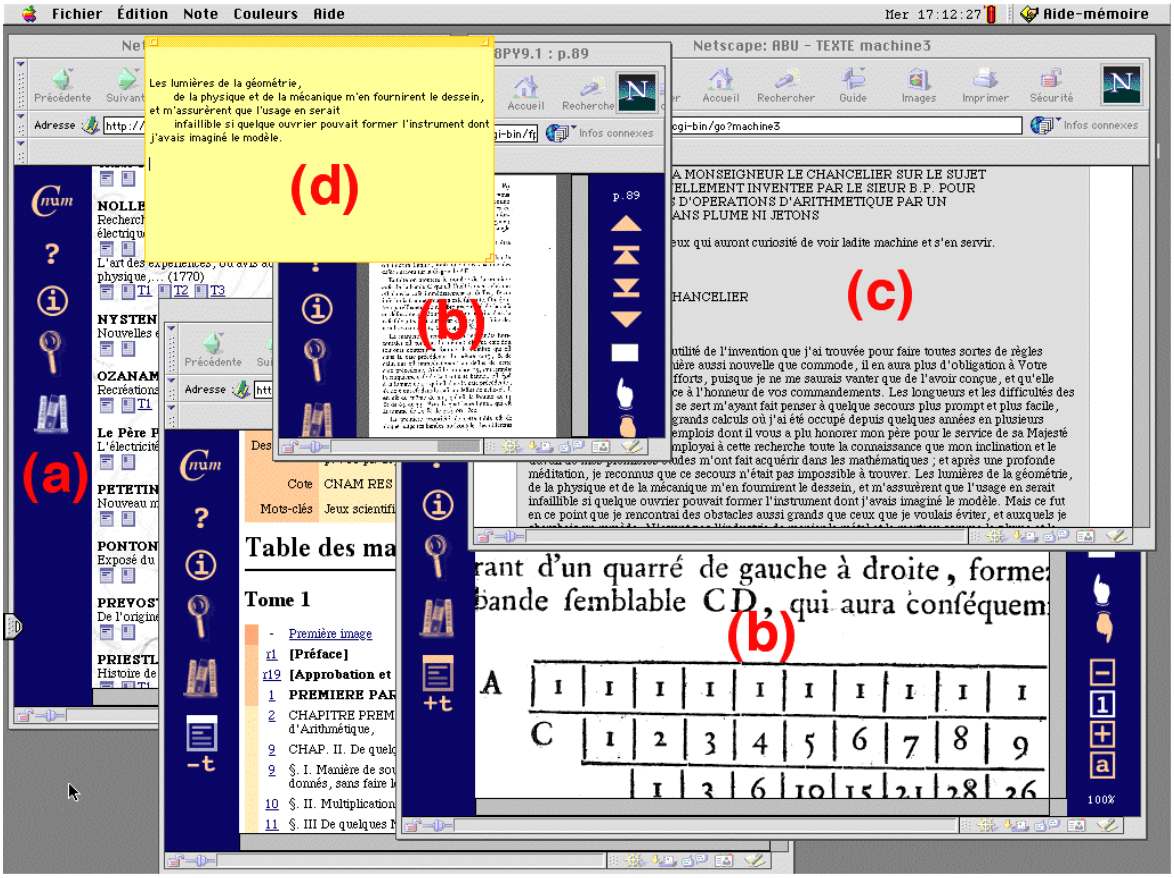

Fig 1 : Screenshot of a working session with CNUM

connectivity. However by looking at the ten years of recorded activity (logs) one can see that the Web interfaces for DLs do not offer a comfort of use sufficient enough to overcome the somehow restricted role of facsimiles diffusion for a remote printing. Hopefully, low-cost 3D graphic hardware and high bandwidth infrastructures for the internet (Cable and DSL) are available since a few years. This new deal has become the dominant configuration for our users since a couple of years. Hence, new visualization and interaction methods for on-line digital libraries can therefore be investigated to overtake the common 2D problems.

We believe that 3D interaction can offer a better understanding of the three main functions of an on-line DL user's interface : (a) catalogue browsing and searching, (b) navigation within the selected documents, and (c) annotations and bookmarks archiving. Let us first describe how these three steps are handled within the Cnum and more generally in most of the standard digital libraries using common web technologies (HTML files and scripts). Fig. 1 is a screen-shot of a probable user session. Browsing through textual lists is the only method offered to the user for evaluating the DL corpus. A book content (chapters and plates) is sequentially described in another window. Cross-reading between books of the CNum and others from related web services (such as the ABU) is made possible by opening multiple overlapping windows. No authoring tool is provided and CNum users rely on their local bookmarking, archiving and word processing facilities.

Design choices

Studies like [1] have shown that 3D interfaces can be more efficient and more powerful than classical 2D interfaces managing overlapping windows. This efficiency can be reached when the right objects and navigation/interaction metaphors are thought depending on the particular context they should take place in. For 3D digitalized libraries, we think that there is no reason to reproduce faithfully a real library building and the real various steps needed to select and read a book (like it is done in [5, 8]). The only positive point in this “real” to “virtual” mapping is to ease the recovery of books for users who are familiar with the real library. However, for new users that are mostly the ones we deal with on the internet, this approach doesn’t help. We believe that it is more appropriate to provide an abstract navigation and representation and offer services like reordering the collection in space depending on search criteria [2].

In agreement with A. Manguel [7] who thinks that a book is distinguishable from others by its cover or shape as much as its authors or title, we decided to use the pictures of the book’s back to offer a visual information. Indeed, it is widely known that libraries patrons can discover interesting bibliographical information by casual glances to the book collections. This “visual heuristic” is only one example of the "many complex information tasks [that] can be simplified by offloading complex cognitive tasks onto the human perceptual systems" [6].

An abstract navigating is also important to minimize moves in a 3D content and therefore ease the training of inexperienced or occasional users. In a real or “virtually real” library, unneeded moves are often necessary to find the shelves containing the books of interest, to pick it and to go back to a reading desk to work on it. These steps can be simplified in virtual worlds.

The Two Basic Tools

The research tool

In a book selection process, a 3D interface avoids browsing through long lists of textual information but, also, offers additional visual information thanks to the books pictures. With a right metaphor to represent the collection, a 3D interface also makes it possible to bind the browsing in the library with the widening or the refinement of search criteria. We settled up an "on the fly" generation of a new organization of the library at each user's request. To do so, books are classified in different groups: those that are relevant to all the search criteria, those that answer such criteria and not such others, and so on until those that are relevant to none of the criteria. We then organize the groups in a geometry and offer to the user the means of passing from a group to another for, either to refine, or to widen its research. This way to build and to submit the results to the user enhances the "visual heuristic" for finding books. Indeed, it makes it possible to gather books not relevant to all criteria beside the relevant group. The user would then be able to see an interesting book even if it is not completely relevant to all criteria just by taking a quick glance around. This way to find a book is often employed in a real library but is not, unfortunately, possible with standard digital libraries.

One of our main concerns beside usability is the flexibility of our interface. For this particular concern, we think that it would be necessary to display the collection using different representations. This way we could use a cylindrical or sphere shaped collection but also other metaphors like semantic maps, cone trees, "virtually real" representations. The idea is to display the collection of a particular library with a default metaphor chosen by the librarian who knows which one is the more adapted. For the moment, only the two former representations are generated "on the fly" in the VRML file format by a CGI script (Fig. 2.). A default sort method for books would also be chosen when entering the library for the first time. The user would however be allowed to change those settings to some he is more familiar or efficient with.

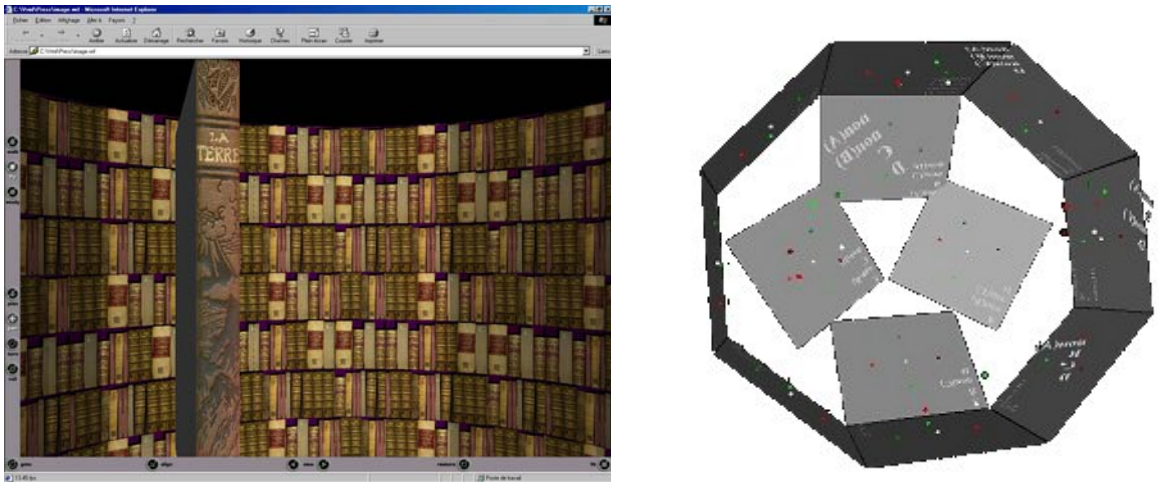

Fig 2 : The cylinder-shaped and the sphere-shaped collection

The reading tool

Our first try was to represent, using a scripted VRML file, the collection and the books enclosed in 2D transparent windows [3] (fig. 3.)[1]. We thought that novice 3D users could benefit from this well known 2D metaphor for organizing their 3D environment. However, it appears that these containers are too limiting compared to 3D metaphors.

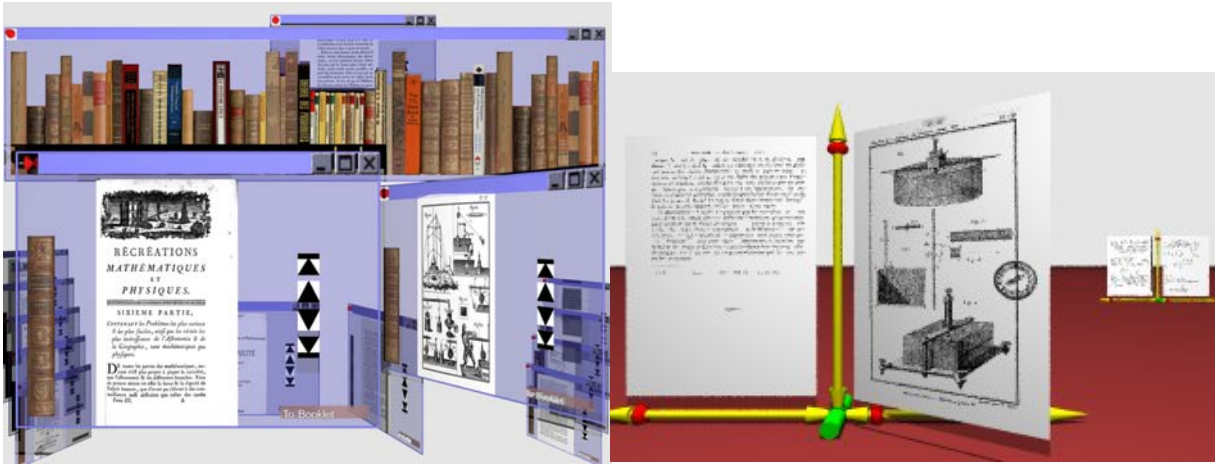

Fig 3 : Screenshot of the VRML prototypal application and the book metaphor.

Using 3D models instead of 2D components is the best solution to obtain a better visual effect. We do not necessarily need a virtually real book but only a book metaphor (fig. 3) that is more practical and comprehensible at first sight. Interactions with this object are easier to understand and are much more powerful. For example a tool can be provided for rolling pages automatically like it is done for Web books in [1]. It would be an intuitive way to acquire the structure of a book. As with a real book, this could also be a quick way for finding pages of interest (those with images or mathematical formulas for example). Interacting with 3D objects could lead to a sophisticated but powerful interface. Thus, we have abandoned this first VRML prototype for a new using the book metaphor. The first 3D interface, developed in VRML and Java [3], has been shipped on the CNum site as an alternative solution to the usual HTML-based reading. However the difficulties when programming interactive behaviours with this language leaded us toward some 3D API (OpenGL) and middleware technologies (Virtools, Criterion Renderware).

Integration Metaphors

Browsing through collections and reading activities are separated in most present WWW-based user's interfaces of digitalized libraries. This context break induces longer apprenticeship and navigation time within the interface. Hence, we also studied how 3D interaction metaphors could be used to provide a continuous navigation space for these two tasks [4].
Two options are possible for integrating browsing and reading activities. The first one is to mix their content and the second is to separate them in space and use a 3D metaphor to switch from

[1] This prototypal application in VRML can be seen on our web site : http://cnum.cnam.fr/vrml

one to the other. We have sketched such navigation metaphors. The pictures below were described and rendered using the ray tracing program POV[2]. In the three integration metaphors, the basket (shown in the three figures 4, 5 and 6) is the only common tool, always visible and in the foreground. It serves as a link between both interfaces. It is used to group the pre-selected books chosen in the collection interface, to access them in the reading one and also to save the user's reading session.

The cockpit metaphor

Fig 4 : The cockpit metaphor

The scene's background is made of the collection (fig. 5). The basket and the opened books are in the foreground. They are always visible and are not affected by the user's navigation. As a pilot flies over a landscape while seeing some data in his helmet, in this interface the user navigates through the collection and sees the books. The main problems are the surcharged screen and the difficulty to see and access the collection behind opened books. Another main issue is to keep a maximum resolution for both tools. Hence, two separated areas in a same interface seems a good choice. And to avoid switching violently from one to the other, we thought about two other integration metaphors.

Horizontally structured workspace

The space is separated in two horizontal zones (fig. 6). The user can switch from one to the other by rotating around the Y axis. In the first zone, the collection is rendered and the user can move the point of view. In the second one, the books are always displayed on the ground. Hence, when the user moves in the collection zone, the ground and books also move behind to simulate their immobility. With this metaphor, the user can also create several reading environments depending on their orientation within the reading area and the view angle of the camera.

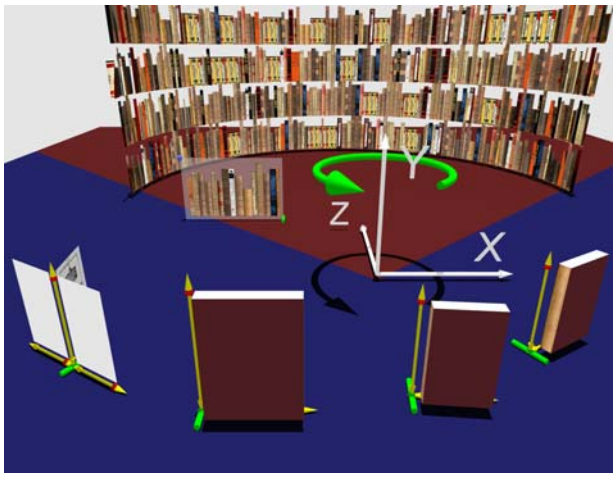

Fig 5 : Horizontally structured workspace

[2] Some animations were also computed and are accessible on our web site : http://cnum.cnam.fr/3D

Vertically structured workspace

With the previous metaphor, after moving in the collection zone, some previously opened books in the reading zone can be hidden. Moreover, half of the space – under the ground – is not used. To avoid these problems and limitations, we can split the 3D space in two vertical zones. Moving the point of view in the collection zone will not affect the view in the reading zone. To switch from one zone to the other, a rotation around the Z axis can be used. In the reading zone, the user can still create several reading environments by rotating around the Y axis. Of course, the user is immersed in the scene. These far views are only given to understand how the two interfaces work

Fig 6 : Vertically structured workspace

Conclusion – Future Work

After a design phase during which we have studied the behaviours of the 3D metaphors within our 3D interface [4], we shall now evaluate our new prototype with a panel of regular readers of the ABU and CNum. We shall also work on the annotation interface in order to provide users with the full service in 3D. With CNum this third interface could be replaced by using a standard word processing tool. Within a 3D environment it must be a specialized interface in order to avoid switching context between 3D and 2D interaction metaphors. A solution would be to enclose 2D applications (a word-processing software, a HTML browser, …) within the 3D scene like we have done in a previous project [9]. However, today's situation is the contrary (rendering 3D scenes in 2D windows). We believe that low-cost 3D graphic cards will lead to full 3D interfaces. In such an environment, 3D models (our library for instance) and 2D applications (word processing tools for example) could share the same common interaction metaphors.

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