INFOSPHERE: ONE ARTEFACT, TWO METAPHORS, THREE SORT CRITERIA.

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KEY WORDS: Correlated spatio-temporal data, information visualisation, interfaces, historic development of Kraków.

ABSTRACT:

Because investigations about sites or artefacts require collecting and sorting out distributed and heterogeneous pieces of information, the handling of these pieces of information has with the development of information technologies opened a number of research issues. Beyond the creation and adopting of standards or best practices, we focus here on the interfacing of collections through visual means. We introduce ***Infosphere,*** an experimental disposal aimed at sorting out and visualising the information behind heritage artefacts or sites. ***Infosphere*** combines a 3D metaphoric model of the artefact under scrutiny, a geovisualisation metaphor (parallels/meridians of a globe), with parallels, meridians and diameter of the globe corresponding to sort criteria (discrete elements of the artefact's morphology, documents, time). The disposal is evaluated on the "signal light tower" in Marseilles, a 17th century edifice barring the entrance to the city's port.

1. INTRODUCTION

1.1 Objective

Investigations about sites or artefacts often start with the cumbersome task of collecting and sorting out distributed and heterogeneous pieces of information. Once this is done, structuring, summing up and/or giving access to the information is yet another challenge, intersecting issues from the field of knowledge and information visualisation. Finally, expert interpretation of the information sets may help in proposing and documenting reconstruction hypotheses, with possible corresponding 3D simulations targeted at a wide audience.
But these steps often correspond to alternative competences and moments in the study. As a consequence, although steps of this iterative workflow should command and complement one another, methods and results are rarely integrated. At the end of the day, 3D models overlook doubts and information lacks, the structuring of data sets neglects the "3D + time" nature of its content, etc..
As a possible answer, we have in recent works proposed a methodological framework, at the intersection of the fields of architectural modelling and of information visualisation (Dudek, 2007), based on the idea that an analytical description of the artefact can be used to integrate distributed and heterogeneous pieces of information.

In this paper, we introduce an experimental disposal called ***Infosphere*** through which documents about an artefact under scrutiny are visualised and retrieved inside a 3D interface. The disposal bases on the hypothesis that for each document in a data set a corresponding element of the artefact under scrutiny can be found (edifice as a whole, parts, details, etc.).
Infosphere is designed as a tool helping to sort out, visualise and retrieve documents concerning an artefact, according to three parameters: granularity of the architectural analysis, level of abstraction of the documents, and time slot concerned.
Documents are positioned inside a 3D metaphoric display by an [x,y,z] triplet (materialised in the 3D interface by the intersection of parallels and meridians of a sphere); where [x] corresponds to a breaking down of a site into sub-elements (spatial granularity, more or less equivalent to level of detail), [y] corresponds to the level of abstraction of the documents itself (from realistic representations to diagrammatic analyses), and where [z] corresponds to a given time slot.
The artefact itself is represented as a 3D metaphoric model positioned at the centre of the scene. A sphere based on a second metaphor (parallels/meridians of a globe as represented by geographers) encircles the first artefact's model. Parallels and meridians correspond to two sort criteria (on the artefact and on the documents), the user-chosen diameter of the sphere introduces a third one (on time).

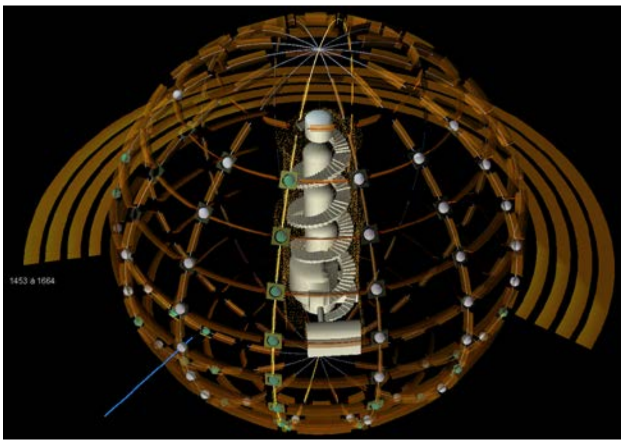

Figure 1: The two metaphors, with rings identifying time slots, and green or white intersection points to retrieve documents.

The disposal is tested on the "signal light tower" in Marseilles, erected during the 17th century as a part of the fortification barring the entrance to the city's port, and serving as a lighthouse. The contribution first introduces this field of experimentation shortly. In section 2, we give a quick bibliographic overview in order to position our understanding of metaphors notably. We then further detail in section 3 the disposal itself, and finally present elements of evaluation in section 4. In the conclusions, we will insist on questions this experimental disposal raises in terms of data analysis, and in terms of readability of 3D scenes for use as interfaces.

1.2 Field of experimentation

One of the symbols of Marseille, Fort Saint-Jean guards the entry to the Vieux Port, the heart of the city. While it is a key element of the city skyline and its recognizable silhouette is present in many postcards, the interior of this old military garrison remains unknown to the public. This will change as the fort will become part of the future Museum of European and Mediterranean Civilizations.

Commissioned by the French king Louis 14th, the fort was built between 1668 and 1671 onto a stretch of land that had previously belonged to the Knights Hospitaller.

With its counterpart, Fort St Nicolas on the opposite bank of the port, its role was to protect the entry to the harbour against enemies at sea but also to underline the power of the monarch over a notoriously rebellious population. Its design was later modified by Vauban in order to reinforce its defences, mainly towards the city.

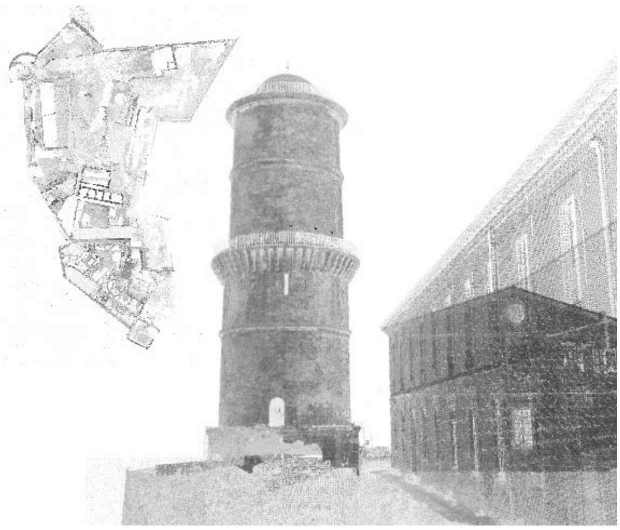

Figure 2: Clouds of points of the signal light tower (Tour du Fanal) and of the whole Fort Saint Jean (raw result of a laser scanning campaign). ***Full credits will be given to authors of these graphics in a non-blinded version of this paper***

The "signal light tower", called *Tour du Fanal,* was built in 1644 as a watch tower and was later integrated into the fort. Its design, a stone cylinder containing five superposed circular rooms connected by a spiral staircase, did not suffer major alterations over the centuries.

Figure 3: A view from the inside of the signal light tower, showing the spiral staircase and the balcony on level 3. ***Full credits will be given to authors of these graphics in a non-blinded version of this paper***

Built on a elevated terrain on the northern shore of the harbour, the tower provides extraordinary panoramas over the sea and the port.

Figure 4: A panorama view from the top of the signal light tower, with, left, Marseille's old port and right, the modern port installations. ***Full credits will be given to authors of these graphics in a non-blinded version of this paper***

During the last years the fort as a whole and the signal tower in particular have been studied by our institution, first by researchers and then more widely by post-graduate students for whom it acted as a sort of test bench notably of survey techniques. A very significant number of documents were produced as results of these actions. They include fist and above all raw results of survey campaigns using photo-based techniques or laser scanning (Figure 3). They also include various results of data post-processing, ranging for instance from simple panoramas (Figure 4) to detailed 3D models (Figure 5), or from 3D interactive promenades to full web sites and videos presenting the Fort's history for a wide audience.

Figure 5: A partial view of a 3D model of the signal light tower, showing the balcony on level 3 and the spiral staircase. ***Full credits will be given to authors of these graphics in a non-blinded version of this paper***

These recent documents should be understood as new inputs in the study of the site. Data was collected thanks to efficient survey techniques, but once post-processed it is scattered in a variety of formats (some commercial and some not) corresponding to a variety of objectives, and consequently forms a very heterogeneous documentation.

These recent documents are therefore not an end, nor are they the alpha and omega in understanding the signal light tower and its changes over time. They are just one more set of indications, with a good metric accuracy, that complements older studies and various heterogeneous archival materials about the site. In other words, because studies we conducted on the signal light tower were test bench studies more than an in-depth, organised investigation, both the "old documentation" and the recent one pose the same problem of heterogeneity.

This is how we came with the idea of trying to experiment on this particular case a new visual disposal aimed at sorting out and at giving access to all these sources in a single interface.

2. ABOUT VISUAL METAPHORS

Visual metaphors are what (Kienreich, 2006) identified as one of the *fundamental units of visual representation are available to a designer*. Visual metaphors base on real-world equivalents to display information. There efficiency relies on the ability of the user to derive from his implicit understanding of the real-world equivalent an understanding of the semantics of the information set. Visual metaphors use analogies, and thereby rely also on intuitive behaviours. Consequently, they often require careful evaluation in order to judge of their efficiency in terms of information interfacing. As noted by (Kienreich, 2006), when drawing a visual metaphor, the designer has to *make sure that a given metaphor is able to convey all relevant aspects of a information space before using it in designing a visualisation.*

A lot has been done and written about visual metaphors, notably in the field of information visualisation, and (Lengler, 2007) "Periodic table of visualisation methods" (itself a metaphor, by the way) gives a good overview of their potentials uses, and relations to other visualisation methods. The real-world equivalent behind a visual metaphor may have, or may have not, a direct relation with the information. We use this opposition in the following sub-section as a way to introduce the distinction we will make later on between our disposal's inner metaphor, the artefact itself, and our disposal's outer metaphor, a globe as seen by geographers since the Galileo.

2.1 Literal real-world equivalents

In most cases, visual metaphors rely on real-world equivalents that are used figuratively. A good example is the well-known family tree metaphor: children do not grow on branches, the tree is a figurative representation of parent/child relation. But visual metaphors can be used in the literal way: in (Göbel, 2003) a 3D virtual edifice acts as a library, with documents stored in drawers like in the real world. Users meander in the edifice in order to locate the storey, the room and the drawers they came to "borrow". Another example, although more questionable, is (Heinonen, 2000) virtual city, where locating spots (*i.e.* information) in the city is done thanks to a simplified model of the city itself. In our proposal, a 3D model of the signal light tower will be used as a literal real-world equivalent, illustrating the level of detail the user has chosen.

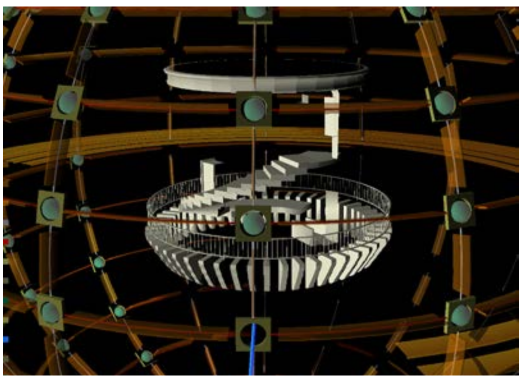

Figure 6: A literal real-world equivalent: the decomposition of the signal tower in sub parts identifies the level of detail of the documents available when selecting this model's meridian.

2.2 Figurative real-world equivalents

Choosing a figurative real-world equivalent means for the designer trying to find an "image" that best matches the information to deliver. Visual metaphors that rely on figurative real-world equivalent are omnipresent in communication, with questionable results sometimes when the image is not shared by the audience targeted. In example shown on Figure 7 (Eppler, 2003), readers do find the visual metaphor convincing if and only if they once played on a slide.

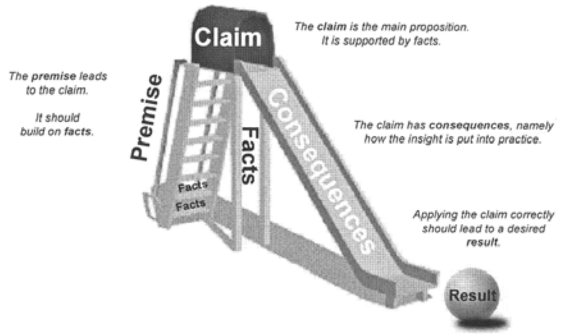

Figure 7: The slide metaphor from (Eppler, 2003)

Many architectural or urban spaces have been (and still are) used as figurative real-world equivalents, for instance in (Russo Dos Santos, 2001) when a virtual 3D city supposedly represents the various parts and elements of a computer.

Naturally, the more the information is rich and structured, the more visual metaphors use complex figurative real-world equivalents. A brilliant example of this can be found in (Andrews, 2003) who introduce the *infosky* metaphors (Figure 8), where clusters of stars and constellation help sorting out thematically articles.

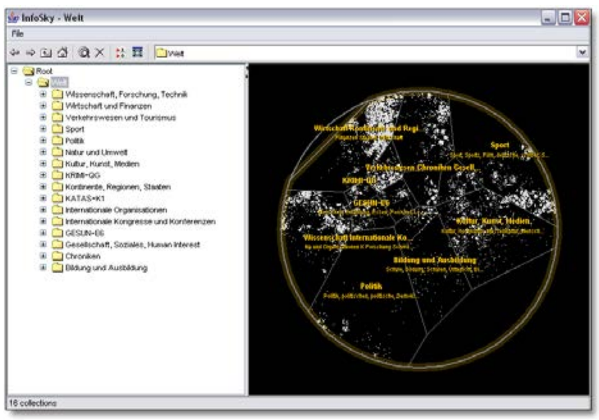

Figure 8: The *infosky* metaphor from (Andrews, 2003)

In our proposal, a 3D model of a geographic globe of planet earth will be used as a figurative real-world equivalent, considering that concepts such as "planet earth is round", and "it is represented as a globe with parallels and meridians distributed on its axis" can be understood widely.

3. THE INFOSPHERE DISPOSAL

Infosphere is an experimental visual disposal aimed at sorting out and at giving access to documents about the site.

It is applied here on the signal light tower for evaluation purposes.

It has to be stressed that ***Infosphere*** bases on the hypothesis that for each document there is a corresponding physical element of the edifice (may it be a detail, a part, the edifice as a whole, the ensemble to which the edifice belongs). For instance, the interactive panorama showing graffiti made by prisoners when the tower was used as a prison (Figure 9) are attached to a physical element (a storey's interior space).

Figure 9: An extract of the graffiti visualisation

The recent picture shown in Figure 10 will be attached to the opening itself, whereas a document like this on Figure 2 will be attached to the signal light tower as a whole. However, observing Figure 2 and Figure 5, one can see that they differ not only in their "spatial coverage" (the former corresponding to the whole edifice, the latter to level 3 storey). They also differ by their "level of abstraction": Figure 2 is raw data (result of a laser scanning), and Figure 5 is an interpretation of the raw data, not comparable in terms of informative load.

Figure 10: A view of the east opening on level 0

Furthermore, archival documents will be sorted out in order to match a physical element but also a time slot, corresponding to the period they show. As we do, the reader should not underestimate the cost of sorting out using the documentation using these three criteria. It is clear then why the Infosphere disposal is an experimental one, the consequences on documentation handling being important.

To sum it up, basing on these principles, the disposal sorts out and distributes information and documents using three criteria:

To which discrete element (*i.e.* ~ level of detail) does the document correspond?

What is the level of abstraction (*i.e.* ~ of human interpretation) of the document?

What is the time slot shown?

The disposal should then allow the visualisation, and the downloading, of one or several documents corresponding to an x,y,z triplet. Each x,y,z triplet is materialised by intersection-points on the surface of the globe metaphor, where x identifies level of detail, y identifies the level of abstraction, and z (varying diameter of the globe) a time slot (Figure 11).

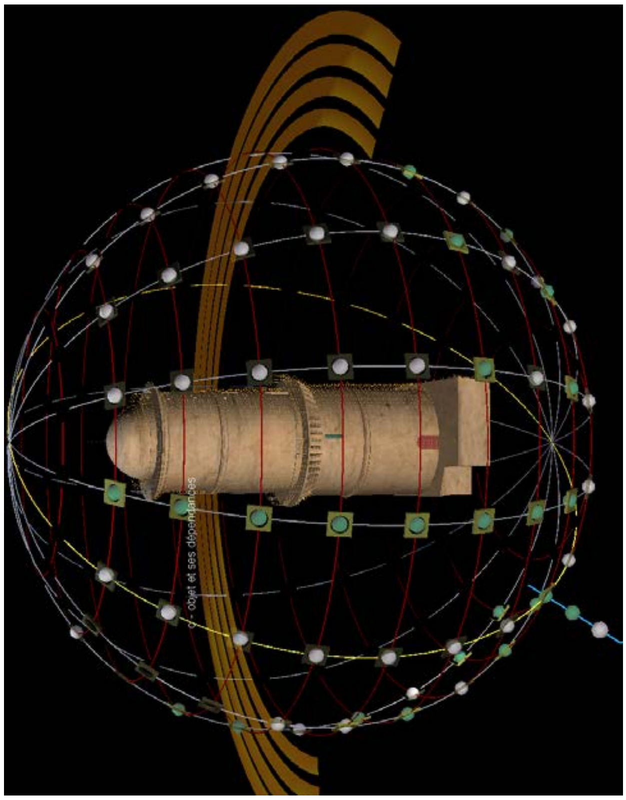

Figure 11: A screen capture of Infosphere. Note, in blue, meridians (x axis, level of detail), in red, parallels (y axis, level of abstraction) and rings to control z axis (diameter of the sphere, time slot). By selecting an x,y,z triplet (done by a click on an intersection-points), the user opens the blue line, (bottom left of the image) and interactively downloads a model of the tower acting as a metaphor for this x,y,z triplet. In the case illustrated here, x-spatial coverage *artefact and its dependencies*, y- level of abstraction *raw photographic material*, z- time slot *present times*. Highlighted in yellow by an onmouseover event, the meridian corresponding to the user's selection.

At each x,y,z intersection an event-sensible intersection point is positioned, represented by a square and a sphere (see Figure 12). The sphere is used to select the x,y,z intersection and consequently to download the corresponding model of the signal tower. In addition, a click on the intersection point's sphere opens a blue line that helps the user know "where he is". Finally, along this blue line all the other intersection points corresponding to different periods are displayed for the user to see whether or not there is information corresponding to his (level of detail, level of abstraction) selection for other periods.

Evaluation section will show that also the learning curve is steep at start, the principles are in fact rather simple and rapidly understood by users. Squares and spheres marking intersection points have a colour code used to deliver some information either about the documents available or about the actions available:

A green sphere is an intersection point where the user will find documents. A white sphere is an intersection where the user will find documents when the study will be over (*i.e.* we have documents, but still unloaded in the system). The absence of sphere (see Figure 13) means no documents have been found for the x,y,z triplet.

Squares are used to focus on the intersection and then download the documents themselves (see Figure 14). When no documents can be downloaded for any period, squares are represented with a high level of transparency (see Figure 11). Squares represented as empty identify x,y for which documents are available only at a different period.

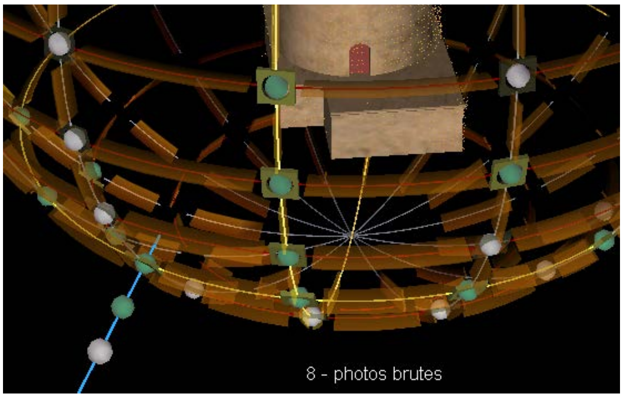

Figure 12: Selection of an intersection point resulted in interactive downloading of a model of the tower. In the case illustrated here, x-spatial coverage *artefact and its dependencies*, y- level of abstraction *raw photographic material*, z- time slot *present times*. Along the blue line marking the user's choice, other information available for the x,y intersection at different periods.

When users want to use the z axis, they can either select the rings or select intersection points scattered along the blue line.

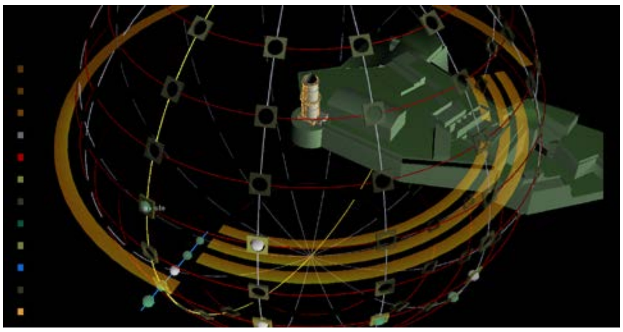

Figure 13: Selection of an intersection point corresponding to the 1644-1668 period, with a number of inactive intersection points (absence of documents). In the case illustrated here, x-spatial coverage *whole sites*, y- level of abstraction *plaster models, B&W graphics*, z- time slot *1644-1668*. Note, left, a column with coloured square: each of them corresponds to a graphic variable that users can interactively turn on / off, like for instance the radiating plates turned on in Figure 12 and off in this Figure.

It has to be said that the readability of time changes is not yet satisfactory, as the evaluation will mention.

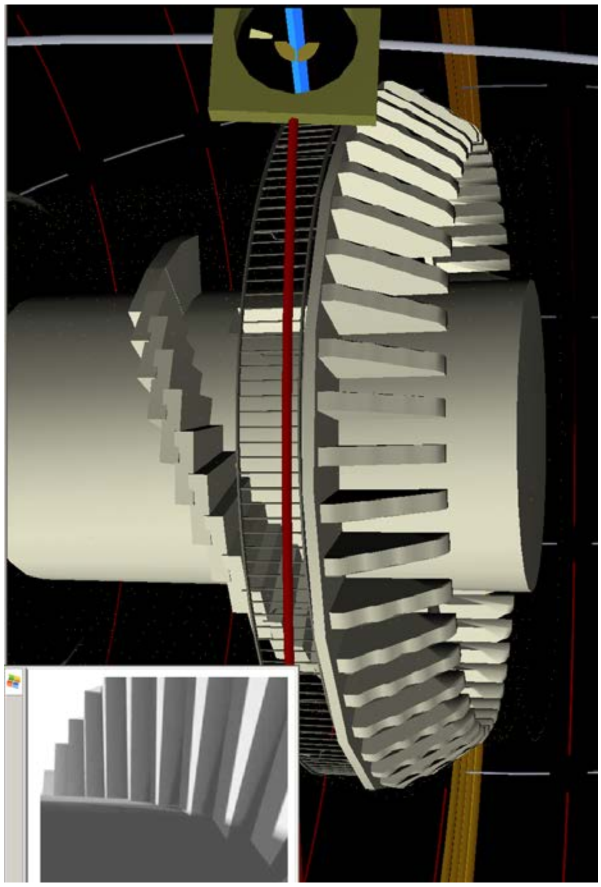

Figure 15: After selecting an intersection point by a click on the square, an automatic zoom puts the user in position to see the portions of disc that are nested inside the square. Each portion of the outer disc (here only one) corresponds to an individual document. Each portion of the inner disc corresponds to a collection (here two). Portions of disc correspond to URLs that are opened in a pop-up window (top left of the image, here a plaster-like model of the staircase). In the case illustrated here, x-spatial coverage *architectural primitives*, y- level of abstraction *plaster models, B&W graphics*, z- time slot *present times*.

A cloud of points can be used as a visual gauge of the edifice (see Figure 16). Finally, it has to be stressed that the objective of the disposal includes, beyond sorting out and giving access to documents, gaining a global vision of our documentation. Figure 16 compares the net of documents we have for the present times (left) with the net of documents we have for the previous relevant period 19th century): graphics talk by themselves. In other words, the disposal acts as an interface, but may be even more useful as an InfoVis disposal.

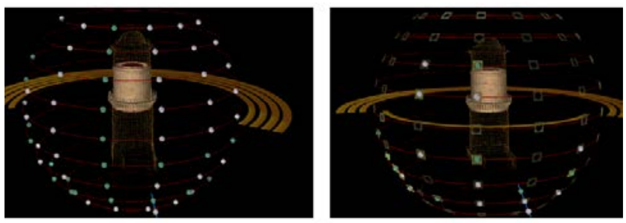

Figure 16: In the case illustrated here, x-spatial coverage *canonical ensembles*, y- level of abstraction *raw photographic material* , z- time slot *present times*. On the left, 19th c. right.

4. THE EVALUATION

Due to time constraints, at he time of writing the paper the evaluation was carried out with a only four post-graduate students, unrelated to previous actions on the site, who were given a half-page description of the system and given forms to fill in. Results should therefore not be overestimated; they only provide an indication of trend. Five criteria were evaluated:
1: readability of the metaphor.
2: Finding one's way in the disposal's space
3: Adjustment of graphic parameters
4: Efficiency in navigation
5: Efficiency in document retrieval.
For criterion 1, we checked whether the overall functionalities were understood (which axis is which, where can you download data form, *etc.*). Results show a good understanding of the functionalities, apart from time handling on the z axis for which we in 2 cases had to intervene. For criterion 2 we checked how long it took them to find the x,y intersection shown in Figure 1. Results are inconsistent, with answers ranging from less than 15 seconds to more than 45 seconds, are inconclusive.
For criterion 3 we provide the two images in Figure 17, (a), asked which setting was best and asked them to fine –tune the interface using buttons shown on Figure 13. Results show less graphic elements are preferred (including for one absence of meridians and parallels), an empiric confirmation of E.R Tufte's (Tufte, 1997) data-ink ration principle.

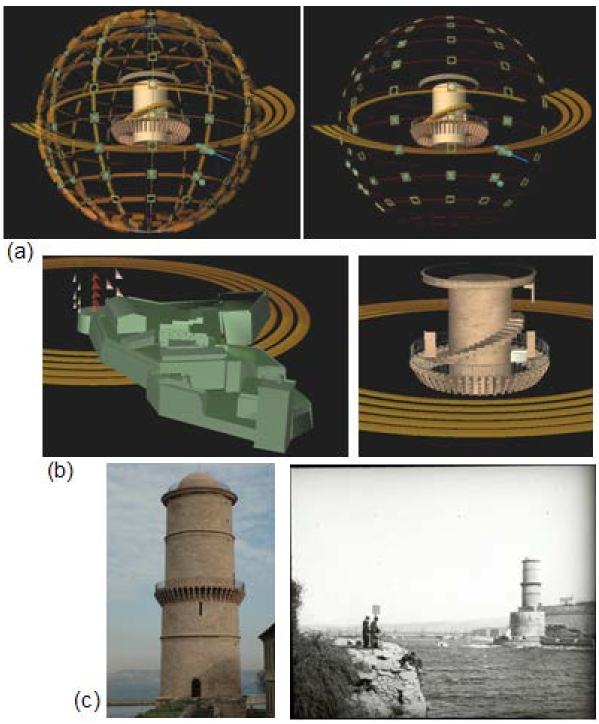

Figure 17: Examples given for the evaluation (criteria 3, 4, 5).

For criterion 4 we checked the time needed and the number of errors in selecting x,y intersections corresponding to Figure 17 (b). Average is more than one minute, and 4.5 errors, not a very convincing result. The same principle was applied for criterion 5, where we checked the time needed and the number of errors in selecting documents in Figure 17 (c). Results are acceptable for the left document (contemporary) with an average one minute and 5 errors (compare this to existing solutions when handling heterogeneous data sets). Results for the right example (19th century period) are less convincing, with mistakes in finding the proper time slot (over 2 minutes, 4.5 errors).
Besides the criteria evaluation, qualitative input was asked, with interesting remarks collected on weaknesses of the disposal (ambiguities of the interface in showing the time slot observed, ambiguities of the attachment of documents to a given x,y,z triplet notably). On the overall, the approach was judged at first glance as almost "frightening", and once understood as a promising way of handling data. It has to be said that although we have a significant number of sources available in the system (over 500), their diversity and distribution in time has yet to be better exploited before going further in the evaluation.

5. LIMITATIONS AND CONCLUSION

It would take pages to analyse the limitations of this disposal, and to separate limitations due to the field of experimentation itself, to the implementation, and those really due to the *Infosphere* "concept". Let us here still quote some: cost of course (architectural modelling), time granularity problem (what when we have 30 periods of interest for an edifice) sorting and inconsistency problems in the documentation, etc.
We are well aware that the disposal is experimental, and that a number of weaknesses exist; however we think that even in this rather early stage it does push to the fore ideas that might prove fruitful. In conclusion, we would like to underline some benefits of general interest that the experimental disposal let us identify:

Sorting out heterogeneous documents using architectural shapes is efficient, although costly.

Learning curve of 3D displays can be reduced by using visual metaphors.

An interface that can also provide information visualisation service is better.

Evaluating interfaces and visual disposals is good.

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