On the relevance of 3D shapes for use as interfaces to architectural heritage data

Dr. I.Dudek *J.Y Blaise* *P.Bénistant*
UMR MAP CNRS/MCC 694
EAML 184, av. de Luminy 13288 Marseille Cedex 09 France
idu@gamsau.map.archi.fr *jyb@gamsau.map.archi.fr* *pbe@gamsau.map.archi.fr*

Abstract

Documentation analysis and organisation are vital to the researcher when trying to understand architectural evolutions. Documentary sources provide partial evidences from which the researcher will infer possible scenarios on how an edifice or site may have evolved throughout the centuries. They provide *clues* that will need an *interpretation* from the researcher or conservator in order to *understand* the edifice or site's evolution. In this process, data interpretation is a critical step that base on the use 3D theoretical concepts originating from those who study edifices: architects, archaeologists, conservators, historians. What solutions can one base on in order to organise a documentation with regards to an architectural analysis of its content? How can we today provide architects, conservators or collection holders with a set of relevant architectural concepts that will serve as intermediates between the edifice's shape and its documentary sources? Our contribution introduces a methodological proposition that tries to cope with those questions, and evaluates possible uses of 3D scenes as interfaces for architectural heritage data visualisation. We describe the relations between documentation and architectural objects, and use the representation of 3D objects in order to access information but also to visualise the state of knowledge of each object.

1 Introduction

In writing hypertexts, establishing clear relationships between sources and destinations has been acknowledged as a vital question, and the same issue is raised when trying to attach 3D architectural shapes to documentary sources. But taking a closer look on what existing computer tools and formalisms offer when dealing with the architectural heritage shows that their relevance may not be optimal. Geometric modelling tools allow the construction of 3D models in which simulations of a morphology is possible. In parallel, GIS systems have proven useful in numerous site management experiences, particularly in archaeology. But whether there is a way in between those families of technologies remains to be proved. To put it more simply, can 3D models be efficient in data visualisation or retrieval? Can they offer a view on the data that other media forbid? Can they localise pieces of information with regards to a position in space and a moment in history? Can they inform the system's user on whether the proposed shape is original or reused, documented or hypothetical, etc.? We observe that although the edifice is not the information, the information is relative to the edifice. But the architectural documentation varies in type, precision and relevance. When representing the edifice as a set of 3D shapes for use as interfaces, we will therefore face a challenge to visualise shapes for which we have partial information, and with it a challenge to graphically notify it. Our methodology defines two complementary tasks:

- Concept modelling and instance documentation:
- Visualisation of the documentation's analysis and of elements of semantics

We consider that it is vital to use what the documentation says *as well as what it does not say*. 3D models, considered with regards to the above mentioned aspects, can be efficient in retrieving or visualising information about architectural evolutions. The paper introduces the research context, and then develop three aspects of our work : the methodology, the applications, and observations on the benefits and constraints connected to our vision of what 3D scenes can become.

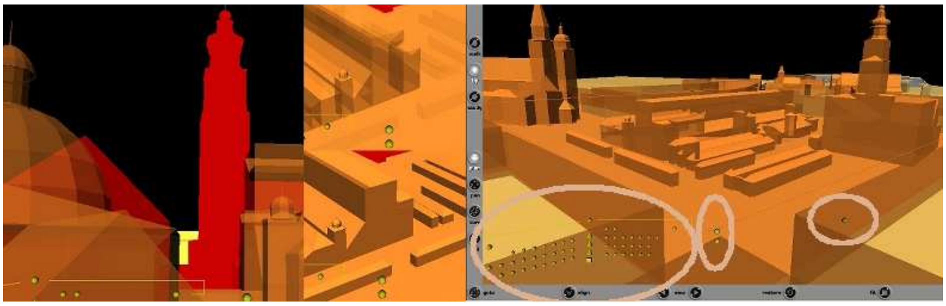


Figure 1 : Appearances (left) give indications on teach object's documentation analysis; interactive controls (right) nested in the VRML scene extend appearance modifications.

2 Research context

Architectural heritage is a domain in which both documentation and visualisation play essential roles. Moreover, ensuring their interdependence has clearly been acknowledged as a key issue (see for instance [Nak99]). Moreover, a physical object such as "an opening" can have been re-used several times during history, and often inside different edifices. Both the shapes reconstructed and the documentation relate to a moment in time. This introduces a level of complexity for which we lack adequate formalisms since such issues as dynamic data visualisation [Rus01] or time handling in GIS sytems [Bil97], although already addressed, do not bring operational breakthroughs in our domain. We propose to use the edifice's morphology as a support for data retrieval and documentation visualisation. Consequently, we need to isolate relevant architectural concepts and build out of them 3D models, as developed in [Dud01]. This idea is in fact nothing surprising for people involved in the analysis of edifices. The methodology used by historians of architecture and conservators in order to analyse evolutions of an architectural object is based on the interpretation and comparison of various types of documentation, as stated in the [Cra00] charter. Therefore the idea that different pieces of information are in relation to architectural elements (a building, a portal, etc.), is for them a natural (although often unspoken) part of their work methodology. But the documentation that serves as source of evidences is far from being exhaustive and non-ambiguous. What is more it is not structured with regards to the it documents. We therefore face several difficulties when implementing a document -> scene link :

1. We face a challenge to visualise shapes that in all cases are hypothetical. Consequently we will need to provide the scenes with graphical codes marking the evaluation of the hypothesis.
2. We face partial or contradictory evidence, lack of evidences, or rely on comparisons. We need to propose markings of the objects that correspond to their documentation .
3. Documentation about one element does not relate its sub-parts or to its super-parts : each concept should be documented independently from others. Scale, a notion oddly absent from 3D modelling, can act as this complementary filter in the information available on the edifice.
4. Inside an edifice that can be widely transformed, individual elements of architecture can, what is more, be reused or even moved somewhere else in the city, underlining another problem, this of localisation in time and space of architectural elements.

In [Hei00]'s experience, a 3D scene is used to navigate into a set of information about a city. The user may question the system on the localisation of services such as hotels, railway stations, etc.. Our experience differs in three main aspects. Elements supporting information are architectural elements (gates, arches, etc..), etc.. The information we deal with, as well as the shapes we represent, are in relation with a period in history. The documentation, and its avatar , a 3D morphology, need interpretation since information may be uncertain, incomplete, etc..

3 Methodological proposal

As shown in figure 2, three main elements have to be developed : a set of architectural concepts that will be represented in the scene, a documentation database and the scenes themselves.
In the first stage, concept modelling, we need to identify concepts that will be used as filters on the architectural documentation. The concepts are identified through an analysis of the morphological, structural and functional differences and similarities between the objects. They are then classified using the principle of heritage of properties (see [Con00]).

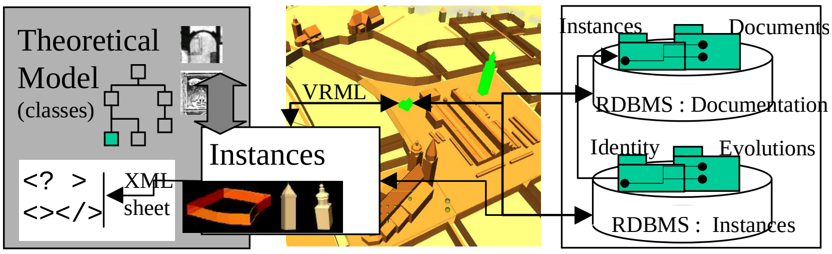


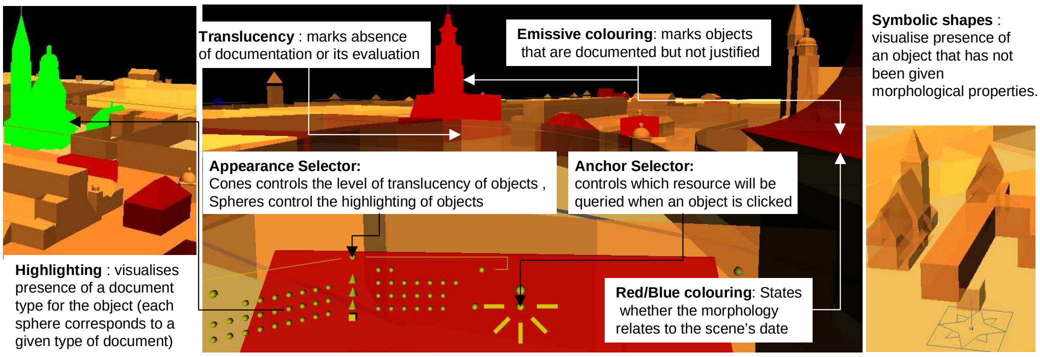
Figure 2 : A system architecture combining various formalisms

Once concepts are identified, and organised in a hierarchy, the making of 3D scenes results in the instanciation of the model's theoretical shapes and a call to the relevant representation method. Each concept is characterised by a morphology, i.e geometrical properties, but also by qualitative evaluators that support the documentation's analysis[1]. Each concept is implemented with a VRML representation method that graphically interprets the values of the qualitative evaluators. Finally, a bibliographical, iconographic and cartographic database stores the documentation itself in a traditional way (see [Ste91]). Each object inside a scene refers to the relevant pieces of documentation in the database using VRML's ANCHOR node. Each concept details methods relevant for persistence handling in XML files and RDBMS context. It has to be stressed that autonomy and durability of the data sheets are of crucial importance in our application domain. We store the textual results (XML sheets) inside files that can be used independently from the system as a whole. We propose in line with [Wal02] a solution based on the idea that a unique input- the instance's XML sheet; has several outputs. Scenes are used as a query mode (predefined time-related scenes) by selecting an object or as a visualisation of the query's result, by instancing the objects corresponding to the search and calling their VRML representation method. Model and RDBMS platforms are chosen independent, we use Perl / PHP CGI Interfacing modules.

[1] Each object contains a group of attributes that are responsible for displaying the object with relevant graphical codes. They show inside a 3D scene the semantics associated to the source's analysis. For example the user of the scene can demand a visualisation of the level of certitude on an object's dating (represented in this example by a level of translucency). We distinguish justification attributes used to represent objects with a graphical code that indicates how credible the information we detain is with regards to specific themes (dating, shape, structure, function). And existence attributes used to represent objects with a graphical code that indicates whether or not we have documents about the object with regards to specific media types.

4 Application to Kraków's historical centre

The methodology we have briefly introduced is applied to the studying of the historical centre of Kraków , former capital of Poland. The city has a rich architectural heritage, and researchers deal with a growing critical mass of documentation, thereby underlining the necessity to investigate new methods of data management and visualisation. We have focused on the urban structure scale, corresponding roughly to the city's exteriors. More than six hundred evolutions have been identified, and with them the corresponding documentation. They cover a period of eight hundred years, with big differences in the number of evolutions between the various objects studied. Besides static VRML scenes at key periods, the web interface we have developed lets the user to query the system with regards to two main (and obligatory) parameters : the period he wishes to observe, the families of objects he wants to visualise (i.e the classes). In parallel, more parameters can be added in order to retrieve and visualise for instance only the objects for which we have inventories, or only the objects for which the dating is imprecise, etc.. VRML Scenes are calculated online. We use two types of information : appearance of the object (colouring / translucency) and anchoring (connection to a URL). Moreover, each scene is displayed with client-side interaction disposals (see fig1) that let the user to choose which DB should be queried or what document type is available on the object.



Each object is displayed natively with a translucency that indicates the dating precision, and with a colour that indicates whether the morphology proposed is this of the object *at the date of the scene* or whether it is a copy of a previous or later evolution of the object, thereby underlining needs for further investigation. Once the scene is displayed, other possibilities are left for the user, notably the highlighting of objects in relation to types of documents as described in the documentation database (plans, texts, illustrations, inventories, etc..). Finally, we need to cope with two possible incoherence : an object for which we have proposed a reconstruction but not yet established the documentation's analysis; and an object that we have fully documented but not yet reconstructed. The former are shown with an Emissive colouring that distinguishes them from the rest; the latter with a library of symbols that only localises the object. In both cases, the scene underlines a current state of knowledge, what is known and what is not, and therefore does remain consistent with the documentation.

5 Conclusion

Architectural historians and conservators face today two challenges when they have to study edifices or urban groups : they have to cope with a mass of documents about the city and its evolution, and deal with the constraints and logic of geometric modelling. What is more, there is a clear need to find a way to better capitalise the research efforts so that not only a seducing 3D

model but also the whole research process gets *persistent*. Finally, in our application field, research about *one* edifice or urban group strongly benefits from comparisons on the whole city.
Our position is that 3D models of the architectural shapes our documentation is about, are a natural and efficient filter for data visualisation and retrieval. A central improvement in the actual practice is the fact that architectural data finds its natural media, shapes, whereas it has traditionally up to now been centred on documentary descriptions (authors, editors, keywords, etc)
On the documentation side, other benefits include the possibility given to reuse existing data sets, the possibility to visualise what a particular document *is about* (edifices quoted in it), the possibility to compare levels of information between various sectors or objects types inside the territory observed. On the virtual reconstruction side, the approach we defend helps the architects to build from his own words rather than from those of geometry, allows the author of the reconstruction to build an object *on which he has doubts* and to represent along with a morphology *the doubt itself*. It also fosters the emergence of a new vision of 3D models, a vision that says a 3D model can be a sustainable research tool if it reaches the readability of a geographical map.
But what our experience with this system has really revealed to us is its capacity to help us in putting the finger on questions that remain to be raised, or that are only partly addressed. In brief, the 3D scenes we provide help the researcher in clearly and synthetically visualise a state of knowledge on the city's evolution, and can be considered as key tools both in terms of what they we know and in terms of what they say we don't know. Our work clearly positions visualisation in our application domain as an interpretation, with an ambition not for realism but for the better documentation readability and access, in line with contributions such as [Alk93] or [Kan00]. We however regard our contribution as nothing more than a first step in trying to use 3D modelling in the visualisation of archival information. We believe that it s possible to greatly enrich the usefulness of 3D representations provided that some attention is put to the semantics behind the rendering, and that this question opens a research area that needs more involvement.

References

[Alk93] P. Alkhoven, The changing image of the city. A study of the transformation of the townscape using Computer assisted Design and visualisation techniques (Utrecht: PHD of the University of Utrecht, 1993).

[Bil97] A. Bilgin, An adaptable model for a systematic approach to conservation walks : an introductory study on GIS […], in Proceedings of. SFIIC 97 Conf., Chalon sur saone, France, 1997, 211-219

[Con00] D. Conway, Object Oriented Perl, (Manning Publications, Greenwich, Co, USA, 2000).

[Cra00] Cracow Charter 2000, in Proc Int. Conf on Conservation Krakow 2000, pp191-193, 2000.

[Dud01] I.Dudek, J.Y Blaise, Interpretative modelling as a tool in the investigation of the architectural heritage : information and visualisation issues, in Proc VIIP 2001, Marbella, SP, pp 48-54, 2001.

[Hei00] A.Heinonen, S.Pukkinen, I.Rakkolainen, An Information database for VRML Cities, in Proc. IV2000, London, UK, 2000.

[Kan00] J.Kantner, Realism vs Reality: creating virtual reconstructions of prehistoric architecture, in J.A Barcelo, M.Forte, D.H Sanders (Ed.) Virtual reality in archaeology, (Oxford: Archeopress 2000).

[Nak99] H. Nakamura, R. Homma, M. Morozumi, On the development of excavation support system, *in Proc. 17th eCAADe Conf. Turning to 2000,* Liverpool, UK, pp341-348,1999.

[Rus01] C. Russo Dos Santos, P.Gros, P.Abel, Dynamic Information visualization Using Metaphoric Worlds, in Proceedings. VIIP 2001, Marbella, SP, pp 60-65, 2001.

[Ste91] R. Stenvert, Constructing the past: computer-assisted Architectural-Historical Research PHD of the University of Utrecht,1991.

[Wal02] N.Walsh, XML: One Input – Many Outputs : a response to Hillesund, Journal of Digital Information, vol 3 issue 1, 2002.