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ACCESS, INTERPRETATION AND VISUALISATION OF HERITAGE DATA USING THE ARCHITECTURAL MORPHOLOGY: EXPERIMENTING EMERGING INTERFACES ON A CASE STUDY.

Dr. Iwona Dudek, Dr. Jean-Yves Blaise, gamsau UMR MAP CNRS/MCC 694

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Abstract

Documentation analysis and organisation are vital to the researcher when trying to understand the evolution of patrimonial edifices and sites. Documentary sources provide partial evidences from which the researcher will infer possible scenarios on how an edifice may have been changed throughout the centuries. They are the only scientific basis from which virtual renderings can be proposed and justified. Still, in the field of the architectural heritage, there is a gap to fill between well established data management technologies that provide solutions for documentation handling, and geometric modelling techniques that underlie reconstruction efforts.

Documentation is organised with regard to what the documents are: books, illustrations, etc. Virtual renderings feature a geometry that bears no link to the documentation's analysis. Our contribution introduces a solution for attaching the documentation to architectural concepts that represent physical beings used in the edifice's structure, and this without modifications on existing documentation descriptions. Three dimensional scenes can then be used as one of the means to retrieve or visualise the information we hold on the edifice's or site's evolution. Our position is that the 3D representation of architectural objects can be an efficient filter on the set of data architects, conservators or archaeologists handle.

This research is experimented on data sets concerning the city of Kraków (Poland) and its architectural evolutions, in the framework of a Franco-Polish research programme.

Keywords: Architectural heritage, Documentation Analysis, Kraków, XML, Interfaces, Information visualisation, Web databases.

Introduction

With the development of web-based data management and visualisation platforms, people in charge of studying the architectural heritage and its documentation face a challenge to better exploit their data collections, both in terms of availability for scientific analysis, and in terms of visibility for a wider public. Documentation analysis and organisation are clearly vital to the researcher when trying to understand the evolution of patrimonial edifices and sites : documentary sources are his scientific basis. In parallel, 3D models, when we think of them as of a scientific visualisation tool, do closely match the very nature of architecture.

In other words, we today observe that a bridge is needed between documentation management techniques and geometric modelling. We consider that this bridge corresponds to the step of data interpretation, and that it should result in the possibility given to visualise through graphical means what the expert understands from the documentation.

Numerous researches conducted at the intersection of these disciplines have proved that using 3D models as interfaces to information is a relevant objective. (Heinonen, 2000) or (Ennis, 1999) for instance have introduced this idea at the scale of a city, stressing the usability of 3D models in showing location-based information. But they have also stressed lacks or limitations of information handling methodologies and of technological answers available today. In the field of linguistics, hypertexts are seen as communication. We believe 3D architectural objects can play the same role for edifices. Understanding the formal language of architecture, and finding a relevant representation for it, i.e. avatars in a virtual environment, appears here as a vital step. But in writing relevant hypertexts, establishing clear relationships between sources and destinations has been acknowledged vital, and the same issue is raised when trying to attach 3D architectural shapes to information.

Numerous experiments, mainly in the field of archaeology, have been carried out using the paradigms of GIS such as (Ioannidis, 1999), (Bilgin, 1997) or (Roberts, 1999). But in the case of architecture at its various scales, geometry cannot be considered as a relevant intermediate between the documentation and the edifice, as established by (Boudon, 1971). In parallel, realistic 3D models prove relevant with respect to communication goals, see for instance (Burton, 1997). But communication through such realistic renderings does not serve the understanding of the edifice since it results in an abusive simplification, stressing only morphology whereas it is not the only element that should be visualised, (see for instance (Dudek, 2001) or (Kantner, 2000)). We develop an approach in which what is “beyond” the image is more important that the image itself, in line with contributions like (Stenvert, 1991) or (Alkhoven, 1993).

Taking a closer look on what existing computer tools and formalisms offer when dealing with the architectural heritage documentation shows that their relevance on this particular application field may not be optimal. E-databases and XML technologies are applied in building or site management and their documentation. At the same time, geometric modelling tools allow the construction of 3D models in which simulations of a morphology is possible. Moreover, GIS systems have proven useful in numerous site management experiences, particularly in the field of archaeology. But whether there is a way in between those families of technologies remains to be fully examined.

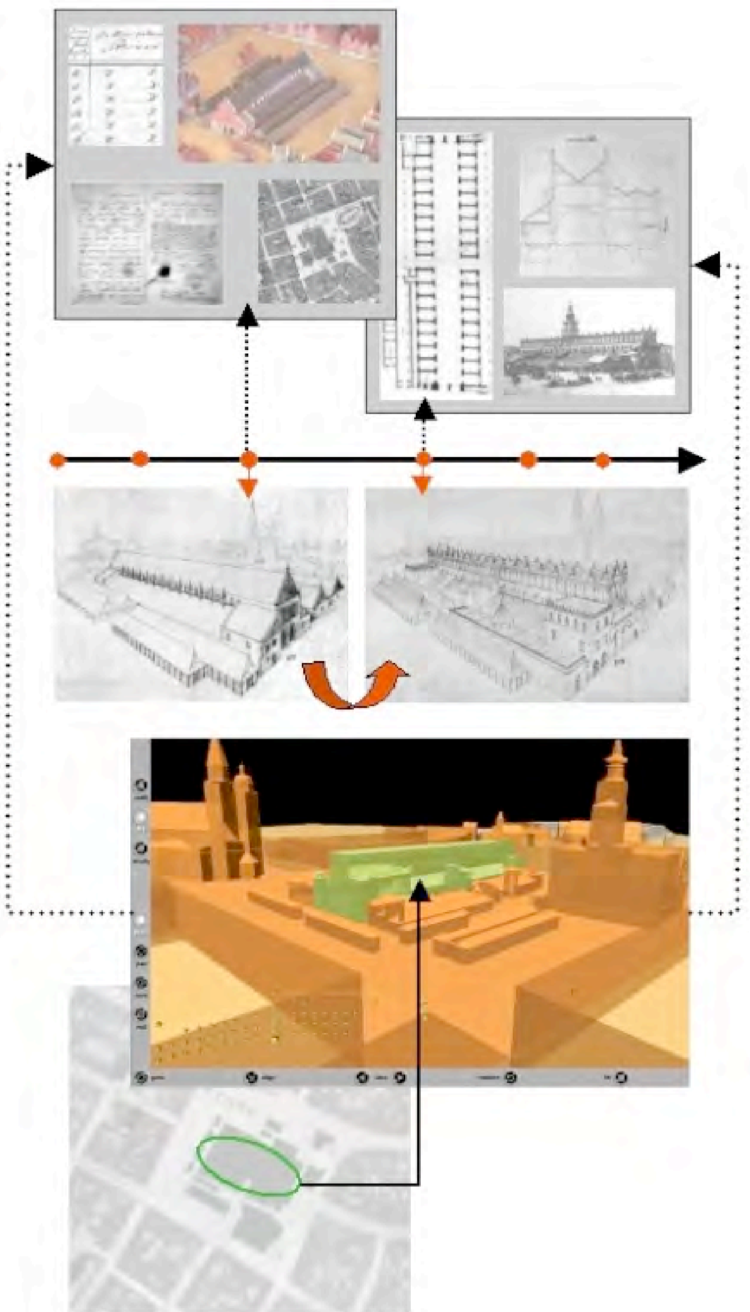


Fig. 1: The edifice's representation localises information, its graphical appearance provides a qualitative evaluation of the information, the actual shape provided relates to the period of observation as chosen by the user.

To put it more simply, we raise the following questions: can 3D models be efficient in data visualisation or retrieval? Can they offer semantic views on the data collection that are absent from other media? Can they synthetically localise pieces of information with regard to a position in space and a moment in history?

Our proposal can be summed up in a very short way:

On how to use the 3D representation of architectural objects in order to ***retrieve*** *information and to* ***visualise*** *information****, i.e. : on how to use architectural objects as filters on data collections.***

In this paper we will present solutions we have investigated in order to use the 3D representation as interfaces to a heritage documentation. Elements discussed will be organised in the following way:

1. An introduction to our field of experimentation, the city of Kraków (Poland), will be proposed in order to try and state why in that case it can be useful to investigate new documentation management and visualisation paradigms.
2. The data collections we deal with, and the analysis step that is required if we want to attach the data to the architectural shapes.
3. The making of 3D scenes, i.e. the identification of the shapes and their visualisation through VRML-based solutions developed with regards to key visualisation issues such as *shape uncertainty* or *hypothesis justification graphical markings*.
4. The necessity to deal with the problem of architectural scales in order to filter the documentation not only through "edifices" but through a variety of architectural concepts that would match the variety of the documentation itself.
5. Aspects connected with the specificity of the architectural heritage.

But it has to be stressed at this point that although problems of 3D representation are, of course, at the heart of our approach, our real aim is not to ***visualise architecture*** but to ***visualise information about architecture***. The consequences of this statement will, we hope, be shown not only in terms of final graphical result (see Fig. 2) but also throughout the whole methodological framework we have tried to establish.

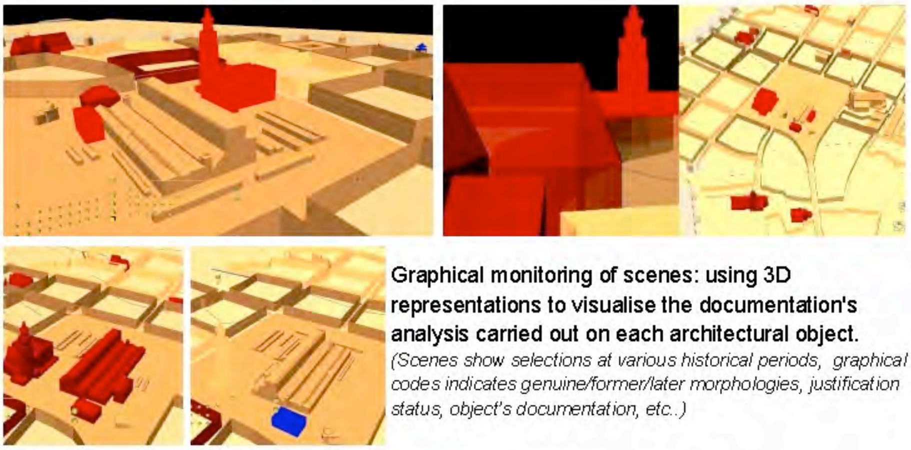


Fig. 2 : Interpretative representations show a current state of knowledge on the urban fabric.

Field of experimentation : the city of Kraków

The field of our experimentation –The Old Town of Kraków is this of our research programmes ARKIW- PICS 1150 CNRS/KBN (UMR CNRS/MCC 694 MAP, Marseilles, France / Institute HAIKZ WA PK, Kraków, Poland) and APN - SHS that focus on the problems of multi-representation in an Internet-based information system about architecture and urban heritage. In this context Kraków has numerous advantages such as the cultural heritage accumulated in a wider European context, a very significant quantity of historical documents, rich cultural and stratigraphic layers, years of conservation actions, investigation and research and wide community of researchers involved in studies of the town's history and evolution.

Kraków (*Krakou Cracow, Cracovia),* former capital of Poland (11th - 17th century) has one of the best-preserved medieval city centres in Europe. In Poland it is known primarily for its respected historic architecture and cultural leadership.

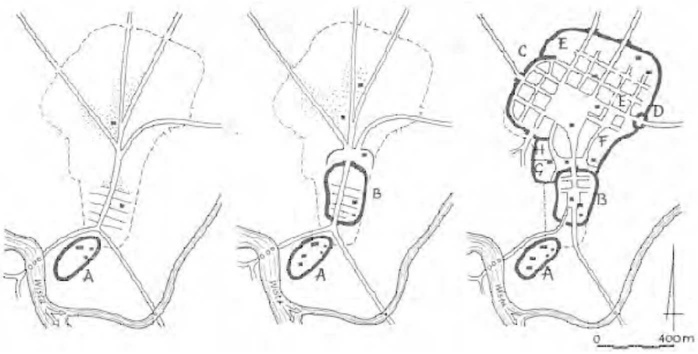


Figure 3 : Kraków, evolution of the early urban structure, according to S. Bobi_ski.

The layout of the Old Town is a result of successive additions and of the evolution of various urban structures - ensemble of the Wawel Hill, the suburbium called Okó_ and the medieval town located in 1257, enclosed in medieval fortification walls, that in the XIXth century were replaced by a park zone called Planty.

In Kraków all roads lead towards the Market Place, former economical centre that nowadays plays the role of cultural heart for the city. This Market Square is perhaps Poland's most beautiful outcome of centuries-old congruence between economy and culture. Frequently claimed the Europe's biggest medieval market square, is surrounded by historical houses and palaces. Up to 19th century the area of the Market Square was furnished with a considerable number of buildings. Nowadays only three of them are visible. But under the layers of pavement the relicts of numerous other structures are hidden.

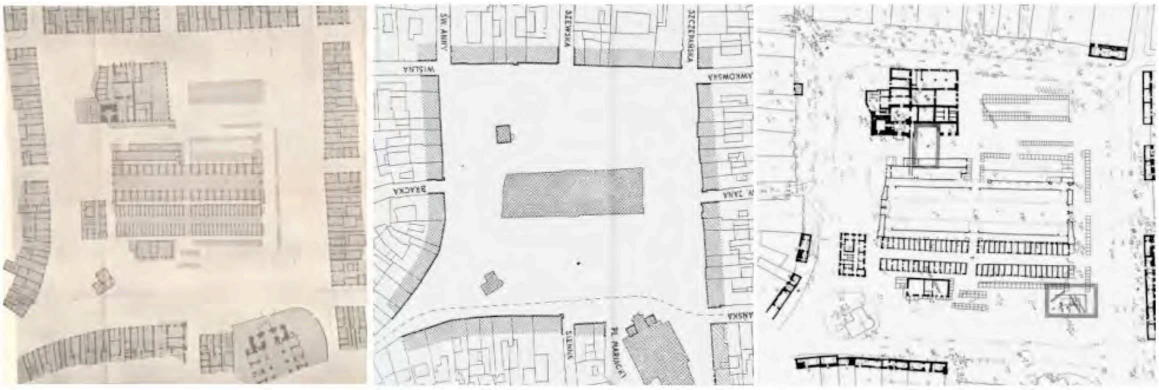


Fig. 4 : Plans of Market Square: (left) corresponding to the period of its highest building density (1787, by D. Puck), (middle) now edifices visible on the surface of Market Square, (right) underground relicts of the historical structures (according to A. Kad_uczka).

Despite various wars and natural cataclysms Kraków was continually growing until the XVIIth century, when the town's decay process started. In the XVIIIth century the population of Kraków counted only 10 000 inhabitants, less than in the middle ages! In the same time Warsaw had 140 000 inhabitants, Paris 600 000, London 1 million. In the XVIth century the differences between the population of Paris, London and Kraków were insignificant.

Although the city was still developing, the basic structure of the town (urban houses, municipal buildings and medieval fortifications) were slowly turning to ruins.

In 1684 three and a half kilometres long fortification walls with forty seven flanking towers were defending the town. Nowadays only the Europe's biggest Barbican, two arsenals and four of the towers are left .

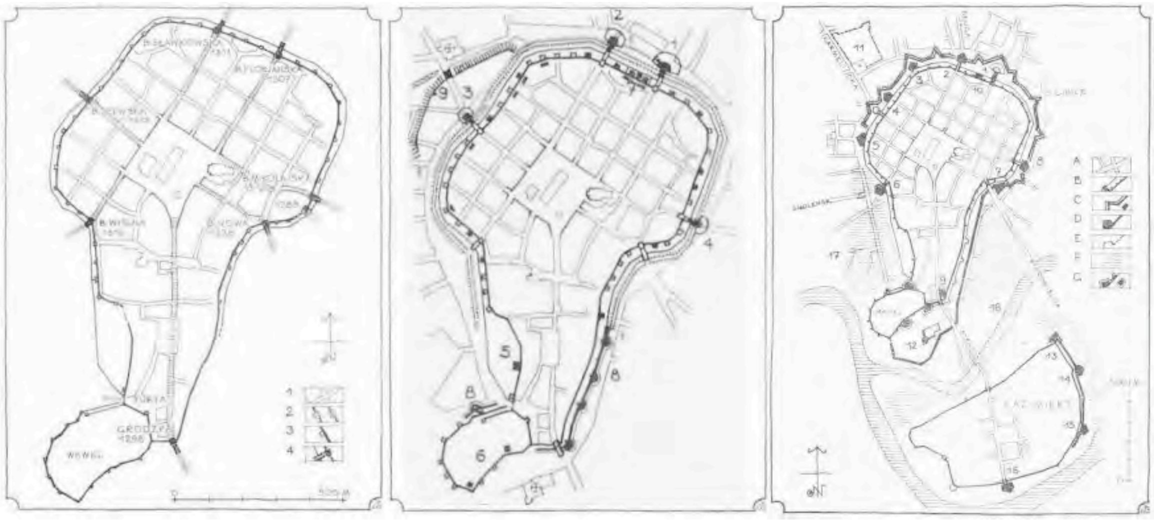


Fig. 5: Kraków, development of the fortification system –XIII/XV, XV/XVI, XVII according to J. Bogdanowski.

On the territory of the listed part of the town a multitude of architectural monuments, coming from all periods and styles from Middle Ages to the present, estimated at 2,5 millions works of art (movables), 6,000 historic monuments and 1,313,000 traditional structures and objects of European scale value can be found.

Genuineness of Kraków makes it very special – the city was not destroyed neither during the I World nor the II World War. Although the image of the city has changed during the passed centuries, the stratigraphic layers keep numerous traces and prove its successive states.

Figure 6: Kraków, evolution of the Cloth Hall (Sukiennice) – XIII/XIV (according to _uszczkiewicz), XV and XVI-XIX, (according to _wiszczowski), XIX (fot. I. Krieger), XX .

It is obvious that historical monuments and sites should be preserved; nevertheless it is not sufficiently stressed that the preservation of our common cultural heritage can not be reduced to the legislative and practical protection of the physical objects. It should include also preservation of the knowledge about it and its evolution.

Years of conservation actions, examinations and research conducted in this place produced a very significant quantity of various documents (descriptions, analysis, drawings, photographs, maps, reconstructive hypothesis, paintings …) that should be gathered, organised and visualised. The fact that the city archives, composed of thousands pages of old texts and planes, have been preserved helped in interpretation of results of architectural and archaeological researches conducted in the 80's 90's of last century. Thanks to continuous and detailed researches almost all edifices of Old Kraków have got extensive monographs. Absolute majority of them remain unpublished, known to a narrow group of specialist and officers of conservatory services. Various professions, institutions and organisations try do organise and preserve documents about the city's transformations by their own means. Although this situation produces positive effects, like diversity of interpretations stemming from different scientific backgrounds, it also results in the lack of a global and unambiguous awareness of the current state of knowledge.

People involved in the preservation of Kraków's heritage face today, with the development of computer technologies, and notably with the introduction of the Internet and of powerful 3D modelling techniques, two major challenges: adapt existing data collections, and moreover exploit the potential benefits of these new computer technologies. One of the issues raised here is the capacity of collection holders to keep the control over their exploitation (avoid software-dependency). It should be stressed that computers may help in the recording and preservation of existing data collections since they can, for instance, prevent a constant direct contact of users with the sources. But what should be stressed even more is that computer technologies can intervene in a better organisation and capitalisation of the conservator's experience, know-how and university researches.

Documentation problems

As mentioned in the introduction, our concern is how to deal with the architectural documentation. In this section we will first of all define our understanding of what architectural documentation can be in our field of experimentation. We will then establish our proposal's main hypothesis and finally describe the resources analysis step that we believe is unavoidable if we want to investigate the use of 3D models as interfaces.

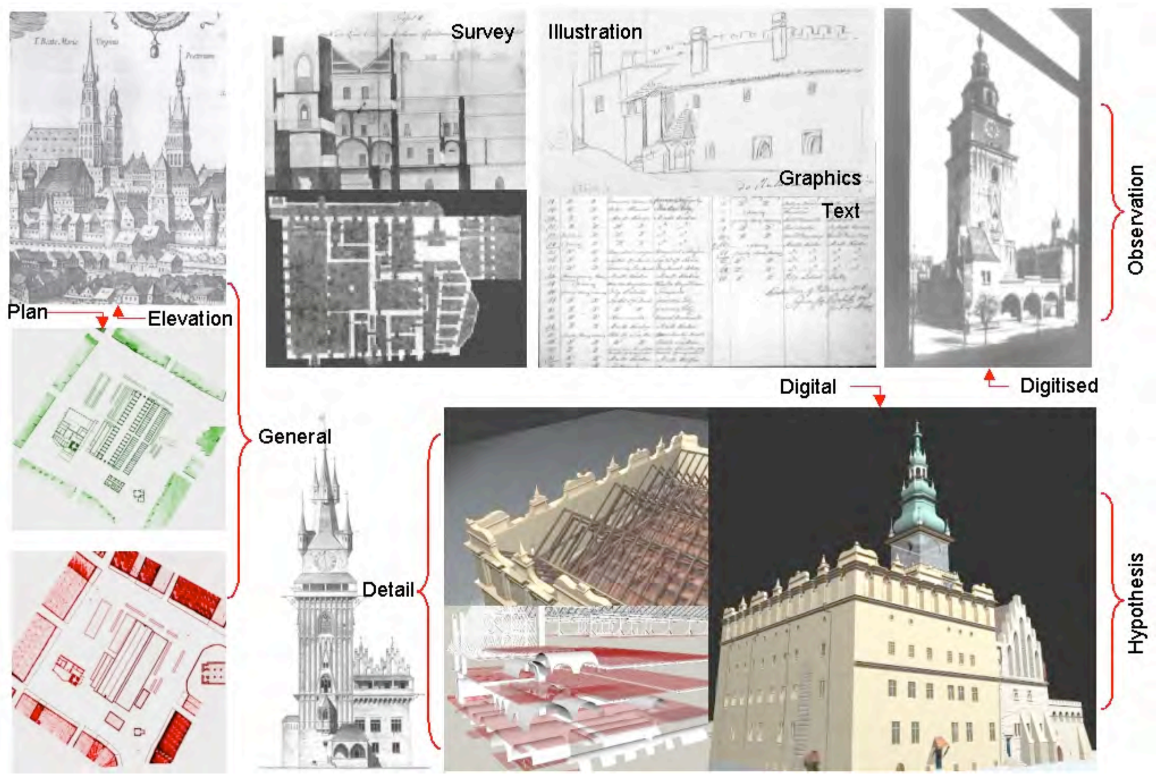


Figure 7: Initial statement and hypothesis

In order to illustrate the architectural documentation's variety we provide in Fig. 3 an exemplary set of material or resources connected with Kraków's old town hall. What is noticeable here is that resources cover several ranges, for example:

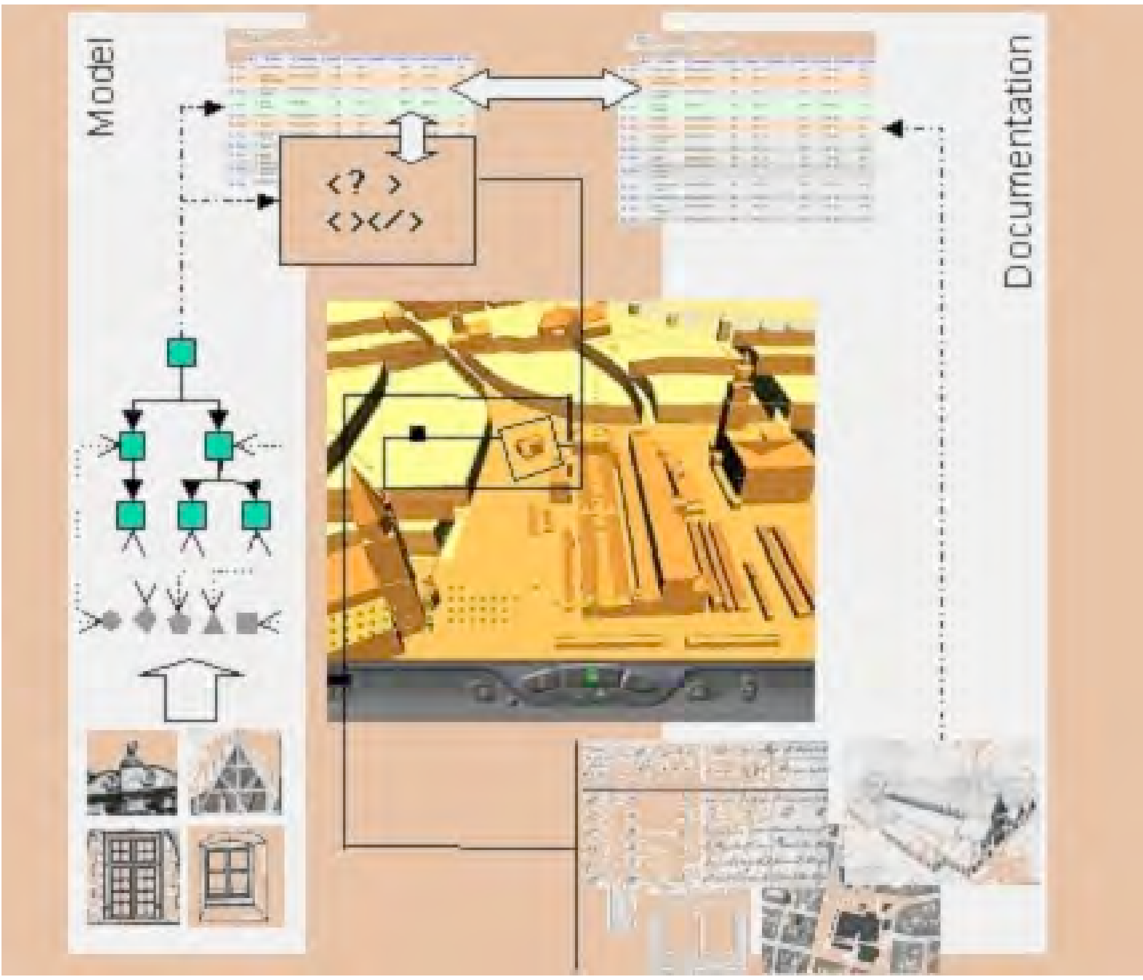
- From archives to contemporary observations.
- From qualitative evaluation/description to "numerical" analysis.
- From textual elements to graphics.
- From sketched illustrations to surveys.
- From past/contemporary observations to past/contemporary hypothesis.
- From digitised material to digital material.
- From descriptions of details to global views on the edifices.
- From elements on the edifice itself to elements in which the edifice is a background.
- From elements on a particular edifice to elements on analogous edifices.
- From raw data to interpreted material.

Given this, what remains the common denominator of the whole set of resources? What concept can bridge the gaps between resources? Answering this question is the starting point of our research: we believe that the edifice itself, meaning the shapes from which it is built, can act as such a bridge. Naturally, in this approach the edifice is an evolutive one: the edifice at time T locates information (resources) at a given position and at a given historical period. The bridge between various historical periods is, in fact, a bridge between the successive evolutions of the edifice.

Consequently, our main hypothesis is quite obvious: we observe that although the edifice is not the information, the information is relative to the edifice. We propose to use the morphology as an anchor for the documentation, as illustrated in Fig. 4. Two aspects are at stake:

- Resources (documentation) analysis step.
- Definition of architectural shapes.

We will now focus on the first aspect and consider the second in section 2.



Resources Analysis

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 (or shapes) and build out of them 3D models, as developed in (Dudek, 2001) or (Donath, 1997).

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 regard to the edifices or sites that it documents. We will therefore face several difficulties when wanting to implement a link between a document and an architectural object inside 3D scenes:

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.
5. In the field of architecture, both documentation and visualisation play essential roles. Moreover, ensuring their interdependence has clearly been acknowledged by numerous authors as a key issue if VR models are to be included in a research process (see for instance (Campbell, 1998), (Stenvert, 1991) or (Nakamura, 1999)).

The main step needed will be to add descriptors of the resources that concern **not what the resource is** but **what edifice it documents**. Following ideas of (Stenvert, 1991) we describe documents in two ways:

- *standard data identification* describing what the document is (author, edition, type of media, technique, …) in a way that is commonly used by the libraries, museums, etc.

- *interpretation of data-content* (morphology typology, etc.), used especially in art and architectural historical studies.

The documentation that we describe is stored in various national and private collections (libraries, museums, archives, etc.). The decision of giving access to the digitised copies of particular pieces of documentation belongs to those institutions. Having it in mind we consciously avoid giving a direct access to digitised sources of various collections. We developed a distributed computer architecture in which we only refer to pieces of information that are detained by various institutions. It has to be stressed that our goal is not to deliver the digitised copies of documents that can be used in the architectural analysis, but to *localise* them in terms of :

- In which library(ies) they can be found.
- To which architectural objects they refer.

References on the documentation are stored in database we have called SOL. The SOL database describes what the data is: a book, a plan, a cloud of digitised points, etc. We attach this data to what it is about : an edifice, a part of an edifice, etc. It has to be mentioned that in our research context the architectural object exists whether or not we have metrical information on it. Its dimensions are for us only one element of its information. Consequently, we consider that data exists prior to our efforts of interpretation and of 3D representation. The 3D scenes do not then describe the data but will only figure our interpretation of the data. The database contains tables supporting a standard indexing of documentary sources: document identification, author identification, graphics description, but also tables which support the source interpretation from various points of view:

- The *Availability Table* states for each document type, whether or not it is available in the specified collections.
- The *Localisation Table* attaches information on XYZ position + orientation in the city to iconographic documents, potentially enabling zone-or-view-related searches in our future developments.
- Finally, the *Comment Table* attaches additional information to entries in the Localisation or Instances tables (notably URLs in the context of a distributed system architecture).

Architectural modelling

Our hypothesis is that b*uilt shapes can be an intermediate between various points of views on the edifice, between various pieces of information partially characterising it*. 3D scenes then represent and localise pieces of information :

- They represent pieces of information since they show through a morphology and an appearance what we know about pieces of architecture.
- They localise pieces of information, in the space of the town and at a given period, since they show through a morphology and an appearance we know about pieces of architecture at that given time.

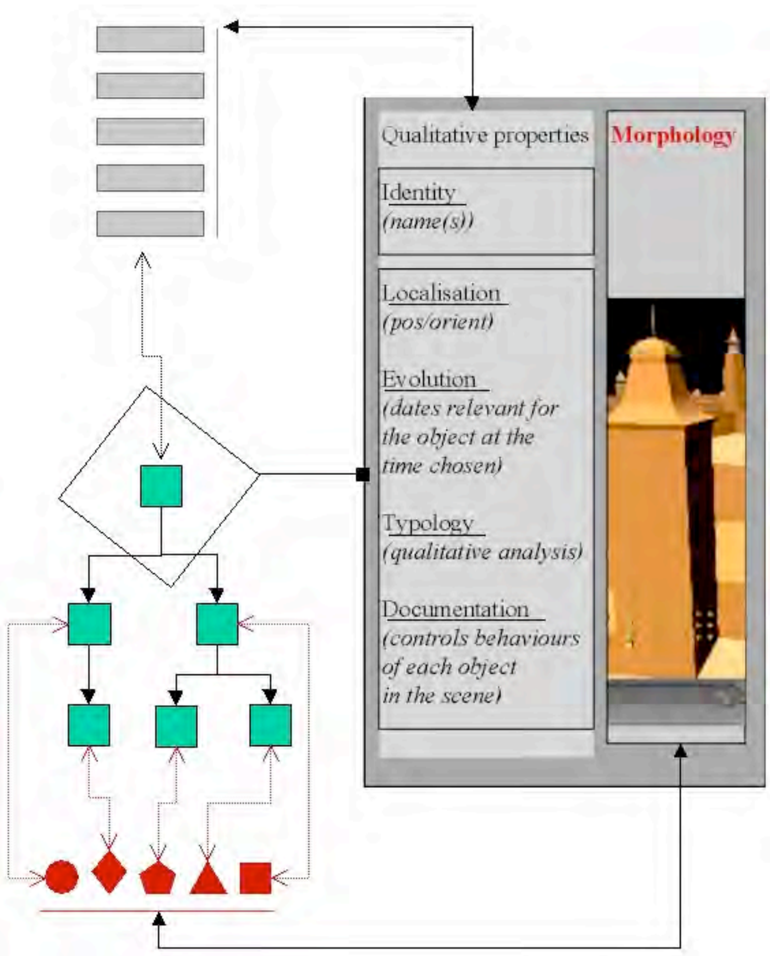
We need to identify concepts that will be used as filters on the architectural documentation.

This process takes three steps: morphological and structural analysis, identification of concepts and classification. The concepts are identified through an analysis of the morphological, structural and functional differences and similarities between the objects (with regard to four identification rules: unicity/structural role/autonomy/information support). The identification step is based on the analysis of respected scientific works in which a careful attention to a non-ambiguous definition of the architectural vocabulary can be exploited for implementation in an object oriented programming language. Once this is done, we classify the concepts using the principle of heritage of properties.

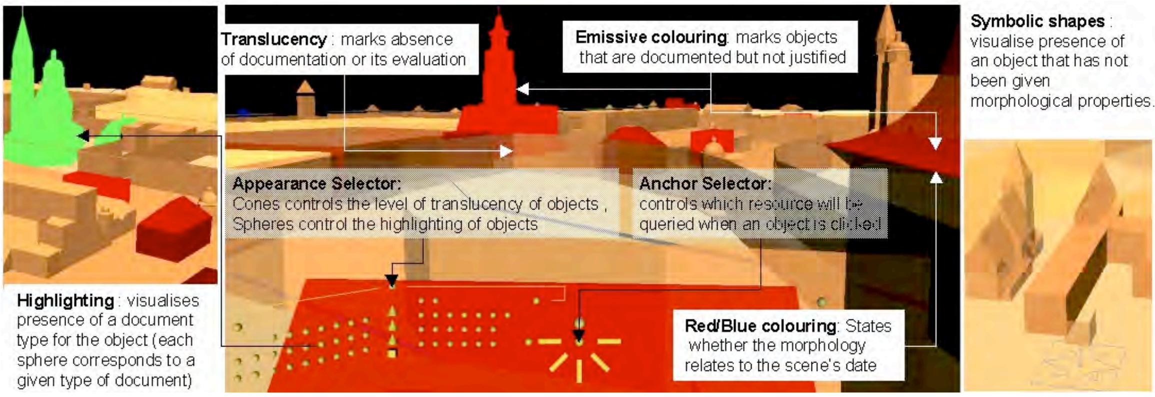
In our approach, built architecture at its various scales (from the urban analysis to the atomic elements of corpus) is described as a collection of elementary objects organised by topological relations. The model's categorisation exploits basics of object orientation. The Aristotelian way of thinking it allows permits gathering elements that feature the same proprieties in the frame of one category. Each category can give birth to a more specialised subcategory.

A commonly used example of such organisation is the classification derived from Darwin's theory of evolution. This downwards tree-like structure includes a mechanism of heritage of proprieties and is characterised by a systematic growth of complexity. Comparable features can be observed in the field of architecture. Evolution of the architectural corpus can be expressed by successive morphological and stylistic changes enriching the collection of prototypical shapes. This evolution is the subject of analysis of many authors dealing with history of architecture. More detailed description of the methodology used can be found in the publications related to the ARKIW program (Dudek, 2001) or (Dudek, 2002).

Each concept is formalised in a class that contains six blocks of information. The Morphology block contains the information relative to the concept's geometrical features, it serves as the main division line inside the model. Documentation, Typology and Evolution information blocks are used in order to attach to each instance a set of qualifying attributes that we call justifiers, and that are used in order to monitor the actual appearance of the object. The Documentation block is responsible for the handling of SQL queries on the SOL database that references the documentation. The Typology and Evolution blocks store an evaluation of the documentation that will be carried inside the 3D scene, letting us, for instance, visualise with different colour codes edifices for which we know architectural drawings exist and those for which such documents do not exist.



3D scenes are calculated consequently online when the user formats his query. They show what we know as well as represent what we ignore: concepts are given an appearance that is monitored by our current state of knowledge on them. Once concepts are identified, organised and formalised, the making of 3D scenes results in the instanciation of the model's theoretical shapes and a call to the relevant representation method.



In our application domain objects are often reused or partly destroyed (problem raised in works like (_ukacz, 1998)). We have, as a consequence, provided each object with a persistence mechanism that stores independently the object identity (identity + concept documentation + position in the model's structure) and its various states of evolution.

Each concept embraces methods relevant for persistence handling in XML files and RDBMS context. The Parsing of XML sheets in order to re-instance and visualise objects selected by a query on the Database is done thanks to the Perl XML::SimpleObject Module (Hampton, 2001).

Autonomy and perenniality of the of the data sheets are of crucial importance in our application domain. We have chosen to store the textual results (XML sheets) of the model's instanciation inside standard ASCII files that can be used independently from the system as a whole. In our approach, solutions for object persistence as those described in (Conway, 2000) are therefore not implemented since they implicate a dependence of the results on the application that gave birth to it. Good elements for a discussion on the XML one input / several outputs paradigm can be found in (Walsh, 2002). We propose in line with this author a solution based on the idea that a unique input, the instance's XML sheet, will have several outputs. The concept's morphological characterisation provides information for the calculation of a geometry for the object. The geometrical representation in VRML can match the concept's complexity or provide a symbolical shape. Pluses, minuses and applications of the VRML standard for architectural modelling have often been discussed, see for instance (Campbell, 1998) or (Oxman, 1999). Our scenes are written in VRML 2.0 both for Cosmo and Cortona plug-ins. Considering the creation of scenes that would remain autonomous from the application that created them, we rejected the possibility of investigating JAVA/VRML solutions (see (Roehl, 1997)) that various experiences such as (Landes, 1988) or (Brutzman, 1998) have proven efficient, but that seem too exposed to versioning problems for use in our application domain.

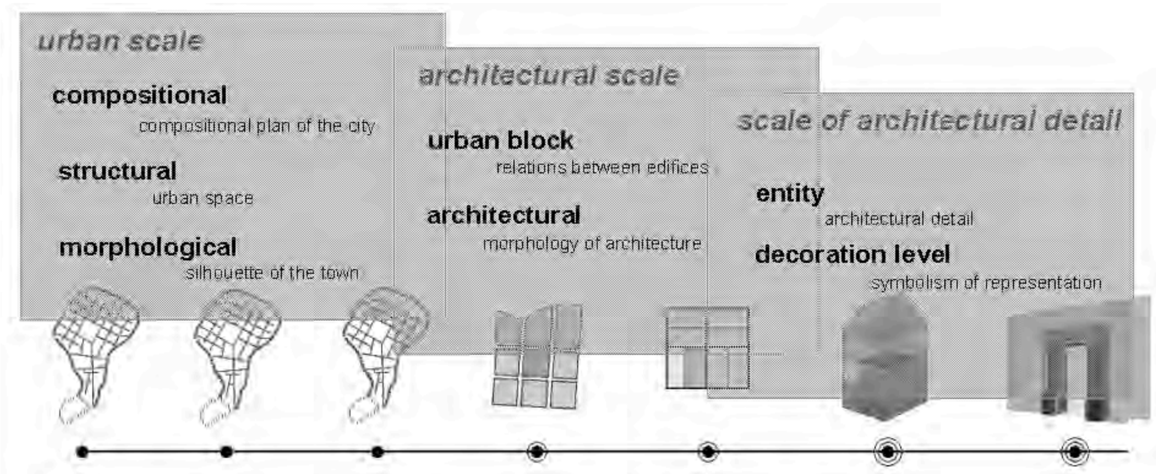
The scale issue

This issue can be summed up by the following question: what would be the benefit of using architectural shapes as filters on a set of resources if the variety of shapes would not match the variety of the documentation? A consistent development of our approach implies that we give the user the possibility to segregate data on, for instance, the town hall's main portal and the town hall's spire. Efficient searches are at this cost. From Borgès' tale (1992) one can read that attempts to represent all the existing information about a territory on one single map is absurd. In the same way we believe that attempts to represent all the information related to the evolution of an urban fabric in one single 3D model appears irrelevant. Even with growing technical possibilities as mentioned in (Brutzman, 1998), (Althoff, 2001) or (Ames, 1997) we consider that from the point of view of methodology this solution can not be accepted.

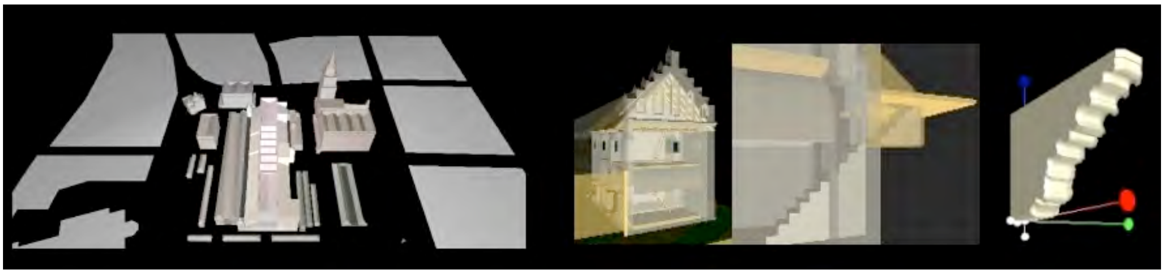
Consequently we divide the real architectural world into different layers of abstraction. Moreover, we believe that in this domain one should avoid also the implementation of concepts containerisation. This means that for example the urban concepts (ex. an urban block) will not "contain" the concepts representing architectural edifices (ex. a building) although from the spatial point of view *a building* is a part of *an urban block*. In fact, from the point of view of documentation content analysis those concepts may have nothing to do together. Our goal is to assure a good access to the data, therefore we have to focus on distinguishing the elements (concepts) which are used in documentation. In order to visualise different problems 3D representations should use not only different levels of abstraction, but also different types of coding and a successive narrowing of the scene's span.

We have defined seven different scales. Scales are classified in three groups, related to urban problems, architectural problems and problems of atomic elements. The conceptual "bridge" that links various scales is a spatio-temporal localisation.

The following figure summarises this framework.



This aspect of our research remains the most prospective one. Still we believe that a real evaluation of the proposal will be possible only once the implementation of those scales is fully achieved. At this stage of our research we have implemented concepts corresponding to one scale inside each group (see following figure entity/architectural/structural scales) but have come to the point where technological choices are at stake. VRML technology may well not be suited for all of the seven scales.



Domain-specific constraints

As a conclusion to this paper we will mention four aspects of our research that seriously question ready-made technological platforms, as well as methodological frameworks. These aspects underline the necessity to evaluate computer-based systems not only with regard to performance, user-friendliness, inter-operability, etc., but also with regard to questions arising from the fields of application. Beyond the actual proposal we have described, we believe our contribution may be fruitful in stating a number of these questions.

Data uncertainty

Edifices that we study have been widely transformed throughout the centuries when they have not been totally destroyed. We visualise shapes that in all cases are hypothetical. Consequently, we should propose visual markings of the objects represented in a 3D scene that correspond to the type and content of their documentation, and to the hypothesis' evaluation.

The amount and precision of information for each object, on each analysed historical moment varies considerably. Therefore 3D visual representations to which we will want to attach pieces of information may be *incompletely defined*, and need to be *visually marked* with an indication on what information the proposed shape is based on.

This implies the introduction of graphical codes for 3D representation, that would be used in order to visualise an evaluation of the nature or accuracy of the documentation attached to each architectural object represented in a scene. Such codes **exist and have always existed in traditional 2D representation** but they are **not used natively in computer-based 3D representations**. We think more research has to be carried out on graphical coding of 3D scenes in order to allow the researcher to visualise such aspects as the state of certainty of a reconstructional hypothesis, or a comparative qualitative analysis of the documentation 's content on an edifice.

Objects removals / deformations

Inside an edifice that can be widely transformed, individual elements of architecture can be reused or even moved somewhere else in the city. We therefore face yet another pitfall: localise in the space of the city architectural elements in relation with a given period of time, and simulate successive coherent phases. Moreover, the actual vocabulary of shapes we base on when creating 3D scenes usually matches "perfect" objects, but hardly lets us to model the real, old and deformed object (see examples on the figure below).

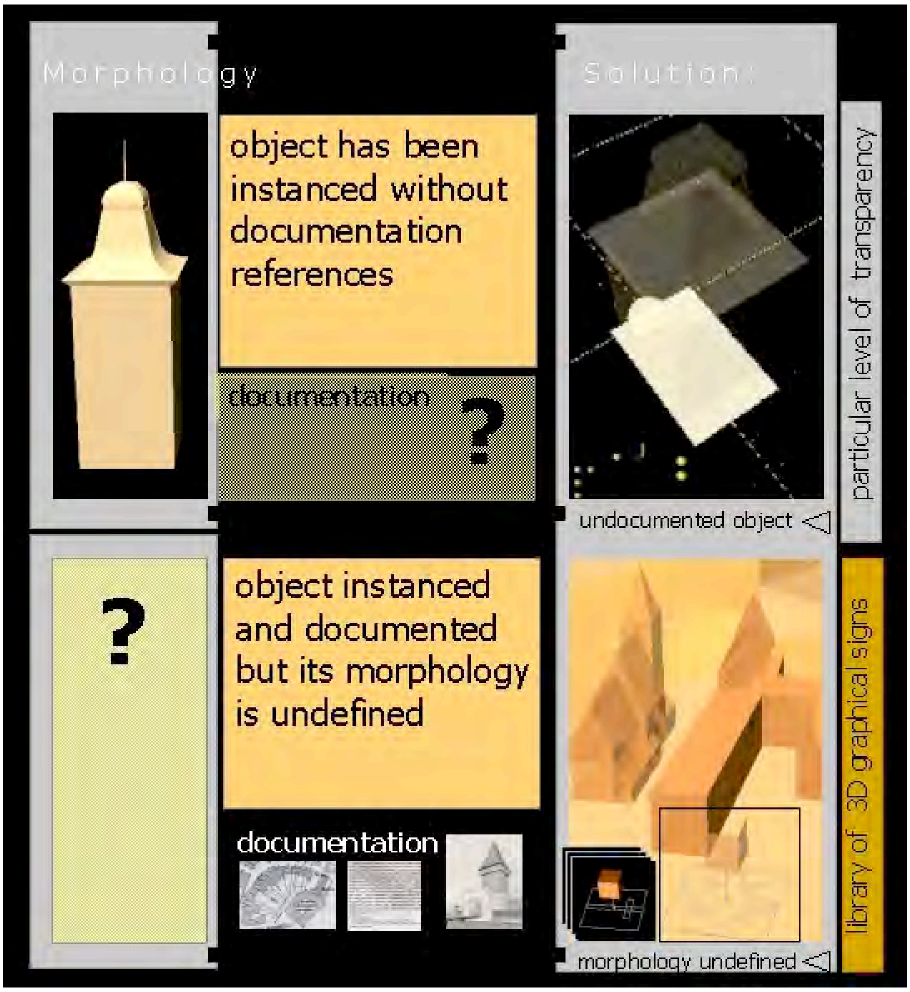
In other words, *The theoretical definition of concepts may match only partially this of the individual elements*. We believe the time of seduction through 3D graphics should now leave some space for a more careful labelling of what is shown on a 3D model. Surveys, reconstruction or interpretative models are essentially different, yet who says it?

Objects evolutions

One key aspect of architectural documentation management is to deal with the evolution of the urban fabric. We propose to document and represent each phase of the edifice's evolution. Still a piece of architecture retains its identity although it may have been transformed. This is why we have formalised a theoretical model of architectural elements in which each meaningful individual concept can be given identity persistence, but state evolutions. Under this condition, evolution simulations can be carried out such as the timeline scenes we have implemented in which the user interactively moves a time cursor in order to visualise the urban fabric's transformations. Such a simulation tool can be extremely useful in evaluating the lacking pieces of information.

Knowledge evolutions

In the course of the analysis of an urban fabric, we are very likely to deal with undocumented or non-dimensioned objects. We may know a piece of architecture existed at position P without having gathered a serious documentation on it. In parallel, we may have documented a piece of architecture but without having proposed a morphological interpretation. Therefore possible inconsistencies appear when we have not gathered enough data on either the morphology or the documentation of the object. In both cases, how can we still visualise something ? The solution we propose is to stress the lack of information by a visual sign in the 3D scene. The following figure summarises this aspect.



Conclusion

In the field of architectural patrimony the meaning of the word visualisation is often narrowed to this of virtual reconstruction that is a dead-end realistic 3D representation. Our work clearly positions visualisation in our application domain as an interpretation indicating what is known, as well as representing what is uncertain and even what is ignored.

The scenes we build support a semantic graphical coding that allows the researcher to visualise such aspects as the state of certainty of a documentation, or a comparative qualitative analysis of the its content. This is possible through the interaction disposals that are nested inside the VRML scenes and that use the values of object's justifiers. It has to be stressed that our scenes are calculated online as results of user queries on the spatio-temporal database of instances. Any change in each instance's documentation or morphology is therefore visible in the scene without any intervention. We believe that scientific circles can greatly benefit from the visualisation that focuses on knowledge inconsistency and incompleteness. Such representations can give not only a new view on our knowledge but also direct investigations on novel objectives. We, however, regard our contribution as nothing more than a first step in trying to use 3D modelling in the semantic visualisation of interrelated spatio-temporal data sets on archival information.

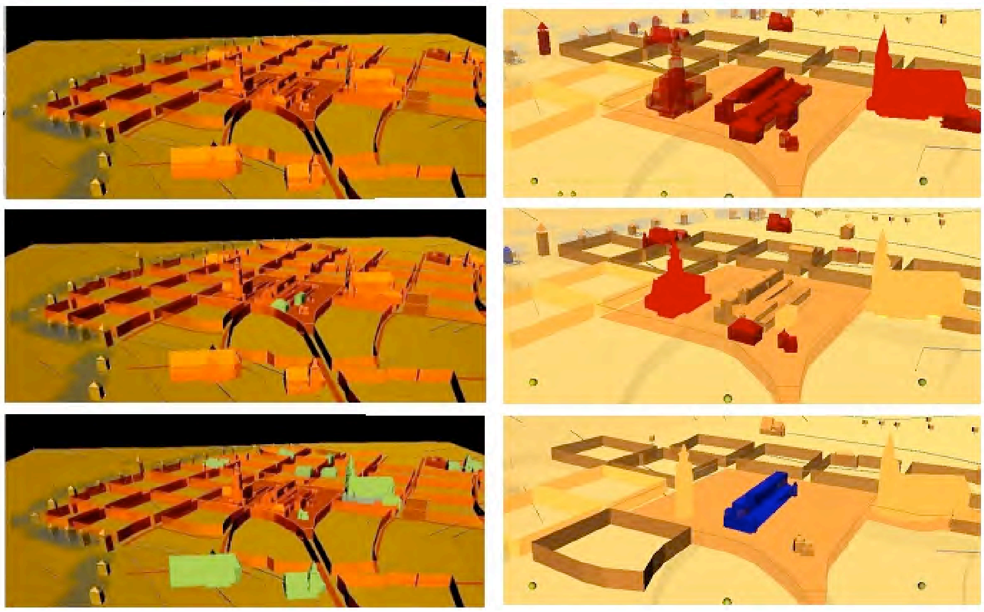


Figure 15: (Right) A selection on the Edifice, UrbanBlock and FortificationUnit classes, at periods 1450, 1700, 1950. Blue colour indicates that the morphology displayed is this of a former evolution period, red colour specifies the contrary. Emissive colours indicate that no justification task has been carried out on the object's documentation, translucency 0.9 shows lacking documentation. (Left) Highlighting of edifices by function types.

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