AN ARCHITECTURAL MODEL COMPILER DEDICATED TO ARCHAEOLOGICAL HYPOTHESIS
AN EXPERIMENT ON KRAKOW'S KRAMY BOGATE

Jean-Yves Blaise , Pierre Drap, Iwona Dudek.

gamsau umr map cnrs 694
EAML 184, av. de Luminy 13288 Marseille Cedex Cedex 09 France
Email (Jean-Yves.Blaise, Pierre.Drap) @gamsau.archi.fr http://moma.gamsau.archi.fr

Instytut Historii Architektury i Konserwacji Zabytków
Wydział Architektury Politechniki Krakowskiej
ul. Kanonicza 1, 31-002 Kraków, Poland
Email idu@gamsau.archi.fr

Abstract :
Our research addresses the question of how to handle the architectural knowledge in order to provide non-computer science specialists with a tool dedicated to the making and to the representation of archaeological hypothesis. Our approach of the architectural object is based on theoretical analysis and on elements of bibliography connected to specific buildings. Relevant hierarchy of concepts (individual elements of architecture that we call entities as well as relations linking them to one another) are formalised following the object oriented methodology in order to provide each element of vocabulary isolated as non ambiguous with a corresponding theoretical definition.

The "Hublot" application we present allows interaction with the theoretical model (create and arrange one's own set of entities) through a web browser in which textual data and VRML 2.0 (Virtual Reality Modelling Language) scenes are linked.

This research is connected with the ARKIW POLONIUM co-operation program that links the MAP-GAMSAU CNRS laboratory and the HAiKZ Institute of Kraków's Faculty of Architecture. The field of experimentation proposed is Kraków's Kramy Bogate (Cloth Hall) located on the city's main market square. Formalisation of the theoretical models and web interfaces are JAVA developments.

Keywords: Knowledge extraction, web, archaeological hypothesis, Java, VRML.

1 Foreword

Concern for the architectural and urban preservation problems has been considerably increasing in the past decades, and with it the necessity to investigate the consequences and opportunities opened for the conservation discipline by the development of computer-based systems. This clearly locates multidisciplinarity as a central aspect of our research, and the enabling of distant web access to all the computer developments as a necessity. As an answer, we have formalised an object-oriented architectural model implemented to serve as a junction between the concepts and methods of the computer

scientist, and the knowledge and practice of the conservationist. This model is provided with formalisms enabling:

- A measurement of objects.
- An updating of the theoretical model contents.
- The representation of archaeological hypothesis (HUBLOT application)

In this paper we will focus on the HUBLOT application that has been experimented on Kraków's Kramy Bogate (Cloth Hall) located on the city's main market square.

2 Background and Context

The GAMSAU-MAP CNRS laboratory (Marseilles, France), specialised in the use of computer techniques, and the HAiKZ institute of Kraków's faculty of architecture, specialised in conservation, have initiated a research and exchanges program, named ARKIW, aiming at investigating the architectural evolutions of Kraków's main market square during its eight centuries of history.

2.1 Methodological background

In object-oriented programming, the field of knowledge is split into elementary concepts structured through refinements of classes. Since the architectural heritage clearly reveals elements of permanence and of variability, the knowledge to be represented and handled features both stable concepts (the roofing, the opening, etc.) and their historical variations. A thorough investigation of each of this evolution's steps by specialists of architecture and conservation is needed in order to identify and organise sets of non-ambiguous *objects* that we call architectural entities. It is therefore vital to provide an access to the architectural model itself both on the computer scientist side and on the conservationist side.

In addition to the architectural entity hierarchy approach of the building, we have developed a "grouping" mechanism that is used when applying the underlying model to fields of experiments. A LALR grammar based on the JAVA grammar allows a textual description of the field of experiment in which the building is seen as a set of entities and of relations linking them to one another. A compiler uses this textual description to represent the building as a collection of instances of the theoretical model's classes.

The "hublot" interface to this compiler gives a possibility to choose, modify or create a script in which the building is described. Following the compilation phase, the interface gives a direct access to the instances generated through the process and by a messaging mechanism allows the user to visualise the VRML representation or to get information on the model's instances data.

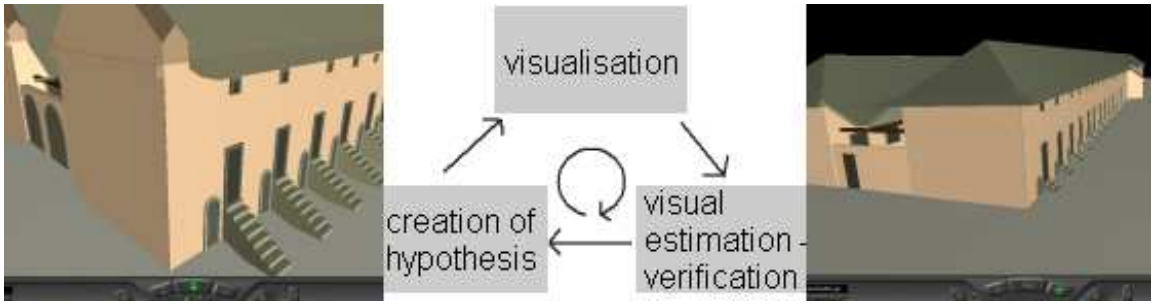
3 Objective of the experiment

3.1 Formalising the needs

Architects, historians of art, archaeologists and other professions that deal with the architectural heritage frequently face objects partly or totally destroyed. Most commonly destruction is the effect of time passing, but also of fires, floods, wars as well as

ignorance or irresponsibility. A detailed documentation that would provide information about form and structure of a despaired object is often lacking.

Therefore any reconstruction either purely theoretical or aiming for rebuilding or adaptation of the remains has to be based on comparisons and analogies. This however gives a place for the subjective point of view of the hypothesis' authors, and consequently in a majority of cases increases the amount of the possible propositions. When come the time for the authors of hypothesis to favour one solution, a visual comparative estimation plays an essential role.

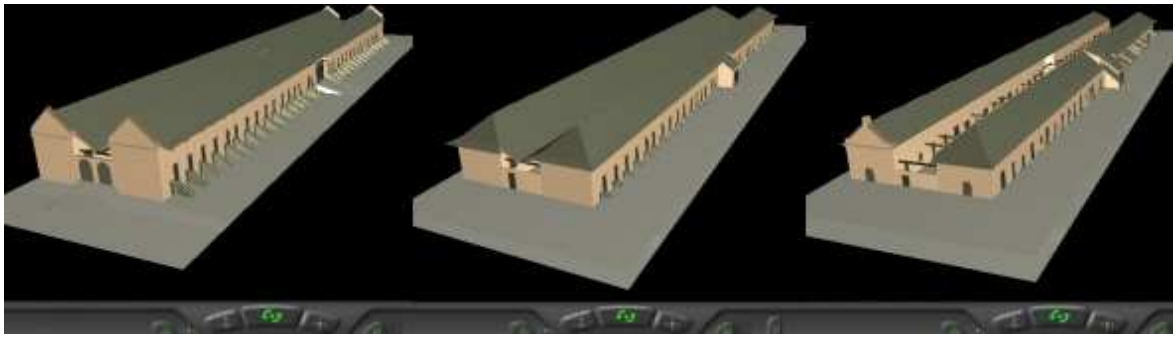


Creation of an hypothesis, as an act, is the result of an author's expertise. The next necessary step is a visualisation of the proposal in a perceptible form, its correctness and probability can then be verified by a visual estimation. This verification process is repeated until the satisfactory proposition is formulated.

Visualisation is a most tiresome and time-taking element in this process, it is therefore important to provide researchers with a knowledge-based tool that could help in authenticating, through the step of visualisation, the entire process of hypothesis building. Since the "hublot" interface represents a given hypothesis as the ordering of instances of the theoretical architectural model, it not only features a possible spatial solution for a given reconstruction problem but testifies of and gives access to the underlying architectural analysis.

3.2 Field of experiment

Kramy Bogate in Kraków is one of the structures that furnished the city's main Market Square. This Market Square, founded in 1257, is one of the biggest in Europe and it is listed as a monument of the UNESCO Cultural and Natural Heritage.



During more than five centuries Kramy Bogate filled the considerably big space of the citie's trade centre – Rynek Główny. Founded in the XIII century as a place dedicated to a cloth trade, they survived wars and fires to be demolished in sixties of

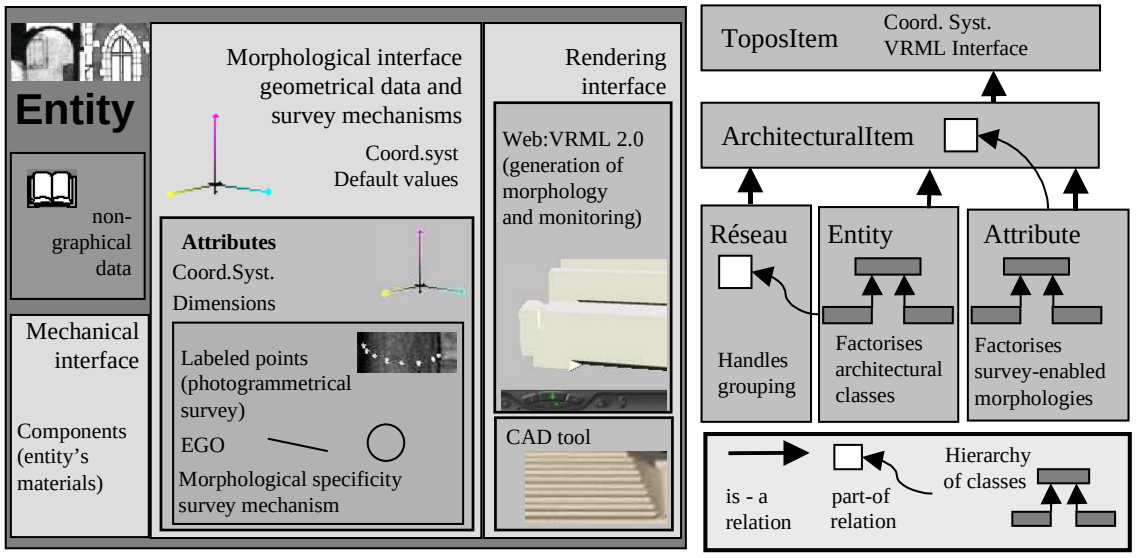
the XIX century. Their cellars still exist under the actual level of the market square, but the location in the very centre of the city makes excavations difficult. Diverse historical documents (old maps, paintings, drawings, inventory descriptions, photographs, etc.) are preserved. From these data we can learn quite precisely the main shape of the object, its situation and general size - two parallel rows of brick shops with a covered gallery in between them. More detailed reconstruction requires the use of a general knowledge on particular elements of architecture. Therefore, Providing a tool for knowledge-oriented virtual reconstruction should bring to the fore a new opportunity for the construction and the interpretation of archaeological hypothesis.

4 The hublot application

4.1 The Architectural model: Definitions

Architectural concepts are described as entities, réseaux (arrays), attributes and relations and are gathered in the ItemTopos hierarchy. Elements of a building will be described as *entities* [Drap, 1997] providing that they meet two requirements:

- An entity is a unique " object " identified by a single element of the vocabulary.
- An entity has an obvious role in the physical structure of the building.



Architectural *entities*, structured by the inheritance of class mechanism are analysed from the point of view of intention. This means isolating object categories for which similarities of structure or behaviour can be observed. Once the properties of the architectural entity are described (both nature and behaviour) the relations between entities are formalised in order to organise the building. *Réseaux* are groups of entities and relations chosen in order to represent one specific combination. *Attributes* are items of vocabulary that correspond to a morphological specificity of one or several entities.

4.2 The definition of a scene : La Demarche script language

A script based on our "La Demarche" script language defines how a given set of entities is organised in an array (réseau), and visualised in a scene. A fist version of La Demarche, developed in 1997 with C++, had a strong drawback: its static aspect. As a

LALR type grammar, it used a LEX analyser and was therefore given a finite vocabulary after compilation. By choosing to develop in JAVA we could transform this language into a dynamic one that allows the integration of new concepts without compilation. With the introduction in the Java language of the metaclass mechanism it is possible to link the name of a class with its computer representation. It is therefore possible to gain access to each of the object's methods without writing tokens in a predefined dictionary.

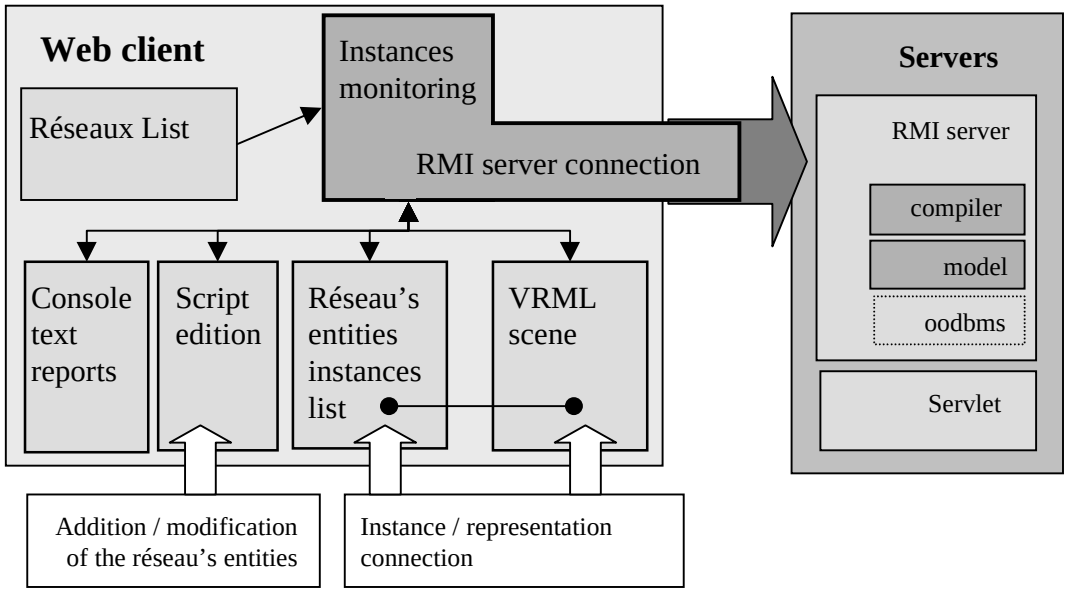
We have also introduced in "La Demarche" the notion of mutable object, not implemented in Java but formalised in UML (Unified Modelling Language). Any instance of an object owns properties (attributes and behaviour) given by its class type. These properties, even though their actual content may vary during the instance's life, cannot disappear, and neither can new properties, not defined inside the class, appear. The addition of new attributes inside an instance implies a change of class type. This is not implemented neither in C++ nor in JAVA. Moreover, a mutation between sister classes cannot be done without facing the risk of an information loss (properties loss). We have therefore preferred implementing mutation in a restricted meaning : refinement of classes. The refinement operation allows the instance of a given class A to mute into an instance of a class derived from class A. We are therefore sure that after this operation all the attributes of the mutating instance will be informed. New attributes described in the derived class are given default values. This approach can prove useful when dealing with a group of architectural objects to be handled inside a common control structure. For example we group the ten beams (Solives) of a ceiling of which two are side beams (Muriere):

Solive ensSolive[10]; a 10 Solives array	ensSolive[0].rafinement(Muriere); instance 0 is refined into a Muriere	ensSolive[9].rafinement(Muriere); instance 9 is refined into a Muriere

This La Demarche script defines a polymorph array of 10 Solive type objects of which two are Muriere type objects.

4.3 A web interface: the Hublot

A web interface dedicated to the edition and analysis of scenes based on our



architectural model has been a strong requirement inside our research. The hublot interface gives access to the LaDemarche compiler and to the architectural objects instanced through it. This interface allows diverse interaction with the model:

- addition or subtraction of entities in arrays (specific combination of entities and relations),
- modification of each entity's features like position, dimension, orientation, etc...,
- on line computing and visualisation of the results in VRML (Virtual Reality Modelling Language) and of the textual reports in HTML (listing the characteristics of each entity in the scene), and connection between them,
- iterative action on each of these levels.

5 Conclusion

The analysis of the architectural and urban evolutions of Kraków's Main Square is today a crossing point for historians, architects, archaeologists, etc.. Computer scientists are therefore confronted to a phenomenon in which both the concepts (the objects) and their representations for diverse disciplines evolve at high speed. Education and research in the scope of architecture and its history are in return questioned on how the development of information technologies can enrich their discipline. Consequently, the implementation of a theoretical architectural model positioned as a junction between diverse disciplines appears as a necessity. The hublot application uses the "representation" interface of such a model in order to allow on-line building up of archaeological hypothesis. Its experimentation on Kraków's Kramy Bogate (Cloth Hall) has shown the possible benefits of developing such a tool. More can still be done in order to ease the tool's use and to implement a JAVA-VRLML-OODBMS connection that will bring new perspectives and raise new questions for both the computer scientists and the architects collaborating in the research.

The ARKIW co-operation is supported by a Franco-polish POLONIUM program.

References

[Drap, 1997] P.Drap, M. Florenzano, J.Y Blaise (1997). PAROS, Photogrammétrie et modèles objet appliqués à l'étude de l'architecture construit. *Revue « L'Objet, Logiciel, base de données, réseaux »* Édition Hermès, Paris. Volume 3 - n° 1/1997, pp 27 à 52.

[Kad, 1986] A.Kadłuczka (1986) Ochrona zabytków Krakowa, PAN Kraków , nr 400.

[Luk, 1969] M. Łukacz (1994) The preservation priorities and the present problems of the historic preservation in Cracow. International Symposium Protection and Management of UNESCO Cultural World Heritage in East-Central Europe, September 14-18 1994, Warsaw-Zamość-Cracow, Poland.

[Kad, 1995] A. Kadłuczka (1995), Relikty monumentalnej zabudowy Rynku Krakowskiego - ocena stanu zachowania i możliwości ekspozycji Ochrona zabytków, nr 1 (188), R. XLVIII, Warszawa 1995, ss. 13-19, and „International Symposium of Relicts of Medieval Monumental Architecture", Warszawa-Lednica 1994, ss 17-25