Visual tools decipher historic artefacts documentation

Jean-Yves Blaise, Iwona Dudek

Visual tools decipher historic artefacts documentation

I. Dudek , J.Y Blaise
(UMR CNRS/MCC 694 MAP, France
idu(jyb)@map.archi.fr

Abstract: Analysing and understanding the evolution of historic artefacts requires the cross-examination of indications ranging from specific pieces of data (remains of the edifice, archival materials, etc.), to generic pieces of knowledge (historical context, comparable cases, theory of architecture, etc.). This research is based on the premise that the artefact's acts as a media allowing the integration of the above-mentioned heterogeneous indications. Consequently, they may enable information visualisation and retrieval through 2D/3D dynamic graphics. In this contribution, we discuss four SVG-based graphic tools aiming at exploiting visually the relations between an artefact and the above-mentioned indications, *i.e.* its documentation.

Key Words: Architectural heritage, Ontology, Interfaces, Information visualisation, Spatio-temporal data, Document analysis and retrieval.
Categories: H.3.3, H.5.2, J.5, H.1, H.2.5, H.2.8, H.3.1

1 Introduction

Analysing and understanding the evolution of an historic artefact requires the cross-examination of various *clues*, ranging from specific pieces of data (remains of the edifice, archival materials, etc.), to generic pieces of knowledge (historical context, theory of architecture, etc.). Such clues, that we will call the artefact's documentation, may vary in type, relevance or spatial granularity (*i.e.* they may concern a whole town or an isolated architectural object). Therefore one single artefact may be described by numerous heterogeneous documents. In parallel, a single piece of documentation – a manuscript for example - may concern various artefacts and various spatial granularities. The analysis of the documentation helps to put in relation architectural elements at various scales (from architectonic details to edifices) with pieces of information, and eventually allows researchers to understand and represent the successive spatial configurations of artefacts. From then on, the artefact's representation can be used as a mean to retrieve/visualise the documentation. It should be stressed however that the artefact's representation acts as a metaphor: its role in the investigation process is *not narration but explanation* in the sense of [Tufte, 01].
In this contribution, we present four SVG-based (*cf.* [Geroimenko, 05]) graphic tools which exploit visually the relations between architectural and urban components of Krakow's urban fabric and their documentation. Four major questions were posed:

- Can we interface the documentation using the artefact's spatial distribution?
- Can we retrieve from a document its *architectural content* and visualise it?
- Can we visualise the reliability of the information extracted from documents and justify the artefact's representation by a "bibliographic" context?
- Finally, in the case of visual documents (a painting for example), how can we describe what we can guess about "*where the creator "was standing"*

In *Journal Of Universal Computer Science – Proc. I-Know 2007, 7th International Conference on Knowledge Management, KVD Workshop, Graz, Austria, sept 2007*

and what he was "looking at" while taking his sketches" and use this information in a map representation ?

The resulting developments we present should be understood as a way to reveal through visual means the analysis of artefacts' documentation, *i.e.* an attempt to *amplify cognition* [Kienreich, 06] about the artefact's bibliography.

2 Scientific background

As demonstrated in J.Bertin's "graphic semiology" [Bertin, 98], attempts to exploit the spatial distribution of data sets raises numerous methodological questions about the efficiency and the readability of graphics. In response, we have in recent contributions [Dudek, 05], [Dudek, 05b] tried to take our inspiration from ideas and methods developed and used the field of infovis, while keeping in mind the particularity of our domain – an approach centred on the study of individual objects and their particularities. In this contribution we focus on one of these particularities: a massive yet highly questionable documentation.

The heterogeneous nature of documentation poses various problems to the analyst - different types of documents pose dissimilar problem (*i.e.* ambiguity of the textual descriptions, exactitude of artistic representations benefiting largely from *licencia artistica*, etc.). A document's interpretation is drawn from its reading as well as from the experience, knowledge and intuition of the analysts. The result of this process is a hypothesis about artefact changes over time. In "historical sciences" however, one cannot use experiment in order to verify a hypothesis (an experiment in the past is not very realistic!). Only through intersubjective comparisons with the results of other scientists (*cf.* intersubjectivity [Bocheński, 88]) can the likelihood of a hypothesis be amplified. Furthermore, we propose to focus on visual means of comparison (access to documents and data, accompanied with critical analyses - analysis of a source/data, its architectural content, its context of creation, etc.) by switching, as often as possible, from ethnical languages to a visual language - more hard one [Lem, 96], more explicit and clear-cutting.

Which tools can we exploit in order to promote the above-mentioned ambition? Researchers dealing with the architectural heritage are offered an array of tools (GIS, laser scanning, virtual reality, etc.) and confronted to renewed methodological challenges (growing mass of documents, XML-based modelling languages, DC Standard, etc.). But in practice, do these opportunities really help understanding architecture in its historical/geographical/cultural context, or do they only reduce the artefacts, here to polygons, 3D clouds of points and meshes [De Luca, 05], there to tags, and all-purpose typologies and links [Pajares, 00]? Most notably because of the narrowness of technological solutions and lack of a sustainable research methodology, clues in the understanding of architectural changes over time remain scattered pieces of information. Consequently, the architectural heritage regularly appears a playground for other disciplines, where architecture appears by way of illustration of a tool or a technology. The tools are not the heart of heritage sites, their heart is a history, partly written in architectural shapes. Beyond the shapes there is also information, and the bibliographic justification of a spatial configuration of an artefact is for any scientist a very important aspect (see [Alkhoven, 93]) - providing the means of visual lecture of the relation document(s)-artefact(s) is therefore a priority.

3 Method and hypotheses

The idea of document retrieval and visualisation supported by assessment of its architectural content is based on two simple observations:

- an artefact's documentation is an information to visualise;
- this information can be found behind an artefact's shape.

Briefly speaking, our objective is to exploit the relation document(s)-artefact(s) in order to produce *a display of bibliographic evidence* [Tufte, 01]. However, this goal can be achieved only if the architectural content of a source has been formerly isolated and described. By "*architectural content of a historical source"* we understand the ensemble of information concerning architectural (or urban) elements one can derive from a source (*i.e.* a list of represented objects, date(s) at which they are represented, etc.). Visual sources theoretically do not present any particular difficulties in the determination of a visible objects (ex. *the Royal Castle, St. Peters Cathedral*). Dating may pose more problems, especially in the case of old artistic representations (ex. *the end of XVIth century?*). Textual sources pose even more problems, (*poli-interpretation, vagueness)*, natural for the ethnical languages.
It has to be stressed that in any serious investigation of historic artefacts, the analysis of documentation is carried out in depth. Consequently, our approach does not introduce more documentation analysis, but only proposes a renewed structuring and memorisation of the documentation analysis. This approach is implemented on a case study - architectural and urban analyses of Krakow's medieval - on which we have several years of research with notably as results:

- an architectural ontology (implemented as a set of classes in the sense of OOP. Various evolutions of an artefact are represented as a chain of independent instances, allowing the system to handle morphological and documentary changes through time;
- VIA artefacts' database (RDBMS). It stores for each artefact a set of descriptive criteria - typological specificity, dating, alternative denomination, etc., with a special focus on a level of certainty of information *(To which extent can we be confident that this artefact was created before year 1345? Who said so?)*. It contains at this stage 817 evolutions of 335 object;
- SOL bibliographic, iconographic and cartographic database (RDBMS), (stores data about documentation - editorial details, physical format, content and context description, etc.), 761 sources have been described;
- XML/XSLT, SVG (2D), VRML (3D) outputs (graphics produced in real-time represent the artefact at any time of its evolution: they implement J.Bertin's view : graphics as "an answer to a question").

Our aim is to perform document retrieval and visualisation by assessing the architectural content of a document. Using M. Eibl [Eibl, 02] definition, the document(s)-artefact(s) relation can be seen as enabling basic Boolean retrieval (yes/no bi-directional relation of the document to the artefact). It should also be considered as enabling vague retrieval since it allows users to expand searches either on ontology similarity, on period expansion, on authorship (etc.). The following section introduces examples of these mechanisms, with a focus on recent visual displays we have developed within the above-mentioned research context.

4 Case study and implementation

4.1 Visual result of basic query mechanisms

As mentioned in section 3, artefacts are represented as a time-chain of independent instances, each of it having its own period of relevance, its own morphology, and its own justification. Basic queries visualise our state of knowledge for one time slot, and provide links to the artefact's related sources and to their analysis (SOL: the sources themselves, VIA: what they tell us of the artefact). The query uses a criterion of time (a period of time) and ontology (a type of artefact) to select artefacts. Colour codes are used to visualise ontological differences and certainty differences.

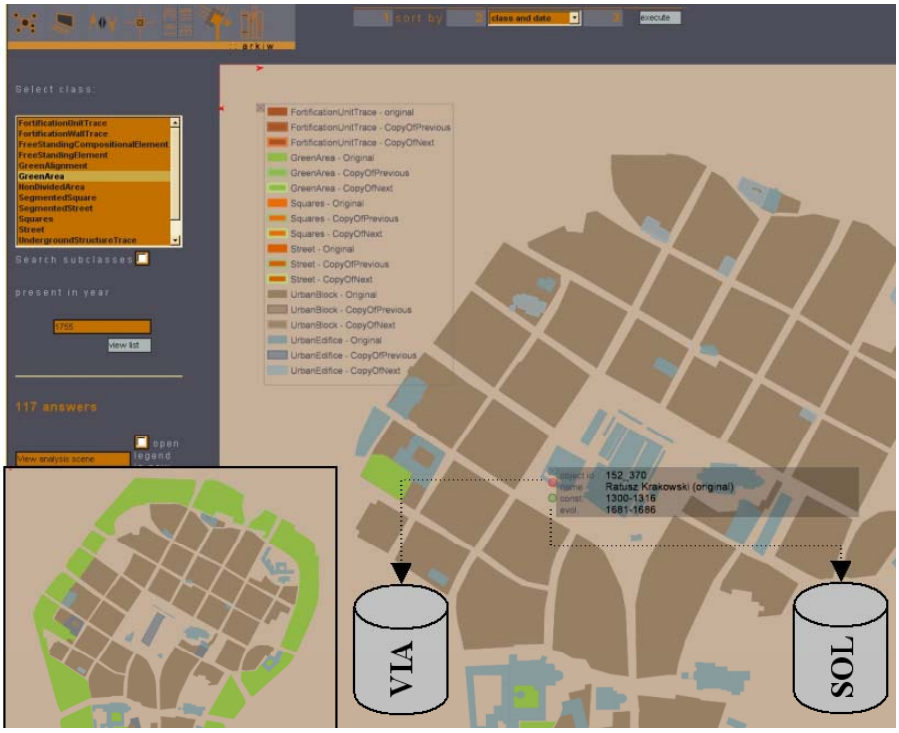

Figure 1: The XML/XSLT/SVG basic query interface (parameters date 1755 with 3 classes of objects, bottom left, in black outlined box, same query for period 1890)

4.2 Visualising the architectural content of sources

In section 4.1 the search is carried out on properties of artefacts and the resulting representation linked to the documentation. In this second case the document(s)-artefact(s) relation is exploited the other way round. The search is carried out on properties of the documentation, and outputs an SVG "architectural content visualisation" which represents the architectural content of the selected source(s).

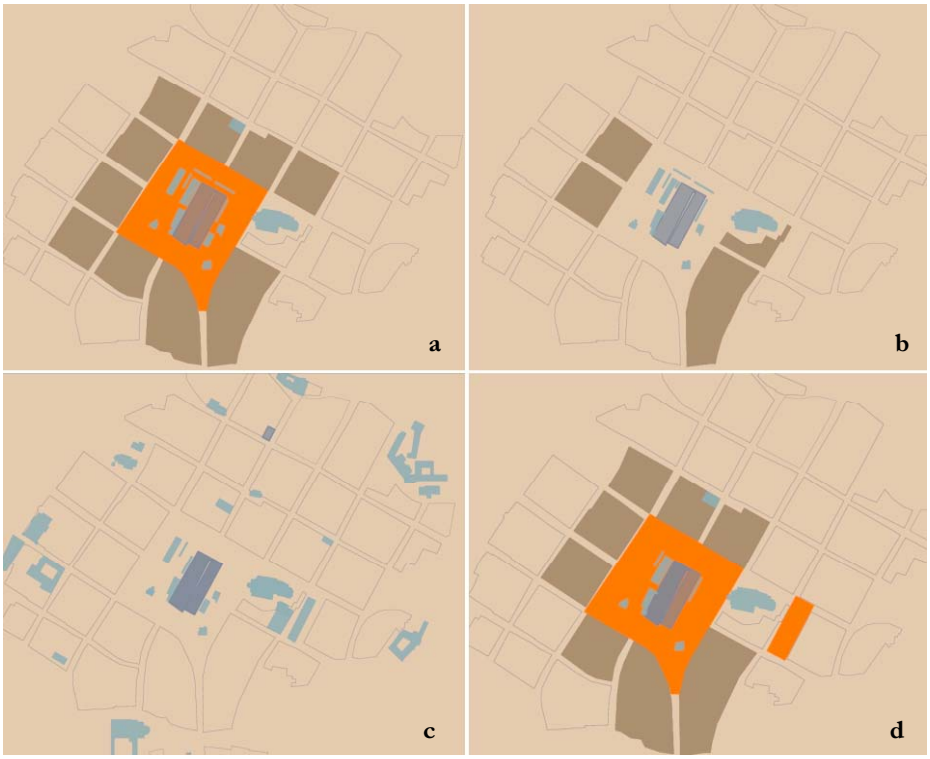

Figure 2: (a,b) - queries on a single source, (c,d) - queries on authors. The typical visual patterns for the content of : (a) - a historical map with a wide ontological coverage (variety of types of artefacts) and for (b) - a painting, (c) an architect's publications (narrow ontological coverage - only monumental buildings, but throughout the city) and (d) a historian investigations (encompassing ontological differences –urban blocs, monumental buildings, squares, etc.)

4.3 Cross examining instance justification and documentation

The documentation's analysis helps researches justifying choices they make when describing how an artefact evolved throughout its history. What we call *justification* is implemented as lexical scales (in the sense of [Zeitouni, 00]) stating "how likely" the information we have is. It is most important to find visuals means to represent this justification. Furthermore, this justification varies with object changes : some periods of evolution are better known (and documented) than others. As an answer we have (see figure 3) developed a three-component visual disposal associated with each artefact (selection of artefacts as in section 4.1):
- an horizontal timeline puts in parallel the chronology of evolution of the artefact, and the chronology of its related sources (in order to point out documentation gaps);
- a vertical line divides (left) total amount of documents for the whole history of the artefact and (right) amount of documents for the time slot under scrutiny;
- four series of six arcs mark the justification level of the artefact (selected value: red).

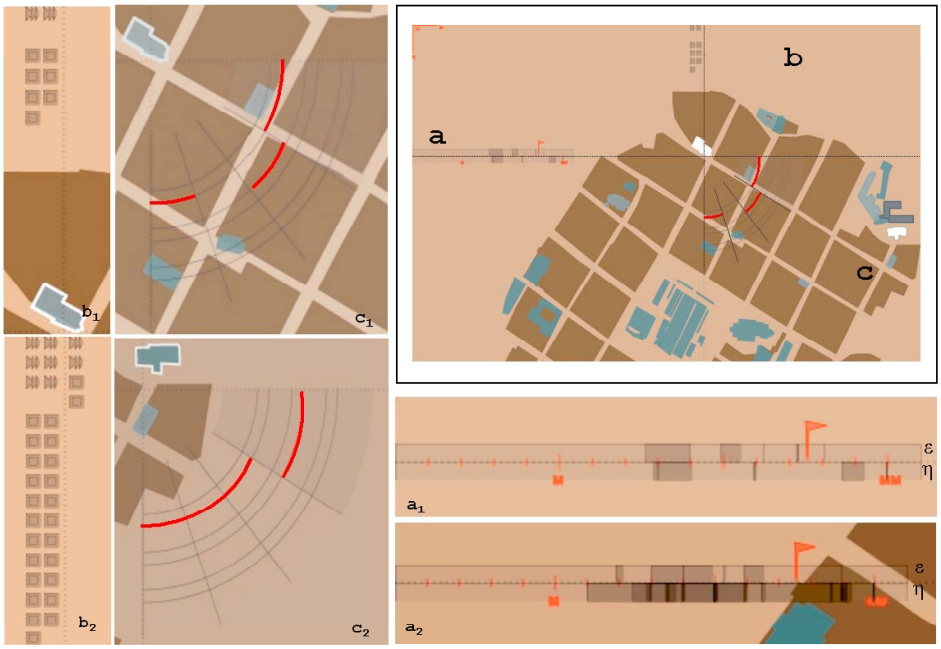

Figure 3 : Top right, composition of the three-component visual disposal (period under scrutiny 1755, disposal over church Sw. Marka); churches Sw Marka (left,1) and Sw.Krzyza (right,2) marked in white; **a** *- visual comparison of the artefact's chronology of evolution (ε-line) and of the chronology of sources (η-line). For church Sw Marka (a_1) documents do not cover each evolution of the artefact. For church Sw Krzyza (a_2) each evolution has corresponding documentation.* **b** *- overall number of sources available vs. number of sources available for the period of the query (underlines moments in the artefact's history than would need further documentary investigation). (b_1) Sw Marka (poorly documented, no document for period under scrutiny), (b_2) Sw Krzyza - better documented.* **c** *– justifiers - visual display. Each sector corresponds to a certainty assessment (period, morphology, structure, function). In each sector an arc corresponds to a value in the lexical scale, the closest to the centre being the "most certain" (active values marked in red). No underlining means absence of data.*

4.4 Current work

When the amount of documents handled for a given artefact is important, or when a document is related to many artefacts, we would need to further filter the documentation. The idea we are currently working on would be to analyse sources in order to know which "part" of the artefact they precisely mention (ex. northern façade). The basic parameters are the viewer's estimated position and an estimated target point. The first may be described by a point (x,y,z) (*cf.* Fig 4a). This parameter requires a coefficient of precision (visualised for example by a cloud-of-uncertainty (*cf.* Fig 4b)). The definition of a *z* co-ordinate may require equally a special treatment (cartography for example) (*cf.* Fig 4cd).

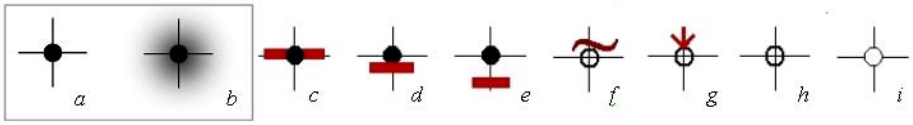

*Figure 4: Proposed symbols for viewer's estimated position - the origin (a), the same symbol with a coefficient of precision represented as a cloud-of-uncertainty (b); A cross defines **x,y** co-ordinates, a circle represents the status of **x,y** co-ordinates (defined/undefined), a red symbol expresses the **z** co-ordinate (lexical scale);*

The estimated target point can be represented – according to the data's precision by: a *point*, a *bearing* (horizontal angular direction of view), or by a *geographical bearing* defining the orientation. For some visual sources it may be useful to provide a *vertical bearing* – vertical angle of view (*cf.* Fig 5).

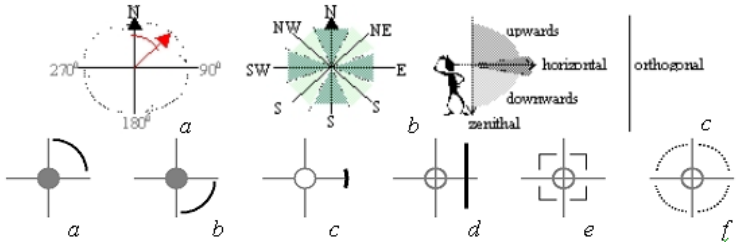

Figure 5: Top, Bearing (a), geographical bearing(b), vertical bearing(c). Bottom, Symbols of vertical bearing are represented with a symbol of viewer's position (a) upwards, (b) downwards, (c) horizontal, (d)orthogonal, (e) zenithal, (f) undefined

A visual representation of image's ratio and a source type are also the important indicators for a user (cf. Fig. 6). Two examples of how sources are projected on contextual maps are given below(cf. Fig. 6, right).

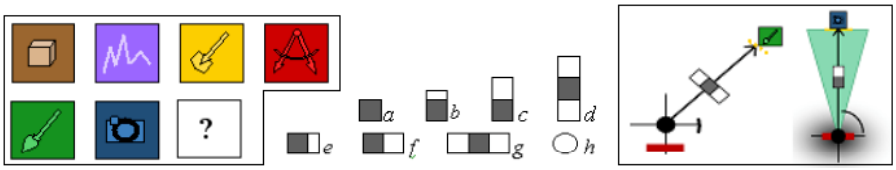

Figure 6: Left, source type - identified by a colour and pictogram, examples: physical model, diagram, archaeological drawing, architectural drawing, artistic representation, photograph, undefined
Centre, image's ratio : (a) square a/a, (b) vertical postcard a/a<b<2a, (c) vertical a/2a, (d) vertical extensive a/b>2a, (e) horizontal postcard a<b<2a/a, (f) cinema 2a/a, (g) panorama b>2a/a, (h) undefined.
Right- first example: a panoramic artistic representation, from an elevated point, horizontal angle of view, fuzzy target point; second example: a vertical photograph, low point of view, an upwards angle of view, fuzzy view direction, fuzzy origin point.

5 Limits and conclusions

We present ideas to retain through visual means the artefact's documentation analysis, and provide graphic tools to reveal it. Our implementation identifies three steps:

- analyse the architectural content of a document;
- cumulative analyses a spatial configuration for the artefact;
- artefact's spatial representation in order to exploit the document(s)-artefact(s) relations.

Accordingly, graphics go beyond mimicking how an artefact is or has been, they deliver an information, and therefore can be considered as a scientific visualisation disposal in the sense of [Spence, 01]. At this point in time, numerous obstacles remain to be solved (ex. the *spatial location* of textual sources) but the gain of insight one gets about the artefacts and their documentation appears promising. Moreover, the document(s)-artefact(s) relation could be exploited beyond the field of architecture and probably find applications in the field of geospatial studies, with as a major constraint the necessity of a long-term cumulative approach in knowledge gathering.

References

[Alkhoven, 93] Alkhoven P.: "The changing image of the city"; PhD University of Utrecht

[Bocheński, 54] Bocheński, J.M: "Die zeitgenössischen Denkmenthoden", Bern 1954

[Bertin, 98] Bertin, J: "Sémiologie graphique", EHESS, *sine loco* 1967/1998

[De Luca, 05] De Luca L, et al.: "Reverse engineering of architectural buildings based on a hybrid modeling approach", *Computers & Graphics*. Vol. 30, 2006

[Dudek, 05] Dudek I., et al: "Using abstraction levels in the visual exploitation of a knowledge acquisition process", Proc. I-KNOW 05, Graz, JUCS, pp. 543-552

[Dudek, 05b] Dudek I., et al: "From artefact representation to information visualisation: genesis of informative modelling", Proc. SmartGraphics, LNCS Volume 3638/2005, 2005

[Eibl, 02] Eibl, M.: "DEVID: a media design and software ergonomics integrating visualisation for document retrieval", Information visualisation vol.1 Number 2, Palgrave 2002

[Geroimenko, 05] Geroimenko, V., Chen C (Eds).: "Visualizing information using SVG and X3D" Springer, *sine loco* 2005

[Kienreich, 06] Kienreich, W.: "Information and Knowledge Visualisation: an oblique view", MIA Journal Vol0 Numb.1, 2006

[Lem, 96] Lem, S.:, "Tajemnica chinskiego pokoju", Universitas, Kraków 1996

[Pajares 00] Pajares Tosca, S: "A pragmatics of links", Journal of Digital Information, vol. 1/6, 2000

[Spence, 01] Spence R.: "Information vizualisation", Addison Wesley, Harlow 2001

[Tufte 01] Tufte, E.R.: "Envisioning information", Graphics Press, *sine loco* 1990-2001

[Zeitoni, 00] Zeitouni, K. et al.: "Join indices as a tool for spatial data mining", Int. Workshop on Temporal, Spatial and Spatio-Temporal Data Mining, Springer, pp.102-114, 2000