Informative modelling
towards 2D/3D visualisation of architectural evolutions
Informative modelling
towards 2D/3D visualisation of architectural evolutions

What a mess !..
Informative modelling towards 2D/3D visualisation of architectural evolutions

J.Y Blaise, I. Dudek
Informative modelling towards 2D/3D visualisation of architectural evolutions

UMR CNRS/MCC 694 MAP - Marseille

Applications of computer science to the field of architecture

Multidisciplinary research actions

One research unit, 5 locations

In Marseilles, a focus on:

- Surveying techniques
- Architectural modelling
- Information Systems for the heritage

<www.map.archi.fr>
Informative modelling towards 2D/3D visualisation of architectural evolutions

- From surveying techniques to architectural modelling
- From the model to the data: using 3D models as a navigation tool
- Using models not only to navigate inside data sets, but also to visualise data sets.
- Circumscribe a global approach to the management and visualisation of heritage data: informative modelling
Informative modelling towards 2D/3D visualisation of architectural evolutions

From artefact modelling to information visualisation (using the artefact's morphology)
Informative modelling

towards 2D/3D visualisation of architectural evolutions

From representing an artefact [geometric information]

to representing what we know of an artefact
Informative modelling

Informative modelling towards 2D/3D visualisation of architectural evolutions

An intersection of disciplines & practices

A focus will be put during this presentation on the role of visual displays
Overview

The research topic

Vocabulary

Observations on heritage investigations

Hypotheses and definition of the approach

Antique theatres experiment (2D)

ARKIW experiment in Kraków (2D+3D)

Final remarks [14 rules+1]
The research topic

Basing on available observations and knowledge about an artefact, how can we better understand and represent its evolution with (or in spite of) new technologies?
Basing on available observations and knowledge about an artefact, how can we better understand and represent its evolution with (or in spite of) new technologies?

- A concern for the analysis, management and visualisation of **data** [eventually information] about the artefact,

- A concern for the analysis and representation of the artefact’s **morphology**

**Discrete temporal items**

**Discrete spatial items**
The research topic

Basing on available observations and knowledge about an artefact, how can we better understand and represent its evolution with (or in spite of) new technologies?

Synchronic* approach : these two objects are comparable.

Diachronic* approach: these two objects differ; they are, at best, related to one another through a “sort-of” relation

The morphology of the artefact, its physical shapes, become meaningful because of the information we derive from them, and this information is more than a technical nomenclature

* a reference to Ferdinand de Saussure

synchronic: deals with a language, e.a. given period, identifies its rules and norms

diachronic: deals with a language’s evolution

What we strive to understand is, beyond the artefact itself, what the artefact tells us about a time, a place, and a knowledge area
Our objective: build abstract representation of artefacts that have existed or still exist in order to:

• understand and recount the evolution of the artefact, in 2D or 3D
The research topic

Our objective: build abstract representation of artefacts that have existed or still exist in order to:

- understand and recount the evolution of the artefact, in 2D or 3D
- Structure and give access to the pieces of data and information that helped studying the above mentioned evolution
The research topic

Our objective: build models and representations of artefacts that have existed or still exist in order to:

• understand and recount the evolution of the artefact, in 2D or 3D

• Structure and give access to the pieces of data and information that helped studying the above mentioned evolution

• «Visualise» this information, and therefore underline its lacks.
Our objective: build **models** and **representations** of artefacts that have existed or still exist in order to:

- understand and recount the evolution of the artefact, in 2D or 3D
- Structure and give access to the pieces of data and information that helped studying the above mentioned evolution
- «**Visualise**» this information, and therefore underline its lack.
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CRACOVIA
models of artefacts

The model is a structure used in order to describe and solve real-world problems prior to the study itself.

1S. Francis, The importance of being abstract actes Conf. Turing to 2000 Ecaade 1999
The model is a structure used in order to describe and solve real-world problems prior to the study itself.

S. Francis, The importance of being abstract acts. Conf. Turing to 2000 Ecaade 1999
Graphic representation is part of the systems of signs that man created in order to retain, understand and communicate the observations to him necessary¹ (…)
Graphic representation is part of the systems of signs that man created in order to retain, understand and communicate the observations to him necessary. (…)

Understanding is reducing overwhelming data to the limited number of information that we are likely to take into account in relation with a given problem.

Graphic representation is part of the systems of signs that man created in order to **retain, understand** and **communicate** the observations to him necessary\(^1\) (...)


**Tell others without information loss**

**Representations of artefacts**
Visualisation is a cognitive activity\(^1\). (…)

[it produces] a gain of insight and understanding\(^1\). (…)

Its result is a mental image\(^1\). (…)

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\(^1\)Robert Spence, Information visualisation Editions ACM Press / Addison-Wesley.
On the specificity of heritage investigations

Our objective: build models and representations of artefacts that have existed or still exist in order to:

- understand and recount the evolution of the artefact, in 2D or 3D
- Structure and give access to the pieces of data and information that helped studying the above mentioned evolution
- «Visualise» this information, and therefore underline its lacks.
From what sources can we build such models and representations of artefacts?

• Generic pieces of knowledge
On the specificity of heritage investigations

From what sources can we build such models and representations of artefacts?

- Generic pieces of knowledge
- Specific sets of information (provided by documentary sources)
On the specificity of heritage investigations

From what sources can we build such models and representations of artefacts?

• Generic pieces of knowledge

• Specific sets of information (provided by documentary sources)

• Observation of the artefact itself (as time left it for us to see)
On the specificity of heritage investigations

From what sources can we build such models and representations of artefacts?

- Generic pieces of knowledge
- Fuzzy indications

1'Auguste Choisy, « Histoire de l'Architecture » (Ed.orig 1889)
On the specificity of heritage investigations

From what sources can we build such models and representations of artefacts?

- Specific sets of information (provided by documentary sources)

Incomplete, heterogeneous, uncertain, questionable pieces of data and information
On the specificity of heritage investigations

From what sources can we build such models and representations of artefacts?

- Specific sets of information (provided by documentary sources)

Incomplete, heterogeneous, uncertain, questionable pieces of data and information.
From what sources can we build such models and representations of artefacts?

- Specific sets of information (provided by documentary sources)

*Documenting the artefact: a cumulative, dynamic process*
On the specificity of heritage investigations

From what sources can we build such models and representations of artefacts?

- Observation of the artefact itself (as time left it for us to see)

Transformations, reuse, etc.
On the specificity of heritage investigations

From what sources can we build such models and representations of artefacts?

- Generic pieces of knowledge
- Specific sets of information (provided by documentary sources)
- Observation of the artefact itself (as time left it for us to see)

Uncertainties, doubts, questions that representations should underline if they are to become what J. Bertin calls « a work and discovery tool »

2D/3D models seen as information visualisation disposals.

Is this the main trend in 3D graphics???
On the specificity of heritage investigations

Examples that help circling the trend [caricature]

Classify by date of creation

Classify by credibility
On the specificity of heritage investigations

Examples that help circling the trend [caricature]:

No means to read from the graphics the info behind the shapes shown, no linkage between the knowledge and the image, no insight gained on the edifices or on our understanding.

In breach of this dominant approach, which tends to hide doubts and inferences made during the research process, what we really need is to «Consider alternative explanations and contrary cases» and underline what we ignore as well as what we know, and this at the various stages of our investigation.

This is where tools and formalisms lack.

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3 Patricia Alkhoven «The changing image of the city» PhD. Utrecht University 1993
4 TAISEI/AOROC/ENS in journal CNRS n°178
« These images are in a way more demanding than the text of a publication since they do not allow to evade from an unsolved architectural problem »

So what when we just don’t know??

If we are to deliver information, we should make choices in relation with what we know of an artefact, and avoid making choices that would be imposed by the use of a technical platform.
On the specificity of heritage investigations

Our claim: infovis provides key concepts when trying to produce information-effective graphics.

“We envision information in order to reason about, communicate, document and preserve that knowledge (…).”

“Excellence in presenting information requires mastering the craft and spurning the ideology.”

On the specificity of heritage investigations

Not a technological issue, but a methodological issue

~ Patricia Alkhoven

«The changing image of the city» PhD.

Utrecht University 1993
Hypotheses, approach

1- The architectural corpus, i.e. elementary physical elements that constitute the artefact, act as a media.
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2- Since we study artefacts that are transformed / or disappeared, these elements will be poorly known, their representation will need some level of abstraction.
Hypotheses, approach

1- The architectural corpus, i.e. elementary physical elements that constitute the artefact, act as a media.

2- Since we study artefacts that are transformed / or disappeared, these elements will be poorly known, their representation will need some level of abstraction.

3- Inside 2D / 3D models, these elements will allow information retrieval (users may query data and info element by element), but also will allow the visualisation of an information localised in time (the period investigated, the moment in our investigation) and space.
La maquette peut aider à déchiffrer l’édifice, et la connaissance que nous avons de l’édifice.

- Localiser les données dans l’espace et le temps
- Trier une documentation analysée
- Aider à lire une chronologie et par exemple y découvrir des manques
- Illustrer les zones d’ombre dans notre compréhension des évolutions de l’objet.

JY Blais, IDU MCR/MCC 694

Representing, beyond the artefact itself, what we know about the artefact and [hopefully] amplify cognition through visual means

J. Bertin’s “discovery tool”
Approach

Finding a way in between information visualisation and architectural modelling/representation
information visualisation, with its need for abstraction, already has to do with spatial data.

The 1854 Cholera epidemic in London\(^1\):

« Put the data in an appropriate context to evaluate causes and effects »

« Make quantitative comparisons »

« Consider alternative explanations and contradictory data »

Lessons to learn when dealing with architecture and its evolution? Not the dominant practice in handling 3D data.

Architectural representation, with its tradition of figuration, already has to do with enhancing information readability.

A section intended at visual explanation.

Approach, origins

Architectural representation, with its tradition of figuration, already has to do with enhancing information readability.

Figuration intersects spatial distribution and evolution.

Architectural representation, with its tradition of figuration, already has to do with enhancing information readability.

Visual comparison

C. Sitte, City Planning According to Artistic Principles (1889), Trad GR, Collins C Collins (Phaidon, 1965)
Architectural representation, with its tradition of figuration, already has to do with enhancing information readability.

Visual analysis and contradictory data assessment.

Nous voyons (fig. 8) que les apothèmes AB, AC donnent les axes des murs de fermeture B et C et la hauteur de la corniche du grand ordre, par leur rencontre avec le nu des murs percés de grands arcs formant les latéraux en D et F. Ces côtés AB, AC donnent aussi les naissances G et H des petits arcs des latéraux. Les deux colonnes IK étant posées, élevant de l’axe de ces colonnes au-dessus des bases un triangle équilatéral IKL, nous avons la hauteur de l’intrados de la clé de l’arc de la tribune. Prenant moitié ab d’une des 4 divisions de la base du triangle ABC, nous avons les pieds-droits de cette tribune. Quant au point diviseur par quart c, il donne l’axe de la pile ED.

E. Viollet Le Duc, E. Entretiens sur l’architecture
Architectural representation, with its tradition of figuration, already has to do with enhancing information readability.

Visual analysis and contradictory data assessment.

Approach, origins
Informative modelling

Walking in their footsteps, but with (against) computer solutions

Informative modelling

Information visualisation

Architectural representation
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Programme STRABON WP6 Initiative EUMEDIS
exploratory WP on graphics for cultural tourism

Theatres of Strabo
Theatres experiment

Programme STRABON WP6 Initiative EUMEDIS

enable visual comparisons
delineate specific parameters

I: formal analysis
II: spatial distribution
III: visual tools
An antique theatre is composed from three basic elements:

- scenea
- orchestra
- cavea

I : formal analysis

analyse of the elements of variation
define the parameters of comparison

I: formal analysis

variations of orchestra

Theatres experiment

symbol

1 2 3 4 5 6 7
Theatres experiment

1: formal analysis

credibility of information

- Each of the three components of a theatre can be described.
- The visual sign that identifies the object’s typology can be dynamically produced.

No scene in the symbol: shows we know no such structure existed there (here Heraclea Minoa)

Grey dashed line marks elements the shape of which is difficult to be given.

White element in symbol: shows lacking information in
Theatres experiment

II: spatial distribution

toponimical hierarchy
europe/italy/valledAosta/Aosta/...

SVG path

No scenea in the symbol: shows we know no such structure existed there (here Heraclea Minoa)

White element in symbol: shows lacking information in
Theatres experiment

II: spatial distribution
toponimical map

for each theatre we can distribute in space a visual sign (typological family)
Theatres experiment
Theatres experiment

III: visual tools

visual signature
Each theatre is described by a “visual signature” - summarises the information that we have about a theatre and not a vision of a physical objet itself.

In this experiment, a unique source:
The date does not make the shape
The type does not make the urban position

Athenae
Théâtre d’Athènes

Syracusae
Théâtre de Syracuse

Augustodunum
Théâtre de Autun

Epomanduodurum
Théâtre de Mandeure

Arausio
Théâtre de Orange

Canetonum
Théâtre de Berthouville
Visual signature and theatre details window

Map configuration window (topography / elements shown)

Tools for comparative evaluation of parameters

Theatre selection: scales up symbol while selecting, opens visual signature window (here Caesaraugusta - zaragoza)
III: visual tools

elements of the interface

Tereste
Théâtre de Trieste

links content description

Trieste: il Teatro Romano [it] - www.ts.camcom.it/..teatroromano.htm

Trieste: panorama virtual, Notizario di Telequattro ... [it] - www.tergeste.net/..trsp

MisterKappa: vedute artistiche di Trieste - Raimondi (pagina 1) [it] - www.misterkappa.it

Trieste: [fr] - www.asso- chc.net/..article.php3

The old Roman Theater: Trieste, Italy - VirtualTourist.com [en] - www.virtualtourist.com

Theatres experiment

combination of standards and freeware technologies

Theatre typo DB
Perl script
SVG, Javascript
Toponymy
XML / XSLT
hierarchy of Perl classes
SVG
The city of Kraków

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 Okół
- the medieval town (1257).

In 1684 forty-seven flanking towers were defending the town. Four of them are left (13th-century Florian Gate, Baszt Pasamoników, Baszt Stolarska, Baszt Mieczników).

Europe's biggest Barbican (a 15th-century circular-like structure with 3-metre thick brick walls, built in the adjacent to the Florian Gate's propugnaculum) and two arsenals.
Unlike in the theatres experiment, we deal with:
- a mass of heterogeneous documents,
- a variety of “architectural types”.

The idea: developing tools & method to support the architectural analysis step [documents, observations, etc..] and to make this analysis a “sustainable” one.
An investigation on edifices at various scales:

• 817 evolution descriptions corresponding to 335 architectural objects,
• 761 resources,
• approximately 4650 default 2D and 3D scenes

The development of tools and formalisms to handle the above mentioned investigation, using standards for the web (XML/XSLT/VRML/SVG):

• VIA architectural object descriptions
• SOL Bibliography and iconography database
ARKI W experiment (Kraków)

2D and 3D Graphics are produced dynamically at query time.

Instances

Documentation

RDBMS

Ressource itself

Model set of concepts (classes)

Qualitative properties

Identity (name(s))

Localization (position)

Evolution (dates relevant for the object at the time chosen)

Typology (qualitative analysis)

Documentation (controls behaviours of each object in the scene)

XML

Instances
Elements of an information system:

- that uses the morphology of edifices as a mean to localise information in time and in space

- that uses representations in 2D/3D of the above mentioned morphology for information visualisation and retrieval, with respect to uncertainty issues.

*An overview of the dynamic graphics we have produced over time, in terms of type and use.*
ARKI W experiment (Kraków) > 3D

• Colours & disposals for analysis
  typically, graphic answer to a question like
  "documentation for objects of type UrbanEdifice,
  UrbanBlock and Fortification Units for period 1790-
  1791".

• Interactive timelines
  typically, graphic answer to a question like “evolution of
  objects of type UrbanEdifice, UrbanBlock, ...”

• Document’s architectural content
• Colours & disposals for analysis
typically, graphic answer to a question like:
“documentation for objects of type UrbanEdifice,
UrbanBlock, Fortification Units, Streets and Squares,
GreenAreas for period 1820-1821”

• Interactive time layers
typically, graphic answer to a question like:
“all objects around object town hall of type urbanEdifice
in a circle of 200 meters”
ARKIW experiment (Kraków)

- The visualisation step
  Visualising for an author/ a source a “spatial pattern”
The visualisation step
“Going abstract” in order to handle poorly known objects, or objects in early stages of the investigation.

Our state of knowledge, in the early phases of research, may not allow us to provide a 2D/3D morphology that would bear indications on what we know about the object we study.

In other words, what graphics can we provide when we do not yet know what an object could be?

We face the challenge to provide a more abstract representation of the object.

State that: “something existed round here” and represent it by a formalism around which one can organise findings.
An information integration formalism

Provide a visual tool that would help us visualise and share the «where we are in the research process» information.

Two constraints:

Integrate all data and information in a common information acquisition model.

Provide autonomy for data/information integration since phases of study are not necessarily correlated in time.
ARKiW experiment (Kraków)

Toponymy

Cartography (SVG)

Rep. XML

Static representations

Instanciation: the object is now attached to a theoretical model

amount evolutions known for this object

2D dynamic representations

3D dynamic representations

Analogies

Ontology (DIVA)

Status

Raw Data

Bibliography (SOL DB)

Documentary analysis (VIA DB)

Justification (VIA DB)

Typology (VIA DB)

Url link to data or applications

Examples of values

Type of data/information concerned

/mopolska/krakow/stareMiasto/ratuszKrakowski

/{/cityBuildingsNorth..wrt, ...}

{/krakow/ratusz/ratusz }

Justification (VIA DB)
ARKI W experiment (Kraków)

Use of the figure as of a navigation tool

Applications browser

Toponymy Ontology

Object choice

Liste of evolutions for the selected object and corresponding links (DB/Representations)

2D/3D dynamic Representations
ARKI W experiment (Kraków)

Use of the figure for comparison purposes

3D survey thanks to Livio De Luca
Final remarks [14 rules+1]

Ideas behind our approach, and examples of application

**informative modelling** as a possible bridge between architectural representation, with a tradition of figuration, and information visualisation

A grid of 14 rules (+1) as a materialisation of the approach, acting as guidelines during the investigation
Final remarks
[14 rules+1]

Ideas behind our approach, and examples of application

**Informative modelling** as a possible bridge between architectural representation, with a tradition of figuration, and information visualisation

A grid of 14 rules (+1) as a materialisation of the approach, acting as guidelines during the investigation

Four families of rules corresponding to four key aspects of the investigation

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**Information**

- Each piece of information about the object will be interpreted in order to distribute information among semantic layers called informative scales.
- The representation of an object will allow the user to retrieve data and information that justify the presence of the object at the time and date the representation shows.
- The shape given to the object will stem from an interpretation of the data, stating the shape's credibility and making it visible.
- For each object, the representation will show what we know that we ignore, and will not contain unfounded affirmations that would not be justified by relevant data.
Final remarks
[14 rules+1]

Ideas behind our approach, and examples of application

**informative modelling** as a possible bridge between architectural representation, with a tradition of figuration, and information visualisation

A grid of 14 rules (+1) as a materialisation of the approach, acting as guidelines during the investigation

Four families of rules corresponding to four key aspects of the investigation

- A theoretical model will describe architectural shapes in a structured way.
- Objects represented inside 2D/3D models will be instances of the above-mentioned theoretical model.
- The theoretical model's implementation will allow the reuse, the comparison and the sustainability of the information on the instances.
- Each concept of the theoretical model will be attached to a given informative scale.
Final remarks
[14 rules+1]

Ideas behind our approach, and examples of application

*informative modelling* as a possible bridge between architectural representation, with a tradition of figuration, and information visualisation

A grid of 14 rules (+1) as a materialisation of the approach, acting as guidelines during the investigation

Four families of rules corresponding to four key aspects of the investigation

2D/3D model will be the visual answer, displayed thanks to the representation of architectural objects, to a query about our state of knowledge.

2D/3D models will be calculated in real time so as to reflect our current state of knowledge at query time.

The appearance given to an object will use a set of graphic codes that should be developed in order to visualise the object’s underlying information.
Final remarks
[14 rules+1]

Ideas behind our approach, and examples of application

**informative modelling** as a possible bridge between architectural representation, with a tradition of figuration, and information visualisation

A grid of 14 rules (+1) as a materialisation of the approach, acting as guidelines during the investigation

Four families of rules corresponding to four key aspects of the investigation

- The object will be displayed inside 2D/3D models with alternative levels of abstraction depending on both/either the scale and the level of knowledge reached in the investigation process.
- The investigation process will be implemented as a non-ordered process allowing the integration of disjoint sets of information.
- The level of knowledge reached in the investigation process on a given object will be represented in real time inside 2D/3D models.
Final remarks [14 rules+1]

Ideas behind our approach, and examples of application

**informative modelling** as a possible bridge between architectural representation, with a tradition of figuration, and information visualisation

A grid of 14 rules (+1) as a materialisation of the approach, acting as guidelines during the investigation

Four families of rules corresponding to four key aspects of the investigation

? If a 2D/3D model does not produce a gain of insight into the underlying information - it should be considered worthless.
Final remarks
[14 rules+1]

Rules?

graphics = alternatives

a graphic = a choice that should mostly depend on what I expect to learn

*Coisy, Celui qui mène les fleuves à la mer, Éditions Le Lombard, 1997*
Final remarks [14 rules+1]

An approach at an intersection of disciplines and practices.

The result of interdisciplinary influences

Current focus (among other) : further evaluate the usability of the rules through practical case studies, further investigate the usability of graphics in the field of the architectural heritage.

Time, Space and the dynamics of change in archaeology
ISA Network Thematic summer school, Tours, 2007

on infovis aspects:
Visualisation summit
< www.ia.arch.ethz.ch/summit.htm >
a forum to share ideas and experiences
MIA on-line Journal
<http://www.map.archi.fr/mia/journal>
Afternoon Workshop:
13:30 - 14:30
Free visit of the cathedral, with an A4 document to fill in
14:30 - Meeting in room C0030
STOP!..