# Real City Museum/Virtual City Model

## *Real datasets/virtual interactions*

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**Abstract.** *Creating virtual city models at different scales, emphases and overall orientations is a topic that has attracted great interest in architectural and urban planning context over at least the last two decades. However the complexity of the city as a historical formation demands new methods of representation embracing interactive technologies. The work discussed in this paper is part of a large multidisciplinary project for the development of the Volos city museum. Enhancing the interaction between the public and the museum exhibits is essential. The paper focuses on the definition, complexity and orientation of the data structures and the integration of 3D contemporary and historic data that is the backbone for the digital representations and the interactive applications developed for the museum.*
**Keywords.** *Database design; XML; Dublin Core metadata; history; 3D modelling; geo-referencing.*

### INTRODUCTION

Creating virtual city models at different scales, themes and foci is a field that has attracted great interest within architectural and urban planning context over at least the last two decades. A basic search on published articles demonstrates that although the number of research projects is increasing, the topics have not evolved significantly. There is indeed a wealth of information and experience on issues related to the creation of digital 2D/3D representations, analytical and/or automated production of digital models and maintenance practices and updating techniques (Dokonal and Martens 2002; Ishida 2000). Furthermore, the topic of realism versus abstraction, levels of detail (LOD), accuracy and delivery methods are thoroughly analysed (Bourdakis 2001). The topic of procedural generation of city models following rules, real life typologies and structure is also sufficiently documented (Batty, 2001).

City museum planning and creation delves into a variety of fields addressing public memory, representation, historical heritage, anthropology, implementation of new technologies, public participation, education etc. The complexity of the city as a sociocultural and historical formation demands interdisciplinary methodologies of data representation embracing interactive technologies in order to mediate in engaging ways multi-level experiences through collective memory, oral testimonies, material remnants and diverse national, ethnic, religious, age and gender orientation social groups of people.

## POSITION

The paper discusses the work being carried out as part of a multidisciplinary project "*Designing the Museum of the City of Volos*" (DEMUCIV) recently awarded (original research proposal in 2009, followed by two resubmissions in total almost three years in evaluation) through the Greek Ministry of Education and the financial support of the European Union. The Volos city museum is the first publicly funded city museum in the country and one of the relatively few dedicated city museums in Europe. Innovation lies on the fact that the planning of the Museum is grounded on a multi-faceted academic research specifying the themes and the methodology through which urban space as well as the means of creating and presenting the museum collections to the public is conceptualized. Digital methods play a pivotal role in creating an interactive environment accommodating all stages of museum planning and creation: retrieval and collection of sources and material, diverse modes of presentation and prototypes of exhibits that combine various materials (oral testimonies, films, sounds, movement, text, etc.). The authors are part of the team developing the interactive content and digital exhibits for this museum.

The proposed project being deeply interdisciplinary is based on the collaborative work featuring marginally compatible data. Starting with, two research teams are working on historical and anthropological research respectively in order to foreground the city's social and cultural structures, the economic activities and the interaction between the city and its regional, national, Mediterranean and European context. A spatial approach to historical past and lived experience is developed transgressing the boundaries between social, cultural, economic analysis. Emphasis is given to the documentation of the history of everyday life practices, common people, public memory and collective subjectivity. A comparative approach to urban planning and history of architecture facilitates positioning the city in the context of Mediterranean port-cities tracing historical convergences as well as divergences in urban planning and architecture.

Research, design and implementation of standards for the management, utilisation and sustainable enrichment of historical and anthropological data for future educational, research, cultural purposes is carried out by the authors' team. Enhancing the interaction between the public and the museum exhibits is one of the main objectives of the project. Namely, the lived experience of city residents as well as visitors will constitute both the source as well as the final recipient of historical and anthropological information. Education and entertainment are the ultimate goals of the interactive relationship between the public and the city museum.

A step further is attempted, as far as utilising digital urban models is concerned, by focusing on the content rather than the container hence on the methodologies of creating, maintaining and communicating the embedded content on representations of existing constructs/built environments. Subsequently, methodology, automation, accuracy and detail of architectural/urban level 3D modelling as well as realism of representation are not among the issues discussed in this paper.

The paper focuses on the definition, complexity and orientation of the data structures and the integration of 3D contemporary and historic data that is the backbone for the digital representations and the interactive applications developed for the museum.

All *DEMUCIV* project deliverables employ digital technologies both to organize the collected material in databases and to develop interactive exhibits, disseminating scientific knowledge and providing visitors and the public with a mediated experience of the city's historic past. The relevant objectives are therefore:

- To create an appropriate database system for the management of research material on a long term basis and on multiple levels (education, research, information, entertainment) and for the development of digital exhibits thus ensuring the sustainability of the future museum.
- To use state-of-the-art digital technologies for the exploitation of historical and anthropological knowledge and culture.

- To produce high quality public and research focused data repository.

The above mentioned objectives necessitate research in information visualization technologies as well as their delivery: small screens (World on Window exhibits), projections, portable devices (utilising locative media)

## APPROACH

The project tries to address multimodal databases, interactive exhibits, personalised searches/subsets for navigating and creating a customised museum experience. The data employed include text, photographs, sound, video, 3D models and various other artefacts providing a continually developing pool of information facilitating the enrichment of the museum's exhibits over time. Complimentarily, Volos city soundscape is currently been captured; an innovative concept collecting sounds of natural environment and urban activities for the production of sound designs of the city's historical sites (i.e. factories, workshops, the port etc.). Data are communicated through large screen interactive museum staged installations, web-presence, smartphones and locative media devices.

The greatest challenge for the authors addressing the above from an architectural perspective is the definition and production of the database that in effect links and relates seemingly incompatible data to the 3D model formulation necessary for the geo-referenced information visualisation system.

### *Datasets*

Trying to approach the database structure and creation inclusively, engaged the team of researchers in extensive discussions with educators, historians, curators and the archivists of the Municipal Center for Historical Research and Documentation of Volos (DIKI) [1]; the managing body and future operator of the museum. In order to be able to decide on technologies to be employed as far as data are concerned, it was necessary to define and list all types of artefacts recorded and archived as well as their structure and multiple relations.

Early in the discussion it was evident that the complexity, flexibility and interrelation of the envisioned datasets meant that typical database formats such as SQL/MySQL used extensively in rigid dataset cases were not suitable. The ease with which new ideas and resulting data structures were generated during the discussions was alarming. Researching on best practices around museums and having not found any cases where the geo-information and its linking to 3D models was a high priority or (as in our case) a design goal, we decided to develop Extensible Markup Language (XML) schemas enhancing well-known, widely accepted and implemented solutions. Bearing in mind that DIKI has already structured its data using the Dublin Core metadata format [2], we build upon and link to their existing system.

A three tier classification was carried out; the focus on this paper is on the entity definitions-thematic areas and layout in the physical space of the museum are outside the paper scope. Entities thus are:

- Image.
- Moving image.
- Artefact.
- Interactive material.
- Textual record.
- Sonic record.
- Oral testimonies.

On each entity the following fields are considered. The list is not inclusive, although it sets the framework that the database creation is operating within.

- Name.
- Category.
- Code number.
- Dating (multiple fields needed to cover production/creation, useful life period, destruction, reuse, etc.).
- Identity (including condition, dimensions, weight, material, owner, creator).
- Cross-referencing.
- Position (geo-reference).
- Description (various fields according to the entity).
- Bibliography.

- Text-based documentation (title, text body, author, text date, usage).
- Research focused crosslinking.
- Museum usage.
- Keywords.

### *3D data structure*

One of the programmatic design goals for the database was geo-referencing the relevant entities. This was considered instrumental for the successful production of interactive museum exhibits that either rely on a Virtual Reality (VR) methodology and are staged within the museum boundaries (as well as communicated via the internet in a simplified format), or with locative media based Augmented Reality (AR) applications that enable the diffusion of the museum within the city.

It is thus interesting to identify the relation between the complex Building Information Management (BIM) models architects are familiar with (and are slowly becoming a liability) and the artefact/entity ontologies described above. The main difference is that BIM ontologies relate to a reasonably defined assembly with a physical analogy whereas the ontologies designed as part of this project are often conceptual with little real world reference. The later applies to historic/relational concepts typically missing from BIM.

The 3D modelling is organised on a per property level; each record identifiable and inclusive of its relevant physical data. Walls, roof, textures, schematic/low level plot defining geometry are all wrapped up in one entity referenced through:

- Insertion point (defined on ground level in the middle of the main façade, recessed by half the façade width).
- Façade street name.
- Street number.
- Postcode (not very helpful in the Greek postal system).
- Other neighbouring street names.
- Planning Authorities urban block ID number.

In order to enable formatting 3D representations on various query methods, the local coordinate system is used to build each property (origin being the overall insertion point as described above) and by storing the translation and rotation from the city grid origin. It is subsequently possible to query and accurately depict a property, a street, an urban block, a full neighbourhood, or even an area extending X units from a set query point, or Y units along a particular route or street. The latter loosely relates to the Level of Detail (LOD) approach employed on most VR and complex scientific data visualisations. Keeping the 3D representations in XML based schemas as in X3D [3] (compared to its predecessor Virtual Reality Markup Language (VRML) means that data compatibility and query flexibility is maximised. Further the urban representations are not bound to city wide rules but as demonstrated above can be fragmentally depicted in order to suit particular scenarios and needs of the museum interactive exhibits.

Considering the on per building basis 3D modelling and the various artefacts that may have geographical information, it was decided to prioritise 3D versus artefact only geo-information.

### *Factoring time*

The actual area under investigation (Volos city) started as a prehistoric settlement and developed over the centuries to the Byzantine and later Ottoman fortified city, to the early 20$^{th}$ century port and finally the current city. Subsequently, time is of paramount importance since the rich archaeological findings are integrated into the dataset. In author's past experience time was a static variable and not a vital dynamic parameter. Models were always depicting a particular period either the present through photogrammetric or other techniques or the past through information collected from historic sources, paintings, sketches, texts, etc. Coordinating georeferenced information of contemporary as well as older excavations and their findings (photographs, sketches, measured drawings, linked to events, etc) is a rather demanding task.

The street name and number based authentication and reference is unsuitable, as it is clearly documented that the urban grid has changed sub-

stantially over the last few centuries. Remains from archaic temples, early christian basilicas (5-6century), byzantine fortifications, ottoman mosques and baths, etc. need addressing. Even the rivers flowing through the city have been re-routed to facilitate city expansion.

Evidently time as in range of period that each particular monument, building, construct was built and/or has remained useable is important. To the same extent, the current condition of particular monuments, namely visible, covered up under protective earth film or excavated and accessible under current buildings needs to be addressed. For example, the minaret from the mosque was to the day it collapsed during the 1955 earthquake the most important landmark in the area. Nowadays it is excavated to the foundations over a meter below street level presenting a completely different image. Elevations need also to be depicted carefully as contemporary street elevation are up to two metres above the earlier settlements creating a completely different impression of the fortified city.

Managing the fragmented views into coherent, meaningful and educative representations is a demanding task. Addressing all records with the geographical references and time based events is the only viable solution. Further care must be taken in referencing fragmented depictions from the past onto todays urban grid; transparency and colour are invaluable tools for clarity and context as is the development of suitable Augmented Reality applications.

## CONCLUDING REMARKS

The paper focuses on the definition, complexity and orientation of the data structures linking and relating seemingly incompatible data integrating 3D contemporary and historic data to formulate the backbone for digital representations and interactive applications developed for the museum.

XML based modelling integrates 3D data with most common types of datasets enabling visualisations suitable for dynamic interactive exhibit creation. Geo-referencing of a variety of constructs enhances interoperability of the produced datasets. Multiple delivery platforms (large scale museum displays, computer screens, mobile locative media and augmented reality) demand careful organisation and scenarios to succeed.

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## REFERENCES

Batty, M 2001, 'Contradictions and conceptions of the digital city', *Environment and Planning B: Planning and Design*, 28(4), pp. 479-480.

Bourdakis, V 2001, 'On Developing Standards for the Creation of VR City Models', *Proceedings of the eCAADe2001 Conference*, Helsinki, Finland, pp. 404-409.

Dokonal, W and Martens, B 2002, 'Round Table Session on 3D-City-Modeling', *Proceedings of the 20th eCAADe Conference*, Warsaw, Poland.

Greenfield, A 2006, *Everyware; The dawning age of ubiquitous computing*, New Riders Publishing.

Ishida, T 2000, 'Understanding Digital Cities' in T. Ishida and K. Isbister (eds), *Digital Cities: Experiences, Technologies and Future Perspectives,* Lecture Notes in Computer Science, Vol. 1765, Springer-Verlag.

[1] www.diki.gr

[2] dublincore.org

[3] www.web3d.org/x3d