Info - Data Constructions

From data to spatialized info visualization

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Abstract. *Previous research dealt with the problem of successfully approaching the combination of multiple, marginally compatible, historical and other forms of digital abstract data. The initial challenge, from a designer's point of view, was to define and create the database for the Museum of the City of Volos (MuCiV) that will contain these seemingly incompatible data to a formulation collaborated with a geo-referenced information visualization system. This paper aims to go a step further by defining and implementing such an information visualization system. Thus, visual structures digitally representing a variety of non-spatial data, as well as the ways that these structures can interact, are investigated. It is argued that the results of this research can have interesting implementations to the museum program; by organizing in alternative ways its content and context and by facilitating the dissemination of information to the public through interactive multimodal exhibits.*
Keywords. *Data-mapping; information visualization; timeline; multimodal, museum database.*

INTRODUCTION

Information visualization systems can be conceived as adjusted mappings of data to visual structures designed for human perceivers (Card et al., 1999, p. 17). Thus, a basic task for an effective visualization is to find out the representation schema for the classification of data. The schema needs to be compatible with user's perception and correspond to his/her mental (and physical) skills; while its structure has to be flexible in order to be redefined when new data are imported (Card et al., 1999). It is essential to create layers of information in order to prioritize the stages of different visualization. Moreover, according to Wright (1995), abstract information visualization should also focus on human judgment and perceptual strengths in order to "provide a more natural framework".

The above mentioned theories are considered in the process of designing and transforming the dataset of the Museum of the City of Volos (MuCiV) to dynamic data structures.

DeMuCiV (Designing the Museum of the City of Volos) is a Research program, funded by the Greek Ministry of Education and the European Union, concerning the development of interactive content for the MuCiV, in central Greece. The Museum is currently created by the Archive, Museum and Library Direction of the city of Volos in a renovated industrial building. Volos, a seaport city of 150.000 inhabitants has a rich industrial, commercial, intellectual and social history marked by cultural diversity and intense population movements.

Initially, the thematic axes of the historical framework are defined and analyzed. Three axes are developed through museum's timeline while segmentations highlight/occupy specific domains. Legibility is of great importance, thus two methods of organizing the three thematic axes are tested. The criteria that govern the overall system are presented and analyzed in order to specify the nature of links that will connect the different data. A model of the dataset is created where historical events are represented and mapped as two-dimensional surfaces or three-dimensional solids.

Consequently, the database is designed as an experimental flexible spatial configuration of dynamic visual structures generating a variety of narrations through interaction. It is argued that proper abstract visual structures can be fabricated by these data-mapping procedures, producing a number of applications that will transform to tangible, communicative and interactive environments.

HISTORICAL FRAMEWORK

Research's guidelines are determined by the final goal of the general project, namely the design of exhibits that will be accommodated in the Museum of the City of Volos. One of the aims of the museum content creation research project (DEMUCIV) is to illustrate, represent and visualize the dataset producing alternative, personalised customisable, multimodal narrations of Volos' history. Creation of multiple starting points is also considered. This particular paper focuses on the creation of Volos' historical timeline and the mapping of data in it.

Historical framework is defined as the period from 1900 to present time. Following the work carried out by the history and social anthropology researchers of the DEMUCIV project, history is analysed/viewed through the lens of three main thematic axes, namely society/inhabitants, spatiality, urban development developing and expanding through time as independent and/or interconnected series of events.

Spatiotemporal segmentation is considered via emergent situations and critical events, viewed as dense sets of data over a short period of time. Overall, aspects of public and private life, politics and politicians, culture, labour, manufacture and also education and leisure are covered in this research.

Through particular, representative and unique stories and events, the most significant procedures of Volos history configuration emerge. However, the selected events are not necessarily considered as representative examples of historical normality.

Researchers stress the importance and relevance of regularities and exceptions, continuities and inconsistencies as well as normality and crisis in shaping the historical evolution of a place. Thus, data are collected with the method of "exemplary stories/events", meaning the sources that shed light on central aspects of the city's history.

HISTORICAL CONTENT – ANALYSIS OF THEMATIC AXES

Society / Inhabitants

Ethnographic research is the main tool for harvesting information in this thematic axis. The goal is to cumulate data that are able to depict the ways that the city can function as an attractor or repeller for its habitants/residents, as well as the composition of a society in different periods, and the ways that a variety of cultural identities can shape inner borders, boundaries and thresholds within the city. Another important issue reflected is the different aspects of everyday life in the city of Volos. Data illustrating family, habits, labour and also leisure are incorporated.

Spatiality

The history of the city through the development of build space is the topic of this thematic axis. Material referring to urban development (additions and changes on urban fabric, integration of new districts), population distribution (social layering, professions, origin and religion), activities relevant to space (monuments, infrastructures, stadia, residence, churches, and entertainment), Mediterranean networks (sea as means of unification, transportation, financial and cultural exchange network), geophysical identity and exceptional spatial events (landmarks) are all included in this thematic.

Urban Development

Research on aspects that compose urban life and the special/particular identity of the city of Volos is gathered in this thematic axis. The aim is to highlight the special characteristics of Volos urban development. Data that are included here relate to industry (infrastructure, installations, transportation, technology, local products, histories/log, biographies), retail (streets, type of stores, itinerants), general culture of labour (working conditions, working class district), new economic/financial functions and institutions (tourism, suburban industry, university).

Spatiotemporal segmentation

The emergent situations/ critical events that occurred in specific periods and radically effected (and changed) several aspects of Volos' everyday life are considered. Socioeconomic, cultural and generally everyday life of Volos had been upgraded or even substantially degraded during these periods. The arrival and the settlement of immigrants from Minor Asia (at the end of the Greco-Turkish war, 1919-22), the economic crisis in the 1930's, the 2nd World War, the national war, the three big earthquakes that took place from 1954 to 1957, the deindustrialization of the 1980's, the current economic crisis are such events.

CRITERIA

Each thematic axis consists of layers that contain variables (such as time, place, topic, code etc). In order to interpret and represent the above in graphical form, a vocabulary of two and three-dimensional geometries (shapes, colours) is created. The links that compose and organize the 3d vocabulary to graphical forms/informational patterns of data are dynamic in order to correspond to the variables and thus facilitate mapping.

The nature of links and consequently the way data are organized is determined by specific criteria. The purpose is to design a flexible visual structure that will be able to correlate and create densifications between data in multiple ways.

Following the historical analysis four main criteria are set and presented below:

- content coherency
- significance (influence in a historical context)
- duration of the phenomenon/event
- effect/relevance and the interconnection to other categories

The number of available sources is also an important parameter but will be considered and evaluated in future. Next the procedures of data mapping (according to these criteria) are presented.

SPATIALIZING/ MAPPING DATA

In previous research (Bourdakis et al., 2012), time was perceived as a static variable rather than a vital dynamic one. Therefore time is represented as the main axis along which the data events/entities are expanded through the chronological succession from 1900 to present. Axes are represented as abstract cylindrical areas that extrude through time in parallel horizontal paths.

The content of society, spatiality and urban development stretch along the X-axis, while the emergent situations and critical events are represented as spatiotemporal cross-sections/segments.

Two methods of organizing the three thematic axes along time are tested:

1. Linear array
2. Radial array

In the method of linear array thematic axes are arranged in parallel and lateral (Figure 1a), while in radial array are scattered in circular and interconnected/permeated arrangement (Figure 1b). The axis of time is extended on the later at the centre of the interconnected space. Both of the arrays have advantages and disadvantages as far as data-

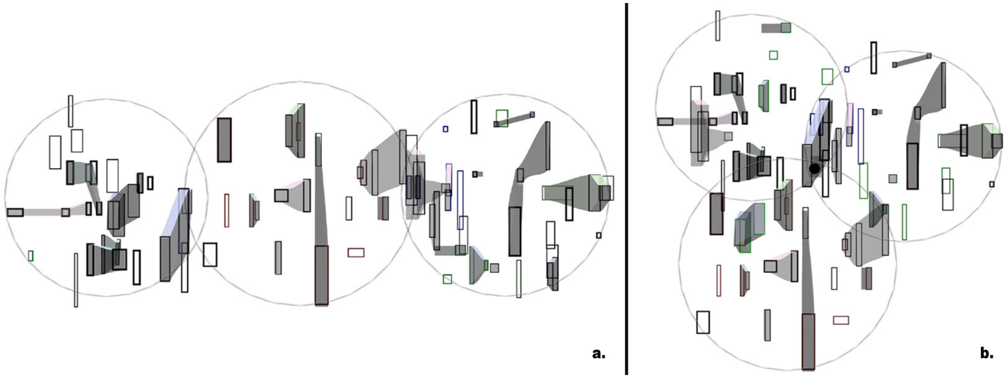

Figure 1
a. Linear array section, b. Radial array section.

mapping is concerned. Linear array facilitates the organization of data in lucid and easily perceivable for the user systems. However interconnectivity is questionable in cases of marginally related data to non-adjacent categories. On the contrary, the value of interconnectivity is properly mapped on the radial array, but the entire model might be less legible.

Each axis is a three-dimensional diagram. As previously discussed X-axis defines time and as a result the duration of the phenomenon. In linear arrays Z-axis sets the dimension of significance while Y-axis the degree of the content coherency as well as the relevance and interconnection to other categories. However on radial arrays interconnectivity is defined as a conjunction of Y and Z axis.

The centre point/axis of each abstract cylindrical area is perceived as the core of the entity. In this three-dimensional layout the dataset are located/scattered in the periphery. Data entities are depicted as rectangular objects (2D surfaces or as 3D dynamical spatiotemporal solids). Their size and location varies according to the previously mentioned criteria. Transparency is added on the later in order to enable the interaction with potential concurrent changes and events.

Section

The height of the rectangle represents the degree of significance and in conjunction with location defines the degree of relevance to the entity. Thus, data that have been evaluated as more significant and also more coherent/relevant to the general content of the category are located closer to the upper/external layers. Data with high degree of interconnection are placed on the threshold to other thematic areas or to their shared/common space. Therefore, each core can function as an attractor or as a repeller of data. The width of the rectangle illustrates the degree of content coherency (Figure 2a).

Front View

Events duration is clearly visible on the side elevation of the model (Figure 3). Data that extend on time are represented as 3D dynamic spatiotemporal solids while static events are illustrated as vertical lines (Figure 2b). Thus the length of each surface defines the duration of an event. The height of each solid during time might vary depicting the historical changes that occur.

Emergent Situations/Critical Events

Critical events are illustrated as coloured spatiotemporal sections (Figure 4). Several significant changes on data in a geometrical and geographical aspect are included in these coloured segments. Events that had boosted or degraded the socioeconomic and cultural life of Volos are respectively marked in vivid and dark colours. In detail, vivid blue areas on Figure 4 represent the arrival and the settlement of immigrants from Minor Asia, while dark red and

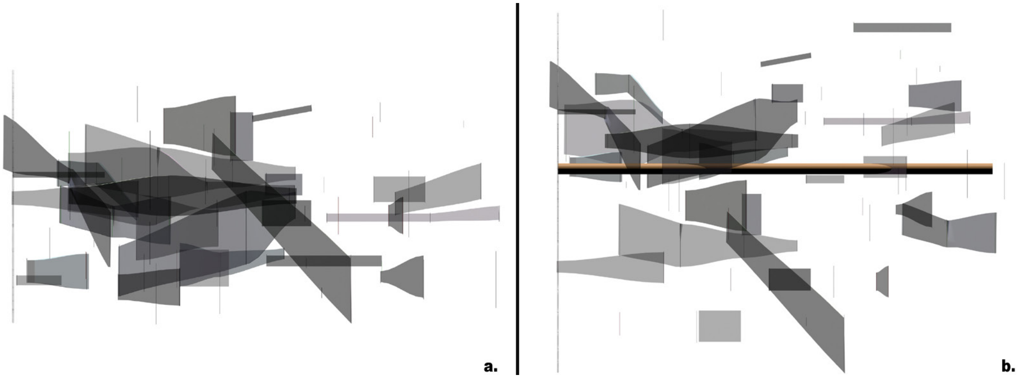

Figure 2
Data-mapping specification, a. Section, b. Front View.

purple areas indicate War World II and the period of earthquakes respectively. The shape of the three dimensional, dynamic spatiotemporal data is also respectively increased or decreased and in cases is re-oriented.

Perspective View

Users are able to visualize the entire database structure (Figure 5). View is unobstructed due to carefully implemented data translucency. However, the user is able to change the number of visible items by defining the criteria and data to be (re)presented.

Thus the entire schema can be re-organized in respect to thematic axes, categories and criteria. Additional information such as title, subscription, chronology, names, descriptions, location/position, shape and colour are also considered.

COMPUTATIONAL APPROACH TO DATA MAPPING AND VISUALIZATION

The visualization of data proposed, is accomplished using X3DOM at the client side. This technology en-

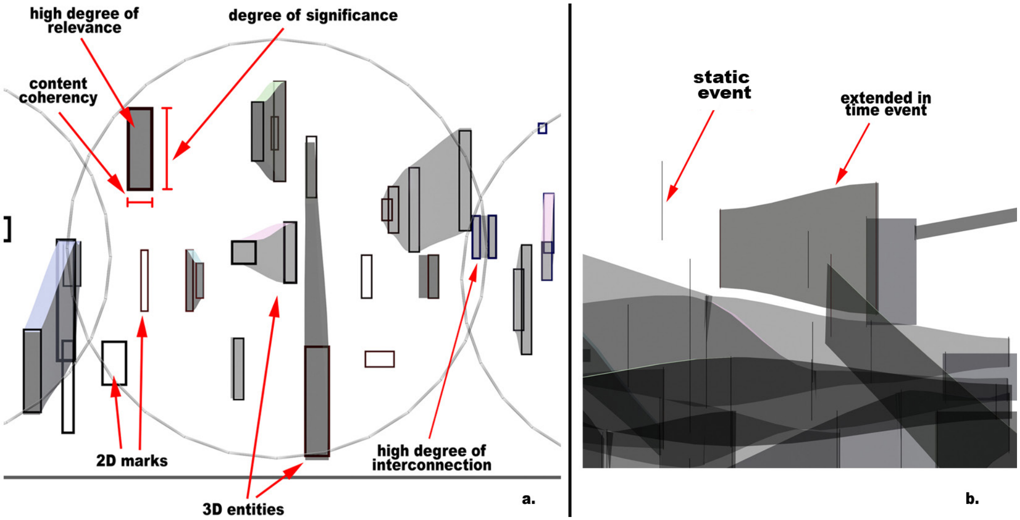

Figure 3
a. Linear array front view, b. Radial array front view.

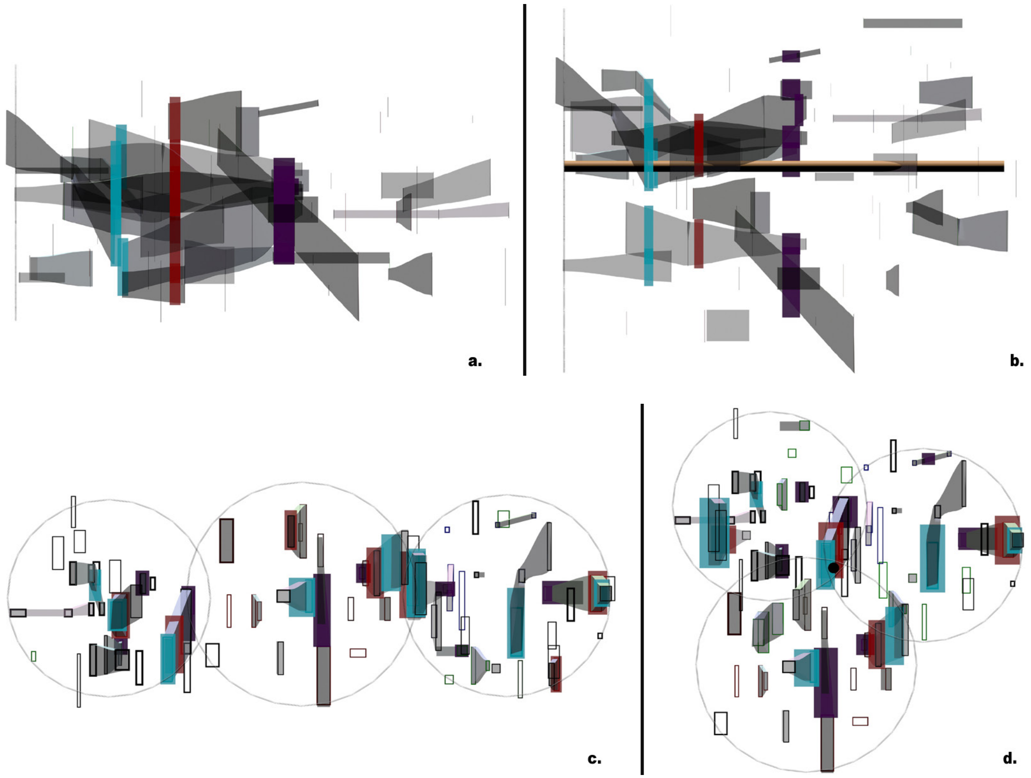

Figure 4
a. Emergent situations/ Critical Events linear array front view, b .Emergent situations/ Critical Events radial array front view, c. Emergent situations/ Critical Events linear array section, d. Emergent situations/ Critical Events radial array section.

ables the real time creation of virtual 3d space and dynamic representative structures and it conforms to open web standards. It also gives the opportunity to different users to visualize and comprehend the datasets in potentially different ways based on their preference. It must be noted however, that user's experience depends on hardware's 3d capability (OpenGL performance).

In order to achieve the aforementioned functionality, the system takes as input the user search criteria and output the code needed for the 3d representation at the user's web browser. Such system collects the user's data, create and execute the appropriate database query, collect the records returned by that query, convert them to X3DOM-aware structures and finally submit them to end user's web browser.

In our approach the end user defines search criteria in a web form which is afterwards submitted to a web server running PHP and also acting as Relational Database Management Server. The PHP program collects the search criteria, forms and executes the MySQL query to the database server and gets the corresponding result records.

For each record a 3d structure is created using X3DOM language. The appearance of the structure varies depending on the thematic axis, the time and duration of the event it describes and its significance. The 3d location of the structure will vary depending the chronological point it refers to, the significance of the event and the user's preferred type of the array, e.g. linear, radial, with or without

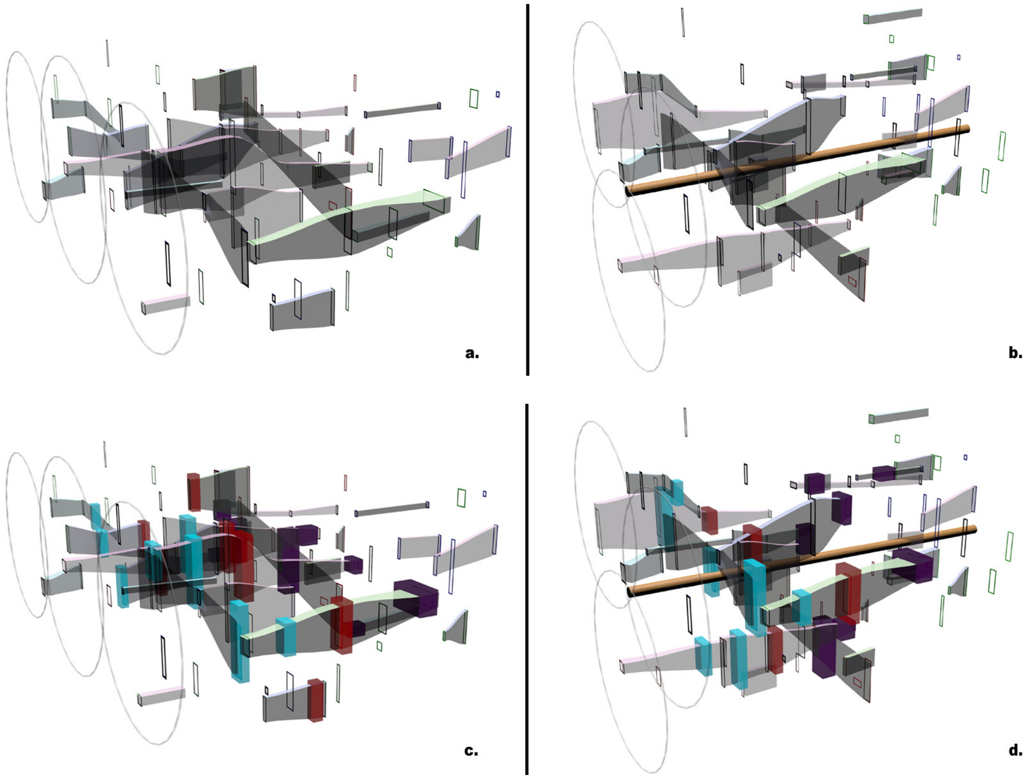

Figure 5
a. Linear array Perspective View, b. Radial array Perspective View, c. Linear array Emergent Situations/ Critical Events Perspective View, d. Radial array Emergent Situations/ Critical Events Perspective View.

critical events.

Upon completion, the 3d scene is transmitted to the user's browser where it is visualized. Additionally, a navigational interface control is available to allow the user to switch the type of view (front, section or perspective).

CONCLUSIONS

This research is part of a large project working towards designing the museum of the city of Volos. The paper focuses on conceptualizing and constructing MuCiV's dataset in information visualization systems. Three thematic axes and a spatiotemporal segmentation are employed to classify/ organize the historical content. Society/ inhabitants, spatiality and urban development are represented as abstract "cylinders" that are extended through time. Data are designed as rectangular two dimensional surfaces or three dimensional solids. Criteria of content coherency, degree of historical significance, duration of an event as well as interconnectivity determine/regulate data mapping procedures. Properties of colour and transparency are applied to produce perceptible structures.

It is argued that the presented visualized information systems manage/ are able to combine the historical data in a meaningful way and to develop strategies that successfully embed the non-spatial data in spatial models.

The research is still very much work in progress and thus the methods of mapping experimental. The outcomes will be tested on experiments run during the 2013-14 academic year. For that purpose and considering the needs of a museum, implementations of multi touch and multi user screens as well as tangible applications and locative media technologies will be utilized and will collaborate dynamically with the pilot database in order to transform visualizations to tangible entities. Issues of simultaneous multi-presence and multi-use will be taken into consideration, due to the fact that this project is addressing a large number of users. The main goal is to create an environment that will transform the museum context to an exceptional lived experience.

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