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Digital representation of the impact of the 1755 Lisbon earthquake

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Maria Bostenaru Dan **Thomas Panagopoulos**

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Abstract

Toys have played a role in the development of 3D skills for architects. As a continuation of this, games, a subgenre of which are city building games, the father of all is SimCity, a variant of construction management games, underlay a socio-economic model. Outgoing from a general view of the role of toys and games in building the skills of architects, we focus on the modelling of the impact of earthquakes on urban areas. The particular case considered is Lisbon 1755, set into the context of related developments such as l'Aquila 2009 and Bucharest 1977. We examined the 3D modelling of the city, which can be the base for computer games, namely the GIS based, Google Earth and Second Life. For all these modells we filled forms which are provided in the annexes, to see the usability and potential improvements, which will be considered in the model we propose. The later builds a game with a socio-economic component, but both later ones have the social component of crowd sourcing participation. The Second Life concept can be extended with narratives of chance like in board games, to realise the immersion like in a novel in the historic time depicted, organising for example virtual events in the public space framework modelled. Different Levels of Detail are identified as necessary in order to on one side identify the landmarks of the image of the city in the perception of inhabitants and tourists and on the other hand to model populations of buildings for future economic studies, based on a structural mechanics instead of statistical approach. Outgoing from this analysis we propose an own concept to model the impact of the 1755 earthquake on Lisbon. We based our concept on the analysis of the space and time aspects in the memory of the pre-disaster city, and considered 72 landmark buildings which can be symbolically modeled as spaces, based on a 2D to 3D concept. Depending on where they were situated, these have been affected by the earthquake or not. We provide besides the overview of the literature on games for architecture on urbanism purposes also this one on memory. This includes on its side a game, for lessons learned in the identification of the landmarks of the city. Apart of the game, there is a guided tour with timeline and the 3D model in itself. Codes are provided. For the analysis we used different views of the city: eye-level, silhouette (from the river) and aerial. This can be the basis of a future augmented reality application including the 3D model and the photos/engravings of the time. The socio-economic component will be based on

the modeling of material resources necessary to retrofit or reconstruct, for the detailedly considered „pombalino" buildings. But first of all identifying the urban morphology through 3D modeling is serving as a basis for master planning, especially the strategic planning of the minimal urban structure, in both preventive pre-earthquake intervention and post-earthquake reconstruction, as aimed for in the „Lisbon in motion" workshop and planned related ones.

Keywords: digital methods, Lisbon 1755, games, earthquake, 3D city models

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The work has been presented in the NeDiMAH cross-working group meeting, funded by the ESF, in Bucharest, 1-3 November 2012, and the publication was prepared then.

In March-April 2012 further documentation has been done in Lisbon, in parallel with a COST STSM in frame of the action IS1104 "The EU in the new complex geography of economic systems: models, tools and policy evaluation".

Analysed were models from the Romanian funded projects HERA and URBASRISK along with Portuguese models, before developing the own model. The HERA project (PI Iuliana Armas, University of Bucharest) has been the one with which it has been adhered to the COST action TU0801. The model developed in it is detailedly analysed in the book.

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1 Introduction

We present in this paper research done by the first author on the invitation of Thomas Panagopoulos about citizen participation possibilities by way of Second Life, which is continuing another Short Term Scientific Mission supervised by him which took place in 2011 at the same location (by I. Jankovska from Latvia, with Panagopolos et al, 2012). We took a look also at virtual globes (Schroth et al, 2011) in this context. This article is about adapting them to climate change. Actually, as presented in Bostenaru (2012a) game theory used for decision is developed for climate change and not for earthquakes, quoting a particular case about confrontation theory – or drama theoy (Levy et al, 2009). The virtual globes are also about climate change, but we will work with several models on earthquakes. Panagopolos et al (2012) also makes reference to the availability of Google Earth models in Portugal (Lisbon only).

In concordance with the aims of Panagopoulos, Bostenaru Dan wrote a short observation to an article dealing with immersion in time (we deal with a historical model, and with how one can enter a historic time by means of literature and games) on an article by Krämer (2011). In the interaction between literature and architecture the first author also read and experienced the novels, centred on architecture, set in the Middle-Age novels by Ken Follett, from which both are available as board game and “Pillars of the Earth” also as computer game.

Given that the focus of the research of Maria Bostenaru Dan lays with natural catastrophes, we investigated the unique opportunities offered by the fact that Lisbon pre-1755 earthquake has been modeled in "Second Life" by the group around Helena Murteira.

1.1 Review of architecture and urbanism games

Toys are a a learning environment for children, but also a tool for adults to develop 3D viewing. Canadian Centre of Architecture exhibitions were dedicated to the relationship of toys and architectural/urbanism production in the period ... Games are a tool of investigating decision, but also economic models, through the construction management models which stay at their basis (the bargaining applied to resource allocation). Most research is done on computer games, but board games follow the same principles. Some niche research is dedicated to them as well, exising a conference on Board Games Studies conference even with an archaeology component.

We reviewed several architecture and urbanism games and toys such as: Playcards, Toys, Puzzle games, Board games, Role playing games at city scale and Computer games.

Playcards contained in the CCA collection are souvenir playing cards (photographic reproduction of monuments): Gaudi, Berlin, Chicago, Philadelphia, a game based on photographic associations: Piu e meno, Baustelle Kartenspiel but also a playcard variant of SimCity.

Toys were an instrument in training architects such as Frank Lloyd Wright and Buckminster Fuller. The best known are Froebel toys (Kindergarten, Fig. 1), to the anniversary of which even Google dedicated a page. Similar 3D competences might be learned today with SketchUp, a more developed version of the Building Maker we use for 3D city model building in the research presented here. Skyscraper/tower building is best known, and we mention the toy depicting Belém tower for Lisbon, subject of this paper. „Stadtbaukasten" (Il Gioco della capitale = Capital game) - "Geburt einer Hauptstadt"

(June 17 - September 17, 1988, St. Pöltens) was a teamwork game, where participation was filmed, just like in the Association for Urban Transition cultural project „Bulevardul, casa si poporul", on the destructured zone of Bucharest we mention, funded by the Urban Observatory, Bucharest.

We considered two puzzle examples: a 2D puzzle, employed in the participative approach of photovoice for the rehabilitation of a cinema in Bucharest and a 3D puzzle dedicated to architectural heritage of Gaudi (Sagrada Familia), again a cultural tourism item (Fig. 2). At the Children's day 2012 wooden puzzles were offered.

Fig. 1. Froebel, the creator of toys, celebrated by Google.

Fig. 2. Difference between a 3D print and an assembled model: 3D print of a church designed by Imre Makovecz (print by Szent István egyetem, Budapest, partner in the COST action), 2D and 3D puzzles, as PhotoVoice or Souvenir (Sagrada Familia in Barcelona), with examples of the Belem tower in Lisbon. Photos and solving of quizzes M. Bostenaru, 2011-14.

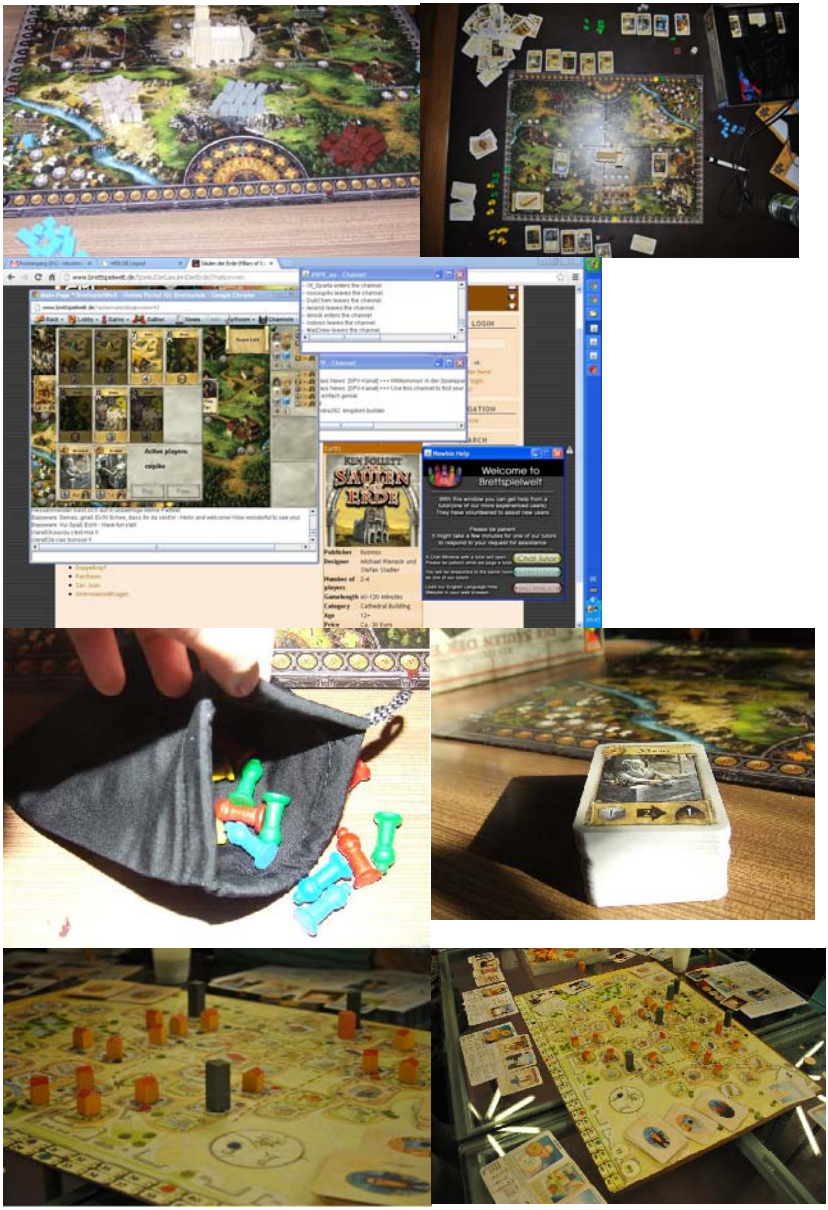

Fig. 3. Board games based on Ken Follett's novels and respectively “Habitat”, analogue and digital photos as well as gameplay M. Bostenaru, 2011-12.

Board games have a strong socio-economic model, as aimed by the scope of this paper. In a board game according to the rules it has to be aimed to become the wealthiest player. They are strategy games with elements of fate (cards, dice) and centuries old. Today‘s model is based on monopoly. The CCA collection includes games featuring Paris, fortifications, skyscraper (King Kong – based on film). Building singular large scale buildings as skyscrapers has its pendant in the historical cathedral, which we find both in the CCA collection and at Ken Follett (novel, films on „Pillars of the Earth“ – translated to computer – and „World without End“ – including a natural hazard) (Fig. 3a). The issue of the man-made hazard of demolition in the American city („Urban sprawl“) or historic European city („Habitat“ for Bucharest, Fig. 3b).

Role playing brings games into decision making, based on the AHP - conflict management method. Role playing games at city scale investigated include:

- „Green CCA“, a game to raise ecologic awareness at different scales,
- „Klosterrallye“, a treasure hunt type game around the student dormitory of HaDiKo, Karlsruhe,
- „SozialLabor: Dorf“, a game based on the „Green Revolution Game“ used in the teaching curricula of regional planning at the University of Karlsruhe, which won a prize 1994, and where the data are basis for study works of master students
- Linz – cultural capital
- World Game (Buckminster Fuller)

Computer games, also known as serious games are rebuilding a virtual world – based on rendering. An urban analysis basis is Winy Maas „Space fighter“. Different is „Second Life“ a participative medium but also with a socio-economic component, since players are able to trade. Based on our research on participation an internet based participative game was developed by students in Stuttgart.

Another type of computer games are quizzes. These can be a learning tool, as in the Art Nouveau Network (http://www.artnouveau-net.eu/Network/Actions/Children/tabid/827/language/en, Fig. 4a), and we developed a prototype (Fig. 4b) for it to use it in our further research of identifying historc places connected to the Lisbon earthquake. Urban games can thus serve as tourism guide

„Construction and management games“ are a sub-genre of which are „city building games“. SimCity is the father of all. At the begin it was in 2D, including natural hazards scenarios (modeling of linear processes only),

then the rendering but not the simulation improved in 3D. SimTorino (http://www.laq-tip.polito.it/SimTorino/) is a simulation of urban development by Luca Caneparo. Followers are CivWorld, CityVille etc. but also the recent SimCity social, all for the social platform of Facebook. Resources for constructing or extending various buildings in these games are simulated through symbols for materials or for building elements and obtained through cooperation, like in game theory.

Other simulation of natural catastrophes in games is one developed at the HfG Karlsruhe on the Fukushima nuclear disaster (http://www.hfg-karlsruhe.de/news/mit-wassereimern-den-atomaren-gau-bekae), which is in so far related to our research on Lisbon that in that case the historic accident, seen in our paper to be either the tsunami following the Lisbon earthquake which shocked the world or the Tschernobyl catastrophe prefigurated in Tarkovsky's „Stalker“ were combined having the nuclear catastrophe triggered by the tsunami. Other educational environment games were developed by Poplin (Fig. 5), or on the location of the NextCampus (Hamburg, Poplin, 2014). Citizens can send their plans to urban planners.

We investigated toys and games having architecture and urbanism subjects. Today the focus is on virtual reality (serious) games – but the hard copy board games are not to be neglected. 3D in toys led also to digital applications, namely CAD. Toys and games are employable for educational purposes.

Example of code for a quiz game (Bostenaru, 2000):

```
  global gcounter
  on enterFrame
  set the visible of sprite 40 to FALSE
  set gcounter=0
  repeat with i=31 to 34
  if inside ( the loc of sprite (i+5), the rect of
sprite i ) then
  set gcounter=(gcounter + 1)
  else
  set the visible of sprite 40 to TRUE
  set gcounter=(gcounter - 1)
  end if
  end repeat
  if gcounter=4 then
  go to "sieg"
  else
  set the visible of sprite 40 to TRUE
  end if
  end
```

Fig. 4. Quiz games: to learn about Art Nouveau (Online activities "Discover Art Nouveau", (c) Réseau Art Nouveau Network, www.artnouveau-net.eu), the principle, and to localise sites on a historical map (games by M. Bostenaru, 2000).

The study of decisions in games (game theory – drama theory – conflict solving & economics research) makes them able to simulate decision making, including cost-benefit analysis. The involvment of society (also through democratic participation in decision making) builds the participatory dimension of planning. (Socio-)economic models are coming from games theory to urban planning and to large scale architectural tasks, the most frequent one presented being that of the church.

Fig. 5. Other computer games: designing the Marketplace – B3 game (from http://seriousgamesmarket.blogspot.ro/2011/07/serious-games-in-urban-planning-for.html, used by permission of the author, Alenka Poplin).

The importance of games will be seen as a continuation of the role played by toys for the development of skills of the architects. While toys dealt with the development of 3D viewing and more realistic "building" focusing, for example, on details, games use stylized construction management models with "symbols" for resources, being it in a board game or in a computer supported social environment.

22 October 1997 to 31 May 1998 the Canadian Centre of Architecture hosted the exhibition "Toy Town". Apart of architecture toys, a field where principles of city building apply are architecture games. City building games are a sub-genre of construction and management games, the best know of each is SimCity. In its initial version of 1989 SimCity included disaster scenarios including the 1906 San Francisco earthquake, but also flooding, fire etc. During the further development only the fire remained as well implemented as the initial scenarios. It was a way to look at the role of disasters in urban planning, not only as way for a new begin, but also as mitigation and earthquake management. It is to be noted that disasters represented in SimCity 2000 are converted to such which develop in surface, such as fire and flood. Earthquake damage which occurs at random buildings is not modeled. Also, the fight against the consequences of the disaster, fire and flood are done in a real-time first hand action game, not as

construction management game. However, there are costs associated to mitigating the disaster, such as the costs for fire fighters. Today such city building games evolved to 3D applications, the semantic enrichment of which involves the economic model. The digital 3D model will be compared with the “hard copy” 3D model which architecture toys represent. Models for SimCity are looked for today, including a development at the University of Torino called SimTorino, which simulates the development of the city in the next 20 years. The connection to another games genre as video games, the board games, will be investigated, since there are games on construction and reconstruction of a cathedral and its tower and a bridge in an urban environment of the middle ages based on the two novels of Ken Follett, “Pillars of the Earth” and “World Without End” and also more recent games, such as “Urban Sprawl” or the Romanian game “Habitat”, dealing with the man-made hazard of demolition. A review of these games will be provided based on first hand playing experience. In games like "World without End" or "Pillars of the Earth", just like in the recently popular games of Zynga on social networks, construction management is done through providing "building" an item out of stylised materials, such as "stone", "sand" or more specific ones as "nail". Such approach could be used also for retrofitting buildings for earthquakes, in the series of "upgrade", not just for extension as it is currently in games, and this is what our research is about. We had the opportunity to compare hard paper representation to digital one in the investigation of the game “Pillars of the Earth”. The game is dedicated to the architectural endeavour of the construction of a cathedral using resources such as people and materials, like in construction management. The advantage of the digital method is the better implementation of the rules of the game. Although useful for our general research on project management, in the particular research project this short visit refers to it was useful to introduce us to the comparison between “material” and “digital”, leading to conclusion on the material model and the 3D model which later led to the developed concept. Also, in games we have to do with the symbolic dimension, and with no issues of scale. Below there are images of the digital and the material version. The church which has to be built in “Pillars of the Earth” follows two different approaches: in the “material” version it is made out of simple volumes which are put one next to the others, like in building a model at an urban scale for architects or in building a model in Google’s Building modeler, about which we will talk at results. Jeffrey Head, former visitor at the Canadian Centre for Architecture, observed how digital tools such as SketchUp are the toys of today in educating the imagination of architects. In

the “digital” version the church is built like with a 3D printer (Fig. 2, 3). The game taught with how to deal with constructing in a way it is dealt with in civil engineering. A building consists out of devices for its elements. But when doing project management in architecture at the overall scale the spaces are considered, building elements coming in question at detail scale (the m^3 of built space or the m^2 of floor space for a different function determine the costs, and not the resources). We should come back to this when developing the concept and thinking of the representation. In architecture the space is represented, considering the walls monolithic, and this is how they are in archive plans or in Nolli’s plans which we will see. The structural elements appear very rarely. "World without End" includes a natural disaster not so analysed today but which was judged by the author as the worst of manhood: the Black Death. The Black Death has effects and costs as well, not only modelled through action cards, but also on the built environment, by buildings remaining empty. On the other hand, games such as "Habitat" rely on role playing, which has been recently recognised as a way to bring games theory to decision making through the so-called contribution of drama, a way to solve conflicts through balancing instead of weighting, and thus related to Analytic Hierarchy Process. The presentation aims to also give hints on how to design a game for the problem of earthquake retrofit, translating the aims of the actors in such a process into role playing. Games are also employed in teaching of urban planning, as in the regional planning curricula at the Karlsruhe Institute of Technology, including a role playing game based on the Green Revolution Game, which builds the basis for getting data for further project study. This one included natural hazards such as drought, and their costs. They also play a role in building public space, as in case of “Habitat”, which was designed to activate the civil society in café. City investigation games may not take only the shape of computer or board games, they may be played in a wider city environment. From activation of public spaces in frame of cultural capitals in Austria, there are models of urban “races” to find landmarks, such as Klosterrallye in Karlsruhe, Germany, also included as a step at another geographic scale in the “Green CCA” game developed at the Canadian Centre for Architecture. Simpler games include the use of software such as Flash/Director to identify quiz like aspects related to architecture features, as employed by the Reseau Art Nouveau but also to disasters such as the San Francisco earthquake. We will present how to program such a game.

1.2 The context

In 1755 the earthquake and tsunami in Lisbon shocked the world – not only in physical sense, but also in sense of humanities, in the time and illuminism, and ended with the birth of Modernity. Although the technical studies of earthquake engineering on the impact of the earthquake are better known, scholarship tries to trace the impact on humanities, be it about history or the depiction of the catastrophe in literature and fine arts. It is here where it intersects with architecture – for example in studies at the Gent university in Belgium dedicated to Baroque (de Meyer, 2011). The video on the presentation of Dirk De Meyer on ruins in Lisbon and the view of philosophy is available at http://www.catastrophe.ugent.be/), and it has been the basis for a previous proposal for a joint doctorate, from which in the final doctorate (Bostenaru, 2012d) aspects of the scenography of memory, to which we refer further down when making the 3D installation of the "Rediscovered space", remained.

The research during this Short Term Scientific Mission takes into account a not yet treated aspect: the 3D representation of the impact of the earthquake on the urban development in Lisbon, by comparing the pre-earthquake Lisbon model (in "Second Life") and the contemporary Lisbon model in Google Earth. Purpose was to identify areas affected (such as Baixa, which was reconstructed) and areas not affected (such as Alfama), or partially affected by this earthquake, but affected by catastrophes in the past, such as the area where today runs the elevador da Bica. Also after the earthquake Lisbon continued to attach new developments, such as the Avenidas Novas in the 20th century. Although not done in connection with the Athens Charter, as in other countries (ex. Romania), they feature interwar architecture which we also investigated to see if the local seismic culture of the “pombalino” buildings was transmitted when going over from the material timber to the material reinforced concrete (related by some authors through their tension requirement).

The research is aimed to be continued building a database on the timber type of building in Lisbon reconstruction ("pombalino"), in dependence of the available forest resources in Europe vis a vis of local seismic culture. A preliminary version of a paper surveying this spread is in Bostenaru (2014). We visited also a “pombalino” city in the Algarve other than Lisbon (ex. Lagos).

An important part of the research was the review of literature related to games in architecture and urban planning, and also of literature on memory (with focus on space and time, from the point of view of philosophy, in

which 1755 was a milestone, and that of architecture theory), regarding the mentioned immersion but also the changes in the urban structure by catastrophe impact (real or virtual rebuild). An annotated reference list resulted from the literature survey.

Aim was to explore to which extent such city models can be used as basis to decision making, to be compared with the results of the "Lisbon in motion" workshop (https://sites.google.com/site/limo15wcee/home see explanation further down), a basis for a workshop to take place in Bucharest in 2013 for the situation in Bucharest in frame of the nationally funded project on the central Bucharest destructured zone (PI Gociman, 2012-2015).

1.3 Previous research

Maria Bostenaru Dan is dealing with citizen participation since the 1990s, when she started working on the later published a book (Bostenaru, 2007). This book provides a case study supported history of participation in mainly German speaking countries in the last four decades of the 20th century. In the 21st century additionally digital methods entered also this field, mainly as tools, for example crowd sourcing. Bostenaru (2004) developed a decision model to be adapted from building size to urban size by means of strategy. The article builds on one which adapts the view of layers in participation/communication (a term later embraced by participation and coming from community) to disaster management, about which she later wrote a paper on its own (Bostenaru, 2012c), which was previously presented at the same location.

Previous research of Maria Bostenaru on the study of the 1755 Lisbon earthquake included the participation in 2005 to several anniversary events, publications on both the earthquake as historic accident (Bostenaru, 2010) and the earthquake resistant typology which emerged after (the “pombalino” buildings) (Bostenaru, 2008). During previous stays in Lisbon it has been possible to visit such "pombalino" buildings courtesy of Vitor Coias. Connected to the knowledge on related Fachwerk housing in Germany some works of Maria Bostenaru Dan (Bostenaru, 2004).

We already mentioned the state of the research in the field of architecture and urbanism games. Building on both of these (participative decision and employment of game theory in architecture and urban planning) a session is proposed in frame of a workshop application for early 2013 in Bucharest (tentative title "Digital methods in the arts - a branch of

digital humanities? The role of architecture and urban planning in this context").

Maria Bostenaru Dan was also actively involved in virtually rebuilding the earthquake affected city of l'Aquila in Google Earth in frame of the voluntary initiative "Come facciamo?". The real time modeling in "Second Life" is different, but in some points of view similar to the research done in frame of the University of Arts and Design in Karlsruhe, to the topic of "Spaces of encounter"/"Rediscovered space". In that project we started with designing the contours which suggest a certain feeling of the space, first in 2D, as black paper on drawings and then in 3D real time modeling with Lingo in Shockwave, going out from the model of a box. As explained in our proposed concept, the pre-1755 earthquake buildings are already represented in 2D in Museu dos Azulejos, and the 3D step in Shockwave can be done faster than the realistic modeling in "Second Life".

In Bostenaru (2012b) "now and then" comparisons have been developed. Today such approaches are followed either by means of photography (for more recent earthquakes than the Lisbon one, where only engravings are available), but without the 3D city scale view, or for recent earthquakes, where satellite imagery is available to identify damages in comparison with the eye view reconnaissance. A further development of the stereo software presented, where augmented reality can be built upon comparing photography and the 3D model, or, in case of what we investigate here, the pre-earthquake and the post-earthquake city model. The aim was to see to which amount such approaches can be involved in the development of an own programmed approach to see differences in the city tissue.

In „Second Life“ the EUR in Rome, an interwar urban development, is represented, and it was dealt with during the doctorate of Maria Bostenaru Dan (2012d).

Jan Kozak et al (2005) wrote a book about the very impact of the earthquake in the moment of the disaster (not pre-earthquake as in the "Second Life" model and not post-earthquake as today). The images are available also in the NISEE database (http://nisee.berkeley.edu/kozak/). This was followed by a book on illustrations of catastrophes (Kozak and Cernak, 2010). We aim at a similar book on photography of disasters as ruins of the moment. Instead of re-photographing we walked through the city model (but also seen the real site through visits).

2 Methodology

The focus of this ongoing research, supported by both national funded projects in Romania and international cooperation networks for an exchange stay in Portugal is the 3D modeling of changes in the urban tissue by catastrophic events. For this purpose central Lisbon (Alfama and Baixa) as well a protected area in the centre of Bucharest were considered. The purpose itself was to establish to which amount 3D city models are useful, usable and used for sustainable development decisions, in this case protection against hazards. Work was done concerned:

1. defining urban planning layers, historic view: theoretical framework. The work comprises review of existing literature on:

a. historic development of Lisbon around the earthquake impact of 1755 (before, during, and after the earthquake) as well as the intervention in Bucharest (impact of the 1977 earthquake and misuse, vulnerability today, development of future strategies, ex. emergency planning);

b. Defining immersion in space and time:

i. Representing memory (classification of literature related to the memory of disasters);

ii. The role of games vis-a-vis the role of literature (real-time representation in Second Life versus an own developed application).

2. investigation of the role of memory in representation of ruins, in relocation in reconstruction after the earthquake;

a. For Lisbon: identifying the monuments (churches) affected by the earthquake for example in Kozak's collection and in the pre-1755 3D model http://lisbon-pre-1755-earthquake.org/ as well as identification of the constructions replacing them (except Carmo convent) on site and in the Google Earth 3D model. Comparison to before and after photography approaches, available for later events, when photography was available, and to the Piranesi project for Baroque time. For Bucharest: identifying the monuments and their displacement, and of places for emergency housing via 3D modeling,

b. literature review of articles comparing satellite imagery and eye-level view in identification of earthquake damage.

3. formulation of definitions for semantic enrichment:

a. .comparison of the models to other 3D historic models within the COST TU0801action (Liege, Nantes) – differences and lessons to be learned,

b. Sketching future works (building of digital database). While for Lisbon the timber structure of the "pombalino" buildings was considered, and the database will be aimed to correlate seismic hazard/local seismic culture but also availability of certain species in the forests as resources, for Bucharest reinforced concrete is the material considered.

The project is on European buildings with reinforced concrete structure from the first half of the 20th century subjected to earthquakes. Rarely the structural system of buildings is documented in architectural history, and even more rarely buildings are listed monument because of it. The gap will be filled by a database of such buildings, using photographic material already gathered (as it is also the case for related timber typologies). Further a taxonomy and ontology for retrofit elements for these buildings is proposed. From the survey, over structural intervention to economic computations the same retrofitted and retrofitting elements are defined. Structural simulation results will be tested on applicability for economic impact analysis through:

(1) Monte-Carlo simulation for extension,

(2) comparison with real projects,

(3) comparison with experimental results from European laboratories databases.

All these will result into a decision system, employing the newest developments from games theory for economics and drama theory for conflict solving, but also the developed ontology approach.

Specific works were

2.1 Meetings and collaboration with other networks

Maria Bostenaru is member of the Steering Committee of the ESF Network for Digital Methods in Arts and Humanities NeDiMAH (2011-2015), the WG1 on “Space and time”, which will held its workshop in Lisbon in 2013 (a cross-working group meeting of this WG and the WG2 on "Image visualisation" will be held in Bucharest 1-3 November 2012 where these results will be presented and with participation of Daniel Alves from Portugal). In Lisbon we met Paulo Teodoro de Matos, steering committee member from Portugal, currently working in the historical demography field (about the sources and general trends of the Portuguese Empire, 1750-1875) at Center of Overseas History, New University of Lisbon.

The historic city model is done in "Second Life" and the research on game theory and the socio-economic model of such city models was continued in frame of the COST action IS1104 (2012-2016), supervision

Diana Mendes, in March-April 2013 in Lisbon in frame of the WG3 on game theory. Being a game, it also have as a basis a socio-economic model.

We met Helena Murteira and Alexandra Gaga da Camara who are building the Second Life pre1755 earthquake Lisbon model. Building such a historic 3D model as the Lisbon pre-1755 one involves numerous disciplines, such as IT, architecture, art history and landscape planning.

2.2. Site visits

Purpose of one week stay in Lisbon was to localise the "now and then" sites in Lisbon affected by the earthquake, in the 3D model and at eye level (including: aerial views of Lisbon from the castle, Graca and Restauradores elevator, skyline of Lisbon seen from the Tejo, exploring Lisbon through the elevador and tram 28 which run the Bica area). The Museu National des Azulejos has a hall dedicated to the representation of pre-1755 Lisbon earthquake in azulejos. The emblematic buildings are symbolised in the legend by simplified shapes, which form a good starting point to 3D representation in Shockwave 3D. Site visit was done to Lagos and other historical Algarve sites. Lagos was (and Sagres, where the discoveries port is, too), apart from Lisbon, affected by the 1755 tsunami following the earthquake and rebuilt, unlike Silves, which maintains the historic substance. In the return visit in Lisbon we did a tour on the steps of reconstruction in Baixa and visited the newly opened Lisbon history centre. During the IS1104 stay we visited the sites affected by the earthquake which can be seen in the Annex.

We also visited the Museum of the City, to see the timber model of it made on the 200th anniversary of the earthquake and its digital transposition. Further on, we visited the Lisboa story centre which presents a dynamic projection of the earthquake effect on a simplified topography of the city, in the way GIS on 3D map does (Fig. 6).

2.2 Literature survey

We consulted the Kozak collection of photos on the damage to Lisbon. We also consulted the European Architecture History Network papers on development of urban layers in Lisbon. There are two papers: the effects of the post 1755 plan (1758) on the 20th century plan (1938) from the European Conference of Architectural Historians in Guimaraes, Portugal, 2010. The 1938 plan is something touched in the doctorate of Maria Bostenaru (2012d), as in Romania a plan was done 1935 according to the Athens Charter, and this rendered earthquake vulnerability. The historical drawings have marked what remained in the new tissue.

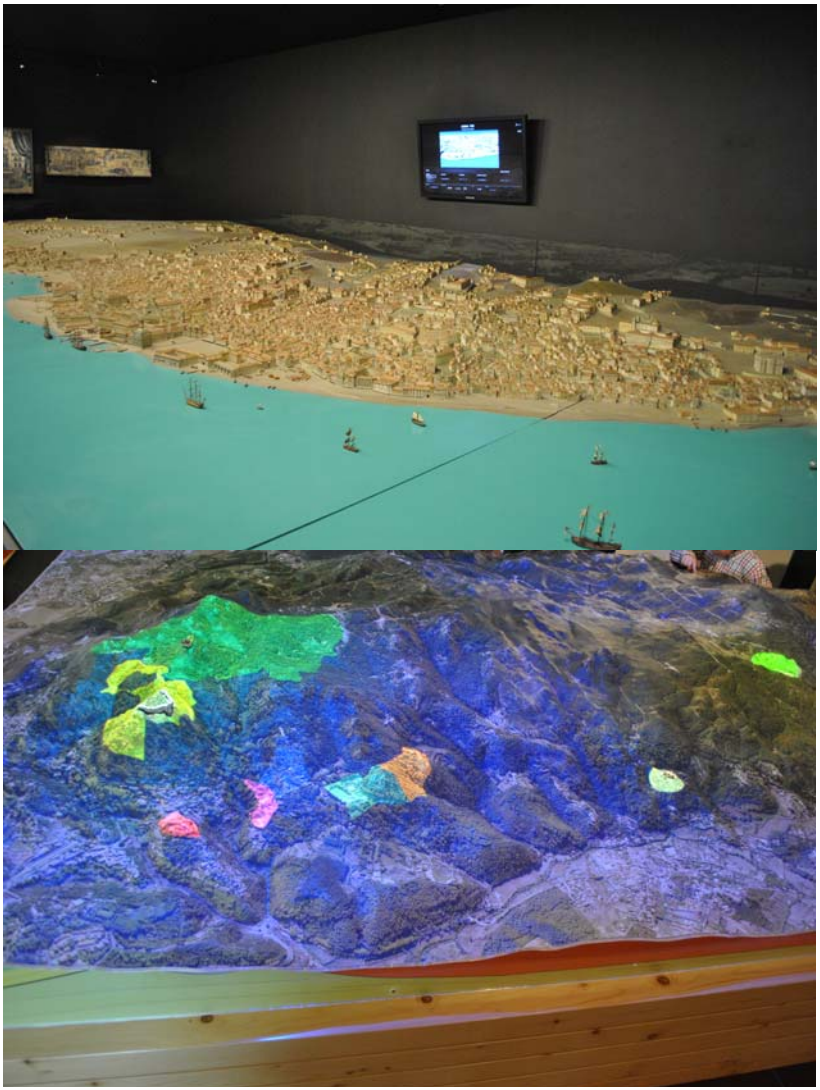

Fig. 6. Wood model of Lisbon pre1755 made on occasion of the 200th anniversary in the City Museum (above) and projection on such a hard model in the Sintra palace. Photos: M. Bostenaru, 2013

We reviewed the contents of the Getty library on literature to architecture and urbanism games. The Getty library contains:

historic books (mainly 18th century, which is the time when the Lisbon 1755 earthquake occured, therefore this approach comes back to the same period and employs therefore an approach of the time) on engravings (focus on optical „games“ – ex. Nekes collection), rules of games (including the game „Faro“). It includes the presentation of „an earthquake“ (the Lisbon earthquake) by Engelbrecht, Martin (1684-1756): Præsentation eines Erdbebens, 1755-1789. 19th century historic books refer except of rules of playing games also to society games including the folk ones), but again also to the image, this time in cutting in timber for playcards or portable dioramas, and it is when histories of games started to be written. Catastrophes continue to be presented, ex. Mount Vesuvius by Spooner, William: Spooner's protean views 1830-1850. Manfred Zöllinger wrote a bibliographie of games books from the 15th to the 18th century.

Although to other epochs there are dedicated items in the Getty collection. As regions: Africa, America, American Indian heritage, Mexico, the Andes, Asia (particularly Japan, China, India), Europe (Brittain, Germany, Hungary, Italy, Switzerland, Netherlands). As periods: antiquity, Renaissance, 15th century games carpets, 15th-16th century playcards, 16th century Venice, 19th century Brittain, 19th and 20th century nautical toys, ceramics/porcelan toys 17th to 19th century, wooden toys since the 18th century. Special books are dedicated to ethnic images.

We built a special category on books in the Getty collection dedicated to the history of games: playcards, hazard games, society games (as wish „geometries“), board games, children's toys (particularly construction boxes),

we made a selection of seminal literature on the subject. Oosterhuis and Feirress (2006) edited a book on the role of games in architecture planning, called „laboratory). Venhuizen (2010) and Luckhard (1998) did the same for urbanism (in the later case for a specific toy developer). Borries et al (2007) connects the two. Hamburger (1979) and several other authors see games as being models for social phenomena (virtual societies). This is where Second Life can intervene in historic research, permitting the imersion we mention in this paper. Other authors see the connection between games and art as „from diversion to subversion“ (Getsy, 2011). Whitton and Moseley (2012) wrote about employment of games in teaching, what we also observed in the example in Karlsruhe in our research. Hewitt (1979) wrote on educational toys (such as Froebel toys have been for many architects), a pendant for games. Children's play can be related to different architecture movements, for example to Art Nouveau (historically – Hansen, 1987 - or in the application exemplified here as

quizz) or in Avantgarde (ESF conference, CCA exhibition). The optical component is not to be neglected – from dram (today drama theory) at Shakespeare (Ackermann, 2011) till the digital applications of today (Pixar). Eberlein (2011) writes on the economic research side of games – the „luck“ as influence factor for decisions.

- toys, including again (contemporary) anamorphic pictures, optical boxes, panoramas and stereoscopes, showing thus a link to the stereo display in 3D computer application we propose to the game approach of pre-1755 earthquake Lisbon we investigated. The oldest optical toys contained are those by Kinora (1910).
- For optical toys (or „playfull images“/“game poems based on a painting“) we built again a special category: Hidden images are games of perception, anamorphic art, illusion and we encounter them from Renaissance to present. Hard copy installations were developed such as game boxes. We developed a similar multimedia installation in our research to display photographs through projection, reflection and shadow (see CCA/ABC submission).
- The Getty collection contains a number of items of personalities of game and toy creators: Alex Hanimann (1955-), Max Geisberg (1875-1943), Arnold Schoenberg (1874-1951), Gilles-Marie Oppenord (1672-1742), Robert Schwartz, Antonio Possenti (1933-), Andy Warhol (1928-1987), Antonio Vitali, Bella Feldman (1930-), George W. Brown (1830-1889), Jules Engel (1909-2003), Julia Kissinia (1966-), Karl Schneider (1892-1945), Liliana Porter (1941-), Ian Hamilton Finlay, Stephen Cone, Barbara Schu
- the Getty is subscribed to a number of electronic journals referring to computer games,
- a number of items are dedicated to digital games and toys, in connection to art/artist authors or social media,
- the relationship from games and toys and art is not limited to digital ones, but is connected to any of them, the library containing also such items, in this context connected to spectacle (the game as a show, as approached by the Lisbon Second Life model)
- some items are dedicated to specific games: puzzles, solitaire, tarot and other playcards, toys in different materials (wood, metal etc),
- some are again dealing with children's toys but this is not subject of our research,
- the Getty has a number of auction catalogues on toys (including optical ones): Sotheby's, Christie's South Kensington, Bonhams, Phillips, Cornwall, etc.

We consulted bibliographies on memory. In what regards the architecture theory Hartoonian (1994) wrote a book on the philosophical, not computer science, approach to ontology in construction. Several other books consulted were dedicated to communication, the newer concept for participation, from the 1990s (Katz and Scully, 1993) to the 21st century, when Cyberspace is defining (Kollock, 2000, Loader, 1998), up to the fact that from the democratisation of planning in participation we can talk of digital democracy (Loader, 1999). A seminal book is Muuray's (2000) “Hamlet on the Holodeck – The future of narrative in cyberspace”, an approach to digital humanities. Also Perry (1998) approached the meaning of the hyperreality in this new space, the cyberspace. From the philosophy of space and time Casey (1998), Stachel (1977), Friedman (1983), Ray (1991) and Jammer (1970) provided a history of the philosophical concepts related in the first case to the binom place-space and in the next two, with even the same title, on space-time theories, then at the last again back to space, from philosophy to history of science, that of physics, the different physics theories being seen as a philosophy, and thus relating to the innovations of though at the time of the Lisbon earthquake as well. If these were about the concepts of space and time, which we aim to represent digitally in historic models, Levin (2000) and Melville (1995) wrote about the concepts behind the (history of) visualisation, another aim of our 3D models.

2.3 Discussion with specialists

These discussions took place, really and virtually about the potential of Google Earth and of Second Life as platforms for 3D.

2.4 Filling up forms of the action

An essential part of the research was reordering the information from the review of three existing models (GIS, Google Earth and Second Life) as well as of the proposed model in filling up survey forms, forms about semantic enrichment and about usability for decision making as provided by the Working Groups of the COST action TU0801. The detailed forms are presented in the annexes, while the analysis summary became the conclusions of this paper.

3. Datascapes

3.1 Introduction

There are no 3D city models of Bucharest, such models, as noticed in the action, being sparse in Eastern Europe. Even Google Earth does not offer oblique imagery and only a few buildings are modeled based on the enthusiasm of individuals. Within this project, the aim of which was multicriteria vulnerability assessment, the 2D GIS data used for analysis have been extruded to 3D. This built only a small part of the project, the aim of which was identifying procedures to correlated the data needed by different actors in vulnerability assessment, which was configured multicriterially, similar to decision processes (ex. the pairwise one based on Saaty and implemented in the software). New in the project was considering the socio-economic vulnerability component, while the economic vulnerability one has to be further developed. The GIS component permits a number of statistical operations and analysis as compared to traditional urban plans. Narrow study area was the historic centre of Bucharest, which has not been affected in the earthquake impact and post-earthquake reconstruction, featuring mainly low-rise masonry buildings. The really vulnerable and affected part is situated north of this, in the interwar development, and that's where extension of the methodology is aimed to be done next. The 3D extrusion (to be seen rather as 2.5 GIS) permits a better visualisation in the vulnerability analysis with effects in elaborating the intervention strategy by decision makers and local authorities, based on the relationship between built volumes among themselves and with free spaces. Such elements of disasters management shall be contained in the master plans. For further multicriteria analysis (ex. prioritising intervention based on the vulnerability analysis of populations of buildings for further economic studies) different levels of detail of the 3D models would be required, through a better connection between CAD and GIS, or the inclusion of the data on the openings and spans in the buildings in the enrichment, the table data on the buildings. The extrusion algorithms have been developed by the ASE partner and are applicable for any GIS depiction of an urban area, not just for the study area in this project. However, there is no web interface for making it publicly available. Similar conversions from 2D to 3D GIS can be done with cityengine (an ESRI product).

Google Earth is a software developed by Google providing a platform for creating 3D city models. Crowdsourcing is used to fill in the models with

data, i.e. with individual models of buildings created with two tools by Google, aimed at different levels of detail: BuildingMaker and SketchUp. The eye level view is seemlessly connected with the aerial view street photographs being included. While it is possible to recreate a historical city, using historical photography (the principle BuildingMaker works with is using photographs of the same building from different angles such as PhotoModeler and related applications, also in frame of the COST action, do), it is not possible to add a timeline to see this development. It has been discussed on LinkedIn which role does Google Earth play for virtual preservation of historical buildings. But an even more important need of improvement of the connection between maps and 3D rendering, in order to better identify the buildings (by address) and to add other enrichment (ex. on the history of the building), such as in the open source counterpart of wikimapia. Nevertheless it remains an example of volunteered geographic information which is useful for architecture/urban planning to reveal the context important for residents and visitors, also by the fact that the image of the city is defined by landmarks identified by the level of detail to which these were modeled (if at all). It is also useful as part of training for better visualisation of the city structure (urban morphology) from various angles to see the Minimal Urban Structure to remain operational during an earthquake in a strategic planning. This last one together with the usefulness as tool within the master planning make the application useful in disaster management, in both pre-earthquake preparatory phase and in post-earthquake reconstruction, including the emergency, mitigation and resilience planning.

3.1.1 GIS

The HERA project “Multihazard and vulnerability in the seismic context of. Bucharest Capital City” is the project with which Romania joined the TU0801 COST action, hence a detailed official description of the project is given here (from the website): “The project aimed to identify the states historically connected and expressed in the form of the urban phenomenon in order to ensure a fast analysis instrument and for the spatial visualization of the environmental vulnerabilities in the Bucharest Municipality, from the perspective of the seismic risk as a multihazard generator. From the dynamic point of view the urban form is a concretization in time and space of the urban phenomenon as a system: spatial forms, territorial organization and urban life forms (psycho-social, economic etc.). The shape of the city is the result of the specific state of every historical era. The present urban existences (urban states) are concretizations of some urban structures and

represent local manifestations of the urban situation. From the (structural-) functional point of view the city is based on an urban activity (for example habitation) connected to a certain way of using the territory (for example residential). The human purpose precedes the urban activity, evolving during the existence of the city towards an aggregate of urban forces. The urban forces – economic, social, political, and esthetic – lead to the determination of the space through decision/action. The human purpose is the initial impulse, but the activity dimensions the urban space. The final product was be not only a complete database at the level of the urban environment parameters, but also offered a variety of analysis procedures validated statistically and ecologically in order to identify the hazard and vulnerability situations in different scenarios of seismic risk, accessible for the local authorities in an attractive web interface that is easy to use and implement in the practice of the emergency situations management and the sustainable territorial planning. At the same time, in order to reduce the vulnerability and also increase the safety of the urban environment, the educational system must function in parallel with the physical system for implementing mitigation measures. In this context, in a so-called second phase of the strategic implementation of the reduction programs of risk, passing from the pilot or demonstrative projects to the routine ones becomes a priority in applying the measures. In order to support the strategy of reducing the seismic risk in Bucharest, the project aims to structure and diversify the information/warning message for the population through different types of contextually adapted messages, based on the identification of the psychosocial state and pattern indexes in the process of adaptation (coping) to the seismic risk, and also through the creation/testing of predictive and behavioral models, fact that will lead to the improvement of intervention in crisis situations, but also in the preparatory (pre-disaster) and resilience (post-disaster) stages." (summary from http://hera.ase.ro/) Objective was to build a software for multicriterial and multidimensional evaluation of the state of the urban system in vulnerability and risk studies (Reveiu et al, 2008, Armas, 2007, Armas, 2008, Armas and Avram, 2008). Novelty elements included the creation and implementation of an interdisciplinary multicriteria method, in the integrated evaluation of the vulnerability of the urban space through inferential analysis in the GIS system.

Contract in the Programme P4 – partnerships in priority areas, National Centre for Programme Management (CNMP), coordinator: University of Bucharest, Faculty of Geography, Centre for Risk Studies, Spatial and Dynamic Modeling of Territorial Systems, Principal investigator: Armas Iuliana. Partners: National Institute for Earth Physics, (The Bucharest Academy

of Economic Studies, Scoala Naţională de Stiinte Politice si Administrative, Universitatea Tehnică de Construcţii Bucureşti.

3.1.2 Google Earth

Frustrated by the lack of progress towards the reconstruction of the medieval city of l'Aquila after the earthquake of 6th April 2009, the company Barnaby Gunning architects started working with Google to construct a 3D model of the city in its post-earthquake state. Over 400 volunteers took almost 60000 photographs at eye level of the city, to enable texturing of the models, and other 200 were trained to use SketchUp. We joined the project as a volunteer one year ago, which was 2 years after the earthquake, modelling over 10 common buildings with BuildingMaker (Fig. 7). The project aims to complete the modelling of the city centre which would turn into a valuable resource for the recontruction. One year after the earthquake new neighbourhoods were constructed in localities around l'Aquila for providing housing for the destroyed houses in the city centre, lacking exactly the participative approch the crowd sourcing does in this project, called “Come facciamo?”. According to the project l'Aquila 3D developed from autoritratto, an earlier project which allowed citizens to upload their own photographs of the city illustrating how the city was before the earthquake and how it is now. L'Aquila Autoritratto was selected for the ADI Design Index 2010. We also visited the city in 2003 and 2010 respectively, and were able to compare the two views of places, as well as their look in the 3D reconstruction. In 2012 the reconstruction started with the planning of a park at Piazza d'Armi, but notable is also the installation developed by Michele de Lucchi doing a stylisation of the propping of the houses left empty. L'Aquila 3D (Come facciamo?) is a project created by Barnaby Gunning Architects. The project was made possible by the generous support of: Fondazione Cassa di Risparmio della Provincia dell'Aquila, Manfrotto School of Xcellence, Google SketchUp, Cassa di Risparmio della Provincia dell'Aquila, Comune dell'Aquila, Provincia dell'Aquila, A.N.F.E., Università degli Studi dell'Aquila, Dipartimento di Informatica dell'università degli Studi dell'Aquila.

http://barnabygunning.com/comefacciamo/

While l'Aquila 3D is a special case of Google Earth modeling of a city, Lisbon was a classical one. The model was also created in 2010, and allowed all those who know the city, inhabitants, tourists, former residents to create some models in the city.

Fig. 7. L'Aquila post 2009 earthquake in Google Earth: the same place before and after in eye-level view and in the 3D reconstruction, and building modeled by M. Bostenaru. Photos: M. Bostenaru, 2003 and 2010.

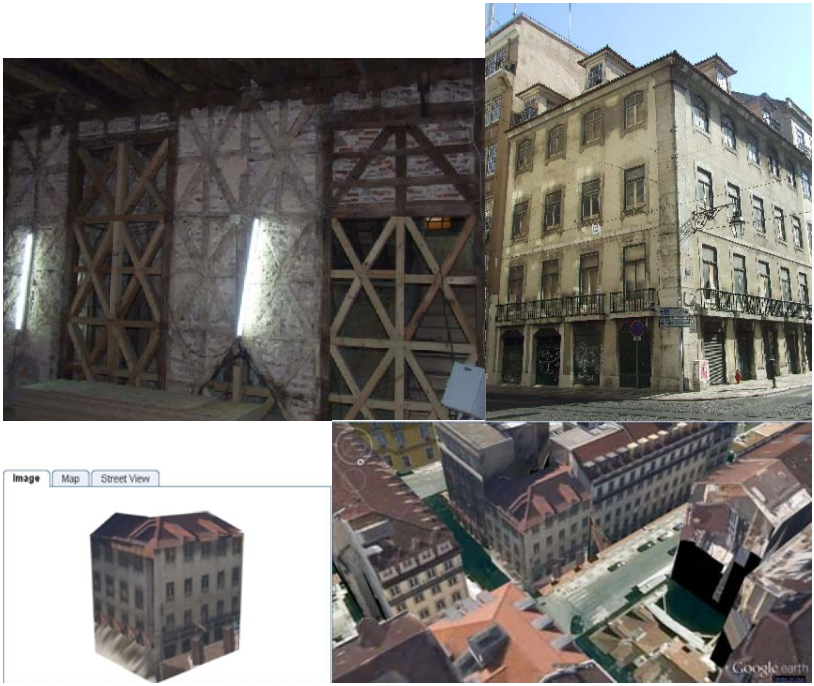

Fig. 8. Google Earth in Lisbon. Photos: M. Bostenaru, 2008, models in BuildingMaker, M. Bostenaru, 2012.

A similar approach to what Google Earth allows is done by a contemporary exhibition at the Canadian Centre for Architecture for Montreal. Recently a new COST action has been launched to investigate crowd sourcing issues. We also modelled some buildings for Lisbon, namely pombalino buildings from after the 1755 earthquake, which we know from eye level view and interior view.

We aim at different levels of detail, including street view and SketchUp model in the future (Fig. 8). Lisbon's model is also post-earthquake, but 250 years after, including near the Pombalino post-earthquake reconstruction development also developments of the 20th century, like the tracing of Avenidas Novas. However, in frame of the World Conference of Earthquake Engineering taking place in Lisbon in September 2012 a workshop on the topic “Lisbon in Motion” was held, and this aimed to define a strategy of making the city more resilient to future disasters. The minimal urban structure has to be defined, and for this it plays a role which elements of the

city are deemed as heritage habitat (a concept by Gociman) by the city's inhabitants. Also the Google Earth model of Lisbon is not yet complete, unlike other cities, for example Budapest.

SketchUp is a powerful tool also derived from the habit of people to play in 3D – it is the today's digital Froebel's toys which helped developing the imagination of architects. But when modeling with SketchUp the photorealistic texturing might get lost for CAD like lines. SketchUp is able to also model the interior of the buildings, as it have been shown by the typical Haitian house developed by Derek Xava in frame of an innitiative involving also the Confined Masonry Network. The reference to the Haiti earthquake reconstruction is important to compare with the two mentioned ones, as crowdsourcing of knowledge and even employment of Ushahidi took place.

3.2 Methodology

3.2.1 GIS

3.2.1.1 Step 1

First we list elements of the current situation:
• User types: Disaster management decision maker, Disaster management researcher, City managers. Target groups:
• the emergency inspectorate Bucharest
• units of public administration (municipality and sectorial administration)
• User needs: identify vulnerable buildings and prioritise them for intervention, identify strategic zones for intervention in an emergency situation (ex. location of emergency housing)
• Tasks to be performed: GIS query and 3D visualisation, navigation
• Identification of 0D-1D-2D-3D data used: GIS shapes map of the historical centre of Bucharest, extruded to 3D (2.5D)
• Specific process: extrusion
• Complementary data (non 3D): tables with data on the buildings (age, height, construction material, listed as monument or not, number of inhabitants etc.)
Then, we proceed with a list potential improvement:
• 3D data needed (enrichment – new objects): detailing of the extruded objects, ex. With roof shapes, texturing of the objects to see possible relation-

ships between openings (a factor in structural identification and vulnerability assessment)
• or information which has to be added to 3D objects (enrichment – new attributes …): recognition of the structural system through a matrix of characteristics from which the building material of the structure can be recognised (applied in SFB 461 database). Other improvements would regard drawing conclusions from populations of buildings on vulnerability using the structural mechanics based method of Pinho et al, for which it is also necessary to know the openings within the building.
We remarks that the Pinho et al simplified analysis of vulnerability of populations of buildings requires either this information to be contained in the table or different LOD (interior), as we have suggested for the SketchUp models in Google Earth, which, however, has no database analysis possibilities. Therefore the exchange formats are important, in this case the connection of CAD and GIS data. This analysis can be the basis for economic efficiency computations used in decision making.

3.2.1.2 Step 2

In step 2 we consider the impact of new equipments (devices) on result of step 1.
For acquiring the new data mentioned at step 1 the digitalisation of building surveys is needed, either through scanning of the paper survey and converting to CAD or through direct digital scanning (ex. laser, or laser point measurement of the spans).

3.2.1.1 Step 3

In this step we focus on the creation of information:
• Identification of 3D information created (through the processes): visualisation of the volumetric relationships in the studied area, with possibilities of identification of the vulnerability enhancement of the vicinity of different buildings and of identification of potential security nodes (concept by Gociman) for location of emergency services.
• Discussion about the way to “keep” this new 3D information (enrichment – new objects, attributes) into a global system: The approach should be extended to the city scale, gradually when 2D GIS maps are available, the next area being the one along the N-S boulevard (interwar buildings).

All this information must be presented as a list and after in the following diagram}

3.2.2 Google Earth

3.2.2.1. Step 1

First we list again the elements of the current situation:
• User types: Architect, Urban planner, Residents of the area, Tourist, Civil protection/emergency reconstruction professionals
• User needs:
• for architect and urban planner: basis for the master plan and respectively insertions in the zonal plan – a detailed view of the context with the image of the city
• for residents and tourists: image of the city as well, but more concentrated on landmarks. For the resident in order to define his/her heritage habitat, which aims to be maintained during future interventions (of reconstruction or strategic retrofit). These can be recognised by the fact that they were detailedly modelled in SketchUp instead of only randomly done in BuildingMaker – Google is here very good in differentiating the common tissue from the landmarks according to Camillo Sitte's definition. For the tourist, on the other hand, this landmarks, pointed to by inhabitants, serve as orientation in the city.
• For emergency reconstruction professionals: locating the strategic points of the city in a navigable aerial view
• Tasks to be performed: navigation, addition of models, with the own 3D creator or separately with SketchUp
• Identification of 0D-1D-2D-3D data used: 2D data: map, oblique images, street views
• Specific process: 3D is automatically created by Google based on the sketched done with the data above
• Complementary data (non 3D): this can be integrated in non-Google maps such as wikimapia. However, Google permits switching to the 2D view to see such.
The we list potential improvement:
• 3D data needed (enrichment – new objects): ex. modeling of street blocks. It would be useful to be able to extract a model from the city model and not only browsing the collection. It is to be investigated to which amount the

3D models can be used by other applications we develop in the proposed concept and vice-versa (import-export formats to .obj).
• or information which has to be added to 3D objects (enrichment – new attributes …): the above mentioned data on buildings which can be connected to maps but not to 3D. A timeline to see the state in different time periods. But more easily to achieve would be an improvement into defining more precisely the address of the modeled buildings (also through linking to the maps).
We have no influence on the developments done by Google, not even if the oblique imagery will be available for one city or another. However, SketchUp views are being done and added also for cities without oblique imagery, such as Bucharest, Romania.While the platform is easy to use, discussions occur in various public participation GIS groups about the appropriatedness to do such models, as uploaded information is property of Google, and does not remain owned by the community who created it.

3.2.2.2 Step 2

We step 2 we analyse the potential impact of new equipments (devices) on result of step 1. A model of Baixa Pombalina is available at recently opened Lisbon city centre. Following the model of other historical city models in the network, such a model could be laser scanned and the 3D model added. Also, we make here a reference to 3D games on traditional support (not digital) and the landmark of the tower of Belem is available. The tower of Belem is however already detailedly modeled in SketchUp.

3.2.2.3 Step 3

In step 3 we focus on the creation of information
• Identification of 3D information created (through the processes): new models of buildings have been added to the Google Earth 3D models, contributing to the completeness of the models.
• Discussion about the way to “keep” this new 3D information (enrichment – new objects, attributes) into a global system: in the future different levels of detail with street view textures and with SketchUp modeling will be created for the selected buildings (those identified relevant for analysing the impact of the earthquake: for which pre- and post-earthquake views are available in l'Aquila and respectively for which we know about the pomba-

lino structure (interior and exterior) – thus approaching different LOD, but not in CityGML.

3.3 Analysis

3.3.1 GIS

3.3.1.1 Semantic enrichment

The purpose of the application is to improve the GIS analysis and visualisation of the vulnerability to multihazard of the built substance in the historic centre of Bucharest. Users are disaster management decision makers, disaster management researchers, city managers (authorities and planners). 2D shapes from GIS have been extruded using the heights to 3D. Semantic enrichment aspects/features are given by the connection provided by GIS to data tables. The application/model is specific to the Bucharest historic core but the algorithms can be used for other locations where the GIS is available.

The analysis goes on with the functionalities of the application. The tasks each type of (human) user can perform are GIS queries and their visualisation (ex. buildings with a certain height, function and out of a certain material), marking of boundaries across groups of buildings with similar characteristics. The visualisation comprises maps. There is no type of interactivity such as navigation, interaction with displayed objects, manipulation /modification of displayed objects. Computations of answers to the query are automated processes that use the model (within the application).

We proceed to describe the 3D model. The (main) entity types, relationships, properties, attributes, that are included in the model are buildings and topological relations. ILWIS GIS data models are used in the application. There is no specific handling of uncertainty, time, multiple representations, data quality, precision, object identifiers.

There is no integration at the rendering/display level (e.g. show models in different windows, superimpose data from different models). Instead, there is implicit integration: the application directly uses several models/datasets without any explicit integration phase. There is no ontology or individual object matching nor a common ontology/federated schema creation.

The model was produced in 2010. Responsibles are For the project: Prof. Dr. Iuliana Armas, University of Bucharest, PI, For the software: Dr. Ma-

rian Dardala, ASE Bucharest. The model might be updated during a subsequent project. For more information see http://hera.ase.ro/ The application and the model are internal to the project and not distributed. It can be accessed through GIS software.

Spatial characteristics are modeled through quantitative representations. 2.5D geometries are being used. The model doesn't include objects with fuzzy boundaries or parts. All topological relationships from the map are considered and explicitely represented. The used frames of reference are absolute. Spatial relations are defined on the geometry/topology aspects instead of with respect to functional/semantic aspects (realistic not according to the meaning). There are no multiple representations of the same entities being used and no multiple levels of details. There are also no varying dynamic elements such as attribute values, since it is a representation of the current situation and not serving a simulation. The model is being stored and exchanged through an inner format (GIS) and no exchange formats have been designed. The size of the model (amount of features or other countable items) is of about 1000 buildings. The (instance) models formally represented are not represented through 3D City Models but as user application domain models which are prisms. The conceptual models (ontologies) aren't formally represented as 3D City Models either, but as user application domain models (data tables). The models are aligned with previously existing modeling frameworks (mapping standards). An instance model or a conceptual model is not translated from one formalism to another. During the integration process no sort of semantic enrichment of the models to integrate has been performed. Similar or identical concepts and data (being) identified are other methods to extrude GIS shapes to 3D visualisation (ex. through CityEngine). No new common ontology was created. The standards used do not fit so well into our concepts since the win for vulnerability assessment is rather small.

3.3.1.2 Usability, Usefulness and Use

The first evaluation of usability, usefulness and use concerns the context. The target groups in usability testing are Disaster management decision makers, Disaster management researchers and City managers. For usability testing the most relevant is the disaster management decision maker. In such testing the main task to be performed by users is to locate vulnerable buildings. The criteria of use are situation dependant: buildings with detailed structural data and buildings where only census information is available.

The measures performed are the definition of risk category and thus urgency to adopt retrofit measures.

We looked then at the usability testing in detail. Environments needed for testing are a desktop system, the building model (complete depiction of building volumes), navigation model, maybe visualisation and finally numerical data associated to each building (tables). The visualisation techniques used to display the information are Rapid Visual Screening (simple visualisation of geometric proportions) and priority setting for risk management intervention (complete GIS analysis). The guide for building value is based on the previous.

(Expected) benefits and value that the enrichment model has created compared to the model started with are motivated by a conversion of the Rapid Visual Screening from on-site analysis to on-line analysis. It is an extension of the 2D GIS analysis to 3D GIS analysis. As genuine benefit it allows a better view of the volumetric relationships in the area, ex. for identification of risk increasing factors (pounding) and of possible location of emergency housing. There is ability to offer a semantic enrichment with GIS database, an addition to simple CAD models which might offer the same. On a level of lessons learned regarding problems and issues we ask ourselves if it is possible to do other levels of detail of the models to explore geometric relationships at the level of the facade? (Difference between 3D GIS and 2 ½ GIS). The availability of GIS models for Bucharest is limited to the central area, so creating a model for the whole city would be very resource extensive. The tool become useful for something that wasn't planned (planned was the visualisation of the GIS analysis on a 3D instead of 2D model but it opens the possibility to integrate Rapid Visual Screening). The simulated area is not the one with most vulnerable buildings in Bucharest. A GIS model for that one is available, but without 3D extension, so future research was necessary as shown latter.

3.3.2 Google Earth

3.3.2.1 Semantic enrichment

The purpose of the model was in case of L'Aquila 3D virtually reconstructing the city after the earthquake, since this was not happening in reali-

ty; in case of Lisbon simply reconstructing it. Users are Architect, urban planner, residents of the area, tourists/visitors and for post-earthquake reconstruction (also valid in a post 1755 Lisbon earthquake strategy) civil protection/emergency reconstruction professionals. We consider the model/application to be a 3D one because it features 3D textured models. The semantic enrichment aspects/features are topological relationships. The application/model is applicable to any city where oblique imagery is available (not so many, ex. Bucharest is not), but in case of L'Aquila 3D it has a particular purpose because of the timing.

We proceed to describe the functionalities of the application. The tasks each type of (human) user can perform is navigation. Maps and 3D scenes are visualised. There is interactivity included. Apart of navigation, adding new models which are not already done or improvements (via Building Maker or Sketchup). Automated processes that use the model (within the application) are not known. The services offered by this application through an API or through Web services are navigation and addition through crowdsourcing over the web.

We proceed with the model details. The (main) entity types, relationships, properties, attributes, that are included in the model are buildings and topological relations. It is not know what type of modelling paradigms are used (e.g. object based representation, relational model, field-based models, cellular automata, agent based, logical (description logics, first order logic, fuzzy logic), discrete events, ...), neither the data models and ontologies (standards or ad hoc). There is a specific handling of uncertainty. If no textures from street view provided, those from neighbouring buildings are taken from the oblique imagery.

There is no integration only at the rendering/display level (e.g. show models in different windows) but textures can be added to SketchUp models. There is no implicit integration (the application doesn't use directly several models/datasets without any explicit integration phase). There is no ontology/schema matching/alignment. There is individual/object matching. There is a common ontology/federated schema creation: in addition to mappings, a common global ontology is created. The application accesses all the data through this shared vocabulary.

The date of the production is for L'Aquila 3D 2010. For Lisbon also 2010. The producer for L'Aquila 3D is Come facciamo? Barnaby Gunning. To contact: http://barnabygunning.com/comefacciamo/, http://sketchupdate.blogspot.pt/2010/05/explore-more-3d-models-in-lisbon.html. Updating procedures are through crowdsourcing addition. Accessibility of the application and the model (in terms of rights and distribu-

tion channel) is done through Google copyright. The city model can be accessed via Digitial Earth browsers like Google Earth.

Spatial characteristics are modeled through qualitative representations. Depending on the level of zoom more buildings appear to be modelled than actually are. This is a representation of inclusion in the model of objects with fuzzy boundaries or parts. Topology is explicitly represented, through street names. The reference frame used for this is based on Google maps. It is not known how do the semantics of spatial relations depend on the used frame of reference. Spatial relations are defined on the geometry/topology aspects. No multiple representations of the same entities are being used. There are no multiple levels of detail – the best model with the highest LOD is being chosen. The model does not contain dynamic elements? (e.g. varying attribute values, moving parts, functions). The model(s) are being stored and exchanged via Modelbase on SketchUp, different collections but also collections of users, and some times the source model can be also downloaded from Google Earth. The inner format is a specific file format (.kmz), which can be used also as exchange format, as we will see in the next paragraph. The size of the model is variable, aimed is the whole city scale. The (instance) models are formally represented as photorealistic rendering for Building Maker made models, CAD drawing type rendering for SketchUp type models. The conceptual models (ontologies) are formally represented writing on the basis map. Our added models correspond to those of the Google Earth framework. An instance model or a conceptual model from one formalism has not been translated to another (e.g. from relations database to XML, from flat files to RDF, from XML Schema to OWL, from relational database schema to RDFS). I used the inbuilt Building Maker. During the integration process we did not perform any sort of semantic enrichment of the models to integrate. Similar or identical concepts and data (being) were not identified. There were difficulties in connecting entities of the different ontologies. The address of the building is difficult to identify in the denomination and navigation has to be used to correctly chose the building to model (Google offers to automatically choose location). No concepts of a reference/standard ontology have been extended. No standards were used to fit our concepts.

3.3.2.2 Usability, usefulness and use

We are first looking at the context again. The target groups in usability testing are the architect, urban planner, residents of the area, tourists and fi-

nally civil protection/emergency reconstruction professionals. The most relevant for usability testing are the residents of the area. An essential task to be performed by users is to locate buildings which define the heritage habitat. Possible criteria are situation dependant: residents and tourists. Possible measures are: Number of buildings identified, knowledge about the history of these buildings.

For usability testing we first define which environments needed for testing (hardware, software, data): Desktop system, building model (of as many as possible buildings in the city, modelled with Sketchup or BuildingModeller), navigation model, maybe visualisation and information about the buildings (ex. like in wikimapia – see next issue about integration with maps). The model uses Urban image analysis (architect and urban planner): visualisation of relationships in the city texture as visualisation techniques to display the information. Other techniques that could be used are residents' perception: photorealistic texturing of the models and to guide tourists: navigation advice.

The motivation for the model is to recreate the image of the city to define the so-called “heritage habitat” (Gociman) which defines a mind map of people on what to be maintained in post-emergency interventions. In L'Aquila we have a city reconstructed after it was affected by an earthquake; in Lisbon it is also a city reconstructed, but long ago, and a strategy for future intervention has to be defined, i.e. define strategic buildings (according to Minimal urban structure) which have to take into consideration the heritage habitat. Ability to integrate with Google Maps to have textual information on the locations describes the (expected) benefits and value that the enrichment model has created compared to the model we started with. Genuine benefit is to allow virtual identification of landmark buildings, ex. through what is detailedly modelled (SketchUp) compared to simple Building Maker models. Obtained through crowd sourcing this is relevant for the residents' perception and a valuable input for planning (architect, urban planner, emergency intervention professional).

Open problems and issues to be addressed in the future include if it is possible to combine models from before and after via a timeline.Google Map descriptions don't show up, so it is to investigate how these can be linked. Also, availability of oblique imagery to build Google Earth models is limited (for Bucharest it is not available). The tool become useful for something that wasn’t planned (disaster management). Possibility of intervention in Google software development is limited, and there are also data ownership issues for uploaded models. As an alternative we will see the

next considered developments. Also, there is a new COST action on investigation of crowd sourcing issues.

3.4 Combination

Outgoing from the GIS model we've done for the interwar boulevard in Bucharest (Fig. 9) in frame of our research in Germany in the SFB 461, we superposed the GIS information with Google Earth (Fig. 10-13) using the method of Datascapes.

Apart from the classical creation of Google Earth models with Building Maker we investigated the integration of 3D models into Google Earth. One early integration of a 3D model of the vulnerability against catastrophes of the central Magheru boulevard in Bucharest, Romania, has been made in frame of the Collaborative Research Centre 461 "Strong earthquakes" at the University of Karlsruhe, Germany (Zikas and Gehbauer, 2007). Working with the same database of the centre of Bucharest we created also 3D models using ESRI CityEngine, which can be imported into Google Earth. The more detailed models of buildings created by enthusiasts for Bucharest (since a whole model of Bucharest does not exist for our knowledge, as oblique photography does not exist either) can be superposed on this or not. But more interesting that the 3D model based on height are the 3D models based on different features of the buildings. As such, we created for example the 3D model based on function, for which only residential buildings are modeled, based on the number of inhabitants. Specially for this use another Google Earth application has been developed, called DataAppeal (http://www.dataappeal.com/). With help or not of GIS data as those by CityEngine, DataAppeal can create data landscapes. As such, both applications, and the initial one developed by CRC 461 using the GIS software employment in EQSIM are combinations of the use of GIS and in Google Earth which we reviewed in this research. Data landscapes or datascapes are a concept, as underlined by DataAppeal, outgoing from the MVRDV research. Several analyses have been based on that, such as Chapel (2010).

Fig. 9. GIS model of the Magheru boulevard in Bucharest. SFB 461 on the basis of data collected by M. Bostenaru and group. Used by permission.

Fig. 10., DataAppeal (see Amoroso, 2013 for the method)

Fig. 11. City engine superposed with Google Earth. Model developed using the SFB 461 data in Fig. 9.

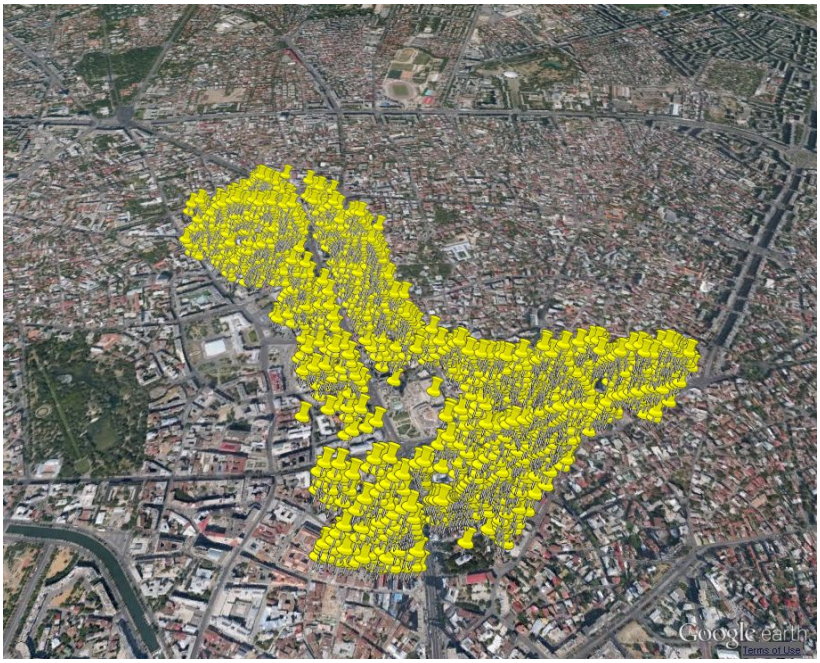

Fig. 12. DataAppeal (a way to transpose the models with pins), use of data in Fig. 9.

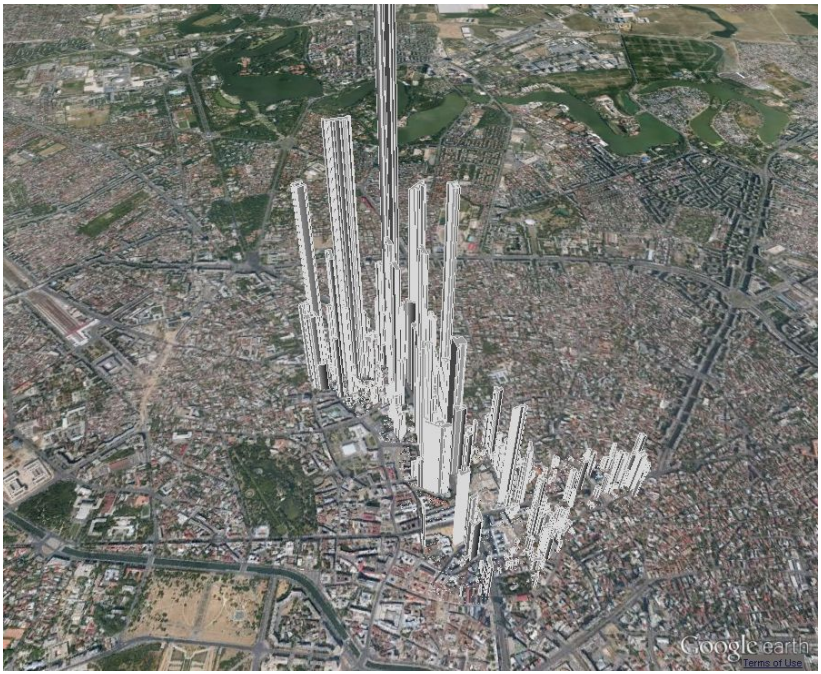

Fig. 13. 3D of residential occupancy data, data used from the SFB461 model.

A special datascape is the one developed by NORSAR in the software SELENA (Molina, Lang & Lindholm 2010). Here earthquake vulnerability can be mapped without help of GIS in Google Earth.

4. More forms of the action

4.1. Initial analysis

4.1.1 CAD

The main author is member of the research team of the project URBASRISK, which there are two partners: the home university, the "Ion Mincu" University of Architecture and Urbanism and URBAN-INCERC, the national institute for research in constructions. Principal investigator is

Cristina Olga Gociman. Funding is provided through the programme "Partnerships for applied research" of the Romanian national funding agency. The project started 2012, and the duration has just been extended to 4 years instead of 3. The aim of URBASRISK is to develop urban planning and architecture strategies to protect an area in Bucharest against the disastrous effects of multihazards. This area has been previously traumatized by the hazard of demolition: Ceausescu disposed to trace here the main boulevard and build on the hill the then so-called "House of People".

The site is in the vicinity of the Dambovita river, and apart of earthquakes, which regularly hit Bucharest, also hazards such as extensive snowing or other precipitations may hit. But the pre-existence of the demolition hazard in this area made inhabitants reluctant to measures taken, for which reason a higher acceptance shall be aimed for. A 3D city model form of visualization maybe an effective mean. We identify three levels: affected people, passive publicity and the experts. CAD models serve in the first place for communication between the experts. For the participative involvement of people we propose integration of projections on the printed model from CAD. In student workshops connected to the project, on the topic of risk management, we did the CAD modelling in archiCAD of the area (Fig. 14), highlighting also the provision for emergency housing. At a later stage students gathered information in questionnaires about different characteristics of the buildings analysed (the semantic part), like in the GIS HERA project, also dedicated to disaster management. This is waiting to be connected to the geometric information. Later on, further studies and training provided at the home university allowed us to look into the geo-module of the CAD software Nemetschek, which provides for a completely different approach. We aim to use Nemetschek to model other historic sites, based on archive records, since entering information from 2D maps can lead to 3D models using the semantic extrusion (different shapes of roofs or characteristics of floors).

We compared the CAD method to GIS in a paper of us presented at the Alexander von Humbold conference in Machu Pichu in 2012 and subsequently have written a paper in Advances in Geosciences. The analysis of the Nemetschek approach and the extended comparison presented here are however newly written. Especially the comparison between CAD and GIS from the point of view of modelling the connection of semantic information to node-line-surface/volume has been developed while in Germany in frame of the project in the Research Training Network "Natural Disasters" at the University of Karlsruhe (TH) by the first author alone. This can build the basis for further software developments to bring the exchange formats to a

dialogue. Also at the University of Karlsruhe we supervised the diploma work of Gregor Bourlotos on digital modelling of the structure in a building, in which geoinformatics and laser scanning for this purpose have been extensively analysed.

4.1.2 Second Life

The Espozione Universale Roma is an example of architecture from the fascist Italy, combining the various styles present in the period. The Centre of Studies on Rationalist Architecture organised a debatte, with support of PiùBlog, a passion for networking on the web, on how EUR got represented in 3D. Two models were available: the own one, done by Fondazione CE.S.A.R. Onlus, which was done with support of Regione Lazio and in collaboration with EUR S.p.A. (http://www.cesar-eur.it/show_eventi.php?nid=100) In frame of the project "EUR Interrotta", and that of the Fondazione Valore Italia for Second Life (http://valore-italia.it/IT/magazine/index.php?m=07&y=09&entry=entry090702-133643). "EUR Interrotta" has done the 3D reconstruction of the original plan of E42 (the 1942 exhibition) on the basis of archive drawings and accompanied by the respective historical research.

Fig. 14. CAD model of the site (done by the graduate students Iuliana Costache, Vasile Milea, Atanasia Stoica, Alin Titiriga).

Aim was to give to the wide public how would have been the EUR if the works would have been finished, it is therefore a virtual construction based on the plan of the architects. Such an approach can be seen in frame of the debate on authenticity: what is authentic, the plan of the architect or the final constructed work with original construction materials from the time but subsequent transformation? If the first would to be chosen, then physical reconstruction would be allowed, but this is not the case. A similar known reconstruction using the plans is that of the not existing anymore pavillion at the Bruxelles EXPO 1958 of Le Corbusier and Yannis Xenakis. Such reconstructions in the virtual world are virtual preservations. The reconstruction in Second Life, however, although done for the public as well, aims at participation in the virtual world, through web 2.0 or superior. PiùBlog was present with headquarters in Second Life during the debate, and projects could be presented in this frame.

Also the Second Life model of pre1755 earthquake Lisbon (da Camara et al, 2009, Murteira, 1999, 2007 and 2008, http://lisbon-pre-1755-earthquake.org/) is an example of world which physically doesn't exist anymore like the ones above. Instead of works not being finished or of demolition, Lisbon before the birth of the modernity was destroyed by a natural disaster: earthquake and subsequent fire and tsunami. The project is being developed at the Centre for History of Art and Artistic Research (Centro de História da Arte e Investigação Artística) – CHAIA, of the University of Évora since 2008 and is a result of collaborative work with Beta Technologies and the King's Visualisation Lab, King's College London. Recreated was the Royal palace with its dependencies (garden, opera house, Patriarchal), but also the first civil building: the theatre (Patio das Arcos). Aim is to create a "research laboratory" of pre-earthquake Lisbon. The model is not yet online, only videos are available.

The juxtaposition of the two models is not arbitrary and is strongly connected with those we chose for Google Earth: the reconstruction of post2009 earthquake l'Aquila followed an urban morphology common for the interwar time and also for the EUR of Zeilenbau, thus models for heritage habitat can be looked at here, and correlated with medieval tissue as it is existent in l'Aquila and is present in Lisbon.

Stephen Krämer investigated in how far the immersion in Second Life corresponds to that done through the arts in novels. On a personal note unlike being conducted by the imagination of the writer, which corresponds to traditional media in the novel, in Second Life the users write the history themselves. It is not even a board game with chance cards, like in the adaptation of Ken Follett's architecture related medieval novels. However, this is

an item to be investigated, given the literature which exists about the time. On the other hand, besides of the social component, being a game Second Life uses the respective economic model, with own currency, thus a virtual development of the city from the historical stage reconstructed and alternative to the current development can be thought of.

4.1.3 Proposed concept

1755 the Lisbon earthquake (and tsunami) shocked the world. The impact was not only physical, but also on the schools of thought of the time. 250 years after the earthquake this was commemorated by a series of events, highlighting that ever since that impact on the physical world but also on the development of sciences, including the humanities, was not achieved.

While the “City and spectacle” project on the pre-1755 earthquake Lisbon lead by CHAIA (University of Evora) and partners recreated photorealistically a representative part of the city, the palace, in line with the ESF network PALATIUM, the 3D city model is still waited for. Since this involves immense resources and funding is not provided, we propose to simplifiedly recreate the landmarks of the city, which are drawn on the background of common buildings as defined by Camillo Sitte. For this reason we examined the pre 1755 earthquake depiction in the Azulejos museum, where such 2D perspectives are available for 72 buildings. Doing this research we saw that they are not all suffering of earthquake impact, so a wider urban history research is required. As model for the concept serves a digital conversion of the “spaces of encounter” from defining spaces by texture and black surfaces to developments from the shape of a box, at the University of Arts and Design in Karlsruhe, Germany. The 3D implementation was done in Adobe Director, which has at the basis the development of films with respective score. This allows instead of different windows to have different parts of the “movie”, namely in one part of the navigation the visualisation of the 3D models, in another part the guided tour on the historical map, in a third the timeline and in a fourth the lessons learned part through a game to identify the historic places on today's Lisbon map. For identification of the site different views were considered: eye level view, silhouette view and aerial view, and the meaning of all these for urban analysis will be explained. The extent to which this can be performed using the Google Earth 3D model of the city is taken in account, as well as the landmark buildings identified by crowd sourcing in that environment, through the detailed depiction in SketchUp instead of BuildingMaker. Apart of the repre-

sentations in azulejos also the historical engravings of the Kozak collection where used. Stereo pairs will be formed when connecting the “now and then” images as well as the 3D model and photographic/engraving image. Comparisons will be done also between the eye level view and the urban landscape one. For the stereo pairs another marker in the movie is set, and a framework has been developed, but it has to filled with data.

Lessons have been learned from the strategy for the future development of Lisbon (“Lisbon in motion” WCEE workshop https://sites.google.com/site/limo15wcee/home). In such a strategy the key points of the urban structure for reaction to preparedness, emergency, mitigation and resilience planning have to be identified. The historical lessons may tell us which parts of the city are more vulnerable through their urban position (not only through the vulnerability of the buildings through its structure, geometry and function), in relation to the city grid. Identification of such elements of the urban morphology (in connection with the structural morphology at building level) is subject of further research.

A literature on the meaning of space and time for architecture and urban planning has been set up, with a special view to the meaning of memory, and a review will be performed during the subsequent stay. Literature on games was included, as these are important for the relationship with the Second Life modeling environment, also an object oriented real time rendering environment, a game.

The concept was developed, its implementation is foresee for the future. Particularly buildings from the reconstruction have been identified. Pombalino buildings in interior, and aerial view, and modeled for Google Earth. For these buildings another level of detail modeling is foreseen (including also the structural computational morphology). Cooperation with tour developers active in the field of natural risks for cultural tourism is foreseen.

4.2 Methodology

4.2.1 CAD

4.2.1.1 Step 1

First, we list the elements of the current situation:

- User types: experts from different engineering fiels (architecture, specialists from installations, construction etc.), urban planners;

- User needs: need to display to beneficiary, need to communicate among them;
- Tasks to be performed: superpose data from the view of different disciplines;
- Identification of 0D-1D-2D-3D data used 2D-3D;
- Specific process: model the situation in CAD software;
- Complementary data (non 3D) results of analysis of the existing situation in form of questionnaires.

Then, we list potential improvement:

- 3D data needed (enrichment – new objects): exploded axonometry superposing different layers of the same situation of the model
- or information which has to be added to 3D objects (enrichment – new attributes …) enrichment with numerical data based on surface computation, enrichment with dynamic evaluation of topography relations (ex. shadows), enrichment with other evaluations from topology (connection between spaces)

Remarks: There is a basic difference between how BIM deals with the situation and how GIS does. This may lead also to their incompatibility. BIM is shaped for the complex 3D building, while GIS works rather with the 2,5D extrusion of a 2D situation (a map). We developed a scheme on how nodes and lines and surfaces can be defined in BIM. We analysed how far these match the Nemetschek Geomodule, which is intended for urban planning and 3D city models.

4.2.1.2 Step 2

In this step we focused on the potential impact of new equipments (devices) on result of step 1 and came to some own research findings.

We analysed the building survey system in CAD.

First, we looked at the role of the building survey system. For the task in this project, many actors are implied in planing measures for improving seismic resistance. These actors have to communicate using some basis frame structure, are interested in different “structures” in the building, while survey plans (or construction authorization plans) available only for few buildings, there are access problems, problems related to the short survey time. For our further research special structuring of the building is required for costs estimation as no statistical data for the units usually taken are available in Romania and the survey wasn’t usually structured for such goals.

Development goals are:

• Modeling of existing buildings, which includes stucturing of the building in spatial elements and data related to the spatial elements (the semantic enrichment) as well as identification of spatial elements on which this data can be linked depending on both the information need of actors in the design process and on architectural, constructive and economic aspects.

• The main goal is built by facilitation of the co-operation between actors implied in the design process, for which a goal oriented building survey is necessary.

Next we focused on photographic measurements and its results. Today's software tools allow rapid building survey. Digital photographs can lead to a 3D building model in vector form. There are low accessibility requirements, quick processing, and it can be done as one-man work. But there is also low precision. However, the software alone is no system. Structuring of the information is needed, and post processing offers more precision, after data obtained with other aids is also needed.

For this we propose tructuring of the building into shells contained one in the other (building shell, storey shell, other storey shells Fig. 15a). A second structuring is done in floor element, ceiling element, wall element (Fig. 15b). Back to building shell reference points have to be provided (the nodes, Fig. 15c) simultaneously defining building elements between these and finally defining spaces between these (volumes instead of the surfaces in GIS, Fig. 15d).

The measurement results build a spatial vectorial drawing of the building in which dimensions are aproximative. CAD use allows structuring of the information which has as result model building (another kind of building information modelling). Where rapid survey is not enough, laser measurement provides more exactity.

Next we focused on laser measurement and its results. Laser measurement took gradually the place of the traditional building survey, and Bourlotos (2001) focused on this. However, it needs long time (except 3D-scanning - a kind of photography), while allowing at the same time for high precision, in almost one-man work. It encounters some accessibility problems and is suitable for detail work. Software tools for using the data obtained in this way are in development. These are CAD compatible and there is a custom configuration possibility. Elements measured by the laser fit in the aproximative structure defined through photographic measuring and are detailed surveyed. Data from laser measurement are available as data tables, modifications are made with use of the database while vector elements are generated from the databases.

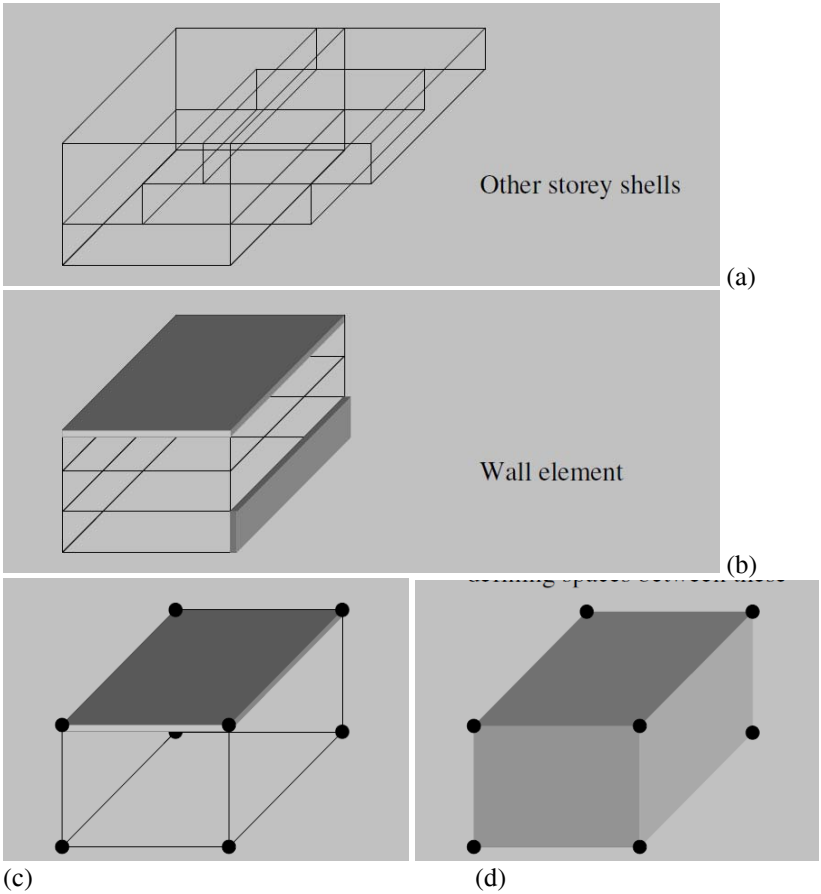

Fig. 15. Concept for CAD employment for semantic enrichment: structuring information in the 3D building survey (M. Bostenaru).

Finally we focused on the layers in the digital model of the building. The measurement layer provides lines. These can be grouped to provide the elements needed by different actors in the planning process. Such for retrofit measures in our definition of the decision tree (Fig. 16):

– structural aspects (the civil engineer actor) need the structure layer,
– functional aspects (the user actor) need the building spaces layer,
– aesthetic aspects (the architect actor) need the building elements layer,
– economic efficiency (the investor actor) needs the surface and volumes layer.

Procedures allow derivation of further layers from the measurement one. The measurement results are the basis for the costs estimation.

4.2.1.3 Step 3

In this step we focused on the creation of information:

- Identification of 3D information created (through the processes) The information aims to connect the different actors who use the model into the decision process (we will see this in the dedicated section). On the basis of the BIM system created each of them can enter information into the same framework. The point-line-surface system of the GIS is translated in our system into BIM. However, the software is not yet so far and there are no exchange formats. The information can be used for information exchange on the basis of visualization connected to semantics.
- Discussion about the way to "keep" this new 3D information (enrichment – new objects, attributes) into a global system – the data from the analysis sheets (questionnaire for the building survey applied to all buildings in the area) shall be entered into the system using our framework.

4.2.2 Second life

4.2.2.1 Step 1

First elements of the current situation were listed:

- User types: Architect, Virtual reality games player (blogger, etc.), Art history researcher, wide community
- User needs: immersion in a historical world, possibility of participation
- Tasks to be performed: navigate the site, interact with other users (eventually master user), develop own buildings (if permitted by the developer of the model).
- Identification of 0D-1D-2D-3D data used: archive drawings were used to create 3D models with Second Life's own editor
- Specific process: real time rendering while navigating the site
- Complementary data (non 3D): social compontent of the spectacle

Then we proceeded to list potential improvement:

• 3D data needed (enrichment – new objects): possibility of the users to develop new buildings is limited by the fact that it is a real historic site and not a fictional medieval city to be built by its users; archive data to complete might be missing but the process could be opened to the public if undergoing a review process

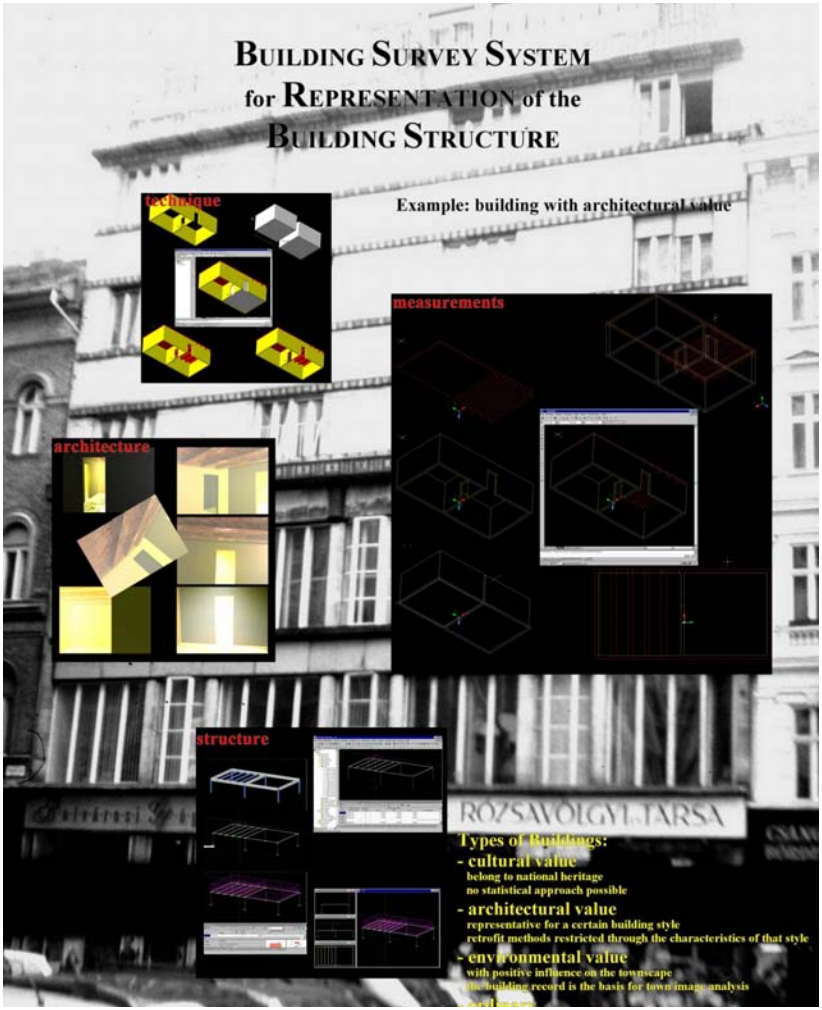

Fig. 16. Communication between actors in the decision tree on the basis of the semantic enrichment proposed.

• or information which has to be added to 3D objects (enrichment – new attributes): social components which could be added are festivities to take place at the locations. Being public spaces with such function this could be adequate.

A lead character could contribute to narratives by creating chance situations to which to react, from the history of the site (ex. why some parts did not get built, were changed, were demolished and how would the cyberworld users react to that today). It is a challenging task similar to that which the author of a novel has when inserting a fictional character into a historical weaving of facts – introducing some common buildings among the landmarks shaping the city.

Some remarks: The 21st century opens the possibility to participate in a digital environment, so-called digital democracy. This can be used through an immersive art history research.

4.2.2.2 Step 2

In this step we analysed the potential impact of new equipments (devices) on result of step 1. This is the possibility of interaction through voice (and other sounds), not only chat, in Second Life.

4.2.2.1 Step 3

In this final step we focused on the creation of information:

• Identification of 3D information created (through the processes): creating of urbanistically coherent public places of the city, including the buildings which define them.

• Discussion about the way to "keep" this new 3D information (enrichment – new objects, attributes) into a global system: as mentioned before the way Second Life is thought by its developers virtual cities can be modified by the users, and there must be a scenario of how this would be taken into account by historic sites. It would also give an opportunity to test the socio-economic model of the game and in how far historical information has been assimilated, the actual scope of the modelling.

4.2.3 Proposed concept

We analysed in a similar way our new concept.

4.2.3.1. Step 1

Elements of the current situation were:

- User types: architect, urban planer, tourist, researcher
- User needs: orientation, historical data, identification of important building, itinerary
- Tasks to be performed: draw an itinerary to be followed when doing a tour of the city, technical or touristic (also useful for tour developers), identify historical data connected to landmark buildings of the city, identify historical city tissue kept in places of new development and subsequently be able to make urban zonal development regulations,
- Identification of 0D-1D-2D-3D data used: 0D: textual information on the landmarks, connected to the 1D for the timeline, 2D for the guided tour on the map and the game, 3D for the symbolic representation of the landmark buildings and the different photographic views analysed to see the current development, as well as the historical engravings
- Specific process: movie specific development
- Complementary data (non 3D): historical texts

Potential improvement included (Fig. 17):

- 3D data needed (enrichment – new objects): enrichment: the 3D objects shall be connected into the map, the game, and the timeline, not only the photographic/engraving/2D historical depictions. Development of a concept for 3D depiction of the common buildings (ex. as building blocks). The main development aimed for is from the field of augmented reality: stereo pairs should be converted to superpositions of the now and then time by these means. Different LOD modeling.
- or information which has to be added to 3D objects (enrichment – new attributes …): Also, the information from the timeline should be visible in the 3D environment, for which reason the environment might need to be cut into the objects, not as a single sprite.

These two categories are not necessarily connected to 3D and information respectively, since they are rather regarding the navigation in the whole application.

4.2.3.2 Step 2

Impact of new equipments (devices) on result of step 1: New equipments may only regard the creation of the augmented reality part/stereo pairs – with respective glasses. For such a large area no laser scanning comes in

question, but different software apart of the 3D modeling one may be of help, ex. converting the historical images with PhotoModeler similarly to what BuildingMaker does.

The information is presented in Fig. 18.

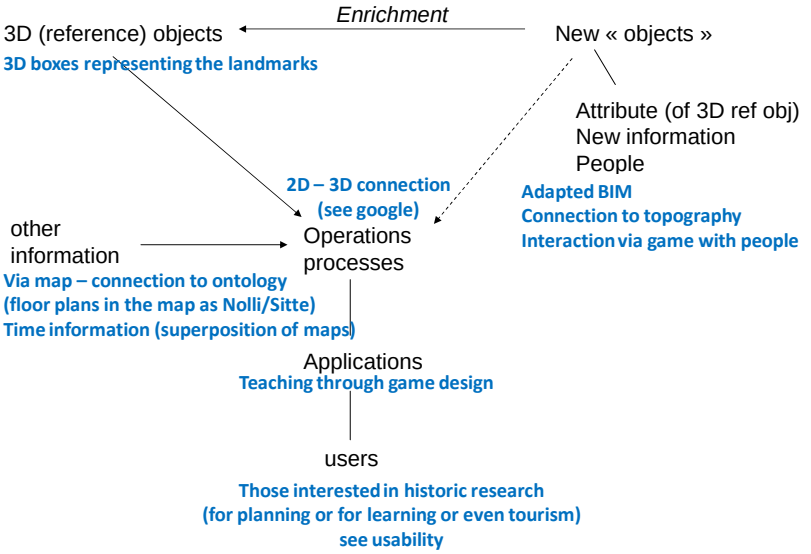

Fig. 17. Diagramm of the information on proposed concept presented in Step 1.

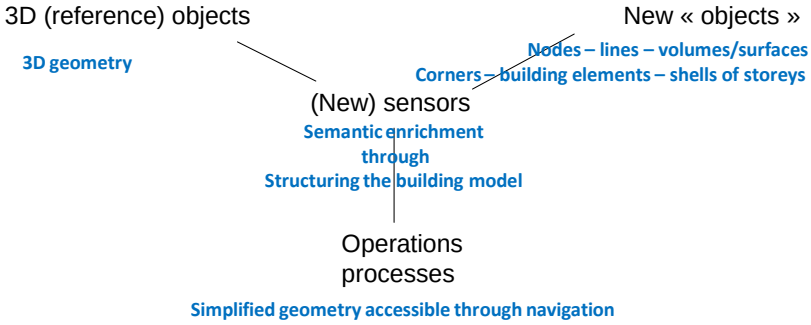

Fig. 18. The CAD model structuring adapted to the simple models used in our proposed concept.

4.2.3.3 Step 3

Creation of information led to:

- Identification of 3D information created (through the processes): The 3D information represents the metaphors of spaces through the volumes of the emblematic pre 1755 earthquake Lisbon. This has been put in the context of the former and current urban tissue, for historical research which may be of use for today's planning (and for emergency development strategies).
- Discussion about the way to "keep" this new 3D information (enrichment – new objects, attributes) into a global system: The information will be freely accessible through the web as Adobe Shockwave. A game concept by Alenka Poplin is proposing choice of locations through participation – we might develop such a game extension for identification of the vulnerable sites through cooperative action of the actors involved. Lessons can be learned for a Romanian funded project on a destructured zone in the centre of Bucharest, which has already been modeled as .obj and thus can be imported for an Adobe Director application.

All this information must be presented as a list and after in the diagram in Fig. 19.

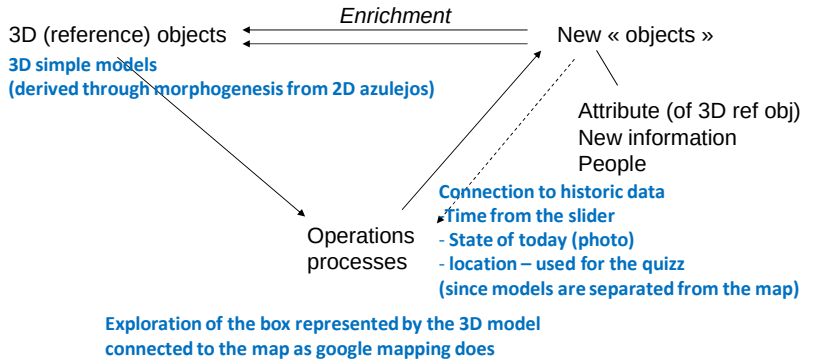

Fig. 19. The role of the CAD enrichment in frame of the proposed web application (game) of the proposed concept.

4.3 Analysis

4.3.1 CAD

4.3.1.1 Semantic enrichment

The model is done for design purposes in architecture/urban planning offices. It is used for visualisation in the design process, towards the customers, but also for communication with experts from other branches. We consider this model/application as a 3D one because it represents city quarters in 3 dimensions. As semantic enrichment aspects/features characteristics of the building can be entered in the Nemetschek model (surfaces, relation to other items through topography etc.). The application is completely general – however we analysed a site in the vicinity of the Parliament Palace in Bucharest in frame of a particular project.

Tasks each type of (human) user can perform are the following:

- One can travel through the model to see the aesthetics – the urban image.
- One can print the model 3D and perform the same as well as analyse the topography or even project different enriching data on this printed model.
- One can do different computations regarding distances between the items, total surfaces of different functionalities and similar.
- One can compute the illumination in different times of day and year.

Many other computations are possible. As kind of visualization maps can be seen when looking 2D, 3D scenes can be even exported to other applications (such as Shockwave) to real time explore them. The main type of interactivity is navigation. Displayed objects can be modified during the design process in the author software, not in the way they are visualised (3D PDF, Shockwave...). Services are offered through an API, but the .obj export allows visualization and navigation in the Shockwave plugin.

The (main) entity types, relationships, properties, attributes, that are included in the model are terrain, buildings, trees can be included, as well as topological relations. The modelling paradigm used is object based representation. Data are linked to either the full elements (ex. wall) or the empty elements described through this (ex. a room of a certain functionality) according to the Building Information Modelling. The specific handling of

uncertainty, time, multiple representations, data quality, precision, object identifiers is not known.

Integration at rendering level is possible. Implicit integration: the application directly uses several models/datasets without any explicit integration phase is to our knowledge also possible. Data are entered manually but the match of ontology/schema alignment is done automated. Same for individual/object matching. There is a common ontology/federated schema creation: in addition to mappings, a common global ontology is created. The application accesses all the data through this shared vocabulary.

We did a CAD Model of the Parliament Neighbourhood in Bucharest in a student exercise in 2011 and 2012. The Nemetschek model we did in 2013. The considerations on the structuring of the model were done 2001. The software developed by commercial companies was employed – for the model we worked with students. The project is still going on, and we hope to update with more information from the Master Plan of Bucharest GIS (provided communication between the projects is allowed). The model is offline. We exported to be able to see on the Web as Shockwave application. However, for the GIS like computations the author software is necessary.

Then we looked to how are spatial characteristics modeled. There are both qualitative or quantitative representations. For quantitative ones 3D geometries are being used. The model does not include objects with fuzzy boundaries or parts. (3D) topology is explicitly represented, and it includes also terrain, and exploded axonometries of different items. The used frames of reference are absolute, using coordinate values. The semantics of spatial relations depend on the used frame of reference but are not georeferenced. Spatial relations defined on the geometry/topology aspects. There are multiple representations of the same entities being used, but there are no multiple levels of details? (e.g. LOD1, some LOD2, LOD3 and LOD4). The model does contain dynamic elements? (e.g. varying attribute values, moving parts, functions). In order for the model(s) of being stored and exchanged various formats are provided, but these are not sufficient for the necessities of the project. There is an inner format (specific file format) as well as echange formats (both read and write support). The size of the model is of about 1000 buildings. The (instance) models are formally represented as geometric prisms, but Nemetschek allows also for roof shapes. These build partial 3D City Models. In what regards the formal representation of the conceptual models (ontologies) for 3D City Models the results of the computation are displayed on the canvas on which one can print 2D the 3D model. We aligned our model with previously existing

modeling frameworks or even standards but aimed for further development as described. During the integration process we performed some sort of semantic enrichment of the models to integrate. Connecting entities of the different ontologies is a manual process. We created a new common ontology (for the survey), for which we used none that is considered a base or reference ontology (e.g. ISO 191xx, EPSG, CityGML, GML, DOLCE, SUMO, CyC, ...). We developed instead a new concept. The main problems and shortcomings are communication with GIS, and we did not succeed. We did not use standards (e.g. OWL, IFC, CityGML, RDF(S), mapping standards, ...).

4.3.1.2 Usability, Usefulness and Use

We first looked at the context. Target groups in usability testing are the architect and other specialists in the construction process: urban planner, installation engineer etc. The one most relevant for usability testing is the architect. Tasks to be performed by users and possible criteria/measures are:

- The user can compute the utile surface of the assembly of buildings (sqm),
- The user can compute the lighting of the buildings to different times of the year (simulation),
- The user can see how the building is sitting on the terrain,
- The user can see how the building is connected to infrastructure,
- Last but not least the user can travel through the building to experience its space.

Then we looked at usability testing. A high end environment is needed to make complex 3D computations (extensive memory space). Data input can be done also as scans, but depending on the CAD software used the kind of export formats can or cannot agree with GIS. To visualize for CAD simulation in archiCAD we used the .obj export to be able to interact with Macromedia/Adobe Director and allow for realtime exploration of the space. The more suitable for CAD simulation of city models of Nemetschek (geo module) can best export to be explored to 3D PDF. Both are not communicating so well with ESRI GIS types of data.

Then we looked at benefits. The model started with (archiCAD) allows 3D printing and can be well used in combination with GIS on 3D applications (projection of GIS data on a model Fig. 6). The enriched model in Nemetschek allows for computations at the level of the city quarter. If we were to implement our information structuring (i.e. semantic enrichment)

model, this would allow for communication in the decision process from the survey of a city situation on.

In what regards lessons learned, open problems and issues to be addressed in the future, better communication between software formats is needed (.obj export also in Nemetschek), better communication with ESRI GIS as to allow to superpose the 3D CAD Models with Google Earth through georeferencing them. As they are, they are for real time exploration or for 3D print (Fig. 2). However, the computations derive from the BIM concept and can be extended with this, maybe following our suggestions. We also had problems in merging different CAD models when the scale used was different, even in the same software.

4.3.2 Second life

4.3.2.1 Semantic enrichment

The purpose of the application/model is to recreate a historic environment. Users are architect, virtual games player, art history researcher. We consider this model/application as a 3D one because it is a real time 3D game platform. Semantic enrichment aspects/features are socio-economic model of games. We considered the application for two locations relevant for our research. These are not even cities, but parts of cities, namely the Espozione Universale Roma, an interwar exhibition land in Rome and the Royal Palace and annexes in pre 1755 Lisbon earthquake.

Users can use the virtual economy of the game and create own avatars to navigate with in the historical virtual world, and to perform cultural events there. Visualisation is achieved through 3d scenes. As for interactivity, navigation is done through full immersion in the scene. As developer it is possible to modify the displayed objects, as player. The automated processes that use the model (within the application) are however not known. The services offered by this application are through an own web browser.

The (main) entity types, relationships, properties, attributes, that are included in the model are buildings and vegetation. As modeling paradigm object oriented programming in e „Linden Scripting Language“, accompanied by visual primitive object and their transforming functions (integrated 3D modeller) – the open source version OpenSimulator is used. Data models and ontologies (standards or ad hoc) used in the application are not

known. Also not known is the specific handling of uncertainty, time, multiple representations, data quality, precision, object identifiers. Integration doesn't take place only at the rendering/display level (e.g. show models in different windows, superimpose data from different models). Instead there is an implicit integration: the application directly uses several models/datasets without any explicit integration phase. There is no ontology/schema matching/alignment (manual/automated) but an individual/object matching (manual/automated). There is also no common ontology/federated schema creation: in addition to mappings, a common global ontology is created. The application accesses all the data through this shared vocabulary.

The date of the production is for EUR: http://www.cesar-eur.it/show_eventi.php?nid=100 and for pre 1755 earthquake Lisbon earthquake: ongoing, started 2008. The producer (responsible organization, developer) is for EUR: Fondazione Valore Italia and for pre 1755 earthquake Lisbon: CHAIA, University of Evora, the group around Paulo Rodrigues, Helena Murteira, Alexandra da Camara. Pre 1755 earthquake Lisbon is constantly updated and will not be publicly available before finished. Contact point for EUR in 3D – Second Life http://www.valore-italia.it/IT/ while for pre 1755 Lisbon earthquake http://lisbon-pre-1755-earthquake.org/. EUR is available on the platform, pre 1755 earthquake Lisbon: not yet publicly available, only for interested researchers. The model is accessible through the Second Life browser.

Spatial characteristics are qualitatively modeled. The model does not include fuzzy boundaries or parts. (3D) topology is explicitly represented. Frames of reference are relative, person centered. Semantics of spatial relations depend on the used frame of reference. Spatial relations are defined on the geometry/topology aspects. There are no multiple representations of the same entities being used. The model does not contain dynamic elements. Only the mentioned complexes have been modelled, rather small size. The (instance) models are formally represented not as 3D City Models but as user application domain models. The conceptual models (ontologies) are formally represented not as 3D City Models but as user application domain models: implicit socio-economic model of the application. It is not known if the models are aligned with previously existing modeling frameworks or even standards. It is not known if an an instance model or a conceptual model has been translated from one formalism to another (e.g. from relations database to XML, from flat files to RDF, from XML Schema to OWL, from relational database schema to RDFS). During the integration process no sort of semantic enrichment of the models to integrate (e.g.

transforming purely geometric data (KML, etc.) to IFC or CityGML data) was performed. Similar or identical concepts and data have been identified: Rome reborn. There were no difficulties in connecting entities of the different ontologies. Processes are automated. The concepts of a reference/standard ontology were not extended. No standards such as have been used OWL, IFC, CityGML, RDF(S), mapping standards.

4.3.2.2 Usability, Usefulness and Use

Evaluating usability, usefulness and use the first factor to looked at is the context. Target groups in usability testing are the architect, virtual reality games players, art history researchers. Most relevant for usability testing is the art history researcher. Tasks to be performed by users and possible criteria/measures are to Investigate the heritage of the past. Criteria are the ability to draw lessons for a historical study and measures: number of aspects which can be covered by studying the models compared to those covered by studying archive drawings and texts. For usability testing the following environments are needed: Desktop system, Building model (complete depiction of the state of the buildings at that point in time), Navigation model, Maybe visualisation and Social component for an immersive environment. The following visualization techniques are are used to display the information:

- to explore the past for the public: simple visualisation of the historic scenery,
- for value analysis: connection of visual and textual data through cooperative action in the environment (textual data from other users)
- to explore the past for researcher: Immersion through means of art, similar to reading novels.

Motivation to enrich the model compared to the model started with is the 3D recreation of the past using a cost-effective platform (Helena Murteira), inclusion of a social component to make the crowd participant and thus raise awareness towards architecture history and implicitely preservation. Genuine benefit is to create a research tool available for specialists on-line, without demanding rendering requirements as for example in the reconstruction of EUR with traditional means, and thus involvement of a larger research community. There is also the ability to include the socio-economic model of games and thus to simulate also the architecture sociology aspects of the time. A lesson learned is that it is possible to export/import models to/from other applications. Full modelling is time expensive and it is ques-

tionable if simplified models would not do it for real time rendering and navigation. Availability of models from the whole city area is limited to the Royal palace and dependencies as well as one civil building, thus a full immersion in the city is not possible => new research line to at least schematically extend the city, and for this to see if different levels of detail are possible. The tool become useful for something that wasn't planned (inclusion of the social component in art history research). A new research line is the integration with our proposed model.

4.3.3 Proposed concept

4.3.3.1 Semantic enrichment

First we dealt with some general information. The purpose of the application/model is to real time simplifiedly 3D model pre 1755 earthquake Lisbon to learn about the history, particularly the earthquake impact reflected in the city tissue. Users are architects, tourists and researchers. We consider this model/application as a 3D one because symbols of landmark buildings are 3D modelled. Semantic enrichment is rather related to the 2D part: the location of the buildings on the map accompanied by guide and timeline. The application/model is specific to a particular city to Lisbon, as the 2D symbolic depictions on the basis of which the 3D models are done are available on azulejos for this. It could be used for other cities where the impact of natural catastrophes is reflected in such depictions (not realistic ones). We are considering of using it for the zone of the Magheru boulevard and the buildings lost in earthquakes as well as the lost gardens through construction on their place.

Then we defined the functionalities of the application. The capabilities of the application/system include the following tasks by the human user: navigation, exploring the city through a guide, checking of lessons learned through a game. Visualisation includes maps, 3D symbols of buildings, timeline of the history related to the landmarks. Interactivity includes navigation, interaction of buildings localised on the map, display of different moments in the timeline. There are no automated processes that use the model (within the application). As services the application is available for Web use. It can be used for tourism services.

The following step looked at model details. The (main) entity types, relationships, properties, attributes, that are included in the model are buildings

and topological relations. The modelling paradigm of object based representation was used. For models and ontologies historic data are assigned to a model similar to openGL in the geometric 3D modelling. There is no specific handling of uncertainty, time, multiple representations, data quality, precision, object identifiers.

In the next step we looked at the integration/interconnection mechanisms. Integration was performed at the rendering/display level (e.g. show models in different windows, superimpose data from different models). One single window, which however contains different parts, including the 3D rendering, and timeline, map. It is aimed that the 3D model is displayed on the map, but this is an issue working on. However, there is also an implicit integration: the application directly uses several models/datasets without any explicit integration phase (see figure 20). There is no ontology/schema matching/alignment (manual/automated) (figure 21), but individual/object matching (manual/automated) (figure 21). There is not yet a common ontology/federated schema creation: in addition to mappings, a common global ontology is created. The application accesses all the data through this shared vocabulary (see figure 22). See Bucella et al (2009) for a reference on the system.

In the next step we provide some practical information to the model. Production is aimed through a subsequent research grant in 2015. “Ion Mincu” University of Architecture and Urbanism in cooperation with the grant host. Updating procedures depend on availability of funds. Contact point is the first author of the chapter. The application should be accessible on the web. The city model can be accessed through the web using the Shockwave plugin.

Another step provided some further information about the model. Spatial characteristics are modeled qualitatively. Fuzzy boundaries or parts are represented symbolically. (3D) topology is not explicitly represented. Semantics are connected visually to the map. Spatial relations are defined on the geometry/topology aspects. There are multiple representations of the same entities being used: 3D model, aerial photography, silhouette photography, eye level view. There are not yet multiple levels of details. The model contains dynamic elements.

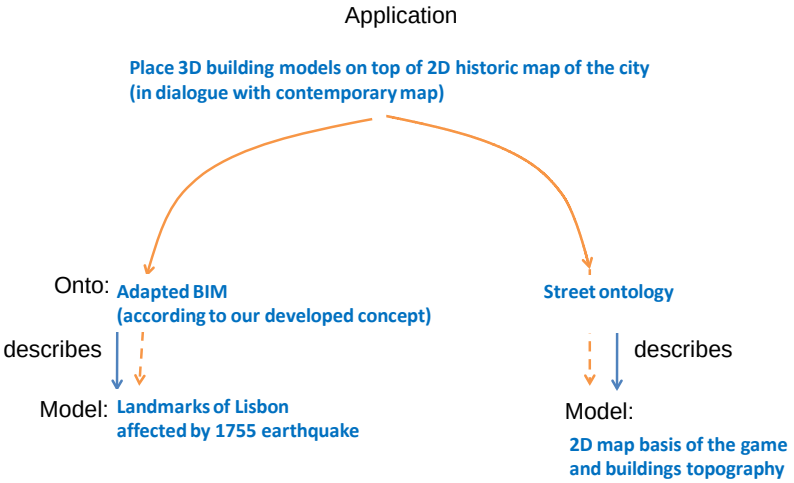

Fig. 20. Explicit and implicit integration.

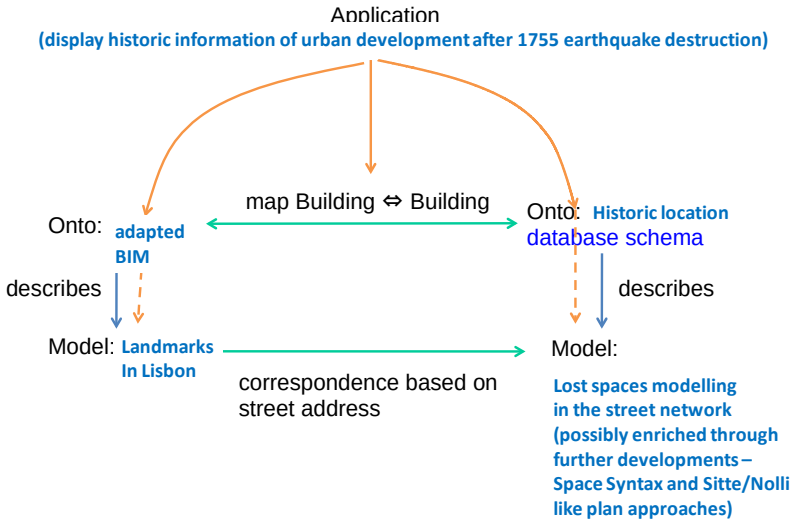

Fig. 21. Ontology mapping.

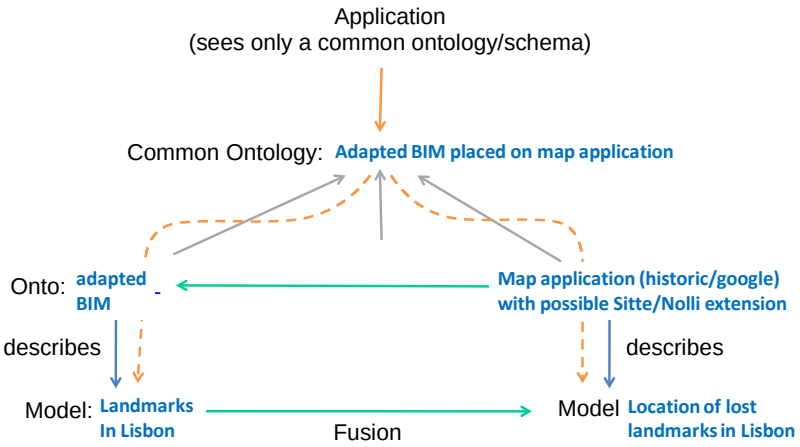

Fig. 22. Common ontology creation.

The model(s) are being stored and exchanged through .obj import in Adobe Director. The inner format is a specific file format (.dir). Exchange formats are .obj. Through this format it can be exchanged with CAD. Regarding the size of the model 72 buildings are being symbolically modeled. The (instance) models are formally represented as geometric shapes. The 3D City Models include only landmarks, not common buildings. There are user application domain models. The conceptual models (ontologies) are formally represented as inserted text when rolling over the item. There are no 3D City Models. The user application domain models are in the map/connected to the other representation of the model. We have aligned our models with previously existing modeling frameworks or even standards. We compared with pre 1755 Lisbon earthquake in Second Life and in Google Earth.

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our models with previously existing modeling frameworks or even standards. We compared with pre 1755 Lisbon earthquake in Second Life and in Google Earth.

With the previous it will be integrated in the future development. We translated an instance model or a conceptual model from one formalism to another (e.g. from relations database to XML, from flat files to RDF, from XML Schema to OWL, from relational database schema to RDFS), namely from 2D drawing on azulejos to 3D on computer. During the integration process we performed some sort of semantic enrichment of the models to integrate. Historical data are included through a timeline, but in the 2D part of the movie, not in the 3D. This is a forthcoming issue. Similar or identical concepts and data were identified. The adaptation to real time rendering is similar to Second Life, as well as the web navigation. Different is the lack of social component. However, in Second Life the window is dedicated to the rendering, while in Shockwave the window can be divided to 2D and 3D items. There are no difficulties in connecting entities of the different ontologies in 2D, but 3D needs to be explored. The processes are manual. We used no standards? e.g. OWL, IFC, CityGML, RDF(S), mapping standards.

4.3.3.2 Usability, usefulness and use

For usability, usefulness and use we first look at the context in this case again. The target groups in usability testing are the architect, the tourist and the researcher. Most relevant for usability testing is the researcher. Tasks to be performed by users and possible criteria/measures include “Find pre-1755 buildings on that location”. Criteria are situation dependant: people who know the history of building and people who don’t. Measures are the number of sites found, number of new locations learned.

For usability testing we define which environments needed for testing (hardware, software, data): Desktop system, Maps of Lisbon (depiction of sites) pre and post 1755 earthquake, Navigation model (guided tour, game), Maybe visualisation and 3D models of emblematic buildings. We use the following kind of visualisation techniques to display the information:

- for learning lessons: game to locate the historic sites
- to train researchers: history connected to the 3D models
- to guide tourists: navigation advice

The expected benefits of the model and the value that the enrichment model has created compared to the model you have started with are given by the motivation of a more rapid modelling than required by traditional

rendering. The genuine benefit consists in the fact that it allows learning lessons for different levels (tourist through guided tour, researcher through training through games). The model has the ability to offer analysis as a service and thus saves time.

As for lessons learned, open problems and issues to be addressed in the future we will look if it is possible to import Shockwave models in Second Life, if it possible to include models using a timeline into Google Earth. Navigational models on the map and 3D model in the real time environment don't integrate well. Hence new research activity is needed to join these up. The availability of 3D models is limited to landmarks, there must be found a possibility to model common buildings which form the city tissue (C. Sitte, ex. as parametric design). The tool become useful for something that wasn't planned (people learned about history of Lisbon and not only about the earthquake impact).

4.4 Conclusion on analysis of forms

The work we are doing with CAD is based on the modelling of an existing situation in a city, not on new planning as usually used for. For this reason we enter 2D information (from maps) or 3D information (from modelling through photographs or laser scanning). These 3D models can build however the basis for new modelling if intervention is needed for disaster management (replacement of buildings for example). Therefore an important part of our analysis has been dedicated to organizing the information for a so-called building survey at city scale. Since CAD is primarily thought for buildings, we entered a permanent dialogue between the building scale and the urban scale. The CAD model sees the information derived from BIM and hence is a real 3D, not 2,5D through extrusion – the topography reflects this, and also the possibility to do exploded axonometries. Shadow studies can be performed, and it is differentiated between superposed floors, not as layers of different characteristics, but as different storey shells as we tell. These can be (in the Nemetschek model) added from different buildings. The use of semantics connected to geometry is important for all actors concerned with the use of the model, being design/planning professions, and we tried to visualize this, with a highlight to our disaster management situation. A drawback of the use is the lack of sufficient suitable exchange formats. Our study on structuring the geometry for a better connection of information might improve this by drawing on similarities in connecting semantics to geometry in the BIM and the GIS model. 3D modelling and la-

ser scanning are the focus of a new COST action, with which we will try to cooperate.

Sites which doesn't exist so in reality, but which aren't fictive either, but based on historical data, have been built in Second Life by Fondazione Valore Italia for Esposizione Universale Roma 1942 and by CHAIA, University of Evora for the part around the Royal Palace in pre 1755 earthquake Lisbon. These are urbanistically coherent places including their installations (garden) and the buildings which define them. Therefore they are suitable for the public events aimed at in Second Life, following the motto "urban experiments – cultural events". The trade fair is the 20th century pendant for the palace, and doing this research on the palace the spectacle component connects to the ESF research network PALATIUM.

Second Life is a game with its socio-economic component. Highlighted in the research was the participation potential. However, it is not clear how much the developers of the models would permit to create own buildings in the game, and even more so how much this is desirable in creating a research environment of a historic site. For a present site the simulation of a future development would be desirable, as, for comparison, in the SimTorino application. But it would be a way of writing stories. In the concept we propose in a further report we blocked this possibility reducing the game to a learning interface about historic sites. Another item from games about historic architecture and which suppose an immersion is the presence of chance events from the history (as included in novels). Maybe this would be possible to implement through a lead character. To conclude, the narrative potential of the game is not used to full, it is more about the historical space simulation, the participation potential being more related to contemporary developments. Maybe it would be possible to organise historical events such as medieval fairs for Lisbon.

During the STSM of Maria BOSTENARU DAN ("Ion Mincu" University of Architecture and Urban Planning, Bucharest, Romania) at the CIEO, University of Algarve (supervision Thomas PANAGOPOULOS) a concept of a Web application to understand the impact of the 1755 earthquake on Lisbon has been developed. For the implementation of the concept another funds are being applied for, also in Portugal, at CHAIA, University of Evora, and for the analysis of the results at the University of Arts and Design, Karlsruhe, Germany, where the initial concept comes from. The concept is based on the successive stages in a movie, implemented through Adobe Director. The role of the movie metaphor, different of that of video, in digital humanities, is a topic of future research. The initial concept of converting 2D symbolic type-medieval depictions to 3D has been initially developed

for emblematic spaces at the University of Art and Design in Karlsruhe, where this research is aimed to conclude with focusing on the role of film in catastrophe research of the historic accident, from the Lisbon tsunami and Stalker to their meet in the Tohoku earthquake 2011. One of the stages is the 3D modeling of 72 landmark buildings of pre 1755 Lisbon earthquake. These are identified in both the historic city tissue and in the contemporary city tissue, to learn lessons on historical development and urban vulnerability. For this identification a guided tour and a game are employed, as well as without 2D or 3D data a timeline. Improvement between the connections of these parts of the movie are possible. We focused in creating less demanding 3D depictions, as well as on investigating the role of games in the representation of architecture and urban planning issues, as the current development of a similar model at CHAIA is based on the real time object oriented rendering, and open to participation through a Web platform (like ours but) in Second Life. Lessons can be learned also for the location in Bucharest. A future development might concern the stereo superposition of real and virtual depiction, in 3D model and in photography/engraving. Also the common tissue will be dealt of, to make the transition to another level of detail of the building scale of pombalino buildings. A literature list to all these topics has been set up and is being reviewed, an adnotated list being the result of future research.

5 Results

The models of Rome (Fig. 23a) and Lisbon in Second life (Fig. 23b) were investigated. For Rome the EUR, the Rationalist exhihition have been done by Valore Italia (http://valore-italia.it/IT/magazine/index.php?m=07&y=09&entry=entry090702-133643). The research centre CESAR (Centro di Studi di Architettura Razionalista) http://www.cesar-eur.it/ compared EUR (Rome) in Second Life versus traditional.

Helena Murteira and her group worked on Lisbon pre 1755 earthquake in Second Life. Currently the Royal Palace and its dependencies (opera house, Patriarcal – for all these historic images of the earthquake impact existing in the Kozak collection -, garden) are modeled, as well as one civil building: the first theatre.

In Google Earth we explored and contributed to the models of L'Aquila post 2009 earthquake and contemporary Lisbon (Fig. 24). We followed a discussion on the professional platform LinkedIn on the potential for preservation of Google Earth models

(http://www.linkedin.com/groupAnswers?viewQuestionAndAnswers=&discussionID=150927820&gid=111926&commentID=95146923&trk=view_disc&ut=1gi8-tRDtIOlo1).

(a)

(b)

Fig. 23. The EUR Square Collosseum (Palazzo della Civilta Italiana), Photo: Maria Bostenaru, 2012, modeled in Second Life, and Second Life model of the Royal Palace in Lisbon by Helena Murteira et al., used by permission.

Fig. 24. Lisbon in Google Earth: view to the former square of the Royal Palace, of the reconstructed part on Baixa (photos: M. Bostenaru, 2012) and of the whole city (compared with aerial view)

Unlike models of other cities, ex. Budapest, both are not complete. For Lisbon Praca do Comercio, Convent del Carmo and the Cathedral are modeled, but a large number of buildings in the new district of Baixa with pombalino houses are not. We try to identify the building we visited from inside with the scope to model with Building Maker. In L'Aquila 3D 10 models of us are accepted. We include in this work the research on a place, seen in 2003 and 2010 eye view and modeled in Google Earth (aerial view, Fig. 7).

Apart of the 3D model we investigated views of the cityscape of Lisbon, also important for 3D representation as we will see in the concept of own application we develop and present later on:

• Ruins of the moment – ruins created by the earthquake and destroyed immediately after (from the Kozak collection, Fig. 25) "now and then" images. "A photography study of before and after was done regarding the Bam earthquake by Randolph Langenbach (2005). For the San Francisco earthquake of 1906 this was performed by Klett (2006). And regarding armed conflict for the Indian Mutiny the sites in the photographs of Felice Beato were rephotographed by Masselos (2000). This leads us to discuss the value of today's photography as documentary, the new possibilities given by digital photography not just to rephotograph but also to photograph sites which

were formerly engravings, like Randolph Langenbach did in his Piranesi project (2008) with 18th century sites such as the ones in the 1755 Lisbon engravings, sites for which no rephotographing projects exist either, and might be an issue for this project." (Bostenaru, 2011)

• Aerial view (different angles, from different hills of Lisbon, similar to the exploration in Google Earth: Alfama, Baixa) versus eye level (Fig. 26, 28) Satellite image has been used to map disaster damaged in the aftermath of the 2001Gujarat (Saito et al,2004) and the 2003 Bam (Chiroiu, 2005) earthquake. Saito et al (2004) compared satellite imagery with that on the ground, an approach we also followed for the 3D reconstruction of the city of l'Aquila after the 2009 earthquake (Bostenaru, 2012b). However, if after l'Aquila the 3D reconstruction was done using Google earth and Building Maker in the Comme Facciamo initiative, to which we participated, after the 2010 Haiti earthquake images were provided by Pictometry © as stereo pairs. The stero pairs were oblique images as those used by Google earth to provide the possibility to reconstruct cities virtually as in l'Aquila.

Fig. 25. The Carmo Convent before the 1755 earthquake. Paper model after a concept of Carlos Loureiro. State today of church and quarter. Photos: M. Bostenaru, 2012-14. Engravings of the ruins of Lisbon in the immediate impact of the 1755 earthquake – from the Kozak collection see http://nisee.berkeley.edu/elibrary/browse/kozak?eq=5234.

Studies on how to identify a neighbourhood of the so-called Gingerbread houses, a typology with timber structure derived from the French colombage and which is a vernacular expression of the local seismic culture were done by Langenbach (2010).

• Views from the river – so-called silhouette views, cityscape views from large distance (Fig. 27, 28). At the Lucian Blaga University in Sibiu (Hanna Derer, personal communication 2008) there was a doctorate dealing with the role of the silhouette in urban analysis and representation (ex. in historical engravings, like the one before and after the earthquake in the Kozak collection). In the views of ruins from the Kozak collection we identified a maintained ruin (Carmo convent) and a replaced ruins (Paco da Ribeira and Terreiro de Paco/Royal Palace Square – Praca do Comercio; Sao Antonio church, destroyed, with only the main chapel left standing, fully rebuilt after

Fig. 26. Carmo Convent today in eye-level view and in aerial view, Photos: M. Bostenaru, 2004, 2010 and 2012

Fig. 27. Royal Palace square – today Praca do Commercio – a place maintained for the silhouette of the city. Photos: M. Bostenaru, 2012.

Fig. 28. Aerial view and eye level view of the medieval and respectively 1755 reconstruction quarters of the city. Photos: M. Bostenaru, 2004, 2008 and 2012

1767 to a Baroque-Rococo design by architect Mateus Vicente de Oliveira.), but also several ones rebuilt partially or with subsequent changes (Sao

Paulo church in a reconstructed, in the zone of elevador da Bica, which maintains pre-pombaline buildings as well, the cathedral - Carlos Mardel's design for the Cathedral/Santa Maria reconstruction of the church), or some which disappeared in the following city tissue after the 1755 earthquake.For the Ribeira palace images before the earthquake, as a ruin, but also repaired after the earthquake exist. Even if the palace was replaced, the idea of the square has been kept in the subsequent development, the urban space/morphology remaining the same.

For the urban development of Lisbon we consulted as mentioned the EAHN papers (2010) and dealt with two stages (Fig. 29):

• the 1755 reconstruction by Marques de Pombal, with main intervention in lower Lisbon, Baixa district, and identified key places through the Lisbon technical tour at the conference and Lisbon history exhibition

• and the Avenidas Novas in the 20th Century, in the north of the city, also a flat area, rich in interwar architecture typologies.

Fig. 29. Urban development of the city and the example of a building by Cassiano Branco. Photo: M. Bostenaru, 2005, map from Bostenaru (2012d)

The hilly areas maintain the medieval substance, as they were not affected by the tsunami. We will see which landmarks of pre-1755 earthquake Lisbon remained till today, which were destroyed by the earthquake, and which were demolished in frame of urban development. Therefore for this impact analysis the view of Camillo Sitte (2002) regarding the plan of Nolli, where landmarks are drawn on a pattern of common buildings tissue is important. http://nolli.uoregon.edu/ is a digital history project for the urban plan from the 18th century (1748) of Nolli, in which landmarks have interiors represented, while the rest of buildings are blocks serving the definition of urban public spaces. Exactly this is the situation for the 3D models: the landmarks are mainly modeled extensively with SketchUp, while a number of buildings from the common tissue, which can be modeled with BuildingMaker and the details seen through the texture resulting from satellite photography, are not. Here we contributed.

Following the two stages considered in the urban development of Lisbon we developed the concept of a digital database of the building typology (Fig. 30). This would contain:

- the pombalino buildings in frame of half timbered typologies across Europe: timber ressources versus local seismic culture (for which a survey has been written in Bostenaru, 2014) as well as modeling of “pombalino” buildings for Google Earth (identifying the ones visited in 2008 and 2012),
- the reinforced concrete buildings of the Avenidas Novas (development of the 20th century) in European frame (Bostenaru, 2012d),
- the connection between the local seismic culture of the timber in “pombalino” buildings and its effect, ex. in more regular plan and section in reinforced concrete, compared to what happens across Europe, ex. in Romania.

Lessons from the reconstruction with half timbered frame in “pombalino” time and its employment post earthquake (ex. in l'Aquila through an installation of M. de Lucchi https://www.youtube.com/watch?v=QQT_GUeJZHY) or post demolition for installations we propose (propping systems converted to half timbered green walls). For this purpose we did a survey on the presence of green walls in today's Lisbon (Fig. 31). In l'Aquila the reconstruction started with a park, so the role of the green in reconstruction is different now than in 1755 when Baixa was designed without green spaces, as seen in the aerial view. Possibilities of abstractisation of the approach are subject of further research (Fig. 32).

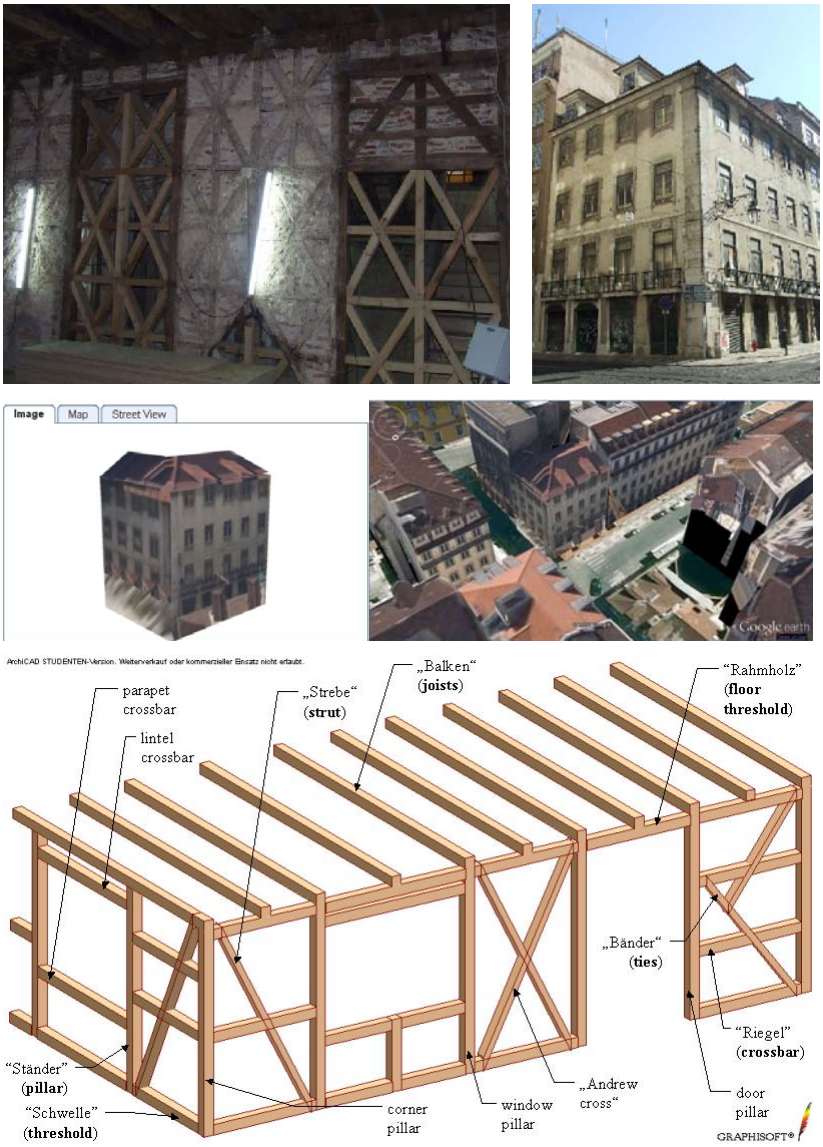


Fig. 30. A typical “pombalino” half timbered building modeled in Google Earth with BuildingMaker. For such buildings a different level of detail is necessary to see the structure (image below). Photos: M. Bostenaru, 2008, sketch from Bostenaru (2004)

For the semantic enrichment we developed a decision taxonomy for retrofit interventions on existing buildings (Fig. 33).

An important contribution is the potential of own developed real time application, to be developed in frame of further research. For this Adobe (formerly Macromedia) Shockwave will be employed, which makes use of object based programming (called Lingo). It is possible to model 3D objects through code (similar to openGL) or to model them in a 3D software and import as .obj files.

Pre 1755 Lisbon is depicted in azulejos in a dedicated room in the dedicated museum in Lisbon. The depiction of the landmarks on azulejos is in 2D similar to medieval art, and the legend includes symbols for landmarks of pre-earthquake Lisbon derived from this (Fig. 34). We identified 72 landmarks depicted as such (Annex 1). For about one third of them we explored what remained from the buildings today (Table 1 in Annex 1).

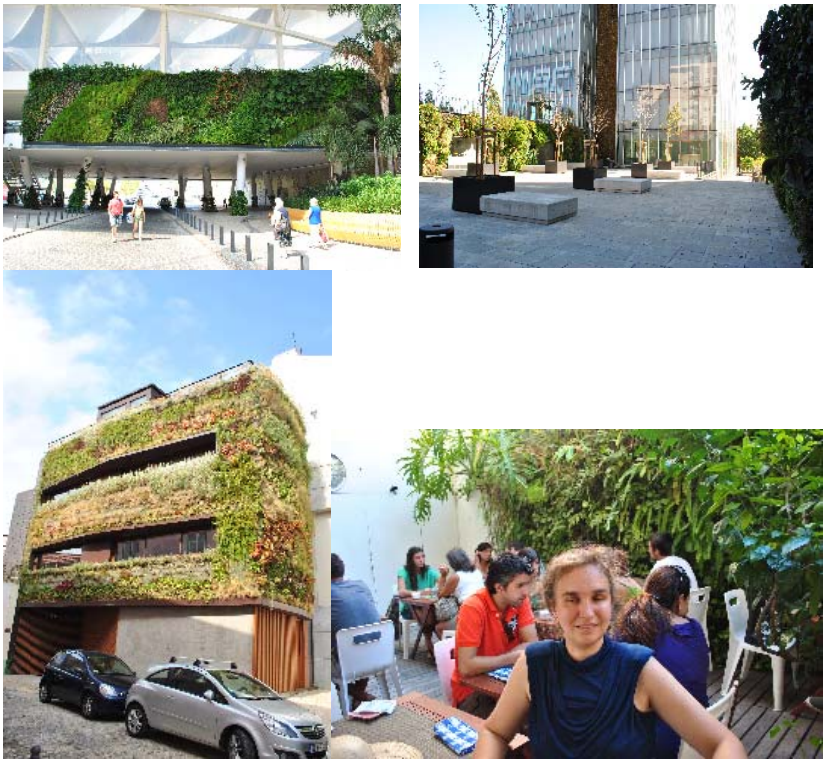


Fig. 31. Green walls in Lisbon. Photos M. Bostenaru (or of M. Bostenaru) 2012

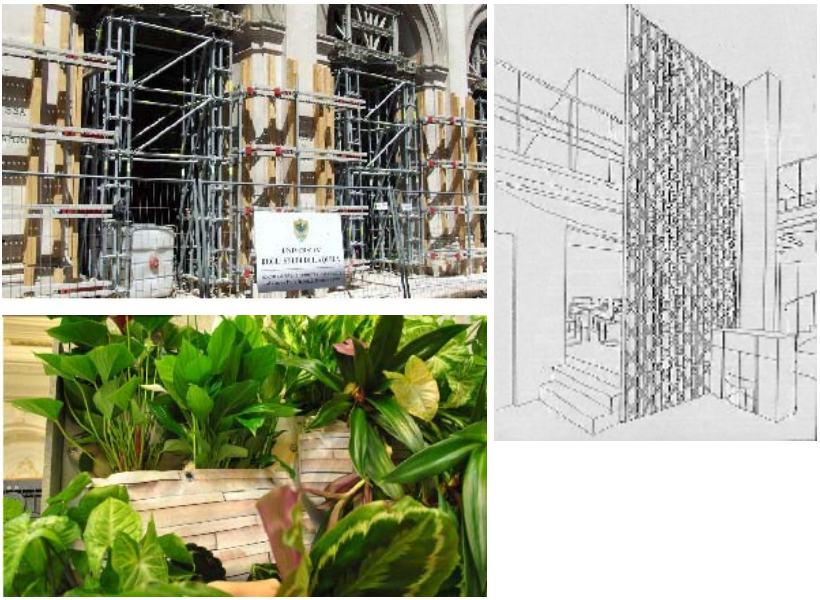


Fig. 32. The metaphor of green walls as proposed installation for the memory of an earthquake. Photo l'Aquila M. Bostenaru, 2010, Photo green wall M. Bostenaru, 2012, separation wall project Bostenaru, 1994

Destroyed in 1755 were 14, a minor part (mainly situated in Baixa, the lower part of the city, as consequence of the tsunami), as follows: Tide Mill, Church of Santa Catarina do Monte Sinai, Irish Dominican Church, Hospital and College, Palace of the Dukes of Braganza, Church of Mártires (and rebuilt), Carmo Monastery, Monastery of Sao Francisco da Cidade, Ribeira palace, Sao Joao Fort, Fountain of Apollo, Fernandine Wall and Slaughterhouse (the segment depicted on azulejos), Church and Monastery of Santo Elól, Customs and Wheat Deposits, Tobacco Customs. The Kozak collection depicts the St. Roque tower, the St. Paul church, the Cathedral (Santa Maria basilica), the Opera house, the St. Nicholaus church, the Royal palace square, Praca da Patriarchal, the Opera house, the Royal palace, St. Catherine church, Carmo monastery, St. Anthony church, street scenes, city houses (and reconstruction works and urban and perspective plans of this reconstruction) and silhouette views (with fire, tsunami but also refugee camps), but also the Trinidade Convent in Lagos, Algarve. The 1755 earthquake led to few transformations regarding landmarks.

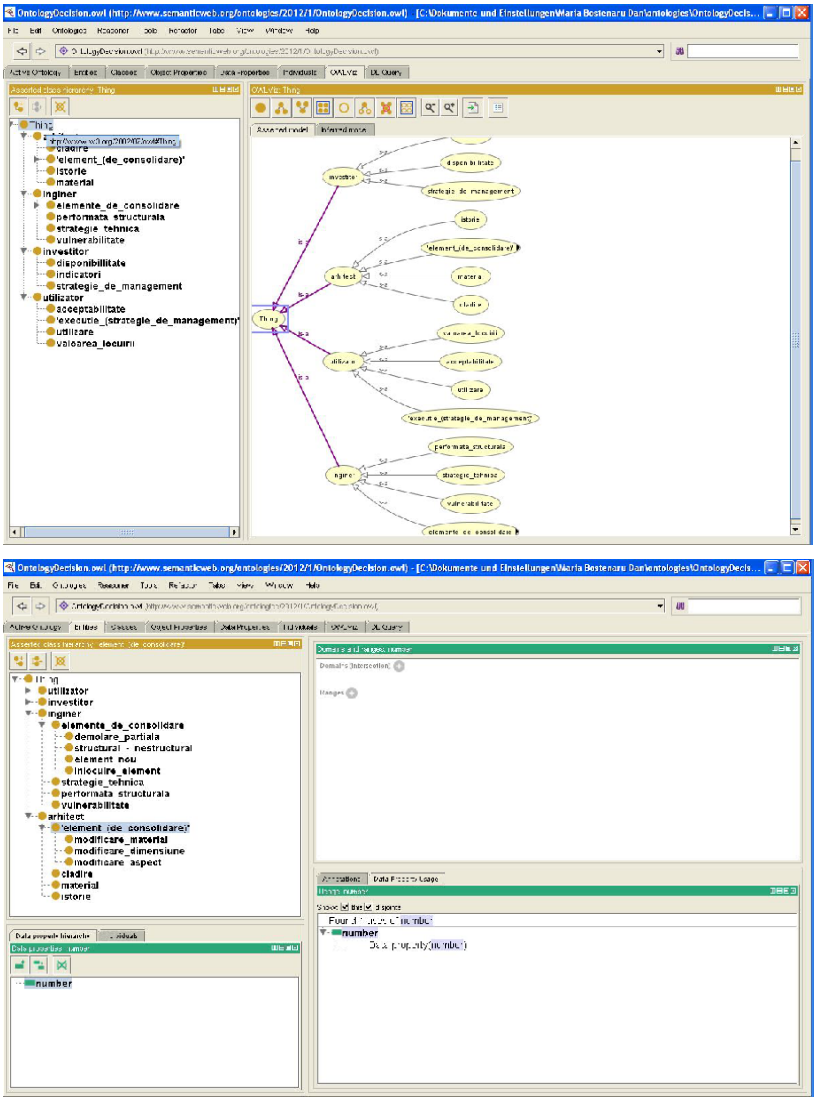


Fig. 33. Ontology for the decision on retrofit – including the point of view of the investor and thus the economic (costs) aspects – possible to incorporate in the model of the game (ex. Second Life) (from M. Bostenaru, 2012d). Such measurement spaces can be designed for the non-numerical values in GIS in the datascape, for transformation in numerical values.

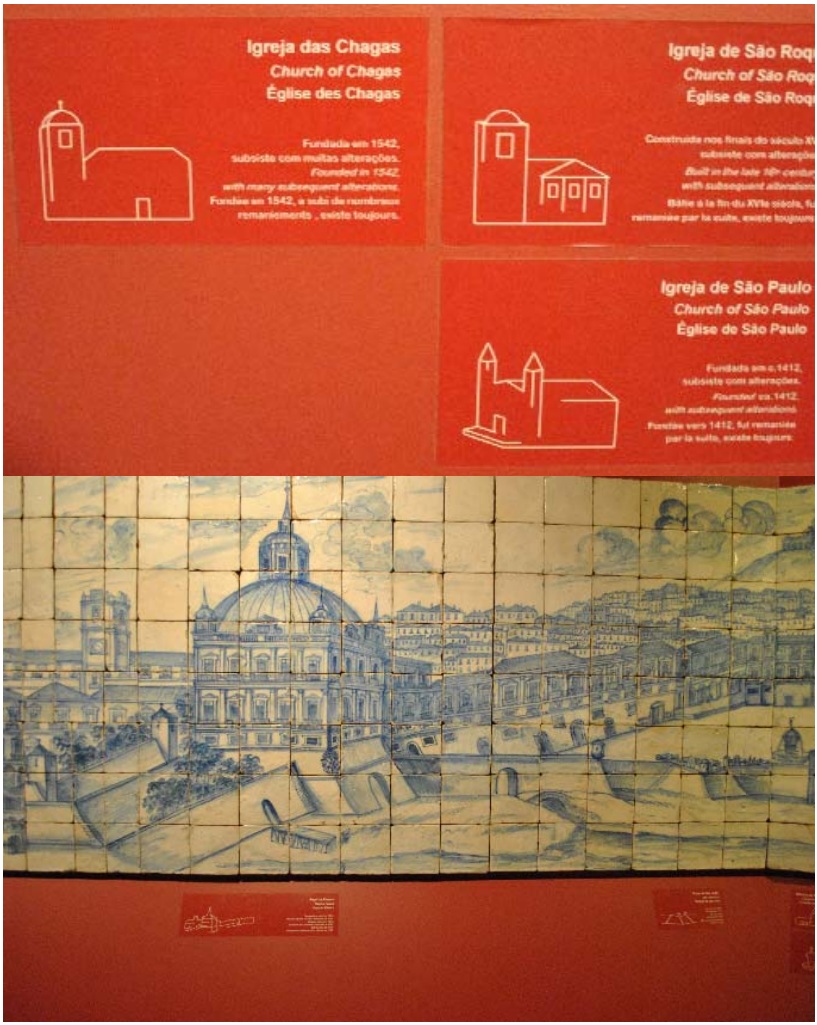


Fig. 34. The 2D symbolic representations of buildings in pre1755 earthquake Lisbon on azulejos – outgoing point for the proposed concept

Different from this, the technical tour in frame of the World Conference on Earthquake Engineering taking place in Lisbon in September 2012 aimed at identifying the impact of the 1755 earthquake will approach: the Carmo Archeological Museum and Convent, the Santa Justa lift, the D. Pedro IV

Rossio Square, the Figueira Square, the Sao Cristovao Square, the Sao Nicolau Chuch, the former convent of Corpus Christi, the Madalena Church, the Santo Antonio de Lisboa Church, Lisbon's Cathedral, Bicos House, Nossa Senhora de Conceicao Velha Church, Rua Augusta Arch, Terreiro de Paco Square and the Lisboa Story Centre.

We aim to convert from 2D symbols to 3D model as from hard copy to digital, in a future research in collaboration with Portuguese partners. This will be a modeling in Adobe (Macromedia) Shockwave 3D of the emblematic buildings of pre 1755 earthquake following the landmark description in the legend of the Azulejos walls in the museum. The models will be created in a 3D software (ex. archiCAD) and exported as .obj. A precedent on how to do this are the „Spaces" metaphors in our work on the „rediscovered space" at the University of Arts and Design in Karlsruhe. We include here the examples on from symbol to 3D in the „borderline space", the „stable space", the „gathering space", the „rediscovered space" (the later converted to a real, not digital, 3D model), and the overview of the application (Fig. 35).

The part in the city between the landmarks will be represented following the theory on agents of Patrick Schumacher (Schumacher,) – textures of pieces moving following the theory of cyclones.

Further, following our application presented in (Bostenaru, 2012b) Stereo juxtaposition (Fig. 36) of pair-wise view of the following categories is aimed for, as follows:

• Photography and 3D model

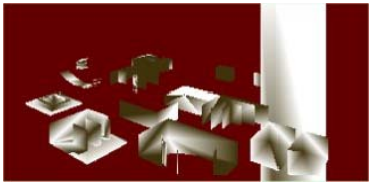
• eye level view – aerial/long distance (silhouette) view of the monuments

• Now and then view with timeline (Fig. 37). The two paralel fields can contain now and then images, and down there can be a timeline (to identify the temporal layers). A timeline code is already developed and there is also a timeline in the Lisbon pre-1755 earthquake project by the other group.

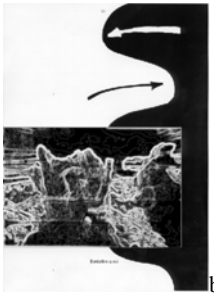
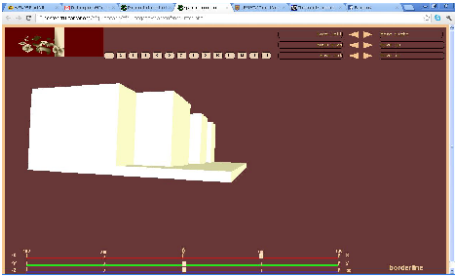
- engraving (then) / photograph (now)

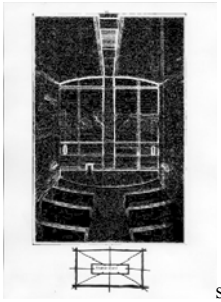
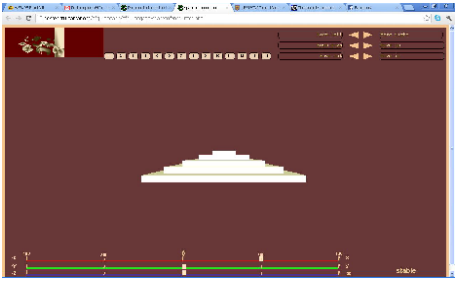
 3D models in Second Life (then) and Google Earth (now)

A further step is the creation of an interactive map/guided tour of Lisbon featuring the monuments affected by the earthquake, identified according to the Kozak collection (NISEE) and based on this map, creation of a game to identify on today's map of Lisbon of the places where the pre-1755 earthquake monuments were.



rediscovered



borderline



stable

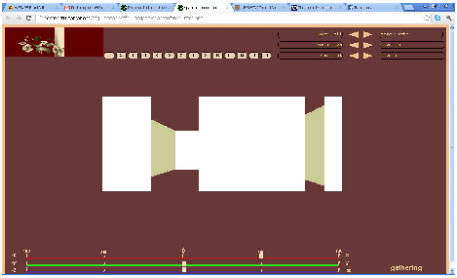


gathering

Fig. 35. From 2D to 3D – from hard copy to digital representation, the basis of our concept (Bostenaru, 2001)

timeline code

```
  on enterFrame

  on mConstrainedValue (me, s, v)
    set the visible of sprite 41 to FALSE
    set the visible of sprite 42 to FALSE
    set the visible of sprite 43 to FALSE
    set the visible of sprite 44 to FALSE
    set the visible of sprite 45 to FALSE
    set the visible of sprite 55 to FALSE
    set the visible of sprite 56 to FALSE
    set the visible of sprite 57 to FALSE
    set the visible of sprite 11 to TRUE
    set the visible of sprite 10 to TRUE

    if v=0 then
      set the text of member "text"="Jahreszahlen"
      set the visible of sprite 11 to FALSE
    else if v>0 and v<0.20 then
      set the text of member "text"="57 v.Ch.-455 n.Ch."
      set the text of member "jahr"="Ršmerzeit"
      set the visible of sprite 10 to FALSE
      set the visible of sprite 41 to TRUE
    else if v>0.20 and v<0.38 then
      set the text of member "text"="456-911"
      set the text of member "jahr"="Frankenzeit"
    else if v>0.38 and v<0.51 then
      set the text of member "text"="912-1475"
      set the text of member "jahr"="Mittelalter"
      set the visible of sprite 55 to TRUE
      set the visible of sprite 10 to FALSE
    else if v>0.51 and v<0.63 then
      set the text of member "text"="1476-1794"
      set the text of member "jahr"="freie Reichstadt
Kšln"
      set the visible of sprite 10 to FALSE
      set the visible of sprite 42 to TRUE
    else if v>0.63 and v<0.72 then
      set the text of member "text"="1795-1814"
      set the text of member "jahr"="franzšsische Herr-
schaft"
      set the visible of sprite 56 to TRUE
      set the visible of sprite 10 to FALSE
    else if v>0.72 and v<0.81 then
      set the text of member "text"="1815-1918"
      set the text of member "jahr"="Preu§en in Kšln"
```

```
      set the visible of sprite 10 to FALSE
      set the visible of sprite 43 to TRUE
    else if v>0.81 and v<0.89 then
      set the text of member "text"="1919-1932"
      set the text of member "jahr"="Weimarer Republik"
      set the visible of sprite 10 to FALSE
      set the visible of sprite 57 to TRUE
    else if v>0.89 and v<0.95 then
      set the text of member "text"="1933-1945"
      set the text of member "jahr"="Dritter Reich"
      set the visible of sprite 10 to FALSE
      set the visible of sprite 44 to TRUE
    else if v>0.95 and v<1 then
      set the text of member "text"="1945-2000"
      set the text of member "jahr"="von der
Trźmmerlandschaft zur Medienmetropole"
      set the visible of sprite 10 to FALSE
      set the visible of sprite 45 to TRUE
    else if v=1 then
      set the text of member "text"="1945-2000"
      set the text of member "jahr"="von der
Trźmmerlandschaft zur Medienmetropole"
      set the visible of sprite 10 to FALSE
      set the visible of sprite 45 to TRUE
    end if

  end
```

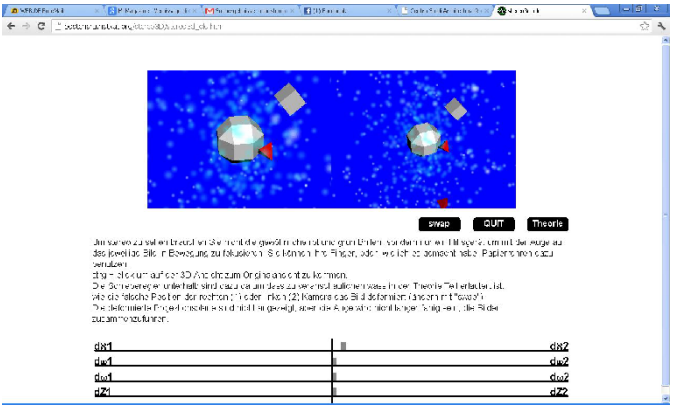


Fig. 35. The concept of stereo-juxtaposition to be followed in augmented reality (movie by Bostenaru, 2002)

Fig. 36. Concept of a timeline (movie by Bostenaru, 2000 and Murteira et al, 2010, used by permission)

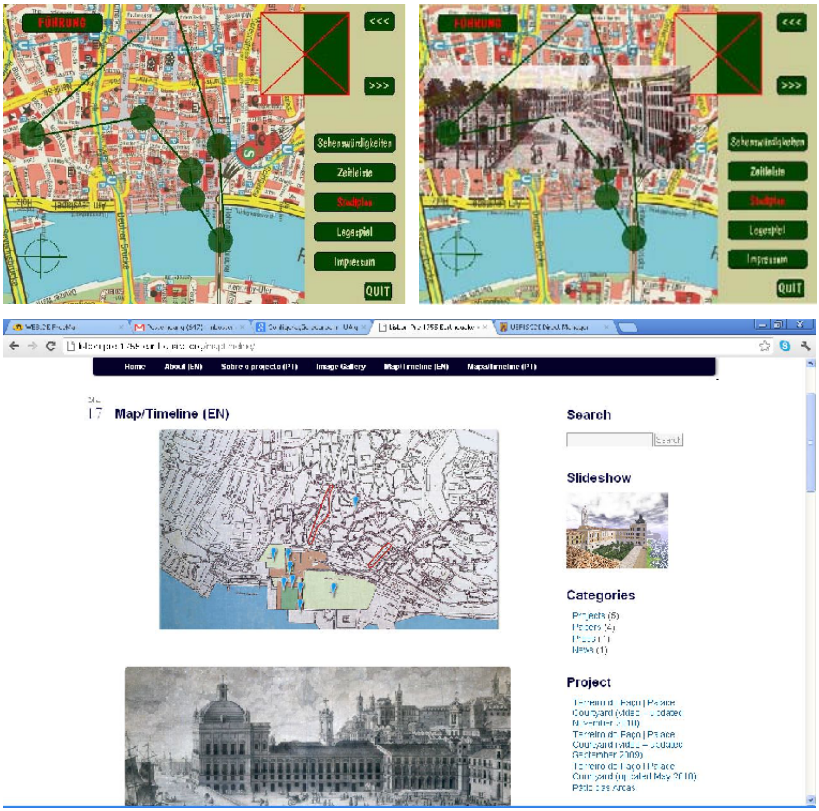


Fig. 37. From the concept of a map to the one of a guided tour (movie by Bostenaru, 2000 and Murteira et al, 2010, used by permission)

The two maps (Fig. 37) would use the contemporary and respectivelly historic maps (for contemporary with option of aerial images, and, as long as complete, also for historic the images of 3D or of the azulejos depiction) to make the virtual cultural tourism more challenging. The code for the quiz on the map has already presented in this paper – the creation as such is subject of further research. The Lisbon pre-1755 earthquake project has a map identifying what has been modeled so far.

A further development is how to apply lessons learned from this to an urban site in Bucharest, affected by demolitions after the 1977 earthquake. The own developed application in Shockwave (3D application as in the following code) was applied to facilitate navigation of an imported city part

model (.obj format), as it was done for the box models in the "Rediscovered space" application.

Maybe the aimed real time modeling is not visible in the the stereo rendering, where the focus is in putting adjacent two different views, in the case views before and after changes in urban structure, for example a photo and a 3D model, but it can be seen here (Fig. 38)

Code by M. Bostenaru, 2002

```
    member(1).newCamera("axonometrie")
    (member 1 of castLib 1).Camera(2).translate(0, 0,
100, #world)
    member(1).camera(2).rotate(45, 0, -135, #world)

    member(1).newCamera("camera2")

    (member 1 of castLib 1).Camera(3).translate(0, 0,
100, #world)
    member(1).camera(3).rotate(45, 0, -135, #world)
    member(1).camera(3).translate(20, 0, 0, #world)
    on enterFrame

    global l
    member(1).resetWorld()
    member(1).bgcolor=rgb(0,0,255)
  t.quality =#low
    t.renderFormat = #rgba4444
    particleresource.texture = t

    mem-
ber(1).camera(1).addChild(member(1).newModel("particles1
", particleresource))
    mem-
ber(1).camera(1).addChild(member(1).newModel("particles2
", particleresource))
    mem-
ber(1).model("particles2").rotate(0,0,180,#parent)
  end

  create world

    sprite(1).camera=member(1).camera("axonometrie")
    sprite(2).camera=member(1).camera("camera2")
    member(1).model[3].rotate(0,     90,     0,     mem-
ber(1).model[1])
  end
```

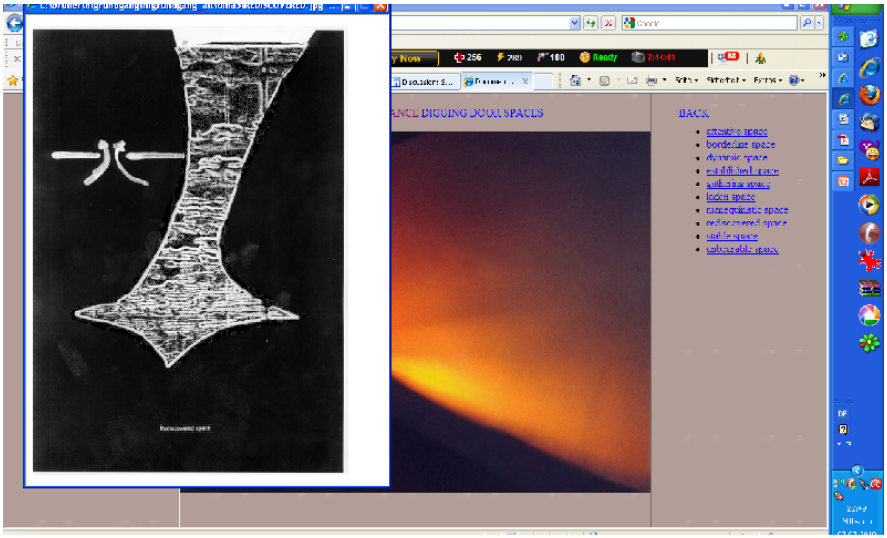


Fig. 38. Webpage presenting the Shockwave concept (Bostenaru, 2001, HfG Rundgang exhibition) http://bostenaru.natkat.org/hfgrundgang/hfgrundgang/spacesofencounter.html

It is possible to translate the model to the situation in Bucharest in a 3D model of central area in Bucharest: Bucharest destructured zone area in the centre (Fig. 39, see our CAD analysis) by multiple hazards, natural (earthquake, flood) and man-made (demolition during Ceausescu), a new Romanian funded project, and thus learning lessons from this stay abroad for the home institution. Consideration will be given also to the strategic concepts elaborated (from the Lisbon in motion workshop September 2012 and from a forthcoming one in Bucharest).

A concept of the development of an application to visualise the impact of the 1755 earthquake on Lisbon has been herethrough developed. Following existing approaches this can be done in a real time 3D application (modeling of the landmarks) combined with the 3D features of the same application for identifying the various effects on the monuments and the layers in the urban development. The concept can be exported to Bucharest. The research can be continued building digital databases on features of the rebuild of Lisbon and their employment given the today's development (green walls). The implementation of the concept in the software is subject of future collaboration as well. Comparisons are open from Lisbon to Bucharest and l'Aquila (the later to were subject of the doctorate Bostenaru, 2012d).

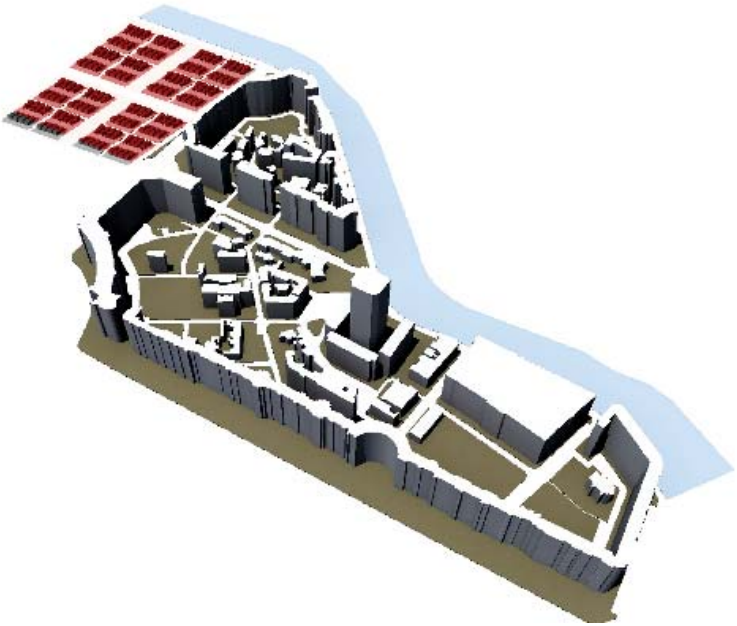


Fig. 39. 3D model of the destructured area in Bucharest (model by A. Chiriloae, 2012)

One outcome of the analysis regards the employment of the grid for the reorganization of the city, which might be regarded both geometrically but also concerning the strategic urban structure (Bostenaru project proposal submitted in 2012, Romanian national funding).

The real time models are quite similar to those in "Second Life", so lessons were learned from the historic Lisbon model for the Bucharest model and for its developments (for example historic model to be developed in frame of the above mentioned nationally funded project).

The aims of semantic enrichment are derived from the paper mentioned on decision, where the criteria build the taxonomy to be translated in an ontology. Decisions which can be taken in a participative manner by means of games/drama/confrontation will be adapted by mean of such a decision tree for urban scale, with defined units of measure, which build the mean of converting to an ontology. The technique of semantic enrichment is not object of the research presented here. Such units of measure can be modelled by means of regression (Bostenaru, 2006).

Several presentations gave feedback to our model, in frame of the course of Panagopoulos in Faro, a poster at the ESF conference “Imaging and visu-

alisation", and a presentation at the "World Conference on Earthquake Engineering", where meeting some further experts. More presentations in Romania were done in the following months, as well as one at the AvG8 conference in Cuzco, Peru (poster).

The research will be completed with a library research grant application at Getty, Los Angeles, USA (Architecture and urbanism representation in games and toys).

One of the invited speakers at the ICAR conference was Antonino Saggio from Rome, he is editing a series on IT revolution in architecture. Maria Bostenaru Dan talked to him and it would be possible to make a book on the history of participation similar to his book on the history of architecture, in which the last chapter is about what is done with the use of IT. Based on the book in German on the history of participation in the last 4 decades of the 20th century, and this investigation on participation by IT means would build the necessary chapter (there are some other developments in crowd sourcing as well - this is a new COST action we might join with the project of my former doctoral supervisor or with my own project if approved). The books are requested in Italian.

http://www.arc1.uniroma1.it/saggio/RivoluzioneInformatica/Index.Htm

6 Discussion and conclusions

There are no 3D city models of Bucharest, such models, as noticed in the action, being sparse in Eastern Europe. Even Google Earth does not offer oblique imagery and only a few buildings are modeled based on the enthusiasm of individuals. Within this project, the aim of which was multicriteria vulnerability assessment, the 2D GIS data used for analysis have been extruded to 3D. This built only a small part of the project, the aim of which was identifying procedures to correlated the data needed by different actors in vulnerability assessment, which was configured multicriterially, similar to decision processes (ex. the pairwise one based on Saaty and implemented in the software). New in the project was considering the socio-economic vulnerability component, while the economic vulnerability one has to be further developed. The GIS component permits a number of statistical operations and analysis as compared to traditional urban plans. Narrow study area was the historic centre of Bucharest, which has not been affected in the earthquake impact and post-earthquake reconstruction, featuring mainly low-rise masonry buildings. The really vulnerable and affected part is situated north of this, in the interwar development, and that's

where extension of the methodology is aimed to be done next. The 3D extrusion (to be seen rather as 2.5 GIS) permits a better visualisation in the vulnerability analysis with effects in elaborating the intervention strategy by decision makers and local authorities, based on the relationship between built volumes among themselves and with free spaces. Such elements of disasters management shall be contained in the master plans. For further multicriteria analysis (ex. prioritising intervention based on the vulnerability analysis of populations of buildings for further economic studies) different levels of detail of the 3D models would be required, through a better connection between CAD and GIS, or the inclusion of the data on the openings and spans in the buildings in the enrichment, the table data on the buildings. The extrusion algorithms have been developed by the ASE partner and are applicable for any GIS depiction of an urban area, not just for the study area in this project. However, there is no web interface for making it publicly available.

Google Earth is a software developed by Google providing a platform for creating 3D city models. Crowd-sourcing is used to fill in the models with data, i.e. with individual models of buildings created with two tools by Google, aimed at different levels of detail: BuildingMaker and SketchUp. The eye level view is seemlessly connected with the aerial view street photographs being included. While it is possible to recreate a historical city, using historical photography (the principle BuildingMaker works with is using photographs of the same building from different angles such as PhotoModeler and related applications, also in frame of the COST action, do), it is not possible to add a timeline to see this development. It has been discussed on LinkedIn which role does Google Earth play for virtual preservation of historical buildings. But an even more important need of improvement of the connection between maps and 3D rendering, in order to better identify the buildings (by address) and to add other enrichment (ex. on the history of the building), such as in the open source counterpart of wikimapia. Nevertheless it remains an example of volunteered geographic information which is useful for architecture/urban planning to reveal the context important for residents and visitors, also by the fact that the image of the city is defined by landmarks identified by the level of detail to which these were modeled (if at all). It is also useful as part of training for better visualisation of the city structure (urban morphology) from various angles to see the Minimal Urban Structure to remain operational during an earthquake in a strategic planning. This last one together with the usefulness as tool within the master planning make the application useful in disaster management, in both pre-earthquake preparatory phase and in post-

earthquake reconstruction, including the emergency, mitigation and resilience planning.

Sites which doesn't exist so in reality, but which aren't fictive either, but based on historical data, have been built in Second Life by Fondazione Valore Italia for Esposizione Universale Roma 1942 and by CHAIA, University of Evora for the part around the Royal Palace in pre 1755 earthquake Lisbon. These are urbanistically coherent places including their installations (garden) and the buildings which define them. Therefore they are suitable for the public events aimed at in Second Life, following the motto "urban experiments – cultural events". The trade fair is the 20th century pendant for the palace, and doing this research on the palace the spectacle component connects to the ESF research network PALATIUM.

Second Life is a game with its socio-economic component. Highlighted in the research was the participation potential. However, it is not clear how much the developers of the models would permit to create own buildings in the game, and even more so how much this is desirable in creating a research environment of a historic site. For a present site the simulation of a future development would be desirable, as, for comparison, in the SimTorino application. But it would be a way of writing stories. In the concept we propose in a further report we blocked this possibility reducing the game to a learning interface about historic sites. Another item from games about historic architecture and which suppose an immersion is the presence of chance events from the history (as included in novels). Maybe this would be possible to implement through a lead character. To conclude, the narrative potential of the game is not used to full, it is more about the historical space simulation, the participation potential being more related to contemporary developments. Maybe it would be possible to organise historical events such as medieval fairs for Lisbon.

1755 the Lisbon earthquake (and tsunami) shocked the world. The impact was not only physical, but also on the schools of thought of the time. 250 years after the earthquake this was commemorated by a series of events, highlighting that ever since that impact on the physical world but also on the development of sciences, including the humanities, was not achieved.

While the "City and spectacle" project on the pre-1755 earthquake Lisbon lead by CHAIA (University of Evora) and partners recreated photo-realistically a representative part of the city, the palace, in line with the ESF network PALATIUM, the 3D city model is still waited for. Since this involves immense resources and funding is not provided, we propose to simplifiedly recreate the landmarks of the city, which are drawn on the

background of common buildings as defined by Camillo Sitte. For this reason we examined the pre 1755 earthquake depiction in the Azulejos museum, where such 2D perspectives are available for 72 buildings. Doing this research we saw that they are not all suffering of earthquake impact, so a wider urban history research is required. As model for the concept serves a digital conversion of the "spaces of encounter" from defining spaces by texture and black surfaces to developments from the shape of a box, at the University of Arts and Design in Karlsruhe, Germany. The 3D implementation was done in Adobe Director, which has at the basis the development of films with respective score. This allows instead of different windows to have different parts of the "movie", namely in one part of the navigation the visualisation of the 3D models, in another part the guided tour on the historical map, in a third the timeline and in a fourth the lessons learned part through a game to identify the historic places on today's Lisbon map. For identification of the site different views were considered: eye level view, silhouette view and aerial view, and the meaning of all these for urban analysis will be explained. The extent to which this can be performed using the Google Earth 3D model of the city is taken in account, as well as the landmark buildings identified by crowd sourcing in that environment, through the detailed depiction in SketchUp instead of BuildingMaker. Apart of the representations in azulejos also the historical engravings of the Kozak collection where used. Stereo pairs will be formed when connecting the "now and then" images as well as the 3D model and photographic/engraving image. Comparisons will be done also between the eye level view and the urban landscape one. For the stereo pairs another marker in the movie is set, and a framework has been developed, but it has to filled with data.

Another model of Lisbon in 3D has been provided by the City Museum of Lisbon, who digitalized a hard copy model into movies. This hard copy model has been created at the 200th anniversary of the 1755 Lisbon earthquake, while the digitalization happened on the occasion of the 250th anniversary. Digitalisation of hard copy models has also been performed in Nantes and for the historic city of Liege (Billen et al, 2012).

Lessons have been learned from the strategy for the future development of Lisbon ("Lisbon in motion" WCEE workshop). In such a strategy the key points of the urban structure for reaction to preparedness, emergency, mitigation and resilience planning have to be identified. The historical lessons may tell us which parts of the city are more vulnerable through their urban position (not only through the vulnerability of the buildings through its structure, geometry and function), in relation to the city grid.

Identification of such elements of the urban morphology (in connection with the structural morphology at building level) is subject of a submitted project for Romanian national funding.

A literature on the meaning of space and time for architecture and urban planning has been set up, with a special view to the meaning of memory, and a review will be performed during the subsequent stay. Literature on games was included, as these are important for the relationship with the Second Life modeling environment, also an object oriented real time rendering environment, a game.

While the concept was developed during the STSM of a "Ion Mincu" University of Architecture and Urban Planning employee at the University of Algarve, its implementation will be assured through an exchange visit at the CHAIA centre at the University of Evora, with partnership from the steering committee of the funding body from the Nova University of Lisbon. The STSM had a duration of 5 weeks, and the exchange visit will have a duration of 6 month, taking place in 2013. Envisaged is also to apply for a DAAD stay at the University of Arts and Design in Germany, for dealing with the common buildings and for the dialogue with film. Particularly common pombalino buildings from the reconstruction have been identified, in exterior eye-level. Interior, and aerial view, and modeled for Google Earth. For these buildings another level of detail modeling is foreseen (including also the structural computational morphology). Cooperation with tour developers active in the field of natural risks research for cultural tourism is foreseen. During the STSM of Maria BOSTENARU DAN ("Ion Mincu" University of Architecture and Urban Planning, Bucharest, Romania) at the CIEO, University of Algarve (supervision Thomas PANAGOPOULOS) a concept of a Web application to understand the impact of the 1755 earthquake on Lisbon has been developed. For the implementation of the concept another funds are being applied for, also in Portugal, at CHAIA, University of Evora, and for the analysis of the results at the University of Arts and Design, Karlsruhe, Germany, where the initial concept comes from. The concept is based on the successive stages in a movie, implemented through Adobe Director. The role of the movie metaphor, different of that of video, in digital humanities, is a topic of future research. The initial concept of converting 2D symbolic type-medieval depictions to 3D has been initially developed for emblematic spaces at the University of Art and Design in Karlsruhe, where this research is aimed to conclude with focusing on the role of film in catastrophe research of the historic accident, from the Lisbon tsunami and Stalker to their meet in the Tohoku earthquake 2011. One of the stages is the 3D

modeling of 72 landmark buildings of pre 1755 Lisbon earthquake. These are identified in both the historic city tissue and in the contemporary city tissue, to learn lessons on historical development and urban vulnerability. For this identification a guided tour and a game are employed, as well as without 2D or 3D data a timeline. Improvement between the connections of these parts of the movie are possible. We focused in creating less demanding 3D depictions, as well as on investigating the role of games in the representation of architecture and urban planning issues, as the current development of a similar model at CHAIA is based on the real time object oriented rendering, and open to participation through a Web platform (like ours but) in Second Life. Lessons can be learned also for the location in Bucharest. A future development might concern the stereo superposition of real and virtual depiction, in 3D model and in photography/engraving. Also the common tissue will be dealt of, to make the transition to another level of detail of the building scale of pombalino buildings. A literature list to all these topics has been set up and is being reviewed, an adnotated list being the result of future research.

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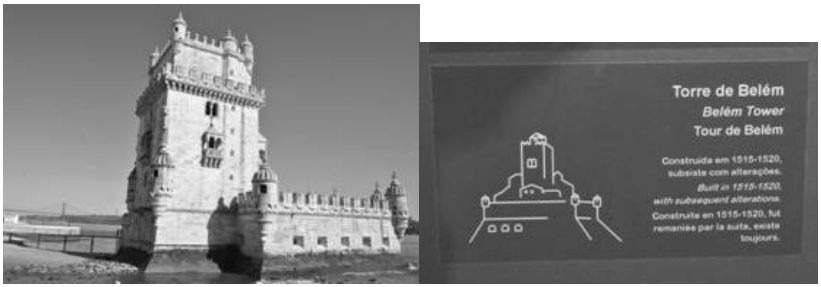
Annex 1

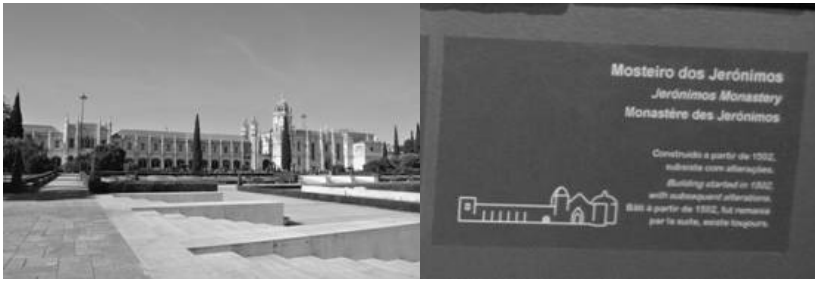
The 72 landmarks are (from West to East): Quinta of the Dukes of Cadaval, Belém Tower, Concent of Nossa Senhora do Bom Sucesso, Chapel of Sao Jerónmimo, Jerónimos Monastery, Quinta de Baixo (or Quinta of the Counts of Aveiras), Águias Quinta, Parish Church of Ajuda, Chapel of Santo Amaro, Quinta of the Counts of Sabugosa, Convent of Nossa Senhor de Quietecaso/Alcântara Royal Palace, Convent of Calvário, Fiúza Palace, Tide Mill, Alcântara Bridge, Convent of Santissimo Sacramento, Chapel of Nossa Senhora das Necessidades, Monastery of Sao Joao de Deus, Palace of the Counts of Murca, Convent and Chapel of Santo Alberto, Mocambo District, Church of Santos-o-Velho, Monastery of French Capuchins, Convent of Santa Brígida, Convent of Nossa Senhora de Esperanca, Convent of Nossa Senhora de Estrela, Convent of Santo Crucifixo, Monastery of Sao Bento da Saúde, Palace of Flor de Murta, Santos Docks, Almada-Carvalhais Palace, Monastery and Hospital of Jesus, Convent of Cardais, Palace of the Counts of Soure, Monastery of Sao Paulo da Serra d'Ossa, Teatinos (or Caetanos) Monastery, Chapel of Nossa Senhora das Mercés, Church of Santa Catarina do Monte Sinai, Church of Chagas, Church of Sao Roque, Church of Sao Paulo, Church of Nossa Senhora da Encarnacao, Church of Nossa Senhora do Loreto, Irish Dominican Church, Hospital and College, Palace of the Dukes of Braganza, Corte-Real Palace, Church of Mártires, Carmo Monastery, Monastery of Sao Francisco da Cidade, Riberia das Naus (Royal Docks), Ribeira palace, Sao Joao Fort, Chapel of Sao Gens (Nossa Senhora do Monte), Fountain of Apollo, Castle of Sao Jorge, Cathedral, Fernandine Wall and Slaughterhouse, Church and Monastery of Santo Elól, Customs and Wheat Deposits, Church and Convent of Nossa Senhora da Graca, Church of Nossa Senhora da Misericórdia, Church and Monastery of Sao Vicente da Fora, Tobacco Customs, Casa dos Bicos, Ribeira Market, Church of Santa Engrácia, „Malcozinhado" Tents, Door of the Walls and King's Fountain Chafriz d'El Rei, Fountain of Praia, Monastery of Italian Capuchins, Convent of Santos-o-Novo, Convent of Santa Apolónia.

Annex 2 - Table

1. Belem



2. Jeronimos



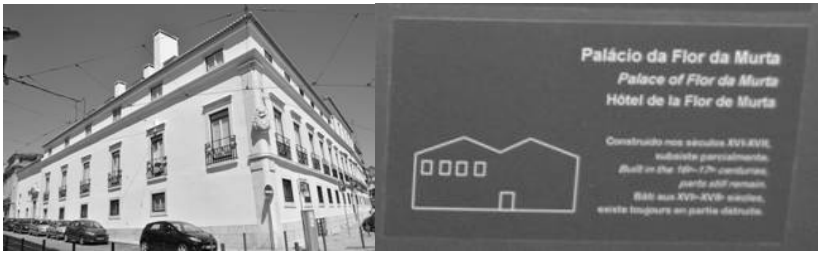
3. Mocambo district

4. Igreja Santos o Velho

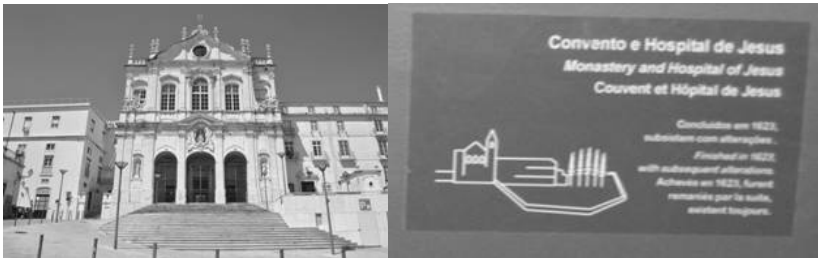
5. Estrela

6. Parliament (Convento de Sao Bento)

7. Apartaments near Asamblea (Palacio da Flor da Murta)



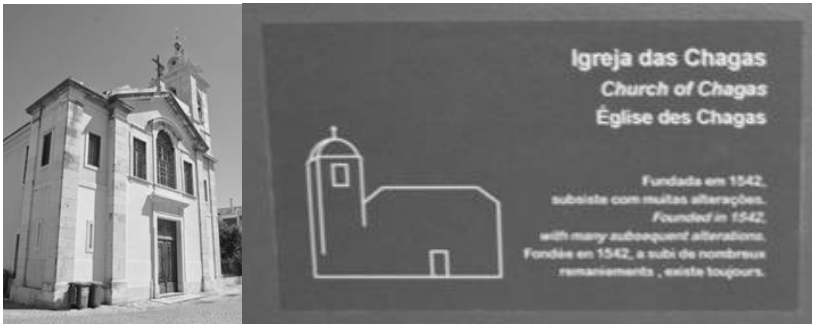
8. Igreja Jesus



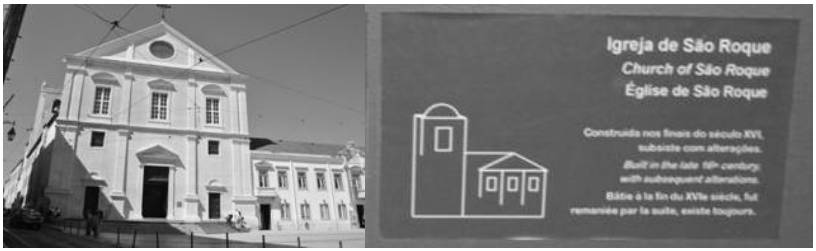
9. Igreja Caetanos

10. Santa Catarina

11. Igreja Chagas

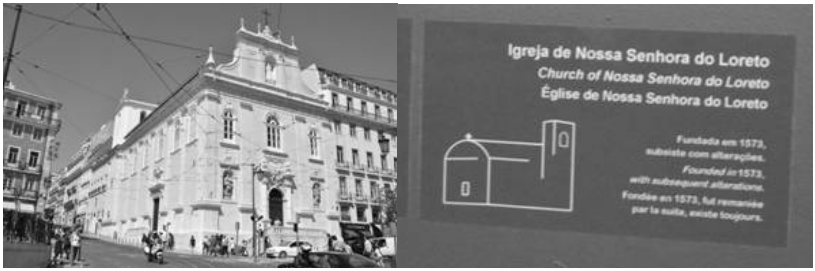


12. Igreja Sao Roque

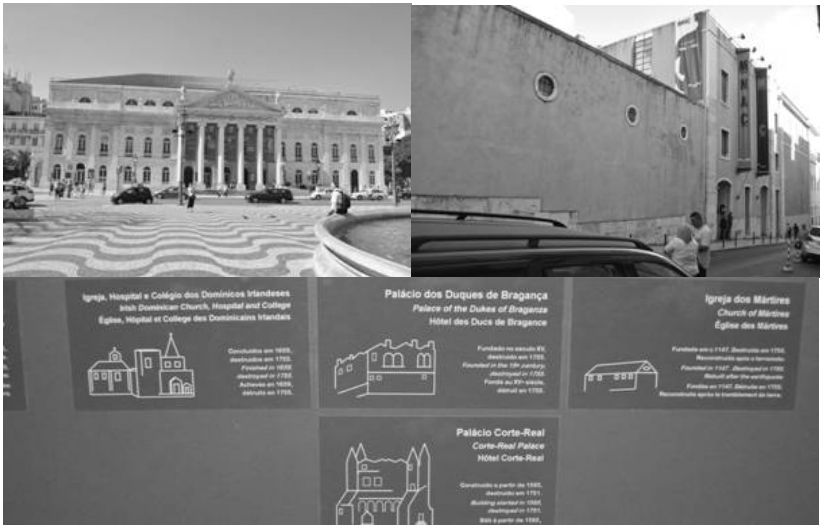


13. Igreja Encarnacao

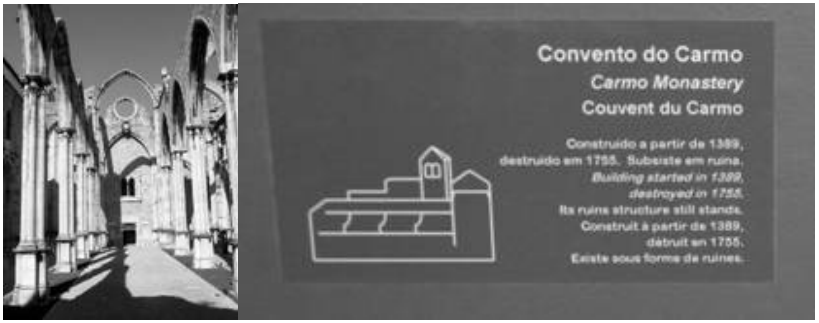
14. Igreja Loreto



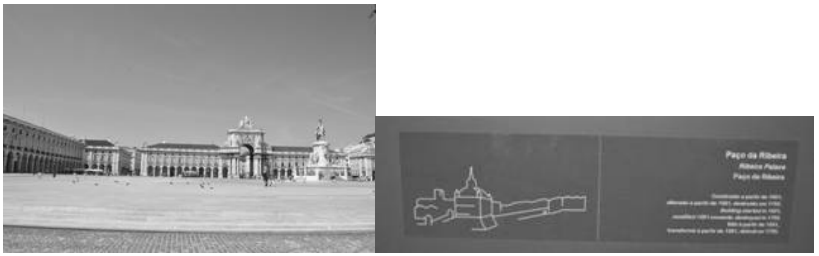
15.



16. Convento do Carmo

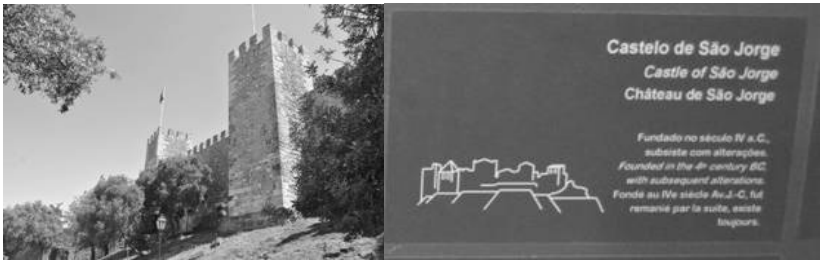


17. Terreiro de Paco

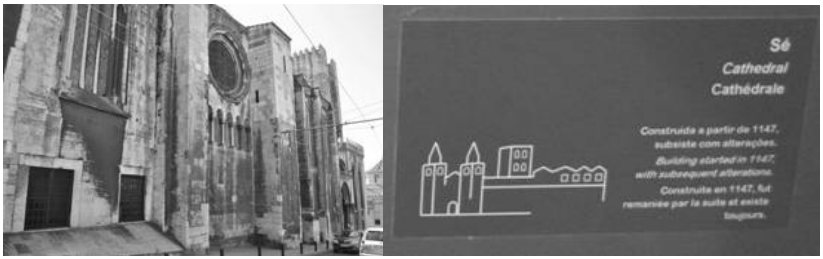


18. Nossa Senhora del Monte

19. Castello



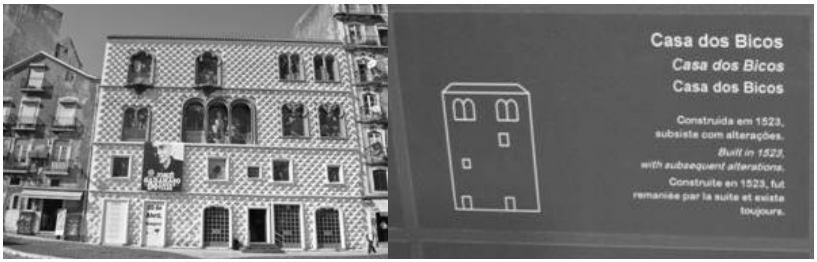
20. Cathedral



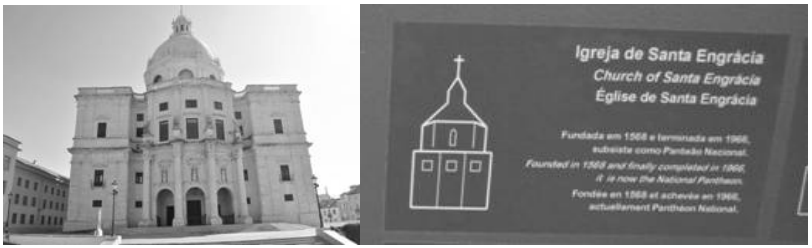
21. Graca

22. Sao Vincente

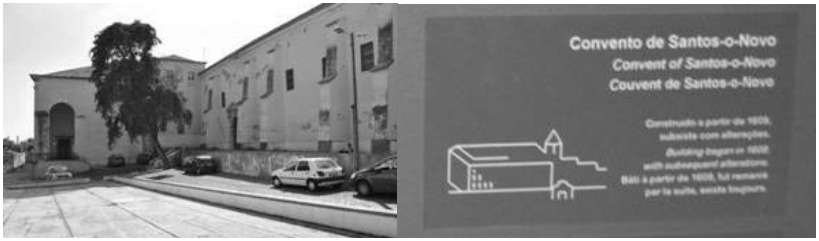
23. Casa dos Bicos



24. Pantheon



25. ISCTE student dormitory



26. Santa Apolonia