CONNEXT: CONNecting metadata to web3D interactive applications of large archaeological contEXTs
Emanuel Demetrescu¹; Guido Lucci Baldassari¹; Alfonsina Pagano²; Sofia Pescarin¹
¹CNR ITABC, Rome, Italy; ²University of Lugano, Switzerland

1. Introduction
Recently in the field of computer graphics we are witnessing a quick shift from large VR, to fast and interactive micro worlds. The interest on those smaller interactive environments is constantly increased due to their accessibility through mobile platforms. This has been possible also because of the actual power and capabilities given to programmers and user interface designers, from open web libraries and tools for the creation of web-based and, consequently, mobile-based applications. In this scenario, issues like large data sets handling (large terrains, large textures, and a lot of additional geometry), application design, relevant content embedding and choice of the best scientific communication channel could occur. For such reasons, this paper focuses the attention on the integration of metadata into an interactive and portable online 3d application, based on webGL. The User experience Evaluation carried out during the event Archeovirtual 2012, in Paestum, provides interesting and essential information about how to manage such kind of application on cultural heritage sites and all its metadata. An approach is finally proposed, using as case study indeed Behind Livia’s Villa. Its primary goal is to develop an interactive product addressed to expert users (archaeologists and architects), aimed at accessing both various models (created for a previous project named Virtual Museum of Ancient Via Flaminia, Roman National Museum, Rome [Forte et al. 2007]) and associated relevant metadata [Ronzino et al. 2012].

2. The case study: Behind Livia’s Villa
The Villa of Livia is an ancient private building near Rome along the via Flaminia. Dating from the earliest of republican period to the late antiquity, the most important event was the ownership of the Augustus emperor’s wife Livia in 1 D.C. The importance of the site is well represented by the famous frescoes of the triclinium and the other rooms (both private and with representation purposes). Such as an archaeological context was little-visited and little known from the Rome’s big tourist circuit due an unhandy position, out of the Town, far away from public transportation. These factors got the opportunity to implement one of the first italian virtual archaeology projects. The original concept was based on the creation of a VR immersive and narrative experience for the visitors of a museum (Roman National Museum). In this first version (Fig.1 a,b), two types of interactions were mixed - for expert users, with access to sources and level of reliability, and for not expert users, with a focus on the storytelling. The Virtual Museum of Ancient Via Flaminia concerned a multi-user (4 users) device-based Virtual Reality application. It enabled visitors to interactively explore two sites (Villa of Livia and Malborghetto) while, not interactively, other two locations (Grottarossa and Ponte Milvio), both in two diffe-
rent historical periods (Roman Imperial and Today) along the ancient Roman road, Flaminia. Both the assets and the virtual application has been made with closed software (models: 3DStudioMax / game-engine:Virtools-dev).

After a first assessment process (2009-2010), it was clear that the two levels of communication needed to be divided into two different applications: one application, designed for the in-site installation, and another one for the on-line consultation. Then Behind Livia’s Villa [Lucci Baldassari et All 2013] has been specifically created for expert users, whose interests are both, the exploration of the 3D environment, along with the contextual acquisition of information on the single parts, of either the actual archaeological site (i.e. rooms acquired with laser scanner technology) or the reconstructed one (1st century AD hypothesis)1.

The final product, of course, for its original aim and for the high scientific value of its data assets, should be accessible and visible easily from the most wide audience: that is the reason that has led us to choose for the web communication channel (Fig.2 a,b).

The whole project relies on open source and free technologies. The 3d models have been re-worked and optimized with Blender 3D. The whole web page is made using standard languages Html5, JavaScript, and therefore is almost fully W3C compliant; for the 3D visualization part we decided to use the WebGL-based framework X3Dom, for which we also managed to establish our own best practice pipeline.
3. Evaluating the project: Archeovirtual 2012

To test whether or not features and mechanisms we developed would truthfully work, a user experience (UX) evaluation was conducted at Archeovirtual\textsuperscript{2} 2012, Paestum, Italy. The annual event - which gathers the best showcases of virtual archaeology and virtual museums projects - takes place in Europe since 2006 under the direction of the Italian National Research Council (CNR ITABC). From 2011, it is co-organised by V-MusT Network of Excellence (www.v-must.net). The four-days exhibition turns to be an opportunity for developers and project managers to directly quest the audience’s feedback towards the virtual products on show. In line with this, from 2011 the V-MusT and the CNR run parallel to the implementation of a UX evaluation campaign which interest, every year, specific UX indicators.

The 2012 edition saw 19 scientifically reviewed projects, divided by genre of supported device (and consequent type of fruition) into 6 categories: Mobile, Touchscreen, Computer Animation, Emerging Technologies, Natural Interaction and Desktop Virtual Reality. Behind Livia’s Villa was mentioned in the Desktop VR category (together with other five installations). It was provided of a single open room in the central part of the exposition area.

The main goal of the UX evaluation was to investigate more on four interaction’s aspects that particularly occur between system and user in the digital domain [Gockel et al., 2013]. The evaluation indeed interested the instrumental qualities of UX, such as [1] utility (the application supports/not support all required and desired functions by the user, either expert or not), learnability (intuitiveness/not intuitiveness of the application’s interface by the user), efficiency (workload for the interaction with the application kept/not kept to a minimum) and stimulation (ability/not ability of the application to engender excitement and joy of the user).

The study of Behind Livia’s Villa here perfectly fitted since we wanted to move towards solving issues like understanding if and how tester could efficiently access metadata, if he could easily manage the desktop navigation and if he could read and interpret interface elements, turning them into hints to be used for a good interaction. Important to highlight is the target selection: as above mentioned, the project considered, as final users, experts in the field of Virtual Archaeology and Landscape Architecture [2], whose interests are information about laser scanner acquisitions of archaeological sites, 3D reconstructive hypothesis, and so on. For this reason, UX evaluation in the case of Behind Livia’s Villa took into account only results coming from high profile inquiries.

For what concerns UX implementation, a combination of two methods was chosen, which collected information provided directly from both the parties: developers and users. Direct interviews and questionnaires have been essential tools in order to capture ground truth data on expectations and behaviours. Specifically about interview, the evaluation took advantage of two piloted scenarios that aimed at exploring, step by step, each graphic and interactive choices of the application. Once tester approached the exposition area, the starting point presented a top view of the Villa. He/she was supposed to autonomously understand how to interact with the desktop interface, what he/she had to do to explore the virtual scene. Both mouse navigation and map indicat-
tions were supposed. By clicking on the arrow icon at the right upper corner of the interactive map, tester could enlarge it and select a location by pointing on a spot. What we wanted to understand from this first scenario was the level of intuitiveness of the interface and the visibility of the graphic elements (good/bad positioning of icons, map, arrows, colored spots, etc.).

In the second scenario, the top view of the scene swapped to the location selected by tester. At this point, a possibility was clicking on the preview at the upper left corner of the screen to switch the Villa to other time. Then, clicking on the info icon at the lower right corner, let the metadata slide in. Likely, holding the left mouse-button and moving it, the Villa’s perspective could be changed. Here was relevant to test the affordance of the contents (type of language, formatting style, multiplicity of functions) and, again the aesthetical features of the interface.

3.1. Results
Behind Livia’s Villa collected a total of 23 written surveys and 10 interviews. In both groups, a main part was represented by experts - either from the CH domain or the ICT sector - with around 52% within the written survey and 40% within the interview.

Analyzing the data, it was possible to interpret utility of such kind of application as highly positive. Within the written survey 70% found all available functions useful and interesting, while one CH expert did not appreciate any function. In detail, the navigation by map was useful to all as it is suitable for navigation. Even though one participant stated that the map is too small. The opportunity to swap between present and past was rated as useful by all participants as it supports the understanding of the evolution over time of the Villa. One expert in CH mentioned that it is interesting, but less informative. Within the interviews the information which is available at every room was not rated as useful by two participants. One of those said that it needs to be a further division between general and specific information. Another two participants stated that the information is hard to find. A person who attended the questionnaire wished to add audio explanations. Another person would like to have general information about the archaeological site. Within the interview one person stated to appreciate to have the chance to include images of mosaics and paintings. Furthermore, one person wished to have the opportunity to move inside the environment within a guided-path (Fig.3a).

Concerning learnability aspects, within the written survey a majority of 51% and within the interview 60% found it either challenging to use the application.
in the beginning or hard to use for the whole duration of interaction. Too small visual navigation elements and a not obvious function for changing the perspective inside a room were identified. Both were hardly noticed by the participants. In detail for the first task, which asked the participants to figure how to navigate around the Villa, 60% of interviewers needed some assistance by the interviewer. Consequently, half of the participants rated that they have coped well with the task as they often needed some advices. 20% found that they only have coped average with the task. The remaining 30% said that they have coped very well. Within the second task, which requested to move to another room and access some information, the majority of 60% did not ask for help. However, 40% still demanded support by the interviewer. One difficulty appeared with the map as it was not clear how to enlarge it. Still 60% said that they have coped with the task good or average (Fig.3b).

Fig.4 a,b - Graphics representing efficiency and stimulation values of UX respect to the application at Archeovirtual

Efficiency evaluation saw a relatively large consent. Within the written survey majority of 74% rated that it took adequate time to reach their goals. 13% reported that it took sometimes too much time. In fact, 9% found that it always took too long. Within the interview no lack of efficiency was noticed (Fig.4a). Stimulation features provided by the interaction with the application resulted positive on average. Within the written survey a majority of 78% reported that the experience was not totally new for them, but they still enjoyed it. Obtained results of the interviews appeared a bit better. For 30% it was a totally new experience. A participant mentioned that reconstructions are already known, but he has never seen the evolution over time presented in this way. However, in overall less novelty in the interaction or content is identified (Fig.4b).

4. Discussion
Behind Livia’s Villa presented issues belonging to both content and structural matters. The former pertained the affordance of certain information: the language (database mode), the way of presenting data (formatting) and level of complexity of the content structure inevitably influenced the evaluation. Indeed users seemed to be confused by metadata interface: they were not properly focused on the information, but distracted. Some were disturbed by too much texts; others by a unified style which did not highlight the most important information and did not assign categories of contents; some suggested to integrate some audio explanations, in order to help users to know more on certain topics; others reported a general confusion in the data presentation. About structural matters, instead, some navigational issues appeared since
users felt frustrated in the interaction and bored. In fact, it was not obvious how to change the location and perspective in the Villa’s view and how to access information. Firstly, some discussed that the arrow on the Villa’s map needed to be enlarged, as it was not noticed by many. Then, the change of perspective activated by mouse represented an “invisible” function, which needed to be somehow introduced to users. Finally, the info boxes were not simple to open and read since again visual indications on how to use them were too small.

In definitive, what needed to be enhanced or changed are:
- about aesthetical features: more visible buttons/icons/categories of information;
- about content: descriptions more suitable for the type of device, granularity of information, more languages’ accessibility; more media (e.g. audio, text fluctuations);
- about navigation: opportunity to move around the virtual environment along a guided path; easiness in the content accessibility, help mode in order to suggest different types of interaction available.

5. Preliminary Solutions

The overall experience carried by the application, especially from the perspective of a web 3D application was successful but, as already stated, highlighted also some issues about interaction with metadata. The main problem was that user seems to be confused on the use of metadata interface and on textual content: he seemed not properly focused on the information provided by metadata, but distracted. We were surprised because we have used as reference the model (interaction/interface/metadata) commonly adopted by 3d interactive applications dealing with collections of objects. Thus, this model proved to be not effective when applied to larger contexts, outside the restricted circle of expert users. The GUI has been indeed enriched to match the suggestions coming from evaluation. The metadata schema has been also modified to refine the granularity from the room-based description to the single archaeologic object level (columns, paintings, protomes).

In detail, we managed how to modify the aesthetical issues making the buttons and icons more visible and the map more intuitive to open and interact with. A visual minitutorial has been graphically implemented as first UI event for user-aid purposes (to explain where to tap/click and what to get).

A new lighter version of the models and a new layout have been deployed to match more kind of devices: tablet and smartphone prototypes are close to a stable version (Fig.5 a,b,c)

From a content point of view we modified the granularity of information to match a new metadata schema, more suitable to describe single 3d object in the archaeological context (capitals, columns). At present however we are not managing new media like audio or more languages than english. The navigation system is another troubled aspect emerged from the evaluation: a primary goal is to introduce a guided path in which the user could walk freely to explore the architecture of the villa taking in account the most important and significative (from an archaeological point of view) areas.
Since there is a problem given by different kind of interaction on different devices (mobile/desktop) we are still developing an alternative approach to deal with navigation and metadata contents. The idea is to manage the two problems separately, switching between a navigation mode and an informative mode. While in the first one all the events are used to allow the user to simply walk through the scene avoiding distractions, in the second, which is triggered by pressing a button on the interface, the focus is on the highlight and retrieval of the informationally valuable contents. In this mode, in fact, the user could just observe all around the virtual environment from its actual position. An invisible vertical plane is casted, starting from the center of the screen to the horizon; each intersected object that carries informative content is highlighted, and a click/touch event is enabled in order to allow the user to access the object-specific information enclosed.

After the activation of the “triggered” object a metadata set is extracted from the xml file and rendered in a dynamic layout: images and texts are showed in a transparent side-window. The metadata schema was further developed to manage, retrieve and visualize a subset of image sources within the 3d real-time environment. The spatial point of view of such iconographic sources is a property of the images and allows to semantically enrich the 3d exploration [cfr. De Luca et All. 2011].

6. Conclusion
Along this paper we have seen how an interactive online 3d application, based on webGL, can be planned, developed and further tested and assessed. In 2008 the project was intended as the first multi-user virtual museum of Eu-
rope, opened with the name of Virtual Museum of Ancient Via Flaminia. Since 2012, the renovated and on-going project of the virtual museum, Flaminia Reloaded, aimed at developing a narrative version at the application (based on natural interaction) and a descriptive online version, based on 3d interaction with models and metadata - Behind Livia’s Villa. That is how we arrived to design and implement such kind of Desktop Virtual Reality application.

The generative approach used to test it provided the benefit to gradually build up some alternative solutions, based on a larger number of investigations and more tailor-made on the final users (experts ones). Content, navigational and aesthetical features have been - and still are - studied through the direct contact between persons-system, who directly answer to interaction queries in order to better their own experience.

Acknowledgements
The work is funded by the European Commission through the European Community’s Seventh Framework Programme (FP7 2007/2013) under grant agreement 270404 -“V-MUST.NET”.

Notes
1 Currently a second branch of the project is going to complete an immersive, storytelling based version of the Livia’s Villa museum application: Livia Reloaded.
2 Archeovirtual is yearly presented within the Mediterranean Expo for Archaeological Tourism (BTMA). The 2012 edition was held from the 15th to the 18th of November, in Paestum, Italy. More infos available at: www.archeovirtual.it

References