Proceedings
ECLAP 2012
Conference on Information Technologies for Performing Arts, Media Access and Entertainment
Florence, Italy
7 – 9 May 2012

edited by
PAOLO NESI
RAFFAELLA SANTUCCI

Supported by
ECLAP partners
European Commission

FIRENZE UNIVERSITY PRESS
2012
3D reconstructions and Cultural Heritage communication

The modeling of the Sala Bologna as a case study for enabling emotional philologically accurate experiences of a work of art

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Abstract—This paper presents the experience of modeling a philological three-dimensional scenario (the Sala Bologna) as a set for a 3D stereo cartoon movie in the Cineca MDC ("Museo della Città", i.e. museum dedicated to the history of the city) cultural heritage project. In 2009 - 2011 Cineca was involved in the challenge of reconstructing three-dimensional historical scenarios to show Bologna in different ages as it probably was (the sets are philologically accurate). This movie will be part of the museum itinerary in 'Palazzo Pepoli' and displayed in the immersion room especially designed by Cineca. The aim is to take advantage of computer-based visualization methods to deliver information (culture) minimizing cognitive overload. The choice of Open Source software made the production pipeline a case-study highlighting interesting features such as model reusability. Cineca MDC Project is a case study for V-MusT.Net. The modeling of the Sala Bologna is proposed as a significant example of the issues dealt with in this new production pipeline which actually faces a twofold challenge: include philological constraints inside a traditional 3D movie pipeline production and test the multi-disciplinary ability of three-dimensional reconstructions to support both communication and research activities.

Keywords-component; virtual heritage; cloud computing; cultural communication

1. INTRODUCTION

Nowadays new technologies are carrying out a relevant role in Cultural Heritage (CH) to allow a work of art to correctly convey the message which it brings as a sign. A work of art is a semantic object (i.e. a sign [1]) originated with the specific aim of delivering a message.

To be correctly understood, such a message requires sender and receiver to share both a code (which is the way the message has been written), and a context (which relates to common information that can be assumed as generally known by people). However, the distance (both in time and in space) which today separates a sender (i.e. the artist who created the work of art) from receivers makes such conditions unfulfilled and people tend to consider cultural heritage as a matter of fact without being encouraged to disclose the embedded message.

3D models and computer-based visualization methods can help people to be more active in visiting a museum and to correctly interpret items on the basis of their original meaning, thus reaching a new audience. The goal is to involve people in emotional experiences which deliver the message concerning a work of art, while minimizing the cognitive effort, increasing motivation and enabling visual entities to be explained by visual tools ("visual is explained by visual", i.e. visual entities can be better explained by visual tools [1]).

For this reason 3D reconstruction can be employed not only to save works of art from the corruption of time but also to fill the gap between people and their ability to experience these works.

The Cineca MDC ("Museo della Città") Project is part of a wide Cultural Heritage project, Genus Bononiae (www.genusbononiae.it) "Musei nella Città", which has renovated several buildings for public use in the historical centre of Bologna in order to define a integrated museum itinerary.

In this context, the MDC Project faced the challenge of producing a stereoscopic short animation movie, whose concept is "the big bang of the history of Bologna". It will be displayed in the immersion room.
(designed by Cineca) inside the museum (Palazzo Pepoli) dedicated to the history of Bologna. The aim is to intrigue the largest number of people (with different ages and backgrounds) in order to prompt them to discover items seen in the movie within both the museum itself, and the buildings in the historical centre of Bologna.

This aim raised a twofold challenge concerning both communicational and implementation issues. From a communicational point of view, the movie enables a philological approach within an emotional/narrative process. The implementation challenge was not only related to finding the most suitable software for a traditional 3D movie pipeline production, but also faced up to requirements which were specific for the project, such as integrating the traditional pipeline production with philological constraints.

Open Source provided the most suitable tools to manage such a complex project, first of all Blender. Furthermore, the Open Source model as a set of heuristics about how to encourage participation and innovation (O'Reilly [8]), enhanced a community actively engaged in the process (Cineca's partners for this work are Spark Digital - www.sparkdigital.com, which has already produced short movies with the software Blender, Lillwood - www.lillwood.eu, as the 3D stereoigraphy supervisor, and several experts such as Enrico Valenza - www.enricovalenza.com).

As a result, this production pipeline has been seen as a Blender Open Project, i.e. as a chance to study, in a real workflow production, requirements which were interesting for virtual heritage projects in general terms. For instance, a modeling approach which enhances reusability for 3D reconstructions. This made the MDC project a case-study for V-Must.T.Net, a new European Network of Excellence dedicated to Virtual Museums (www.v-must.net).

The rest of this paper explains such aspects through an example: the modeling of a set for the MDC short movie, the Sala Bologna. In Section II we address communication issues introducing the relevance of the Sala Bologna for the history of the city. Section III summarize implementation issues, then delves into specific in Section III.A, III.B and III.C to outline some issues of general interest for virtual cultural projects, which have been addressed as further work. Finally, we will outline some conclusions in Section IV.

II. THE SALA BOLOGNA

The room called Sala Bologna (depicted in Fig. 2) is in the Vatican City, Rome. Built in 1575, on the occasion of the Jubilee year (and consequently the enlargement of the third Loggia of the Northern wing at the Cortile di San Damaso - St Damaso court), it was explicitly required by Gregorio XIII, the Pope who reformed the calendar.

Ugo Boncompagni, who chose the name Gregorio when he became Pope, was from Bologna and the Sala Bologna takes its name after the many frescoes depicting Bologna in the room, one for each wall: a bird's-eye view of Bologna (also termed Mappa Vaticana) on the Southern wall, a plan on the Western wall and a view on the Northern wall. Other pictures may have decorated the Eastern wall too, but they have not been preserved due to deterioration caused by tapestries when this room was employed as a picture gallery. Further, the windows on this side were closed when the Sixtus V palace was built.

The Mappa Vaticana, which has been acquired in high resolution by the University of Bologna for Nu.M.E. (‘Nuovo Museo Elettronico’, i.e. New Virtual Museum [2]), is not only a work of art which could not be approached by people (it is a room next to the Pope's private apartment and near the Vatican Secretary of
State), but it is also a sort of Google Earth of the XVIIth Century. The 'Mappa Vaticana' shows details of the buildings inside the 'circla' (i.e. the old city walls) in an iconographic way. This representation is precise, as verified by Dr. Ghizzoni in her PhD work [5]; in actual fact this work was able to verify how much weight the author's artistic choices had, and how much was determined by the Pope's will.

Cineca MDC favoured the experience of entering a room which is usually forbidden to people. Viewers travel with Apa, the main character of the movie (Fig. 1), from the top of the Garisenda tower (Torre Garisenda) in a Medieval Bologna, to Rome in 1578 and enter the Pope's apartment. This scene also gave us the opportunity to show a philological view of the ancient via Emilia highway, as well as St. Peter's square before the Bernini’s dome was built (Fig. 5). Apa enters the Sala Bologna facing the 'Mappa Vaticana' which is suddenly shown in all its beautiful features (Fig. 3).

At the end of this scene (the full storyboard is shown in Fig. 4), Apa dives in the Mappe Vaticanae and comes back to Bologna reappearing in one of the canals flanked by mills and part of the productive system of the Renaissance Bologna (Fig. 6).

III. Implementation Approach

Implementation issues faced the challenge of selecting the most suitable software tools for managing the traditional pipeline production for a short 3D stereoscopic movie, as well as for carrying out the aims which were specific to the project.

Open Source proved the most appropriate choice to manage all these aspects and the workflow in general. The traditional 3D movie pipeline has been almost completely realized with Open Source software, first of all Blender, a single product similar to other 3D tools such as 3D Studio Max or Maya, which allowed us to build the sets as well as characters, and to make the animations up to the final production of the frames on Cineca Render Farm.

This is a consolidated approach adopted by Cineca due to many benefits, such as:

- high availability and great compatibility;
- being always able to cope with problems, fix bugs, or adding new features;
- for students who attend training courses or a stage at Cineca, Open Source tools are immediately reusable;
- open format allows the reusability of the models even after many years.

This last property concerning file formats was a specially crucial issue for this project. In fact, a dialogue was required between these software which were often used in discordant contexts, such as reconstructing areas that are changing over the time, as well as the vegetation, to model cities, etc. Equally, the large amount of available documentary, iconographical and rheaological sources coming from projects of the past (i.e. made with the University of Bologna, with CNR ITABC, with the cultural department of Bologna and the Civic Museum) had to enter into the production chain.

The capability of exporting their output into a large range of different file format for Open Source software allowed us to find the right one to overcome the problem in any occasion it occurred. It is worth noting that such a capability enabled to enter a proprietary software (i.e. City Engine, for which there has not yet been implemented an open software alternative showing the same performance) in our Open pipeline.

Collaborative tools were also required to coordinate Cineca's parties, sometimes geographically distributed (i.e. Spark Digital is in Rome). In order to avoid change internal IT design, we developed a mechanism implemented with the Cloud computing delivered by Google Docs. So the production pipeline was abstracted in terms of assets (i.e. any part of a 3D scene) life cycle. This enabled different teams to produce assets with the technologies most suitable for the existing internal IT.

We delve into this subject in Section III.C.

Finally, it is worth noting the additional feature entered in the process by Open Source software: a rich developers community. This is not only a support to problem solving, but also entails an Architecture of Participation that O'Reilly points out as a more representative property for the Open Source model today, than in fact the source availability [8]. So parallel with the production pipeline, the project developed a blog (https://rvn05.plx.cineca.it/12001/php/MDC/portal/wordpress) which collects internal communications as...
planning. So tasks, people involved in each task, and time needed to accomplish them are planned and scheduled once and for all. Any new philological information coming in the middle of the production process risks compromising the delivery (which also means compromising the budget reserved to the project), so it should not be taken into account.

Equally, a movie cannot show uncertain information, which is a standard choice for insiders to highlight when the info is not known. The rendering of the Sala Bologna during the texturing shown in Fig. 7 can be taken into account as an example of models highlighting missed information with a uniform colour. One suitable choice would be to position the camera to look the parts of the model where valid information is available. As an example, the camera placement in the Sala Bologna photographed the walls which displayed most of the existing information. This limits the amount of information required to complete the set but not supported by sources.

So the employment of three dimensional historical scenarios as sets for a movie requires to make some choices which risk compromising the philological precision.

In order to preserve the philological features of the three-dimensional models (and according to the London Charter Principle 4), all these choices are recorded into documentation. This enables future improvements, too. We will deal with this subject in the next Section.

As a result, the philological approach inside a 3D movie pipeline mainly affects the architecture of the repository usually implemented to store assets. In fact, sources as well as internal documentation cause a subtree which will be part of the repository.

This also is compliant with the Principle 3 in the London Charter [4] which states: "In order to ensure the intellectual integrity of computer-based visualization methods and outcomes, relevant research sources should be identified and evaluated in a structured and documented way".

Data are basically ASCII or large bin files stored in a repository which is arranged as a sub-tree in the file system of the machine storing (and delivering) data (i.e., a server). So data can be accessed in a twofold way: with a browser to navigate them or with visualization tools such as fusedav (lpointer.de/lemart/projects/fusedav) to enable the operating system’s breadcrumb approach to file and folder navigation. This second approach also enables users to manage data, i.e., to performing operations such as creating, updating, deleting, and so on.

B. Enhancing reusability for 3D reconstructions

Cultural experiences enabled by 3D technologies are meaning-driven, i.e., strongly connected with one specific meaning among all the ones concerning a work of art. This idea extends to a “one to n” relation the concept theorized by Manovich in [6] about new cultural forms and existing ones.
A database logic is a basic concept introduced by new media (with navigable spaces) which also entails new narrative forms as a method of accessing data among others. This changes the idea of work of art as unique, made within a particular medium when the tool was the medium and any level of an interface did not exist.

Today this is not true yet and a basic but crucial distinction must be made between art that uses digital technologies as a tool for the creation of traditional art objects and art that employs these technologies as its very own medium [9]. So the content of the work and the interface become separate. It is therefore possible to create different interfaces to with the same material.

In the same way, 3D technologies can be made interface for cultural information. A similar experience was pursued in the past by Cineca with the Certosa virtual museum [3]. Sources and documents, organised inside a multimedia database, get to the final user through the virtual interface in a continuous and bi-univocal interaction between virtual reconstruction and historical, artistic and archaeological documents. Equally, as observed in Section 1, the 3D reconstruction of the Sala Bologna employed in this movie delivered a specific meaning concerning the aim of relating the history of Bologna.

However, this room (and its frescoes) brings many other meanings that visual 3D technologies with a different communicational aim can deliver, employing the same model (or causing just some changes). Consider, for instance, motivations which drove into reproducing a landscape in a map (it was the time when the written works of Ptolomy came of age in Italy), or true author's artistic choices which affected the way Mappa Vaticana today presents itself.

As a result, a unique 3D model can be employed to achieve a wide range of different experiences, each of them directed to deliver a specific meaning among the ones concerning a work of art as a sign. So reusability is a property which should be carefully addressed. In order to address such capability, it is required to focus on the process in which models originated.

Generally speaking, careful planning before starting modeling is a good practice. It becomes of crucial importance for sets in a movie which attempts to be philologically accurate. Differently, there is the risk of employing a back tracking approach which entails starting anew, throwing the previous model away. It is a widespread opinion that it is a more suitable choice starting afresh than having to cause too many changes to an existing model.

This will lead to introducing a relevant delay in the delivery time, which is a crucial requirement for a 3D movie pipeline, as already mentioned in Section III.A.

This project has been the chance to study a way of producing models enhancing reusability.

The already mentioned method to document modeling and rendering choices in details used to preserve the philological precision, proved suitable to address reusability, too. In fact, such a documentation can be employed among different virtual heritage projects, to introduce further improvements for the model. When new information is available or it is required (different contexts can also require a different degree of resolution of a 3D model). In fact, new information can be added to previous procedural annotations in order to be facilitated in modeling the new model.

For instance, when modeling the sala Bologna, no definite information was available for the cornice so it has been realized in probabilistically, as shown in Fig. 8, which is part of the documentation produced.

When (if) new information becomes available to refine the model, such a documentation will help to know how to add definition reducing the time required to plan alterations.

As a further work, we highlight some course of action which should be suitable to automatically acquire and share information about modeling procedures followed to create a 3D model.

As an example, new Blender 2.5 allows developers to save in a Phyton script all the sequence of commands employed in modeling. However, a stable version of Blender 2.5 was delivered at the end of this project (which was developed with Blender 2.49). On the other hand, a sequence of procedural modeling can be shared as XML files (see for example [10]). It can be presumed that philological information could be preserved through XML procedural sequence of commands which can be implemented with the 3D modeling software preferred by the modeler.

C. Cloud Computing to support a collaborative work

As mentioned in the Introduction, Cineca involved partners for this work (i.e. Lilliwod and Spark DE). The participation of such teams, sometimes geographically distributed (i.e. Spark Digital is in Rome), required collaborative tools not only to share data but also to coordinate the pipeline process.

Although Blender was the common software we all employed, each team was dependent on an internal IT
and got used to managing assets production in a consolidated way. For instance, Spark usually manages the production pipeline with a software implemented inside the company (SPAM), which had not been imported at Cineca because of the strength requirement for a network file system (NFS) architecture. This was not suitable for IT inside Cineca, which is basically composed of high performance super computers. Each team was required to produce assets with the technology most suitable for the existing internal IT. As an example, we implemented an architecture based on a centralized repository and a version control system (SVN). So people at Cineca were allowed to checkout the repository in a local machine and then submit the new model to the repository on the server with a service which is able to automatically manage subversions of files and for each changes it maintains the history.

However, a framework was required to abstract the production pipeline in order to preserve the assets lifecycle. In fact, an assets is involved in many production phases before being ultimated, i.e. wait, hold on, working, revision, approved, rejected, and closed.

A first prototype which was used in this project has been implemented with a paradigm of cloud computing such as delivered by Google Docs. However, this required a large amount of human intervention which could be avoided.

From now on, such a mechanism can be automatized with tools such as Google gadget API and iframe tag to embed them into a Web page.

IV. CONCLUSION AND FURTHER WORK

Relying on previous experiences on CH projects developed at Cineca, the MDC Project tries to test the ability of computer-based visualization methods to involve people in emotional historical experiences. The aim is to enable works of art to correctly deliver their messages as signs (in a semiotic sense), decreasing cognitive effort, while increasing a motivational drive.

The modeling of the Sala Bologna has been proposed as a significant example of the issues encountered in this new production pipeline which actually raised three challenges of general interest for virtual heritage project: (i) integrating the traditional pipeline production with philological constraints, (ii) studying a modeling pipeline which enhances usability for 3D reconstructions, and (iii) studying an automated way to implement the cloud computing mechanism designed for collaborative working.

Furthermore, a design for an interactive immersive space with Real time raytracing will be developed thanks to the GPU acceleration. A first prototype will be set up in Cineca virtual theatre using the new PLX-GPU supercomputer introduced in June 2011 by SCS S.r.l SuperComputing Solutions and CINECA.

ACKNOWLEDGMENT

We would like to acknowledge Dr. Ghizzoni, whose expertise and helpfulness have been crucial in reconstructing the Sala Bologna. Her Ph.D. Work [5] has been especially important because of the in-depth knowledge of the Sala Bologna it offered, the author having had the chance to see the subject of her PhD work in person. Equally, we would like to acknowledge Prof.ssa Francesca Bocchi. A few years she had already started looking ahead and seen the requirement for research to integrate Human and Computer Science disciplines, so she was the first in Bologna to support interdisciplinary PhD. projects which have been delivered as contribution to a larger Virtual Heritage project, Nu.M.E. [2].

REFERENCES