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MODULAR REAL TIME APPLICATIONS FOR CULTURAL HERITAGE AND DECISION-MAKING

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Abstract

Virtual Reality offers always new options for studying and promoting Cultural Heritage and even decision-making processes. In order to reach better results, a modular development is mandatory. It enables to envisage constraints and requirements suggested by the partners of the project, by the users and to manage the limited financial resources. Applications can be manifold and, starting from one kind of implementation, many others can be performed, adding in time new interactions and functionalities. The ViSMan software is based on a new paradigm in order to meet these needs and it is nested into a working methodology capable of enhancing a new creative approach to Cultural Heritage applications.

Keywords: Virtual Reality, Cultural Heritage, portability, interdisciplinary, interaction, decision-making.

Introduction

Virtual Reality applications are proving their increasing functionality not only for cultural and educational purposes, but also for decision-making ones. A Virtual Theatre, as the one in CINECA, can show models with their real proportions, promoting a direct and natural perception of space. The wideness of the screen, better if viewed with stereoscopic glasses, amplifies the sense of presence in the reconstructed environment and enables a collective view. In this way, it is possible an immediate exchange of opinions among the public. Virtual Theatres can be ideal environments for visualizing landscapes and urban areas along with 3D models: politicians and local administrators, who should take decisions on public projects, or even citizens, asked to give an opinion, are able to take into consideration hypotheses that, otherwise, could speak only a technical language. Despite its usefulness, the huge cost of these installations can suggest and favour desktop solutions, cheaper, easier to manage and, lately, with progressively higher quality levels. That is why the use of flexible applications, adaptable to High End as well as to desktop systems, can be considered a good solution: the integration of different platforms can follow a developmental path that, during the life of a project, keeps track of the changes in the availability of financial resources. Anyway, modularity is not only needed in the kind

of platform adopted; it should be the guiding principle during the development of whole projects, fostering a smooth interaction between cultural and technological partners.

Currently, at the VISIT Lab at CINECA, in collaboration with the ViSMan project (Virtual Scenes Manager - funded by the Spinner Consortium with Regione Emilia Romagna and EU funds), the City of Bologna, Bologna University and CNR ITABC in Rome, Virtual Reality applications are being developed with a particular care in their flexibility, quickness of use and in the improvement of context awareness. There are several multidisciplinary undergoing projects that use various computer technology functionalities and attain flexible multi platform realizations. The 3D virtual worlds become starting points for a straightforward interaction with complex environments that can be navigated, modified and queried through the link to more than one relational Data Base at a time (GIS, Multimedia data , etc.), becoming an interface for accessing different information.

1. Limits as opportunities: structural constraints in the realization of Virtual Reality applications in the fields of Cultural Heritage and decision-making

In the fields of Cultural Heritage and of Decision-making there are several constraints and exigencies that weights heavily on the kind of possible developments when the aim is to realize efficient and satisfactory computer based applications of virtual reality. Modularity, both in the developing phase and in the application itself, is the ideal solution for overcoming successfully all these limits and, at the same time, meeting the requests and expectations of the final user or owner of contents.

when working for Cultural Heritage, for example, there are too often severe limitations for obtaining funding in support of the development of projects. The cultural wealth of the European Cultural Heritage doesn't correspond to adequate economic resources for its preservation and valorisation and the access to Communitarian, national or local funding is hampered by the great number of projects looking for economic support. This situation suggests and, not so rarely, even obliges to pursue a kind of development for cultural projects made of at least a couple of steps: the delivery of an appealing demo, not too

demanding from an economical point of view but with a high visual and communicative impact; a new search for funds, helped by the demo; a widening of the development activity, for going over the demonstrative phase.

Usually the collection and processing of data and sources in humanistic fields takes a long time and even when, at the beginning of the project, the producer of cultural contents already owns a significant collection of data, organized, computerized and granted with all the permissions for using them, times of final development are likely to become longer.

Connected to the previous aspect is the exigency of following the evolution of the requests coming both from the cultural partner and from the audience. The group of final users, too, can be segmented in a set of more defined targets and, consequently, the communication has to become more flexible. The first step can foreseen, for example, a free navigation into the artificial 3D environment. In a second time, when the contents manager has fully understood the potentialities of the application and has a clear mind about the communicative aims, guided tours can be realized. These can undergo a further process of segmentation, producing new thematic tours. There could also be the need to adequate the application to the arrival of new information, to be integrated with the previous one, or the possibility of developing temporary tours, conceived as in real museums, in order to outline specific aspects or connections.

Last but not least, there is also the possibility of choosing among different visualization platforms. During the development of a project, it is very useful to follow a general and flexible implementing path in order to achieve a product suitable for a wide range of technical options. These different opportunities can be taken into consideration in a sequence, depending on the financial resources available and/or on the kind of final user which is desirable to contact. Platforms can range from Web to Desktop, from High End to wireless systems; and these last two technologies can be segmented among further choices, such as Virtual theatres, CAVE systems or Virtual Sets and PDA or mobile phone.

This way of approaching the realization of digital applications can be transposed to the field of decision-making as well. For example, if we analyze the sectors of architectural or town planning or of environmental impact, it is clear that tools have to be tailored depending on how the decision process is evolving and on the peculiarities of the audience that should be targeted (the application can be used, for example, for supporting communication and decisional processes inside the customer's reality or, on the contrary, it can be addressed to an external context). In this field as well it is very important to start from a simple implementation, characterized anyway by a high level of communicative and visual impact, and, then, modify it with a series of subsequent interventions and additions.

2. Modular solutions : some Case studies

A modular development of Virtual Reality applications has its core in the 3D model, that act also as the interconnective point among all the different elements of the application. Because of its key relevance, the digital model must be realized starting from scientifically validated data and using specific strategies conceived for the optimization of the output (that is, capable of involving the viewer thanks to the enhancement of realism but without hampering the fluidity and quickness of the movement in the scene). These aspects are fundamental for delivering products that are, at the same time, scientific and appealing. The other segments of the application are gradually added to the model depending to the availability of time and resources.

2.1 The Certosa Museum Project

The Certosa Museum Project can be seen as a significant example. Through it we have the possibility of following the evolution of a complex project, with several steps of development, in all its main phases.

The Certosa Cemetery in Bologna is both historically and artistically an important monument. Built in an area dedicated to the dead since Etruscan times, it hosted a

Certosino convent until 1797 before finally becoming a public cemetery in 1801 (C. Borgatti, M. Felicori, A. Guidazzoli, M.A. Mauri, T. Diamanti & M.C. Liguori, 2003). It is also among the most ancient cemeteries in Europe but, in spite of its extraordinary importance, the site has lost relevance in the public awareness, maintaining it just in narrow communities of historical and artistic researchers. The Certosa Museum was designed by the City Council in order to valorise and communicate the monument, attract visitors and, at the same time, trying to help its management and protection (http://www.progettocertosa.it). A computer based solution was acknowledged as an effective way for reaching these goals and it has been developed starting from the different requirements of possible users such as tourists, school classes, researchers and the employees working on the management and upkeep of the cemetery.

2.1.1 Content owners requirements and technical solutions

As a first set of data, the City Council of Bologna delivered the plan, as an Autocad file, and the elevations of the area of the cemetery called “Campo degli ospedali” and related to some graves (among which there is the grave of on of the city most important major) and the partisans’ sacrarium. Starting from this information, the modellers realized the 3D geometries, valorised with an ad hoc photogrammetric campaign used for creating two sets of realistic textures (with two different levels of definition, to be used in accordance with the power of the platform). Once the model of the first area had been created, it was uploaded in a visualisation sw, ViSMan, capable of managing the scene and the interaction with it (L. Calori, T. Diamanti, A. Guidazzoli, M.A. Mauri, M.C. Liguori, F. Serafini & L. Valentini, 2003). The addition of some environmental sounds (such as wind, birds or footsteps), inside a navigation system with the user’s point of view (FPS with collision detection and perception of differences over the terrain) the opportunity of using some strategies for optimizing the smoothness of the real time navigation (such as Image Based Rendering, Levels of Detail and the composition of polygonal writings with data coming from a database) have enabled the presentation of an initial demo (L. Calori, T. Diamanti, A. Guidazzoli, M.C. Liguori, M.A. Mauri, and L. Valentini 2003). This first realization made immediately evident the subsequent possibilities in development.

Fig. 1: A view of the 3D reconstruction of the Partisans' Sacrarium inside the Certosa.

The second phase was about, on one hand, the linking of the model to a relational database, a series of descriptive web pages and to other multimedia documents (movies, a song, images) and, on the other hand, the creation and connection of a new 3D model, regarding the landscape, as a different level in the artificial environment. The database is being populated with the multimedia biographies about the nearly 500 partisans buried inside the sacrarium. It has been created by the F. Parri Institute for the History of Resistance but it is still under construction. We are therefore facing a situation in which the production of contents is still in progress and takes a lot of time. Nevertheless, it was possible to link to the model the portion that has been realised and validated up to now. In this way we have the opportunity of valorising from the beginning even partial data and, then, to follow the growth of the database, integrating it into the model without any particular problem. Also for the integration of the landscape level into the 3D reconstruction it was necessary to wait for the availability of the new set of orthophotos and their georeferentiation realized by the Territorial Informative System (SIT) of the City Council.

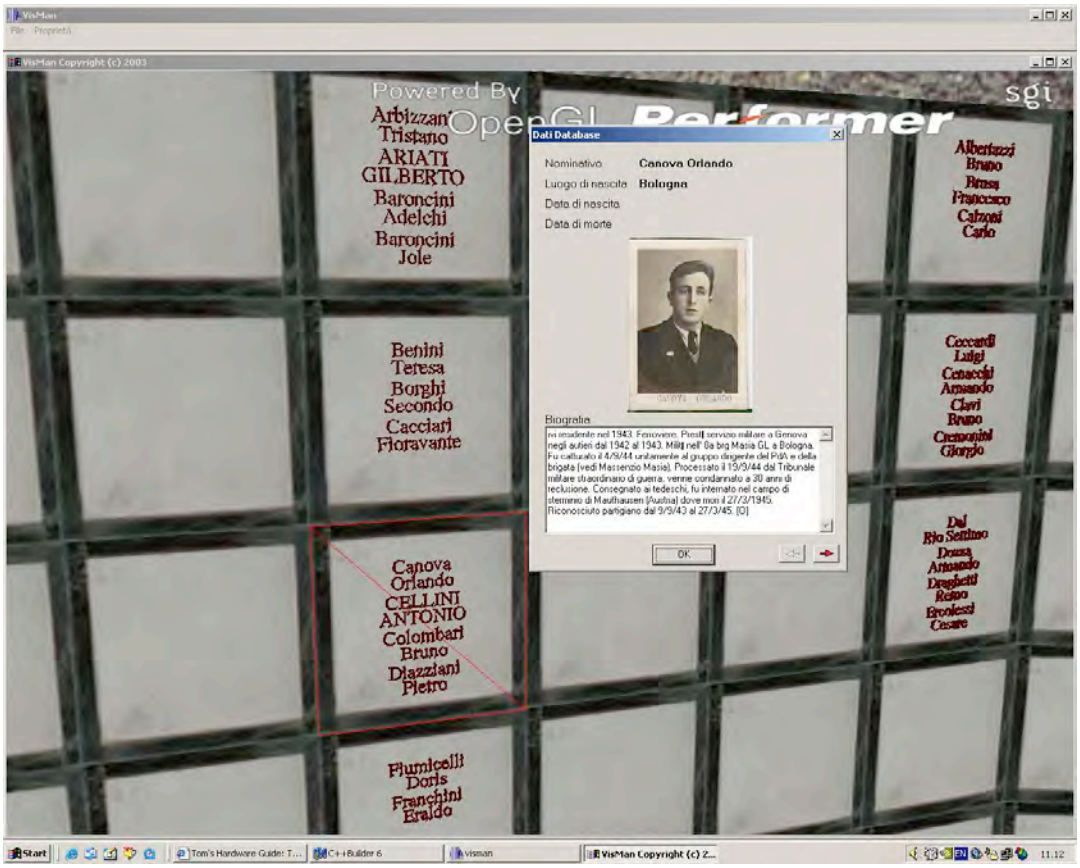

Fig. 2: Querying the multimedia database about the partisans.

Fig. 3: An aerial view of the Digital Terrain Model along with its explanatory flags.

At this stage in the development of the project, the level of scientific, visual and communicative impact was already high enough and therefore it was successfully showed to the City Council commission, reaching the aim of getting new funds in order to implement next development stages. They planned the realization of more 3D models about further areas of the cemetery and the connection to more databases - one about the artistic and architectonic aspects, the other about the land register. The last one should be used by those City Council employees in charge of the management and safeguard of the monumental cemetery, who should take advantage of a tool recently added to the application. This tool was developed trying to meet one of the most frequent requests coming from City Council technicians and while the computer scientists of the team are waiting for the new land register database and the related permissions to use it as part of the application. It enables the user to use the databases for orienting him/herself inside the artificial environment. At present this mechanism has been connected to the partisans' database but, of course, it will be also of great use in the management of the monument when applied to the architectural and artistic database and to the land register one that catalogues all the graves pertaining to the cemetery. The database can be queried so, if the viewer wants to make a selection among the records, a number of filters can be applied to the complete list of names. When choosing a name from the list - filtered or complete - the application changes the point of view automatically, moving towards the corresponding tombstone computing the shortest way to get there. From a technical point of view, this tool could offer a very useful opportunity if applied to the model of the whole city, transforming the entire virtual urban environment into an inquiring reality in which the visual aspect increases even more its relevance in the management of information.

2.1.2 Envisaging users' requirements

The relation with the possible user has been taken into account as a inevitable complement of the above mentioned implementations. Relating to the navigation processes, during the first phase a "casual movement" option was preferred, choosing to trigger the curiosity of the visitor for exploring the digital world. Once inside the 3D model, the user can navigate the space freely, just following what subjectively seems to be the most attractive way, guided by a visual or by a communicative appeal. In order to help the user, while passing the mouse over the scene, it is possible to get some glimpses of

information about the model: in connection to the different areas of the reconstructed Certosa different flags appear showing very short descriptions that introduce to each section. An additional piece of information about the kind of sources that can be accessed relating to that particular area is delivered by the colour of the background of the dialog box. If the small dialog box is yellow it is possible to get only the name of the section, if it is blue there is a link to descriptive Web pages or images and if it is red, there is the possibility of reaching a more detailed model.

After this stage, during which the database about the partisans' was linked to the reconstruction of the interiors of the sacrarium, the attention of the developers has been focused on the intentionality of the users. Regarding this phase is the possibility of querying the database and, as before said, of using it as a tool for orienting the viewer inside the virtual environment. This kind of navigation has been conceived mainly for technical users, such as researchers or City Council employees, trying to promote even more a visual approach to data, but of course it can be satisfactorily used by general users as well.

A further step will be reached through the development of guided tours prepared thanks to thematic paths conceived by the City Council and aiming to specific groups of users or for highlighting specific topics or cultural connections. For example, the tours can be about historical, artistic, architectural or even archaeological aspects. Referring to the last topic, it should be managed by the Civic Museum of Archaeology, that is owner of GIS about the excavations of the Etruscan necropolis found also inside the Certosa perimeter. Of course, guided tours would be of great use to tourists and as an introduction to educational visits.

2.1.3 Different platforms for answering users needs

Specifically referring to different groups of users, the attention focuses also on the opportunities offered by different technological platforms, each characterized by a range of costs and performances.

For this aspect too, modularity has a particular relevance. The first option taken into consideration was conceived for a limited budget and has been developed as a desktop application. This realization is suitable for a distribute fruition; it can be viewed on totems set in key positions around the city, such as at the tourist office in the city centre or at the

Certosa. Even if the desktop was the first option, the models were produced taking in mind the complete range of platforms. As before said, the reconstructions are optimized for a real-time navigation and, for example, have a double set of textures with different resolution. The accurate phase of modelling enables an immediate visualization not only on desktops but in HI End systems as well. Without any further modification it runs, for example, in the Virtual Theatre at CINECA and it will run, as well, in the immersive environment that the City Council is planning and likely to arrange in a building open to the public and dedicated to the History of Bologna. In a further perspective, another platform could be adopted: PDA (Personal Digital Assistant). Mobile systems are increasingly considered as feasible ways for delivering information directly on site. Audio guides are already a common tool for the fruition of contents at museums or cultural sites (archaeological, artistic, historical, and so on); now portable visual guides, and wireless systems at large, are seen as the new successful opportunity (Lattanzi E., and Bogliolo A., 2002). For the Certosa, as well as for other projects developed at the VISIT Lab at CINECA, currently several tests are ongoing (Benini L., Bonfigli M.E., Calori L., Farella E., Riccò B., 2002).

A slightly different path was followed through the realization of a project about the “Casa del Centenario”, a Pompeian villa that is being excavated by prof. Scagliarini of the Archaeological Department of Bologna University. In this case the wireless system was set as a priority, to be used as a support during the on site visit of the villa. Starting from this major aim, the application was developed not only for the Virtual Theatre but also for a television production. The 3D model, flexibly and modularly conceived, was easily adapted to the systems by Orad, used at the Virtual Set of RAI (Italian Radio and Television Broadcasting Company). The 3D model of the reconstructed villa become a virtual scenography and was used as a background in a RAI Educational documentary about the “Casa del Centenario”, its restoration process and its digital reconstruction. At present the documentary is still visible thanks to an on-line mediateque by RAI Educational for on-demand satellite broadcasting (Guidazzoli A., Liguori M.C., Mauri M.A., Salvi R., 2003).

2.2 Bononia DVRa project

Also in another case it was so important to create a modular application, such in the Bononia DVRa project. This project started as a research of the PhD in “History and Computing” by Sofia Pescarin and then kept on being developed inside a interdisciplinary team, composed by different institutions and different skills.

The project’s goal was and is (it is, in fact, still a project work in progress, an application and also an experimental environment) to study the actual and ancient (Roman age) landscape of the city of Bologna, in Italy, through a dynamic interaction with the landscape itself. The initial issue was that such an interaction was possible just with a system capable not only of data visualisation, but also to create a proper virtual environment to manage, in real time, all the information required: historical, archaeological, geological, architectural, and all the data with a connection with the territory (we can say with a geo-reference) (Pescarin, 2002; Pescarin, Guidazzoli, Mauri, Bonfigli, Forte, 2003).

The theoretical and practical development was divided in three different phases: the creation of a digital elevation model (DEM) for the actual city of Bologna, to be used as a base and as a reference; the creation of a model for the territory in Roman times, useful even to do some spatial analysis; finally the building of a “conceptual” model representing the cognitive space of Bononia, the Roman name of Bologna.

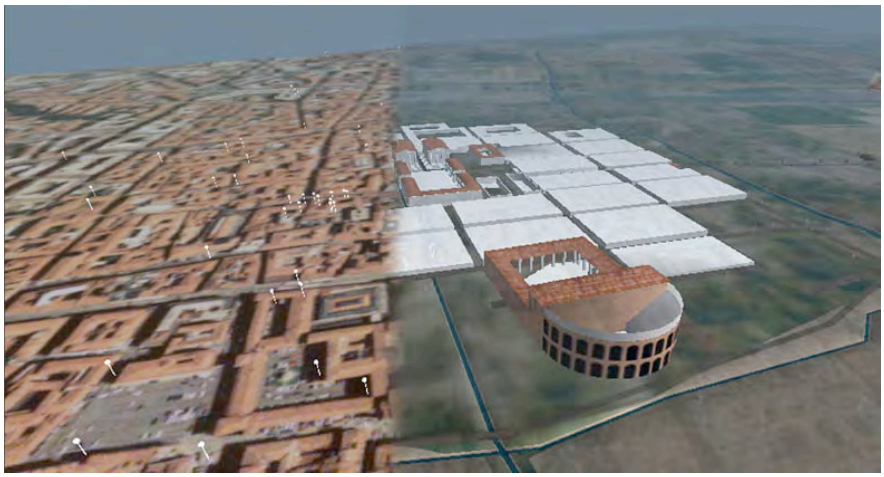

Fig. 4: the reconstructed Roman landscape of Bologna.

We had different sources available: aerial photos, cartography (technical and historical), archive materials and excavation documentations. Technical cartography was used to realised the basic GIS (Geographical Information System) project. Different georeferenced thematic layers (aerial photos, thematic maps, vectorial layers representing main landscape elements such as rivers, roads etc. and data referred to altimetry) were overlaid on the cartography. All the data were used to realised the first Spatial Model of the actual territory of Bologna.

The other sources available were overlaid to this model, after having being processed. We used data useful for the classification and interpretation of the ancient landscape: we acquired, indeed, maps of archaeological excavations done, in the city centre, from the end of the XIX century to the end of the 90's. After being georeferenced, even historical and thematic maps were overlaid, together with various archaeological documentation: information on digging activities, remains, maps, etc..
The goal was to get to the study of the geo-morphological aspect of the territory where Bononia was founded. From the documentation was quite clear since the beginning that most of the remains and sites excavated have been found deep under the actual ground level (2-7 meter). For this reason every analysis, every conclusion related to the Roman city should have necessary taken in account the ground level of the ancient city and not the actual one. Moreover every attempt to reconstruct the landscape should have been connected and related no only to the archaeological remains, but even to their eight above sea level.

To get to the reconstruction of the "Roman ground" we can't consider all the data, but just those well documented and with clear indication of localisation, typology, date, indication of depth. Remains belonging to some classes, such as wells, water pipes, sewage systems, burials, basins, couldn't be taken into account.

The remains, registered in a relational Database, were almost 600, but only 200 were useful for the definition of Roman ground level. They have been georeferenced and placed on the cartography, but not distributed homogenously on the area. For this reason we used a particular algorithm in order to interpolate correctly the points/remains and obtain the digital elevation model.

This model was used to do some spatial analysis that helped us to understand the territory and to obtain an hypothetic reconstruction of the area considered: the city and its surroundings.

In the reconstructed predictive model some questions found their answer, such as the location of the Roman city on the river Aposa, at the eastern end and on another canal, Rio Vallescura, on the western part; such as the position of some artificial structure, such as that in the public centre, where probably there were two twin temples, an architectonic scenario for the Roman forum, the square, heart of the city.

Fig. 5: The Bononian forum: a hypothesis for its reconstruction.

After these long but fundamental phases and in order to have a simpler and easier approach to the archaeological data and to the comprehension of the ancient landscape, we realised a Virtual Reality application. It was planned since the beginning to use data and file format normally employed by archaeologists and to be used either on simple PC either on more complex graphical display, such as virtual theatres.

In this way we give an important indication on the potentialities of such tools, used since now by military and entertainment fields, even for Cultural Heritage. Testing these tools we found out a methodology that could integrate different data and technology, without substituting those traditionally adopted by researchers, academics, museums, etc.

What we obtained basically is a Desktop Virtual Reality System (DVR) that have the great advantage: of maintaining the basic connection with the GIS project and, for this

reason, of keeping perfectly the spatial dimension of the cultural information; of interacting dynamically in real time with visual and multimedia data. Thanks to this system different layers have been imported and some behaviours have been added as well to the virtual world, in order to give the user the possibility to travel in different ways inside the territory, creating its own paths and interpretations. To realised the virtual model of the terrain we used a software, specific for this kind of operation, called Terravista, by Terrex (www.terrex.com).

If GIS allows the user to extract new data, through spatial analysis, just a Virtual Reality System (VR-GIS) can be used to get to new interpretation of the landscape and visions, through an approach that is in the meantime cognitive and symbolic. Thanks to the use of a real time navigator it's possible not only to navigate in the territory of Bologna, but also to test hypothesis in the urban structure.

Conclusions

Manifold technological developments are radically transforming what is possible in the field of new media (K.H. Veltman, 2003). Telecommunications, Television and Internet are converging into a single network. Developments in nanotechnology will lead to electronic devices that will "disappear" from sight and become part of ambient intelligence (J. Ahola, 2001). As a result walls, windows and other surfaces can function as computer screens and interaction devices.

Each medium in the analogue world has its own production cycle which is different from the digital one: we have to link people in charge for content to the ones able to set a context and the communication experts. We need something that goes across, something able to link different views: local, regional, national, international while preserving the complexity of knowledge. We should be able to export the concept of quotation through different media.

Summarizing, the challenge rely on an enduring knowledge linked to a creating new knowledge in multi disciplinary approach.

Virtual Reality as a new medium and interaction with other media in the life cycle of a digital cultural object can be in the future available for didactics in schools, in virtual sets for TV productions and also on the Web by means of video streaming techniques.
Developing ViSMan having in mind the scenarios described before we have paid attention designing future software developments integrating new natural interfaces as PDAs and gestural ones. This new way of thinking is useful because it allows us to experiment an instrument (ViSMan) able to show potentialities of these new technologies specifically with respect to creativity.

Undoubtedly there are trends towards contextualization, objects that describe themselves, alternative interpretations and world-views.

We think that the challenges of finding new ways of visual as well as verbal quoting and new ways of combining universal and particular offer new roads for creativity.

The contextualization of spatio-temporal knowledge means that one can potentially have access to knowledge about any place at any time, linking one's personal impressions with formal ones and having access to multiple interpretations.

The meta data have to be applied to the concept of citation through different media and different type of content as well as for historical validation of reconstructed models.

Traditionally treatments of spatial forms have been the domain of those in Geographical Information Systems (GIS) but the Bononia DVRa experience demonstrates a new opportunity. With respect to the Certosa Museums project has shown how a specific space could also be treated temporally such that one can trace the evolution of a site from the Etruscan time to the present. If applied systematically such an approach would open enormous possibilities with respect to our abilities to access information. The databases need to be linked with new editing tools whereby both verbal and visual quoting are an integral part of the software, where access to enduring knowledge is combined with spaces for collaborative and personal creation and co-creation.

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