Argumentation paths in Information Infrastructure of the Archaeological virtual realities

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Efficient documentation and annotation of digital multi dimensional data, is a critical challenge for contemporary research in virtual archaeology. Means to document precisely the increasing amount of information stored in and derived from the archaeological virtual reality simulations has become essential. This paper discusses the documentation and management of archaeological virtual reality documents. The focus is on defining theoretical premises for managing VR as a feasible research tool and a communication media in archaeology. The issue is conceptualised by using theories of argumentation (Freeman 1991; Kircz 1991; Sillince 1992) and of infrastructures (Star and Ruhleder 1994, Star 1995). An outline of "argument paths" method is proposed as an approach of enhancing usability of the archaeological virtual realities as publications.

Introduction

Virtual archaeology suffers from a paradox of simultaneously lacking and excessive resources. From a researcher's point there is seldom enough information about a particular site or subject to make satisfactory virtual representations of the past. From an information management point of view, virtual archaeology produces an excessive amount of information and archivables that makes their efficient storage and occasional retrieval a critical issue. The key for managing both, the non-existent information and as a consequence, approximations and inconsistencies, and the existing data in the virtual models, is to develop functional measures for efficient and communicative documentation.

This article discusses the documentation and usage of virtual reality documents in archaeology from an information management point of view. The focus is on defining theoretical premises of how and why a virtual reality (VR) might be a feasible research tool and a medium of communication in archaeology. The issue is conceptualised by using argumentation theory (Freeman 1991; Kircz 1991; Sillince 1992) and infrastructures (Star and Ruhleder 1994, Star 1995) as a theoretical framework. A notion of "argument paths" is proposed as a basis for enhancing usability of archaeological virtual realities as publications and a form of information storage. Special emphasis is placed on supporting the functionality of the documents by considering appropriate documentation strategies.

Archaeology and Virtual Reality

During the period from the mid 1990's to the present, multidimensional visualisation techniques have established themselves as a standard instrument of analysis and tool of trade in archaeology and cultural heritage work. A quick survey of the recent literature gives an impression that the techniques have been tested and applied rather widely in different sectors of archaeology and cultural heritage work. The use of the virtual reality technologies varies, however, considerably from one expedition, excavation, institution and project to another, and the skills and experiments seem to be geographically somewhat unevenly distributed in different institutions, countries and fields of study. In Europe, the EU development, research and technology programmes have contributed, on one hand, to an emergence of a number of advanced projects and, on the other, basic development efforts in low-resource countries, but the actual involvement seems to depend considerably on individual participants' personal skills and interest.[1]

In spite of the multiple projects and conceptual ponderings on the topic, a question remains that what is an archaeological VR. An important aspect of a virtual reality is in its non-linear structure. In this respect, virtual realities resemble other digital forms of media such as hypertext, which is similarly a descendant of the postmodern ideology of making non-linearity a standard aspect of media experience. Another approach to the nature of VR is to focus to the question of that what is virtual and what is reality. Considering the proper meaning of the combined notion of virtual reality, a VR can be hardly limited to denote in a theory-free manner a mere three-dimensional sibling of cross-sections and plans, even if this type of an approach was rather strongly argued by Gaiani (1999). Instead of calling a multi-dimensional visual documentation technique a VR as Gaiani, a 'proper' historical or archaeological virtual reality that takes into account the multidimensionality of the notion of VR, could rather be defined as a dynamic projection of an assumed past reality following a suggestion by Barceló (2001). A virtual reality could be seen as a virtual form of an essentially 'real' phenomenon. A multi-dimensional document can be a representation of recent field documentation work, it can be such a document that is complemented with assumptions, hypotheses and theories, but it can be a virtual form of a reality only when it is a virtual reality. Finally, following the thinking of Barceló and Millette, an important aspect of a VR is also that it is always a theoretical composition, not a copy of some other form of reality or something that belongs to a non-virtual reality *as is* (Barceló 2001; Millette 2003). It is a document, but as such also something that need to be documented in order to be communicative.

A rather unsophisticated conceptual and practical approaches to virtual archaeology and archaeological virtual realities,[2] can be helpful because of the present challenges related to the illusion of false completeness that are easily summoned by photorealistic presentation. (Eiteljorg 2001) Because an original plan or documentation produced by an excavating archaeologist (an eyewitness account) is already a highly theory-laden construct, a virtual reality of the past that is an accumulation of multiple archaeological and historical interpretations, is necessarily even less theory-free. Therefore, an essential value in creating a virtual reality or "writing space" (ref. Bolter 1990 and 1991) and studying it ("reading the space") is the possibility to develop and express educated arguments. The value of an excavation report is in reporting minute details, but the value of an archaeological virtual reality is a possibility to filter the details and to test and express complex hypotheses.

Multiple dimensions of archaeology

The multiplicity of the different possible approaches to archaeological virtual reality applications raises a question of consequences. Many of the possible practical benefits of VR in archaeology proposed by Maurizio Forte (2000, 250-251) have by now (had not by then) been realised in various projects. Further, a number of new uses for the techniques have been introduced since then. In contrast, the second question presented in the same article of the extents of virtual archaeology as a phenomenon (Forte 2000, 250), has received considerably less attention in the literature.[3] In spite of the diversity of projects and definitions of (and the definitions used of), virtual reality applications, the overall aims of VR in archaeology have remained more or less the same from the beginning. Virtual realities are seen as a visualisation technique. As a somewhat provocative generalisation, it might be argued that even the most of the researchers that are aware of the conceptual problems of the 'virtual reality' visualisations, wash their hands of the problems by emphasising their scientific and scholarly aims at the same time when the final published results of their efforts are aestheticising images of the past monuments instead of virtual realities in any real (or virtual) sense. The scientific rationale of using virtual realities is seldom explained in the accounts of the practical applications of the concept.

Considering the theoretical and practical limitations of the current approaches, the main aim of archaeological virtual realities should probably not be to create a perfect spatio-temporal simulation of the past. The aim could be to focus on how this approach might contribute to the practical scholarly research and how to improve the understanding of the past of the general public. In both cases, the question is essentially about communication. Barceló (2001) discusses the question of the future of archaeological virtual realities and insists on the necessity to implement a true form of interactivity by placing the focus of virtual reality research in archaeology to the communication aspect of the VRs. According to him, this is necessary before the user experience may reach a state of a proper virtual reality. The importance of communication may be justified also by the most commonly expressed explicit motivation of creating archaeological VR applications: disseminating knowledge of the past (Forte 1997, 12). In this discussion and similarly, in the present paper, the notion of communication has to be understood in a rather inclusive manner to comprise communication within scholarly communities, communication of science to the general public and also communication by a scholar to him/herself. In this sense even the motivation of creating virtual realities for personal research may be seen as a form of communication during which a scholar arranges source data in a manner that the data communicates back to the scholar him/herself.

From the documentation point of view, the various problems of the communicativeness of the archaeological virtual realities have been recognised as a serious practical issue only rather recently. The fear of not being able to deliver information on the accuracy of archaeological data and the premises of different interpretations to the audience has lead to a discussion of the practical possibilities of documenting archaeological entities properly in a scholarly sense. (e.g. Ryan 2001, Pekkola 2002; Niccolucci and Cantone 2003, Vatanen 2003) As noted already (Vatanen 2003), the debate has been focused, from a quite atomistic point of view, on rather mechanical issues of inserting this-and-that kind of metadata to the documents, instead of discussing how and for what purposes the VRs are actually expected to be used, and how their practical usability could be supported.[4]

Barceló refers to Holland and Stornetta article of 1992 "Beyond being there" that discusses the problems related to an assumption that traditional face-to-face communication functions similarly whether it is mediated by a computerised environment or not. The frailty of the assumption is confirmed in a number of usability trials (E.g. Chen & Czerwinski, M. 1997; Westerman & Cribbin 2000; Büscher et al 2001). Consequently, as long as the experience of computer mediation is apparent and as long as it effects the human experience, using a VR is different than experiencing a 'non-virtual reality' (NVR). However, in spite of the differences between computer mediated and non-computer mediated communication (and VR and NVRs), the two modes are not entirely unrelated. The effects of computer mediation are complicated, and therefore functional usability of digital systems, whether VRs or others, depends on an interplay of both traditional and novel communicative techniques and approaches. Recent research on the premises of human-computer interaction (HCI) and especially on computer supported collaborative work (CSCW) has suggested a number of functional approaches to deal with the problem.

A widely discussed paper "Steps towards an Ecology of Infrastructure" by Susan Star and Karen Ruhleder (1994) examined a collaborative computerised environment called Worm Community System (WCS) used by biologists studying genetics. The authors conceptualised the focus of their research by using a concept of an infrastructure to make visible the choices, politics and relations traditionally invisible in the structures. Star and Ruhleder use the notion of infrastructure to conceptualise a relation between different entities rather than an entity, or a thing, itself. The concept has become popular especially in (management) information and knowledge systems, CSCW and classification literature. (Bowker & Star 1994; Monteiro et al 1994 etc.)

The point where a computer system used genetists and the concepts of collaborative work and infrastructure meet archaeological virtual realities is that they all relate to a common aim of making something collectively known and used. Even though a VR is not a work group, strategies developed in and applied by CSCW research may provide a useful basis for enhancing the communicative capabilities of archaeological virtual realities. To underline the nature of archaeological virtual realities as communicative artefacts rather than copies of reality, it is suggested that an archaeological VR may be conceptualised as a dynamic (in the sense of historic processes, the transitions in the archaeological stratum and the model, e.g. Barceló 2001, 224-229) multi-actor (the initial, historical creators and users of the present material cultural remains, their excavators, researchers and the present and future public audiences) infrastructure in which different identifiable and implicit measurable and immeasurable 'facts', interpretations, ideas, political views, possibilities and motivations coexist.

Infrastructures and beyond

As such, the conceptualisation of virtual realities as infrastructures does not imply anything practical. Infrastructures become operational if the essential characteristics of infrastructures are mapped to an archaeological VR with a specific consideration of the relations between the representation of represented entities, their representations and place in within the infrastructure (Star and Ruhleder 1994), and especially the essentially political nature of the entire infrastructure (Star 1995).

On a certain level, the documentation of virtual realities, as a task of attaching descriptors to entities, is a rather

trivial operation. Intensive work for functional specifications and standards, and research conducted on their premises, usability and use will be definitely needed. The multiple problems discussed and addressed in the context of the recent major documentation related efforts such as the Semantic Web initiative of W3 Consortium (www.semanticweb.org and www.w3.org/2001/sw) or the compilation of the CIDOC Conceptual Reference Model should not be underestimated. The practical and technical solutions do not, however, provide an unambiguous answer to the question of the consequences of the documentation work and the use of certain semantic models. However, even if it would be conceivable that a unequivocal formal description of the semantics and an ontological model of archaeological VRs will be available in the future, it is unlikely that even the ideal documentation framework would be nothing but a complex and highly obscure structure from the perspective of an individual archaeologist or a member of the general public even if the model would supplied with an advanced set of productivity tools and guidelines.[5]

A notion of the obscureness of documentation data, upon which the argument in this article is largely based on, is by no means a novel one. Kircz (1991b) questions the efficiency of content driven data indexes. Meta-data schemes are a good example of them. He suggested that argumentation rather than content driven approach would be a considerably more efficient from the point of view of information seeking tasks. Sillince (1992) broadens the approach and proposes an arguer search programme for retrieving theoretically all types of academic articles. The use of rhetoric in non-linear documents is further discussed by Juby (1996) and Carter (2003).[6]

The problem with the approach presented in the original Kircz model, is its rather mechanistic and mono-disciplinary nature that restricts its usability in scientific and scholarly disciplines with different types of publishing cultures than in the discussed example of physics. The same has been noted to apply to other discourse based documentation schemes. Schemes tend to be rather domain-specific that tends to make them unsatisfactory in general contexts of usage (Teufel et al 1999). Restricting the documentation to a rigid framework of a single form of discourse would (even within a single discipline) cause difficulties in adapting to paradigm changes, new methodologies and extra-disciplinary influences. In spite of the shortcomings of the general approach and article-centricism of the proposal, the Sillince (1992) arguer programme does provide a basis for considering how to develop a new type of framework for simultaneously conceptualising (as they 'are') and describing (as they are perceived) archaeological virtual realities.

In a somewhat more recent article, as a contribution to the question of the shifting forms of scientific publication and representation, Kircz discusses the question of the new layout of scientific writing (Kircz 1998). He argues that as a product of historical evolution, the article could be replaced by a format that is more suitable for the electronic environment. It is plausible to assume that a scientific publication that would break the traditional form of a scientific article might have prospects to establish itself especially in the contexts where such 'forms of representation' such as hypertext or virtual reality have specific significance or potential. A possibility of radically different forms of scientific and scholarly publishing is rather self-evident in the on-going discussion about the use of a virtual reality as a scientific publication, but unlike Kircz, the debate has tended not to addressed the essential link between scientific and scholarly work practices and the virtual reality form of publication. The Kircz suggestion (1998) of

documents that would consist of modules is not entirely unproblematic as a generic replacement for a scientific article and, in the end, it may also be seen as a rather conservative approach to breaking the form of publications.[7] It may be suggested that the both debates might benefit of the infrastructural approach i.e. a focus on publication more as an infrastructure of research work than a form (or structure) of representation.

Combining the argumentational and infrastructural approaches together has a number of practical difficulties. As recognised by Star (1995) regarding the information structures,[8] every formalised set (of data) is in a sense a political entity (an argument) and therefore a structure presents only a subjective view of the thing it represents. The evident inconsistencies have to be accepted and also expressed in a meaningful manner. From the documentation point of view, it is thus inevitable to include an explicit political dimension into a VR. As suggested earlier, conceptual models can be used to describe data, describe data about data, and relations between different data elements. In representing politics and inconsistencies though, the models based on formal, or even fuzzy, of models tend to be weak. In this sense the Star and Ruhleder (1994) view on infrastructures could provide a plausible functional framework for defining the premises of a documentation scheme, and the notion of argumentation, could complement this with the methods and techniques of expressing the content. In an ideal case the arguments should be transparent in such manner that opinions, their nature and their degree could be distinguishable from each other. This presents two important conditions to the practical realisation of an infrastructure: (1) that the practical infrastructures consist of co-existing, interrelating, controversial, conflicting and incomplete structures that still complete each other. (2) Infrastructures have to be able to be evaluated, not by absolute values, but on relative, explicitly argumentative scale that relates itself to relative yet somehow established categories.

Infrastructures of Paths

Making a practical tool out of the infrastructures a difficult task. Both the communication and dissemination of arguments are rather non-graphic processes that are difficult to represent in a multi-dimensional environment. Communicating an argument to an audience is according to the classic rhetoric theory, a progressive task that consists of cycles of motivation and presentation. The strategies are still conceivable in non-linear contexts, although not necessarily readily exploitable by using any conventional approaches.

Carter (2003) discusses the aspects of rhetoric that functions in hypertexts. The different tactics of expressing arguments in non-linear documents presented by Carter may suggested to be usable (to a degree) also in virtual realities. In the documentation sense, there is, however, an essential difference between the two. Thinking of the purpose and place of the documentation, in a hypertext the argument may be expressed literally within the document (as a part of it), but in a virtual reality we have no similar explicit conventions of expressing arguments.

Of the argumentative tactics presented in the literature, the Freeman argument analysis offers a functional basis for developing a metaphorical structure for expressing arguments in virtual reality (Freeman 1991). Freeman extends an argument diagram presented by Toulmin (1958) to cope with larger arguments consisting of a set of sub-arguments. An illustrative visual metaphor of the argument structure could be a path that leads the audience, not

necessarily straight but often bending, that crosses and unites with others, and passes through a number of stages before reaching a final conclusion. The path metaphor is drawn as a practical proposition for coding arguments functionality into the virtual realities.

A path is defined in this context as a basically linear structure that guides the audience through the essential entities of a VR. Depending on the level of ontological information attached to the virtual reality document, an argument path can be constructed as a flat list of references to different relations and data objects in the ontological data (level A). This presupposes, however, that the presence of motivation -type ontologies (because that, because_of, due_to, derived_from), and support for expressing and tolerating inconsistencies, probabilities and assumptions within the ontology. A less developed variant of argumentation paths (level B) can be accomplished as a list of references to specially written objects containing the sub-arguments. Level C represents the trivial case of an external document with references to the VR describing the argument.

A path is suggested to require to possess certain qualities:

1. A path is a list of references (nodes) that represent sub-arguments, and forms a complete end-argument.
2. A node may be descendant of one or more nodes of one or more paths.
3. A node may be an ancestor of one or more nodes of one or more paths.
4. A node may belong to one or more argument paths.
5. An unlimited number (or zero) of paths may refer to a single virtual reality document.
6. Each path and each node has to have an owner (a person e.g. a scientist) that is explicitly intellectually responsible for the (sub)-argument.
7. Arguments and sub-arguments of different paths may contradict, support or interfere with each other.
8. Sub-arguments within one path may not be contradictory with each other or with the end-argument of the same path.
9. The path is supposed to communicate the sub-arguments and the end-arguments. Path becomes invalid if this requirement is not met.
10. In levels B and C the means to describe the arguments and the sub-arguments should not be explicitly restricted to any particular format or media of presentation. Descriptions can be (short) scientific articles, but any other form of scientific communication has to be considered acceptable.

An outline example of a hypothetic argument path might be represented by using the following pseudoformula:

1. TELL node_name call_name_of_the_entity_the_virtual_reality_represents
2. TELL node_name who_formulated_the_argument
3. TELL node_name call_name_or_id_for_the_argument
4. TELL node_name when_the_argument_was_formulated_and_revised
5. TELL node_name sub_argument_1_and_refer_to_motivations
6. TELL node_name sub_argument_2_and_refer_to_motivations
7. ...

Below, as a more practical example, the formula is applied to a argument made on a virtual reality constructed on a Roman republican era anchor:

1. TELL "2" NAME ! "La Giraglia wreck anchor" (Marlier, Sabine: La Giraglia, a dolia wreck of the 1st century BC from Corsica,France: study of its hull remains. IJNA (2002) 31.2: 161-171).
2. TELL "3" ARGUMENT_BY "Isto Vatanen <ivatanen@abo.fi>"
3. TELL "4" ARGUMENT_FORMULATED "2003/03/04"
4. TELL "8" ARGUMENT_REVISED "2003/04/16"
5. TELL "6" SUBARGUMENT !(reference to four moulded astragals) !(reference to those identification to Venus coup) !(reference to Marlier 2002, 169)
6. TELL "8" SUBARGUMENT !(reference to source 2)
7. TELL "8" SUBARGUMENT !(reference to decoration) FOUND_AT ((reference to site location) and (reference to a location information of source 2)
8. TELL "FINAL" ENDARGUMENT !(reference to decoration) CARRIES_ATTRIBUTE (likely not uncommon in Roman world) AND CARRIES_ATTRIBUTE (during the late republican times)

The proposed example is intentionally simplified to illustrate the basic capabilities of the argumentation paths - approach.[9] With the same basic framework it is possible to refer to considerably more complicated arguments including ones referring to dynamic components in the model, but also more simple argumentation diagrams of the Freeman categories (Freeman 1991).

Conclusions

The question on how to document effectively the genre of documents referred to as "virtual realities", is not a problem related also to virtual archaeology. The demand for efficient management of information stored in similar documents is critical also in a number of other applications. Mutual benefits should and could thus be found in interdisciplinary efforts. The large and relatively unique variety of source data in multiple formats, the temporal span, scientific uncertainties and inconsistencies, and especially rather well established methods for coping these inconsistencies make archaeology an interesting case from a more general point of view related to the future of scientific publication.

The proposed method for virtual archaeology documentation has to be considered as an approach. The recent research in documentation and presentation of non-linear information has clearly shown that even though the general aims of the different actors are relatively consistent, the supportive methods for an effective use of information differ considerably. Argument paths intend to contribute on the issue of difficult comprehensibility in the content-based documentation. Further research is definitely needed on descriptors and the data upon which the argument paths are to be built. The most critical question is though the direction to which the usage patterns of the virtual realities are evolving: what for and for what purposes the virtual is used in reality.

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1. An quick survey was conducted by examining a random selection of recent archaeological publications, the BRITARCH-mailing list archives and European Union projects database at Cordis-server (www.cordis.lu).

2.The term "virtual archaeology" is used of a discipline working with archaeological virtual realities, in practise mostly visual, but essentially anything digital and virtual in an academic sense of the meaning. (C.f. Reilly 1991; Forte 1997; Renfrew 1997)

3. Few papers and articles (e.g. Barceló 2001; Jablonka et al 2003) address the question, but the general debate and questioning of the "what is being done" has remained almost non-existent.

4. The need for broader understanding of the potential position of VR in archaeology does not imply that metadata research is insensible as emphasised already in Vatanen 2003, 73-74.

5. In the sense discussed in this article, iit s important to note that the on-going semantics and ontology -projects aim to introduce and empower machine-readability of human-readable documents, not to enhance the structure of documents from the human reader point of view.

6. The general argumentation theory used in the presented texts is strongly influenced by the New Rhetoric of Burke and Perelman, (see Kircz, Sillince and Juby) and the treatise of Habermas (1994) that sees argumentation as a essential characteristic of a human society.

7. Kircz proposal actually resembles Carter's (2003) tactic 1 of writing hypertexts with a minimal number of nodes.

8. The question of the relative nature of accuracy of information and interpretations is not a novelty for archaeologists or historians, but is reflected rather poorly in information processing and storage systems. See e.g. Skeates 2000, 104-107; Sidiropoulos & Sideris 2003, 65 on issues relating to uncertainty in virtual archaeology.

9. A small scale Java application framework "VRDocTOOL" has been prepared for practical documentation and consistency tests.