

## 04 | 3D MODELLING AND VISUALISATION

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### Does Virtual Archaeology Exist?

*Abstract:* The present paper takes Paul Reilly's article "Towards a Virtual Archaeology" as a starting point to expose a reflection about the epistemological implications of virtual reality for archaeology. In his contribution at CAA90, Reilly talked about "solid modeling" and indicated that this new tool would inevitably push archaeology towards a new scientific stage. After fifteen years of diverse implementations, have we reached this "virtual archaeology" towards which we were moving? Has virtual reality (VR) modified the debate over archaeology's epistemological foundations? This paper addresses this question, firstly by developing the underlying implications of Reilly's publication, and secondly by examining the field's current state of the art applications and vocabulary. This comparison between the potential and the actual uses of virtual reality, especially for dissemination purposes, will demonstrate that archaeology never became "virtual" in the way Reilly expected, because the traditional concept of archaeology was reinforced instead of being transformed by VR technology.

#### *"Towards a Virtual Archaeology"*

In 1990, Paul Reilly presented at this same conference the paper "Towards a Virtual Archaeology" (REILLY 1991). In his contribution, the author talked about "solid modeling" as a tool for the management and analysis of archaeological records which transcended the simple description of graphic visualization techniques because, he claimed, this new tool would take the relay of previous research methods and inevitably push archaeology towards its next, finally scientific, stage. After fifteen years of practice in research and dissemination, have we reached this "virtual archaeology" (VA) towards which we were supposedly moving? Have computer applications, and more specifically virtual reality (VR), modified archaeology's internal debate about its goals, methodology and epistemological situation?

This paper will try to answer this question and, taking Reilly's publication as a starting point, will present a reflection about the theoretical issues related to VR applications in archaeology. To that end, it will undertake two tasks. In the first

part, more closely related to research applications, it will develop the implications of Reilly's three main underlying arguments. In the second part, more closely related to dissemination applications, it will present the results of some case studies and it will analyze the field's current vocabulary. The comparison between the potential capacities and the real uses for VR, especially with regard to dissemination, will demonstrate that Reilly's expectations have not yet been accomplished because, due to several internal and external reasons, the incipient "virtual archaeology" – then mainly referring to scientific modeling of processes – moved towards "virtual heritage" (VH), which instead corresponds to hyper-realistic reconstructions of objects and monuments and thus reinforces the traditional cultural materialistic conception of archaeology. Finally, the paper will present some suggestions about the different uses of VR in archaeology and will show that Reilly's initial proposal is still valid, although the use of the new name he suggested was not only unnecessary but even detrimental.

### *Three Arguments for a Virtual Archaeology*

#### **The Nature of Archaeological Data**

Reilly's proposal was implicitly founded on the premise that VR is suitable for archaeology because both work with the same basic units. It is interesting to note that all epistemological trends in archaeology coincide in this point, acknowledging the usefulness of VR for the visual presentation (and manipulation) of spatio-temporal data. There are four ways to understand space: Aristotelian (space is static, hierarchical and concrete); Newtonian (space is like a net in which objects and events are located); Leibnizian (space is relational and defined in terms of these relationships); and Kantian (space is a way of apprehension imposed by the human mind over an external unknown reality). While the first three have predominated in geographical studies, the latter has been applied to human cognition. The Newtonian and Leibnizian perspectives postulate that space is regulated by a set of physical laws that can be scientifically measured thanks to the analytical potential of Euclidian and Cartesian geometry. Thus, space becomes an empirical, objective reality, external to us. This is the concept underlying processualist archaeology and most VR applications. However, this essentialist perception gave later place to a new concept of space, which understands it as a social construction (DODGE / KITCHIN 2001) or, in other words, which put the emphasis on Kantian intuitions. This is the concept underlying recent post-modern VR applications.

The middle solution would be to distinguish between two different concepts: "physical space" (which can be mathematically, a priori formulated) and "spatiality" (a notion derived a posteriori from the space constructed by human relations and perceptions at different scales). This conciliatory concept follows Leibniz's relational perspective and matches information and communication technologies (ICT) because, lacking physical entity, Cyberspace is neither continuous nor ordered, and in that context meaning is created through the different kinds of relationships established between elements through "actualization" (LÉVY 1995). In the case of VR, a spatial dimension is purposefully added; yet, because it is a virtual representation, it cannot act as a full ontological entity but rather as an epistemological one. VR offers the advantage that, because it combines iconic representation and computational

calculation it can integrate and make explicit both Euclidian/Cartesian analyses with new postmodern ideas about perceived space.

Time, on the other hand, would seem to be more stable because all actions performed within Cyberspace happen in real time. However, our concept of time has always been linked to the instruments created to measure it. From first solar, sand or water clocks to mechanical analogical clocks, there has always been a direct or indirect relationship between the instrument and a physical, spatial transformation in our universe. On the contrary, numerical time does not make reference any longer to a preexistent astronomical model. It is virtual, it does not exist outside the electronic impulses emitted by quartz or internal computer clocks taking as a reference the stability of crystal frequency (COUCHOT 1989). Therefore, with computers time has stopped being continuous and inexorable; it has become autonomous, another variable that can be manipulated and operated by the machine.

This is very relevant for empirical sciences studying long-term processes and particularly for archaeology, because until now it had to deduce the temporal dimension only from the spatial distribution of artifacts, experimental studies or ethno-archaeological analogies. On the other hand, the inconvenience inadvertently inherited by archaeology from geographical studies and tools, is the adoption of a static approach, which does not take into account that time conditions the materialization of human activities (DODGE / KITCHIN 2001). Therefore, VR offers an invaluable scientific tool because it puts together the spatial, the temporal and the behavioural simulations. Its computational virtuality can perform operations without being limited by time or materiality. At the same time, it keeps an isomorphic/analogical relationship with the world, which is convenient for scientific purposes because the simulation's features and behaviour are considered equivalent to the reality. In this sense, VR can become a revolutionary tool for archaeological inference and verification because the combination of iconic representation of spatial data with artificial intelligence programming allows representing and simulating the processes which have originated the results observed in the archaeological record. Another advantage is that it obliges the modeler to eliminate vagueness and make explicit the basic reasoning processes, concepts and problems. Considering that

defined languages and explicit procedures are the basic characteristics of fully scientific domains, this demonstrates that VR can play a fundamental role in the epistemological debate.

### The Origin of VR's Introduction into the Field

Reilly's belief about the epistemological potential of VR started from the idea that basic technical needs prompted the adoption of technology and ultimately this would have had an impact at the theoretical level. The future development of VA has been said to depend on three factors: the technological and communicational evolution; the digital elaboration of archaeological data; and the theoretical discussion within the scientific community (FORTE 2000). It is historically proven that technological development has always been a motor of development for sciences. From this point of view, we can consider that archaeology stayed at a standstill because it was limited by the materiality of paper, while now ICT has opened new horizons of development which should necessarily induce a theoretical "adaptation". However, as the evolution of science also demonstrates, the availability of technical improvements is not enough, especially if they are external. The real transformation of paradigm is only accomplished if or when the field is epistemologically prepared for it. That is, when the addition of discoveries which do not fit current theories makes more and more people doubt them and try to find another framework that can satisfactorily include them. Or, conversely, when the theory exists but needs empirical evidence of its previsions to be proven. Therefore, the present transformation of any discipline cannot be totally due to external factors because without a pre-existent theoretical anchorage, it will remain totally impermeable to the influence of "cyber-culture".

Yet, in archaeology, this preparation already exists – for example, Jean-Claude Gardin's philosophical basis (GARDIN 1990). Unfortunately, the theoretical transformation remains limited: until now, quantitative methods and computational applications have only influenced data gathering, management and basic analytical levels, but not higher levels, which really determine the epistemological debate. Some authors believe (ORLANDI 1999) that archaeology has no methodological need for ICT but that they can be useful from a practical, technical point of view. The reason is that archaeology itself continues to be

essentially descriptive. Consequently, VR applications have consisted mainly of reconstructions of monuments where people accomplish a decorative function instead of being shown as agents of change.

### The Explanative Goal of the Discipline

According to Reilly, the goal of archaeology was to offer causal explanations. This makes VR really appropriate because, as previously mentioned, it allows the verification of hypotheses about the causes that led to the present archaeological record, through the simulation of human and natural processes. However, all present virtual reconstructions invariably come across the impossibility of going beyond verisimilitude about how the past "was". This is because not even archaeology can go beyond this verisimilitude: its current scope confines it to the simple description and superimposed interpretation of material remains.

CAA07 has definitively established the spreading of VR's more scientific uses. However, all these applications, even the experimental ones, relate to the site and not to the social and natural agents behind the formation of the archaeological record. The only way to go a step further and be explanative is to pose questions starting from the present. Hence, archaeology should ask for the causes of the social phenomena observed nowadays (BARCELÓ 2001). Causality is indissolubly linked to time and takes the shape of processes, the origin of which has to be looked for in the past. However, since the past does not exist anymore, the temporal development of social systems must be analyzed indirectly, through the physical, observable consequences they left along these processes. Unfortunately, the more indirectly objects are linked to their causes, the more they will be liable to subjective interpretation. Consequently, archaeology should be – in contrast to history, which can also deal with intangible phenomena – the historical science specifically devoted to questions related to material culture.

If the final interest of archaeology is not focused on sites and objects but on the present society as a system which creates and is created through material culture and space, it will find in VR a fundamental explanative ally because both work with the same basic units, because VR combines the advantages of programming and visualization in a single flexible

tool that can integrate GIS functions, simulation, modeling, CAD, etc. and because it acts as an iconic interface, which facilitates the operation to those who are not familiar with the previous techniques. Consequently, the goal of archaeological simulations through VR is to interpret empirical data according to a new dynamic geometrical language that allows manipulation to test and understand causal processes. This is how archaeology becomes, at least on some level, an inferential cognitive science.

### VA Today

#### Analysis of VR Applications

In previous works (PUJOL 2004) the concept of VR and its applications in the field of cultural heritage were studied. These works as well as the present paper have been supported by a scholarship granted by the Catalan Government (FI, III Pla de Recerca de Catalunya 2001 / 2004) and a Marie Curie EST Fellowship of the EU's Sixth Framework Programme (CHIRON, contract number MEST-CT-2004-51439). Several examples were chosen (Fig. 1), spanning from the introduction of VR in the field to the most recent displays, covering different countries and all kinds of existing interfaces. For the analysis several variables were considered:

From a general point of view, the choice of VR technology depends both on the object of study and on the goals and methodologies defined by the disciplinary field. In the first case, the representation of an object might not need more than a PC, while the reconstruction of a cave or a landscape will be improved inside a CAVE®-like device or a Virtual Theatre. Seemingly, creative works tend to be situated in a fully virtual world, while descriptions or explanations of the real world tend to use Augmented Reality systems. In the second case, "scientific" fields regard VR as a model for research and experimentation, while "humanistic" fields use it as an illustration for dissemination and observation.

The analysis of the nine examples demonstrated that in archaeology most applications are conceived as a Desktop system (regardless of the screen size). The reconstructions allow, at most, navigation but not real transformation of the model because the resource is understood as supporting a unidirectional transmission of information. On the other hand, all of them try to achieve a full photorealism, independently from the interface, the use or the location. The oldest examples used textures and colors; later applications looked for realism in buildings and environments. Now designers have turned their interest to realism in human bodies and movements. The development of this trend, totally oblivious of

	Presence metaphor			Interactivity			Realism			Utility	Location			Institution
	Desktop	CAVE	RA	0	1	2	0	1	2		In.	Out.	Web	
Longmarket	x			x			x			DM	x			MU
Dudley	x				x		x			DP	x			
Vilars1	x			x				x		DM	x			U
Vilars2			x	x				x		DM		x		U
Vilars3	x				x			x		DM			x	U
Mur	x				x			x		DP	x		x	U
Baetulo	x				x			x		DP	x		x	E
Dunhuang		x		x					x	DM	x			U E
PDA			x	x				x		DO	x			
ARCHEOGUIDE			x	x				x		DM		x		M E MC
Meta-Museum			x	x	(x)			x		DM	x			U

Interactivity: 0 = observation; 1 = navigation; 2 = model manipulation.

Realism: 0 = textures and colors; 1 = combination; 2 = photorealism.

Utility: DO = object description; DM = monument description; DP = description of the past.

Institution: E = Enterprise; M = museum; U = university; MC = Ministry of Culture.

Fig. 1. Analysis of VR applications.

Non-Photorealistic Rendering capacities and helpfulness, demonstrates that the level of realism is only a function of the technological capacities, not of the models' utility. In this sense, most reconstructions are aimed at the description of the monument. Consequently, these applications allow a superficial learning about the more evident aspects of material culture but not about social causality or methodology. All these features are irrespective of the institutions which participate in the project and seem to be more related to the addressee: some models (KADOBAYASHI 2000) were implemented at universities for scientific purposes, but from the moment they were aimed at non-expert audiences, they lost any capacity as an explanative model and became pure illustrations.

This confirms the incongruence between the potential of VR proposed in some publications (interactivity, and discovery of the past) and its implementation, especially for dissemination purposes. This is not caused by technological constraints, as it has been often claimed, but instead it is due to two main reasons: first, a non-critical adoption of ICT, stimulated by fashion and/or economical interests; and second, at a more basic level, the underlying conception of archaeology (recuperation and interpretative description of remains), reinforced by current heritage legislation. This makes VR purely descriptive and eliminates any interactivity beyond bare navigation inside a hyper-realistic reconstruction of monuments, thus clearly under-using its true capacities.

### **From Virtual Archaeology to Virtual Heritage**

Another way to follow the evolution of what Reilly had baptized "virtual archaeology" is to analyze the current vocabulary used in the field and its understanding by non-expert audiences. With regard to the academic field, a look at the available bibliography and related websites makes evident that nowadays the predominating concept is not "virtual archaeology" but "virtual heritage". One exemplary definition says:

"Virtual heritage applications use the immersive and interactive qualities of VR to give students or museum visitors access to computer reconstructions of historical sites that would normally be inaccessible, due to location or fragile condition. They also provide the possibility of visiting places that no longer exist at all, or of viewing how the places

would have appeared at different times in history." (PAPE ET AL. 2001)

This definition of VH supports the use of VR for the creation of virtual replicas which guarantee its preservation and accessibility. The monument (not history) constitutes the central element, because archaeological remains are valued only as witnesses of the past (not as knowledge sources). On the other hand, accessibility is mainly achieved through simple visualization. As a matter of fact, this is not different from the VR applications we analyzed in the previous section, and demonstrates the assimilation of the two concepts, VR and VH. With regard to the relationship of these concepts with VA, Roussou says:

"Virtual Archaeology refers to the use of three-dimensional computer models of ancient buildings and artifacts visualized through digital interface technologies that offer some degree of immersion and / or interaction with the content. [...] Virtualization, as experienced today, is a technological condition that is generalized much beyond what we understand as virtual reality. In this sense, virtual heritage involves the synthesis, conservation, reproduction, representation, digital reprocessing and display with the use of advanced imaging technology." (ROUSSOU 2002)

The first thing to remark is again the central role of buildings and artifacts. Secondly, we have to note once more the disagreement between the characteristics of VR and its use in the archaeological field: VR is essentially constituted by computational virtuality, immersivity and interactivity; but according to Roussou's definition, interactivity is considered to be optional and can even disappear. The second part of the definition indicates that VH simply constitutes a step further which, as previously seen, corresponds to the use of VR to preserve heritage and make it accessible. If VA consists in the presentation of heritage elements by visual means, and VH does too, then it is evident that there is no difference between the concepts.

This concept is also shared by non-expert audiences. A survey conducted during the exhibition "Building Virtual Rome", held in the Trajan Markets of Rome during September and October 2005, asked visitors what the words "virtual archaeology" suggested to them. Those who affirmed having a good

knowledge of this field defined the concept mainly as “the reconstruction of the past”; those who declared not being familiar with heritage/archaeology associated it also with pure technology. Only 3 visitors out of the 35 interviewed, answered that it had to do with research. The conclusion (FORTE / PESCARIN / PUJOL TOST 2006) is that, at least in this case, the most disseminated concept of VA combines the traditional artistic or descriptive goals of archaeology and some of the properties of VR (visualization, navigation) and therefore is mainly associated with the depiction of a “past” represented by objects and monuments and not with scientific research.

VH is the result of combining the illustrative use of VR with archaeology and UNESCO’s concept of heritage. The artistic notion of archaeological remains is, in a feedback process, both the cause and the consequence of the assimilation between both concepts: it determines VR applications from the field, but at the same time reinforces these uses through the construction of VH, because it is the most popular and lucrative side of archaeology. Consequently, VA is on its way to mean a totally different thing from what Reilly intended.

### *Virtual Archaeology, Virtual Heritage... Virtual Record*

The paper was aimed at thinking about the theoretical implications of VR applications in archaeology after 15 years of experience in the research and dissemination fields. To that end, it firstly developed the implications of Reilly’s historical paper, and secondly it presented the current state of the art from two different points of view: first, the examination of several examples in order to define the general features of VR applications; second, the analysis of the current vocabulary to see which are the most used concepts and how they are related. Now we are ready to answer the title’s question. Does VA exist? The answer is that the term is still used but Reilly’s VA has become another thing altogether. Instead of taking advantage of the interactive modeling side of VR, and therefore bringing archaeology closer to hypothetic-deductive schemes, the traditional descriptive conception of archaeology has prevailed and only the strictly illustrative or, more recently, geometrical/spatial aspects, have been emphasized. Consequently, especially in the dissemination field, what

predominates nowadays is the notion of VH, with which VA has been assimilated.

At the moment, we can find four different uses of VR, which correspond to four different archaeological models. The most traditional perspectives understand VR as the conclusive illustration for a process of description. In many cases, the confluence between a romantic perception of archaeology and economical interests or pressures produces applications which use very sophisticated interfaces to present spectacular discoveries or famous monuments. On the other hand, more empiricist perspectives emphasize the application to the first stages of the research process and understand VR as an experimental tool for the visualization and analysis of data and hypothesis verification. Finally, postmodern conceptions make for a more intuitive use during field work but mainly focus on the last stages of research, and understand VR as a semantic/symbolic resource aimed at the narration of subjective construction of knowledge and social identity. In our opinion, all these options should have their place in the archaeological domain, because they constitute different ways to explore new languages for research and dissemination, but only if we are aware of the underlying theoretical framework and the real possibilities of VR. The same way there are different perspectives of space and time, there should exist different uses of VR, adequate to them, as well as to the addressee and the object of study.

Nevertheless, VR is especially suitable for the last two options because by definition it necessarily implies the presence of interactivity. We have already seen the potential for research; with regard to dissemination, this has three advantages. First, interaction can take the shape of a discovery process, which improves motivation and allows the development of formal reasoning. Second, by showing how archaeological knowledge is obtained, it evidences that in its current state archaeology does not provide truths but instead anyone can construct his or her own discourse with the same evidence. This should help non-experts, and especially the younger audiences, to adopt a critical, relativist attitude towards social and political positions based on historical legitimizations. Third, it can substitute the descriptive romantic idea of archaeology with a more scientific conception, which should favor its perception as a useful domain and therefore improve its social and political consideration (i.e. with regard

to funding priorities, working status of professionals, etc.).

To achieve these aims we first need a change of perspective: instead of reconstructing monuments valued only for their artistic qualities, we should use VR for the representation and analysis of the archaeological remains. Therefore, before being considered “virtual heritage”, VR applications should first become “virtual record”. As a matter of fact, this is not so different from what Paul Reilly was proposing fifteen years ago. However, because it is part of the natural development of archaeology, there is no need to design it with a different name. In reality, the concept of VA was inappropriate and indirectly caused the subsequent evolution of the field: it is not archaeology what is or should be virtual, but some of the tools it uses which, thanks to this particular feature (the operational capacity of computational virtuality), could certainly help in the construction and wide perception of archaeology as a scientific discipline.

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