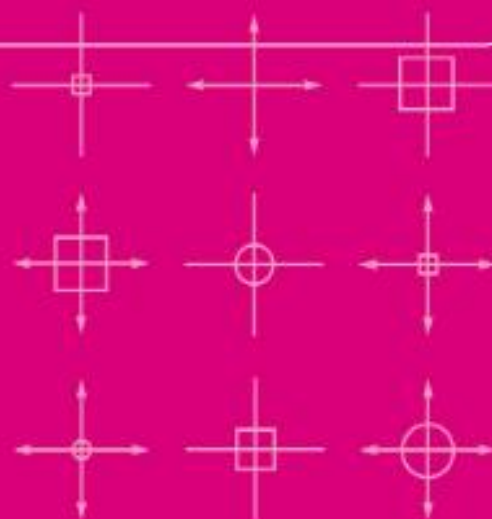


# Workshop 15

International Conference on  
**Cultural Heritage and  
New Technologies**  
November 15-17, 2010

**Proceedings**



STADT   
ARCHAEOLOGIE   
WIEN   


## Imprint

### Editor / Publisher

Museen der Stadt Wien – Stadtarchäologie

Leitung: Mag. Karin Fischer Ausserer

Obere Augartenstraße 26–28

A-1020 Wien

Tel.: +43 (0)1 4000-81158

Fax: +43 (0)1 4000-99-81177

E-Mail: [o@stadtarchaeologie.at](mailto:o@stadtarchaeologie.at)

Homepage: <http://www.wien.gv.at/archaeologie/>

ISBN 978-3-200-02448-9

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Mag. Wolfgang Börner, DI Susanne Uhlirz

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Vienna, 2011

## 3D reconstruction and the formulation of a new paradigm of archaeological spaces

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**Abstract:** The contemporary approach to the paradigm of an archeological space depends on 3D technologies. We are talking about the procedure that is, in an ideal case, infinitesimal approach to the original archeological space. Bearing in mind that reconstruction of an archeological space pertains, first of all, to the area of archeological interpretation, it is necessary to introduce a new methodology into the paradigm of archeological spaces. This opens up the possibility of ensuring observability for spaces created by means of 3D reconstruction, which in the domain of virtual spaces has the meaning of the total reconstruction, but which does not actually mean a full reconstruction of the real space. This paper is related to the investigation of the impact of 3D technology on interpretation of real spaces. The paper proposes the methodology of the theory of deconstruction, which offers possibilities for creation of a new paradigm of archeological spaces.

**Keywords:** 3D reconstruction, archaeological spaces, paradigm.

### Introduction

In the cognitive - theoretical and methodological point of view, heterogeneous areas assign semantic values to the term *space*. Physical, technological, logical, electronic (virtual), topological, mathematical, geometrical, symbolic, absolute, imaginary ... are just some of the possible spaces that, depending on the subject matter of investigation, have corresponding places in the hierarchy of meanings in the domain of philosophy of science. In an area such as archeology, there is a series of other spaces, such as: historical, geographical, architectural, allegorical, metaphoric ... then spaces of identity, entity, ethnicity, to the way to the integrate to overall intelligible space and human habitus.

Bearing in mind the history of thought and epistemological and methodological dilemmas about real and abstract spaces, from Leucippus, Plato, Aristoteles, to Leibniz, Newton, Kant, and Heidegger and to Bergson, Wittgenstein and Lefevre, in the IT scientific environment, we look at an archeological space as a polyvalent, virtually possible, in line with 3D technological and scientific interpretative forms. Drawing on the history of thought about space, using 3D laser reconstruction, we introduce logically and geometrically founded structures in the perception of a dominantly historical and symbolic space.

We are talking about a collaterally derived result, resulting from the need for a more perfect documenting of archeological artifacts, which is reflected in the opening of new issues in the theory, particularly in the philosophy of space (POLIĆ RADOVANOVIĆ 2010). If we define an integral archeological space, as a vertical (hierarchical) and horizontal (coexistent) structure, where in virtual reconstruction takes place simultaneous interaction of numerous specified spaces, the question arises as to how 3D reconstruction

gives rise to inevitability of change of the paradigm of archeological space and able overcome the conventional models of thinking.

### Physical, Virtual, and Archeological Space

When we talk about archeological artifacts and sites, we think about three-dimensional, physical spaces and historical and symbolic spaces. When we wish to interpret possible contents of the space that existed at the time of construction of archeological sites (artifacts), we use the techniques of 3D laser scanning.

We observe a physical space as the subsistent reality, in terms of three-dimensional expansion in which constituents of reality are contained. When considering the coexistence of different spaces, we proceed from the reality of an archeological site (artifact) and the reality of the set of instruments we use in order to transpose and enable virtual and factography super-structuring. Observation of physical space takes us into the technological space, which allows interpretation of different spatial relations. The principle of operation of a laser scanner is based on focused transmission of a laser signal from the measuring instrument, which reaches the desired object of scanning and is reflected back towards the measuring instrument. The accuracy of the process depends on the appearance of the surfaces of an archeological artifact, optics, and mechanical parts of the system, as well as on the resolution, and thereby on the extent of infinitesimal approximation on the original archeological space (AKCA 2006).

There are two phenomena at the heart of the transposition process, the light and geometrical ones, which belong to different totalities, physical and abstract, and possess the form-relevant quality, which according to its performances has equal impact both on the issues of empirical obtaining of results and on the level of simulation of measuring information (POLIĆ-RADOVANOVIĆ 2005, 2007)

However, virtual space calls for geometry that is invariant to perspective projection. The space of projection of the dimension  $N$  is obtained as a perspective image of  $N+1$ -dimensional space. The method of transposition of dimensions is immanently technical, but the actual result is nothing technical in itself, it is essentially a geometrical principle (MOHR, BOUFAMA and BRAND 1995). Ideally, the transfer from physical to electronic space, and then in a geometric space, meaning that during this operation does not lose *essentia* geometric quality. For example: laser point projected on the surface of marble belonging to the three-dimensional space. Electronic images of laser points on the computer, (in electronic projection space) is seen as a two-dimensional entities. And when combined photogrammetric triangulation or lidar-based application to simulate the measurements, we have a de facto data as a geometric entity with Gaussian distributions or other functions of probability distribution uncertain (KORPELA, TUOMOLA and VÄLIMÄKI 2007). Then Talking about abstract space. Real archaeological space exist in the hierarchy and in the coexistence of physical, electronic and abstract space. Paradoxically, in an abstract measure space we look measure of reality of archaeological space.

In the geometrical and philosophical-semantic sense, 3D reconstruction of an archeological space enables creation of a virtual set design (AUSTEM 1998; EARL 2007; FORTE 2008) that emerges by reconstruction of a network of objective relationships between diversified positions of space, structure of the space of different genealogical potentials, on the basis of empirical and theoretical results, as well as variations of historical

and symbolic spaces, their complex positions and dispositions as micro-cosmoses of scientific interpretations.

Material finds at archeological sites give us the idea of the physical space as a component of the archeological space based on empirical results and historical and symbolic interpretations. However, the reality of such space only partially expresses the reality of the authentic space that once existed. Virtual space provides the possibility for super-structuring, technological and ideational reconstruction of an artifact or a site back to the time of its creation, but always as one of possible views of a possible space (BOUROUMAND and STUDNICKA 2004). Thus formulated multidisciplinary approach to archeological space is, in its nature, a techno-archeological interpretation. Depending on the number of exact data, we can speak about the extent of infinitesimality approximation to the original archeological space and the historic reality. Thus 3D reconstruction may be described as way to integrate and intersect all the partial perspectives the resultant of which is a complex opinion about the object and subject of investigation, and the archeological space no longer has only one universal interpretation, but gets a series of indiscriminating interpretations, which represents the quality that takes us into the ambiance of the theory of deconstruction. Space becomes the *term-means* of explication, analogous with Jacques Derrida's notion of *différance* (1978). Space as a variable dimension, in the context of the theory of deconstruction, possesses its own infinitesimality that initiates the tendency to create the final meaning, so as to enable the actual notion to be always capable of being supplemented. Hence the possibility as well to formulate a new paradigm of archeological space, in which interpretation equally appertains to virtual ability of the spirit and virtual realization of an electronic medium in which it subsists owing to the specific potential of the computer memory space (FAUGERAS 1993). Potential and reality (*energeia / actus – dynamis / potentialia*) thus become mutually analogous, they interrelate as *infinite* and *finite*.

### Methodological Investigations

We investigate an integral archeological space as a simultaneous existence of different spaces that are mutually in relationships of hierarchy and coexistence (POLIĆ-RADOVANOVIĆ, RISTIĆ, NIKOLIĆ and KOZIĆ 2010). We model the *hierarchy* of space starting from Euclidean space towards a Non-Euclidean space. When we wish to model *coexistences* of different spaces, our aim is to observe, from the same point of view, the phenomenology of different spaces that emanated in different epochs. And to include them all in an integral space, which we call techno-archeological interpretation. In order to establish the relationships of hierarchy and coexistence of different spaces at an archeological site, we initiate classifications of spatial data into classes and objects, depending on the nature of the entities and their stratified meanings (historical, symbolic, material, light, electronic ...). The technique of 3D reconstruction shows to us that a space in our perception takes shape in the form of relations (TSAI 1987), and enables us to redefine, in line with the theory of deconstruction in considering an archeological space, all the notions along the long path that starts from Plato's *primeval image and reflection* (*parádeigma – eikón*), to Foucault's *arrangement patterns* (1991) or Husserl's *actual reality, true reality, and actual true reality* (1950). Thus we re-investigate all the ways of thinking in the course of the history of thought about space in the light of new potentials of 3D reconstruction.



If we deal with the *parádeigma – eikón* relationship, we formulate relations, depending on the type of data (physical dimensions, parameters of laser beam, a historic datum, interpretation of symbols ...), according to the logical structure of their forming, exploring the possibilities of forming new relations. In the case of light and geometrical phenomena, the relations would be formulated as in Table 1.

Table 1

Phenomenon	Transposition	Space as a result
Laser spot in physical space of N+1 dimension	→	electronic space of N-dimensionality
Geometrical point of N-1 dimensionality (Euclidean space)	→	electronic space of N-dimensionality

If the subject matter of investigation is the relationship of *actual reality*, *true reality*, and *actual true reality* of an archeological space, we have a double paradox.

Table 2

I Paradox	Virtual, 3D reconstruction of an archeological space provides a more realistic image of the archeological space than the real physical space.
II Paradox	The degree of reality of an archeological space obtained by 3D reconstruction can be measured only with respect to the physical space the reality of which is insufficient to us in the extent that a we have small number relevant of material traces for techno-archaeological interpretation

The question arises: How is it possible to measure the reality of a space? One of the criteria would be morphometric similarity (minimal spatial error) that is achieved by 3D reconstruction (BERALDIN 2003, 2004, 2005). The second criterion may be the data quality that, with a minimum number of information, attains the objective of comprehensive presentation of an archeological space. Bearing in mind that, on this level of scientific knowledge, change of the paradigm of archeological space has been enabled exactly with the advent of lasers, holography represents an ideal technique without which the goal of an integral reconstruction of an archeological space can hardly be reached in this century.

One of the possible criteria for the measure of reality of space at any rate must also include the time dimension. In view of the fact that the reality of an archeological space is a set of numerous realities (phases) from its onset up to the present day, in an ideal case, we could obtain a series of *n* images that will successively speak about the life of the archeological space over time. However, at this level of scientific development, such an *nD* reconstruction is not possible. What is possible is 3D reconstruction that, with the post-structuralistic theory of deconstruction, redefines and reconstructs a space as the *term-means* of explication, continuously subjecting all possible meanings to notional revisions, in line with the pace of technological progress that demonstrates the trend of dispersive acceleration.

Methodologically, this practically means a continuous process of contextualization of meanings, by which *genius loci* is reconstructed in the spirit of its time, from Aristotle to contemporary philosophers. We do this by applying logical expressions formulated at the time that we investigate, and which become descriptions of spatial relations. Space becomes parameters susceptible variable to Logical testing the results of 3D reconstruction. Results must have function in different norms to in order to establishing reality.

For example, by investigating *energeia / actus – dynamis / potential* relationships, we can define the time component of archeological spaces. In this respect we investigate the universality of two statements: *Actus et potentia realiter distinguuntur* (Tab. 3) and *Actus non limitatur nisi per potentiam* (Tab. 4).

Table 3 – *Actus et potentia realiter distinguuntur* (Reality and potential is differ)

Actus	Potentia	Explication
Archeological space	3D space	Reality of a space is really different from the currently possible interpretations, and it is limited by the possibility of techno-archeological interpretations of the space, because the technology has not reached the maximum of perfection. Almost every day, we learn about innovations and improved methods of investigations.

Table 4 – *Actus non limitatur nisi per potentiam* (Reality is not limited except by in regard to possibility)

Actus	Potentia	Explication
Archeological space	nD space	Bearing in mind the progress of technologies, the possibility of achieving nD reconstruction limits the degree of reality of an archeological space. Progress of technology in the 21 <sup>st</sup> century in this respect should lead to the maximum of infinitesimality approximation to real space.

### Conclusion

The technique of 3D reconstruction has paved the way for a new way in thinking in the philosophy of space, creating conditions for formulation of a new paradigm of archeological space. The methodology by which space as a variable parameter is contextualized in the framework of the theory of deconstruction enables infinitesimal closing in on nD reconstruction, which will always have the degree of reality in the reconstruction of an archeological space adequate to the technological progress. A new paradigm of archeological space as techno-archeological interpretation, in this line may be defined as the continuous process of infinitesimal closing in on the primeval image (*parádeigma*) of an archeological space and its reflection in time (*eikón*).

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