IMPORTANCE OF COLOR RECORDINGS DURING DOCUMENTATION PROCESS BEFORE CONSERVATION AND RESTORATION APPLICATIONS; THE CASE STUDY ON ASPENDOS THEATER

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ABSTRACT

Detailed architectural survey of an old building before the conservation and restoration has a great importance in order to get a reliable future attempt. In this context, determination of the color specifications of the building's materials, in other words "color records of the building" should also be done in scope of the original physical documentation of the building. Those analysis will serve in choosing new materials to be selected/designed in order to be used in the future restoration applications, furthermore it will enable to create the most real image when the virtual reconstruction of the building is considered. In this context, color documentations and measurements done in scope of the ERATO Project implement the importance of the color subject, on which conservation experts didn't use to dwell and interest enough.
ERATO -Identification, Evaluation and Revival of the Acoustical Heritage of Ancient Theaters and Odea- Research Project carried out within the Fifth Framework INCO-MED Program of the European Commission, is designed by the goal to identify virtual restoration and revival of the acoustical and architectural heritage in a few, selected examples of the ancient theaters and odea (i.e. smaller, roofed theaters) in a 3D virtual environment. At the Project scope, physical specifications of the environment and the buildings such as color- light, climate, and topography are also determined and evaluated besides acoustical data.
In this paper, color recordings have been made in the Aspendos Theater within the ERATO Project, which is one of the best preserved Roman theaters in fairly good condition, is presented by emphasizing its role playing in the real and virtual restitution and conservation applications.

1. INTRODUCTION

With the advancement of software technology, it is today possible to recreate environments belonging to one of the different periods of the building in virtual reality and present it together with the artificial environment visualizing the cultural features of the related period. In this context, an interdisciplinary research project named ERATO - Identification, Evaluation and Revival of the Acoustical Heritage of Ancient Theaters and Odea-, carried out within the Fifth Framework INCO-MED Program of the European Commission (Project No. ICA3-CT-2002-10031) was designed in the field of architectural conservation. Virtual conservation by the audio-visual restitution of spaces in 3D virtual environments is innovated in this project. It was held by a consortium constituted of seven entities from six countries: Technical University of Denmark - DTU (Denmark), Yıldız Technical University - YTU (Turkey), Hashemite University - HU (Jordan), Universita degli Studi di Ferrara - UNIFE (Italy), AEDIFICE (France), Ecole Polytechnique Fédérale de Lausanne - EPFL (Switzerland) and University of Geneva - UNIGE (Switzerland).
3rd article of Verona Charter states that virtual images could retard the being damaged process of the real building (edifice) by diminishing its usage especially when antic theaters and similar cultural wealths are considered. ERATO Project is carried out exactly in order to realize this approach and also to expose it by experimenting with.
ERATO Project is designed in order to achieve architectural heritage conservation and restitution of the selected examples of the Antic Greek and Roman theaters and odea (antic roofed theaters) via audio-visual revival in 3D virtual environment. The virtual conservation and restitution aims to integrate the visual and acoustical simulations.
The project covers the identification and revival as well as the restoration and conservation of the visual and acoustical heritage of the monuments in a virtual environment. A benefit of using a virtual environment is the possibility of simulation of the space with different acoustical and visual properties after it was once formed in a virtual environment. This fact gives the possibility of restitutions of the different periods. If surface materials of the spaces utilized at the past uses are known, they could be easily revive in virtual environment.
Theaters and odea (1st and 2nd Centuries) selected from Mediterranean Region to work on at the ERATO Project are given at the Table 1.

Table 1. Theaters and odea to work on at the ERATO Project

Theaters	Odea
Aspendos (Turkey)	Aphrodisias (Turkey)
Jerash South (Jordan)	Aosta (Italy)
Syracuse (Italy)	

Among these, Aspendos Theater and Aphrodisias Odeon have been chosen for a combined visual and acoustical virtual reconstruction. The time period for the reconstruction has been chosen to be around the first century A.D. Those spaces were modeled and conserved at the virtual environment of different function configurations.
Aspendos Theater examined in scope of this Project is the best spectacular Roman Theater at the Mediterranean world preserved in fairly good condition (Fig. 1, 2). It was constructed on 161-180 AC by architect Xeno [1].
This paper aims to present recent color recordings have been made in the Aspendos Theater by emphasizing its role playing in the real and virtual restitution and conservation applications.

2. COLOR SPECIFICATION OF THE ASPENDOS THEATER

Collection of the appropriate and accurate data is an important issue for virtual reconstruction of a historical building.

Therefore, to create a realistic virtual environment, necessary data on the lighting and color properties of building should be collected precisely as well as different subjects. Within this context, to constitute a database on the color properties to be used in the visual part of the ERATO Project,

- daylight illumination levels,
- material colors and light reflectances

were identified for Aspendos Theater.

Figure 1. General View of Aspendos Theater

Figure 2. Aspendos Theater, View from Inside

In order to constitute a database to be used in the visual part of the ERATO Project, color specifications and light reflectance of the surface materials were measured according to the objective method by using "Minolta Spectrophotometer - CM-2600D" and evaluated using its software, Spectra Magic (Ver.3.6) Program. Some photos showing measurement process and surfaces are presented at Figures 3-7 [2]. Preferred illuminants for color measurements such as D65 and C have been used as the illuminant types at the measurements. Illuminant D65 is used for Lab, Lch, Yxy color systems and C, for Munsell Color System. More accurate estimations of the average reflectance values have been done considering measured color specifications. Daylight illuminance levels were also measured in situ and calculated according to the average sky conditions and statistical meteorological data of the region to obtain realistic visual virtualization.

Color measurement results of Aspendos Theater are given at the Table 2 in terms of color specifications and average reflectances.

Figure 3. Cavea (Lower Section) – Seating Rows

Figure 4. Northern Side Wall and Seljukian Plaster on Analemma wall

Figure 5. Marble Wall Declining from the Paradose

Figure 6. Cavea (Middle Section) – Seating Rows

Figure 7. Northern Side Wall (Upper Section)

Table 1. Measured color specifications of Aspendos Theater's surfaces and average reflectance values (r; %) [2].

Materials		Color	Lab (D65)			Munsell (C) Hue Value Chroma			Reflec. (r; %)	Aver. Reflec. (r; %)
			L	a	b	H	V	C		
Orchestra	Orchestra Floor (Stone Pavement)	Beige	73,79	0,85	10,79	1,6 Y	6,5	1,5	36,20	36,20
Cavea (Lower Section) (Fig. 3)	Seating Row (Vert. Face)	Beige	53,24	0,57	6,92	2,7 Y	5,2	1,0	21,62	23,62
	Seating Row (Hor.)	Beige	57,54	1,41	10,27	1,6 Y	5,6	1,5	25,62	
Cavea (Middle Section) (Vert.) (Fig. 4)	Seating Row (Vert. Face)	Beige	47,62	0,62	6,83	2,8 Y	4,6	1,0	16,37	19,57
	Seating Row (Vert. Face)	Beige	55,34	0,40	7,33	2,9 Y	5,4	1,0	22,58	
	Seating Row (Vert. Face)	Beige	51,52	0,69	6,92	2,6 Y	5,0	1,0	19,77	
Cavea (Middle Section) (Hor.)	Seating Row (Hor.)	Beige	63,95	0,59	8,87	2,2 Y	6,2	1,2	32,43	27,92
	Seating Row (Hor.)	Beige	55,18	1,34	9,49	1,7 Y	5,4	1,4	22,58	
	Seating Row (Hor.)	Beige	60,33	1,57	10,86	1,3 Y	5,9	1,6	28,90	
Cavea (Upper Section) (Vertical)	Seating Row (Vert.)	Beige	52,54	0,78	7,46	2,4 Y	5,1	1,1	20,68	21,09
	Uppermost Seating Row (Vert.)	Beige	49,27	0,29	5,71	3,3 Y	4,8	0,8	18,02	
	Uppermost Seating Row (Vert.)	Beige	56,32	0,46	9,56	3,0 Y	5,5	1,4	24,58	
Cavea (Upper Section) (Hor.)	Seating Row (Hor.)	Beige	53,48	1,35	9,37	1,8 Y	5,2	1,4	21,62	24,82
	Uppermost Seating Row (Hor.)	Beige	62,99	0,75	8,18	1,9 Y	6,1	1,2	31,23	
	Uppermost Seating Row (Hor.)	Beige	53,70	1,62	9,99	1,5 Y	5,2	1,5	21,62	
Diazoma (Pavement)	Diazoma (Pavement)	Beige	63,36	0,48	8,32	2,3 Y	6,2	1,2	32,43	25,60
	Diazoma (Pavement)	Beige	67,64	1,22	11,74	1,6 Y	6,6	1,7	37,52	
Diazoma Wall	Lounge on the Diazoma	Beige	70,58	0,64	8,13	1,6 Y	6,9	1,1	41,63	34,14
	Diazoma Wall	Beige	66,80	0,49	8,71	2,1 Y	6,5	1,2	36,20	
	Diazoma Wall	Beige	56,55	0,48	4,90	2,2 Y	5,5	0,7	24,58	
Walls (Fig. 5, 6)	Northern Side Wall (Lower Section)	Beige	46,77	4,26	16,46	0,4 Y	4,5	2,5	15,57	32,33
	Northern Side Wall (Upper Section)	Beige	75,05	3,06	17,01	0,3 Y	7,4	2,6	49,09	
	Arched Gallery (North)	Beige	71,92	2,09	13,95	0,8 Y	7,0	2,1	43,06	48,50
	Arched Gallery (Middle -Renovated)	Beige	78,13	3,67	20,97	0,3 Y	7,7	3,2	53,94	
	Southern Side Wall (Lower Section)	Beige	68,51	7,31	25,40	9,2 YR	6,7	4,2	38,86	30,44
	Southern Side Wall (Upper Section)	Beige	49,51	3,53	15,31	0,7 Y	4,8	2,4	18,02	
	Seljukian Plaster on Analemma Wall	Beige	52,74	11,13	17,01	4,6 YR	5,1	3,5	20,68	28,44
	Seljukian Plaster on Analemma Wall	Beige	66,93	4,06	18,10	10,0 YR	6,5	2,8	36,20	
Paradoses (Fig. 7)	Mrbl. W. Declining from South. Parad.	Beige	43,72	0,46	4,26	2,5 Y	4,2	0,6	13,35	13,35
	Vault	Beige	54,14	0,73	12,31	3,1 Y	5,3	1,8	22,58	22,58
Scaenae Frons	Masonry on Back Wall	Beige	77,15	3,92	23,27	0,5 Y	7,6	3,6	52,30	46,27
	Plaster on Back Wall	Beige	69,10	5,73	26,48	0,2 Y	6,8	4,1	40,23	
	Marble Pillar Pedestal	Beige	66,64	-0,08	6,93	3,2 Y	6,5	0,9	36,20	30,30
	Marble Pillar	Beige	51,86	0,45	6,83	3,0 Y	5,0	1,0	19,77	
	Marble Pillar	Beige	65,49	0,66	10,67	2,2 Y	6,4	1,5	34,92	
Outward Face of Stage Building	Cement Filling	Beige	85,49	2,37	16,95	0,4 Y	8,4	2,5	66,46	41,42
	Cement Filling	Beige	47,00	3,69	14,69	0,5 Y	4,6	2,3	16,37	
	Masonry	Beige	61,34	6,49	20,79	9,1 YR	6,0	3,4	30,05	35,14
	Masonry	Beige	70,00	2,64	18,16	1,1 Y	6,8	2,7	40,23	
	Window Sill	Beige	53,55	6,31	19,95	9,3 YR	5,2	3,3	21,62	19,82
	Window Sill	Beige	49,82	0,80	8,45	2,7 Y	4,8	1,2	18,02	
Seljukian Entrance	Cement Filling	Beige	60,67	9,54	27,23	8,5 YR	5,9	4,6	28,90	27,04
	Masonry	Beige	66,10	0,87	8,72	1,6 Y	6,5	1,2	36,20	
	Plaster	Beige	58,65	3,27	15,34	0,5 Y	5,7	2,4	26,69	
	Stairs	Beige	47,59	1,21	10,41	2,4 Y	4,6	1,5	16,37	
Rough Masonry Along Outside Wall	Cement	Beige	33,85	4,47	8,10	7,5 Y	3,3	1,4	7,96	17,86
	Masonry	Beige	51,79	0,36	6,75	3,2 Y	5,0	1,0	19,77	

3. USING OF THE COLOR DATA

The visualization part of the project has two steps: Data collection and virtual modeling in 3D environment. Color measurements are done in scope of the data collection which was carried out in situ and from literature. In situ data collection covers photographic and video recordings, data on the color and light properties of surface materials, the lighting systems, whereas literature scanning covers gathering of the most recent results in history of architecture, archaeology, theater history, clothing, theater performance and early period music. Partners sharing the work packages related to the visualization part of the Project, reorganized all the collected data to allow the forthcoming work of virtual restitution of the diffuse maps (to be applied to the) for the 3D model and to complete the architectural documentation about the present state of the building [3]. Lightmap and diffusemap and real time, multi-texturing approach of Aspendos Theater are seeing consecutively at Figure 8 [4].

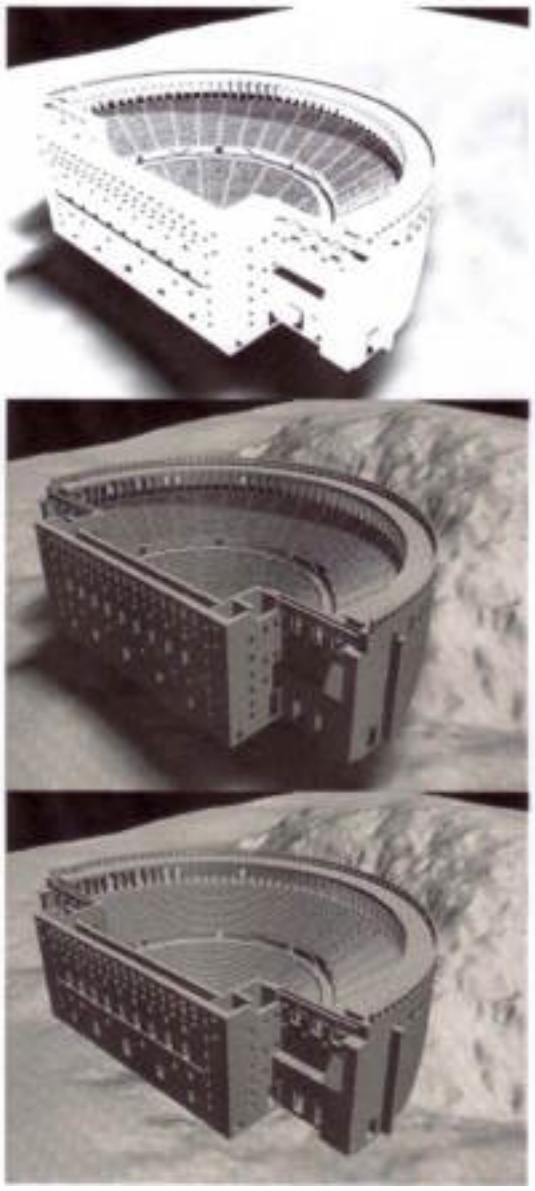

Figure 8. Lightmap and diffusemap and real time, multi-texturing approach of Aspendos theater.

For the creation of the set of light-maps and diffuse maps for the real-time simulation of the theater model new rendering and illumination techniques; the use of High Dinamic Range images (HDR) and Image Based Lighting (IBL) were investigated (Figure 9) [3]. Then, the 3D models of the selected ancient worship places were virtually constructed by using 3D Max and Photoshop software to provide textures. Virtual human models are also created in order to increase realism of the reconstructed spaces. A virtual crowd simulation was integrated into 3D virtual real-time simulations of the edifices for recreating life inside architectural models [5].

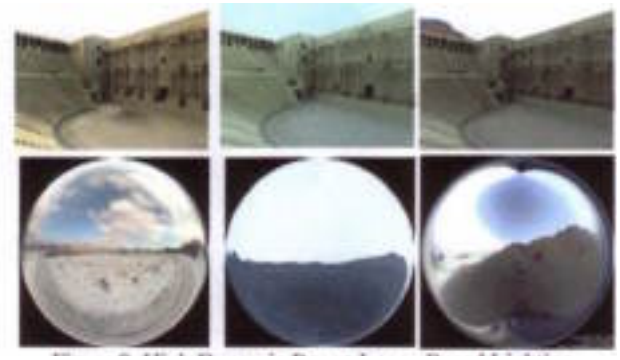

Figure 9. High Dynamic Range Image Based Lighting (offline)
MIRALab – University of Geneva

4. EVALUATION OF THE COLOR SYSTEM AND CONCLUSION

Before conservation and restoration applications of old buildings, detailed architectural survey has a great importance in order to get a reliable future attempt. Those analyses will serve in choosing new materials to be selected/designed in order to be used in the future restoration applications. Color measurements and documentation have also to take place within the scope of the determination - documentation works of architectural survey for being able to create the most real image when the virtual reconstruction of the building. At the ERATO Project where virtual 3D restitution and simulation of the acoustical environment is available, color measurements and documentation were also done at the scope of the documentation works' process of the recent status of the edifice and inserted to the 3D models. As the theater's main material is stone, it can be considered from the results that ultraviolet rays of the daylight have not had harmful effect within the time. Even though there are minor effects, doing the color documentation of the theater in a virtual environment is important in order to determine its recent conditions and to be able to transfer them to future for monitoring future conditions in any case of disappearing.

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