

Reviving the Architectural and Acoustical Theatre Heritage: the Role of ERATO Project, The Fifth International Conference of the Center for the Study of Architecture in the Arab Region (CSAAR 2008B): Responsibilities and Opportunities in Architectural Conservation: Theory, Education, and Practice, November, 2008, 3-5, Amman, Jordan, pp.421-434.

## **Reviving the Architectural and Acoustical Theatre Heritage: the Role of ERATO Project**

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### **Abstract**

ERATO is a research project (2003-2006) entitled 'Identification, Evaluation and Revival of the Acoustical Heritage of Ancient Theatres and Odeas' that was implemented within the Fifth Framework INCO-MED Programme of the European Commission, under the thematic title 'Preserving and Using Cultural Heritage'. The project was designed to identify virtual restoration and the revival of the acoustical and architectural heritage. In fact, the ancient theatre in its many aspects has attracted a great deal of interest in the recent years. Some of them are still in use today. However, understanding that we are dealing with man-made space designed for dialogue between audience and actors, the subject of the acoustical qualities should be considered as an important component of theatres and odeas. Though, the most critical issue in the conservation and restoration of those monuments is how to create a sense of space in the theatre, where the acoustical reflections and the visual imagery are fundamental components.

This paper attempts to discuss some new aspects concerning the approach for conservation and restoration of these monuments. It argues that the conservation and restoration of acoustical characteristics, and in order to take advantage of the acoustical design of ancient theatres and odeas should be considered as the most important support for the conservation process. It also attempts to evaluate, how conservation and restoration of ancient theatres and odeas can enhance and preserve their authentic scientific information, since the cultural significance of many theatres and odeas is not readily apparent.

**Keywords:** *acoustical and architectural heritage, authentic scientific information, simulation, sense of space, modern use, conservation approach.*

## 1 Introduction

Greek, Hellenistic and Roman theatres were influenced by a multitude of geographic, climatic, political, economic, social and cultural factors. It was not until the early 6th century BC, that the theatre had a separate architectural space in the city for drama performance. Every city had to have its public entertainments, so a theatre and later an amphitheatre, were an important section of the original planning and later expansion of Roman cities and were constructed according to the population of the city. A smaller but still more specialized type of theatre building identified by the generic Latin term *theatrum tectum* (roofed theatre) was being developed concurrently with the larger outdoor one. This kind of theatre, the *odium*, occurred already in Greece and became widespread in the Roman period; it is actually a concert hall for singing and music performance, and also used for major meetings (Haddad, 2006a).

However, in every historical epoch, all theatres both outdoor and roofed have been used for many purposes. These are categorized technologically as being either *multi-purpose theatre*, which is the outdoor open-air theatre and is intended to accommodate a variety of public events as disparate as athletics and the performing arts, or *multiple-use theatre* which is the odium (Izenour, 1992). It is ordinary that the odium was built in a short distance from the larger open air theatre. It is also characteristic that the amphitheatre is located far away from the theatre and odium. Actually, both theatre and odium served as a cultural centre and stood as a huge multi-functional, social, religious, propaganda and political meeting space (Haddad, 2007). The importance of the city was reflected by the number and scale of its theatres. The theatrical presentations were considered as a big event. When festivals were held in the theatre in a city, the size of ancient Athens, the city became the centre of attention, and all normal civic activities came to a halt because a significant proportion of the free population attended the events (Peter, 1989). Interesting enough, the ticket was a donation from the state (Walton, 1980). As a meeting place it provided a dignified setting, stratified seating by status, and the audience's gaze focused on the wealthy and the colonnaded *scaenae frons* (Bieber, 1961).

## 2. Theatre Architectural Approach and Design

Theatre is a specialized category of buildings designed for public assembly and performance. Theatres and odea, in their architectural design, reflected the actual social structure of the society. From the beginning, the seating area was designed to separate the different ranks of society using parapets (Walton, 1980). Unlike Greek theatres, which were situated on natural slopes, the Romans were not restricted to building them on the slopes of hills; the Romans implemented and created new structural elements and techniques that solve this problem like vaults, arches and cross vaults. With these structural elements they were able to build their theatres on flat areas and on different shapes of the topography and landscape of the city. Therefore, the building of the Roman theatre was one unit

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building, which gives the feeling of more privacy, rather than the Greek one. However, each theatre posed its own problems which typically arose from its topography (Segal, 1995) and landscape. Generally, there is a connection between the theatre function, location and size. The location is affected by the general planning of the city and is directly related to the main elements forming the urban fabric, such as the *cardo* and *decumanus*, the forum and the temple. However, major locations of theatres tended to be around temples. This relationship between theatre and temple emphasized the spatial and sequential concept of the dramatic play in the Greek and Hellenistic period (Haddad et al., 2007).

Theatres started out as simple, temporary wooden structures. The theatre of Aeschylus, Sophocles, Euripides and Aristophanes, was a temporary wooden structure built for the festival (the City *Dionysia*) and was dismantled when the celebration was concluded. The audience probably sat on wooden benches (*theatron*) and the actors and chorus performed on flat dirt floored acting area (*orchestra*), roughly circular.

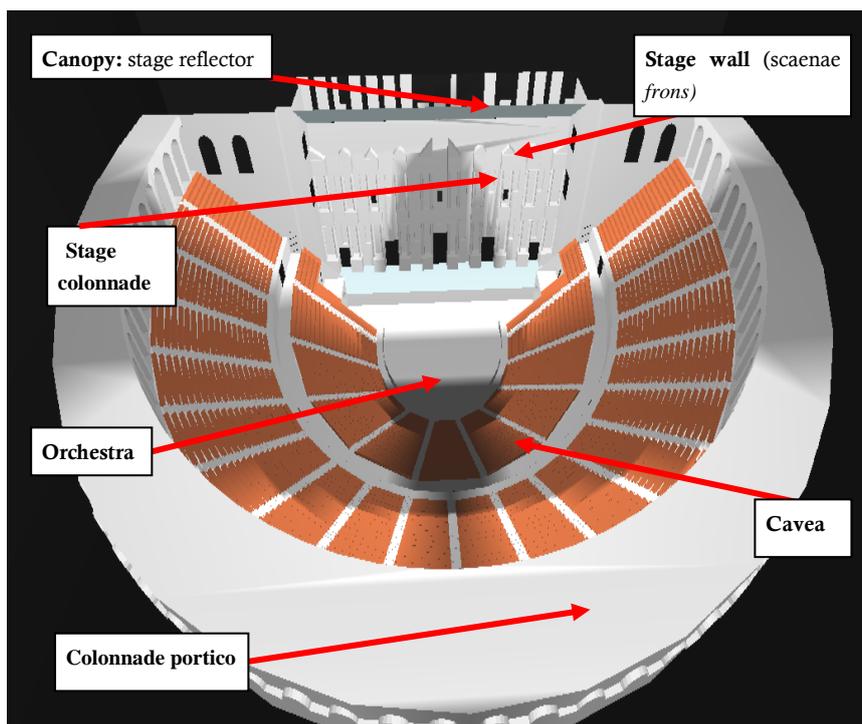


Figure 1: The main architectural and acoustical elements of a typical open-air Roman theatre according to Vitruvius and acoustic simulation.

However, Hellenistic theatres were enlarged and significantly altered in the first century BC. Meanwhile new theatres were erected in the first and second centuries AD with Roman construction methods and techniques, but with plans that imitated those of Hellenistic theatres. In fact, the basic approach of theatre design is concerned with the dual phenomenon of seeing and hearing (sightlines and sound lines) of public performance, preferably seated as close as possible to the performers. In general, the Greek, Hellenistic, and Roman open air theatre was composed of three elements (Figure 1).

- (1) The area for the audience "*cavea*", the "*theatron*" which means "seeing place". The *cavea* or auditorium containing the tiers of seats for the audience was designed with great skill to ensure its adaptation to the landscape, and the easy movement of the spectators.
- (2) In front of it and partially surrounded by it lay the *orchestra*.
- (3) The "*skene*", as theatre building, formed the background for the orchestra. The skene, the source of our word scene, was the place (or scene house, stage) at the rear of the acting space (Bieber, 1961).

## **2.1 Identification of the architectural and acoustical characteristics of ancient theatres**

As all auditoria rely on both visual and acoustic stimulation, engineering, architectural and acoustical problems encountered in erecting a theatre were surely far more complex than was the case in other public buildings (Segal, 1995, Haddad, 2006a). The physical phenomenon of seeing is directly observable, and is therefore subject to straight-line of sight common sense explanation. On the contrary, the physical phenomenon of hearing is more complex, even while it is not directly observable. These two sense-based phenomena mark to a great degree the legacy of Roman and Greek theatres.

Vitruvius provides some interesting information about theatres in his Ten Books on Architecture. He explains how to lay out a theatre of the Greek and the Roman type, their construction and proportions, the orientation and many acoustical aspects. Some of this information has often been misunderstood. However, it must be borne in mind that his book appeared at the beginning of the Augustan age a period that witnessed remarkable architectural developments, not least in theatre architecture. According to Vitruvius, the section of theatre : a line drawn from the first to the last step should touch the front angle of the tops of all the seats; in which case the voice meets with no impediment. The roof of the *portico*, in the upper part of the theatre on the last step, should be on a level with the top of the scene; by which arrangement the voice will extend and be distinct to those on the upper seats and roof, for if it be not equally high, were that height is deficient, the voice, first striking thereon, will be stopped (Figure 1). In his article "Vitruvius and Roman Theater Design" Frank Sear (1990)

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concludes that architects of the early Empire modified the layout of their theatres but did not abandon Vitruvius method. Sear tentatively offers a method of designing theaters according with the archaeological evidence and is close to the Vitruvian model. He also clarifies that "it is perhaps a mistake to expect to find the perfect Vitruvian Theatre. In fact, Vitruvius himself fully expected departures from the norm and he spells this out clearly and unambiguously.

However, one main reason for the success of the ancient Greek and Roman theatres was that disturbing environmental noise was generally quiet, when they were in use. Interesting enough, the acoustics of open-air theatres were mentioned by *Vitruvius*; meanwhile he did not mention anything about the acoustics of roofed theatres (Haddad, 2006a). *Vitruvius* also provides us with an elegant theory for the manner in which theatre sites can be unsuitable, namely if they exhibit acoustic dissonance, circumsonance, or resonance, in which the voice is supported from below, increases as it goes up and reaches the ears in words which are distinct and clear in tone. Hence, there has to be careful attention in the selection of the site to be perfectly suited to the purposes of a theatre (*Vitruvius, chap. VI, article 2; chap. VII, article 2*). This interesting document shows the author's overriding concern for acoustics, rather than vision, and this extends even to the rules he gives for the seating design (Haddad, 2006b, 2007).

Vitruvius explains many acoustical aspects including the placing of bronze vessels around the auditoria (Vitruvius, 1960). In fact, acoustic qualities suggestions had been raised by Vitruvius as to the advantages of placing bronze vessels round the auditorium of theatres. "... *let bronze vessels be made, proportionate to the size of the theatre, and let them be so fashioned that, when touched, they may produce with one another the notes of the fourth, the fifth, and so on up to the double octave.* (Vitruvius. 1960). However, in certain cases, as in the example of the acoustical results of the *Rani Gumpha* (ca. 200-100 BC) (Ault, Manthravadi, 2002), the evidence indicates that it is an acoustical performance site, sharing characteristics of the classical Greek and Roman theatres. The *Rani Gumpha* is a rock cut structure, carved into hill, where the entire performance space is backed by a decorated facade, and it is remarkably similar to Greek theatres of the Hellenistic period, having both an upper and lower level for playing. There are acoustical chambers behind each level as well as on either side, or a special "cantor's chamber" stage left on the lower level. The effect on the voice is astonishing. This is in fact a rock cut acoustical installation analogous to that described by Vitruvius in Book V, Chaps. 5 and 8, of his *de Architectura*, he speaks of vessels placed in theatres for the same purpose (Ault, Manthravadi, 2002).

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### **3 Evaluation of Theatre Cultural Value and Use Benefits**

#### **3.1 Theatre cultural value**

Ancient theatre in its many aspects has attracted a great deal of interest in the recent years, meanwhile they are among the most precious and spectacular monuments of cultural heritage in the Mediterranean countries. In ancient theatres and odea, we are dealing with Greek, Hellenistic and Roman places of cultural significance. Their cultural value and their significance are clear from their vital relationship with other important buildings on heritage sites, their design, structure and their architectural concept (Haddad, 2006b; 2007). However, their economic value can be clearly understood by the benefit of saving the built heritage through reuse for tourism, modern needs and pleasure, within the cultural context. Thereby, while these cultural heritage sites have an intrinsic value for all people, as an important basis for cultural diversity, social and economic development, they should continue to be a source of information for future generations as documents of history.

#### **3.2 Theatre enhancement and contemporary uses**

It is important to clarify that modern use is altogether different from ancient use. As places of performance, some are still in use today (Figure 2). They represent the only monuments from classical antiquity that still serve the purpose for which they were originally designed. At present, they are threatened by the erosion of natural threats (wind, orientation, temperature, rain) and human threats by the improper modern uses as a result of the overloaded capacity, the air and noise pollution, the thermal effects of lighting systems, to which they are sometimes put (Haddad 2007). On the other hand, the absence of conservation plans, lack of maintenance, and poor application of conservation principles and lack of skilled people can cause further decay to the infrastructure of these historic theatres and odea.

Reuse is currently used as a means of conservation as well as justification for the enormous costs that restoration and conservation entail. However, since all ancient theatres have their own unique set of conditions; reuse cannot be separated from the whole ancient/modern context that surrounds them. However, modern use of theatres if respects their function can encourage researchers to look for intensive investigation on the effects of events on ancient theatres. Thus, enhancing the theatre heritage and arouse the audience interest in the ancient theatre. Today, they have four main contemporary uses: (1) Tourism (2) Festivals (3) Conferences and receptions (4) Virtual reality (Haddad, 2006b, 2007).

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The use of virtual reality, 3D modelling and animation, nowadays, is essential in the conservation and interpretation of ancient theatres, odea and their use in ancient times, for such use supports the relationship between public and monument (Yüksel et al., 2005). This approach provides them with a virtual life in this digital age. This also facilitates the generation of historical and archaeological experiences using the techniques of computer animation, while reducing the need to reconstruct these historic sites.

### **3.3 Theatre conservation and compatible use**

While the cultural significance of many theatres and odea is not readily apparent, conservation, restoration and interpretation should endeavor to preserve their authentic scientific information. The Ename Charter emphasizes interpretation of access and understanding of the significance of heritage sites by sustainable interpretation, and sustainability in the long term, which must among the central goals respect authenticity, the local community and the participation of associated communities and other stakeholders (Ename Charter, Principles 1, 4, 5, 7). By infusing ancient theatres and odea with their full role as places of cultural and artistic creation, shared enjoyment and emotion, and by means of activities and performances we can enhance the theatre heritage and arouse the audience's interest and contribute to local cultural identity and development. Now, we are in a position to consider if such investments are effectively useful and could really increase and diffuse knowledge of theatre heritage and satisfy users' requirements. In fact, conservation of theatres and odea can assist in its promotion and management, in ways that could preserve and protect their authenticity and enhance the visitor experience. However, interpretation through reuse can better enhance understanding, enjoyment, and be culturally appropriate. Actually, theatre reuse is not only needed for proper conservation, but foremost to raise public awareness.

To achieve a compatible and sustainable use, where compatible use means respect for the cultural significance of a place, such a use should involve no, or minimal, impact on cultural significance (Burra Charter, Article 1.11), while conservation, restoration techniques and materials must be compatible with the original materials of theatres and odea. Meanwhile, interpretation and management of these places should insure the participation of people for whom the place has special associations and meaning, or who have social, spiritual or other cultural responsibilities for the place (Burra Charter, Article12). Through the interpretation work we can merge the need of visitors, audience and local community and the need of the site. Thus, theatre interpretation can play a significant role in presenting to the society the aesthetic, historic and scientific values of theatres and odea to the local community and the surrounding regions.

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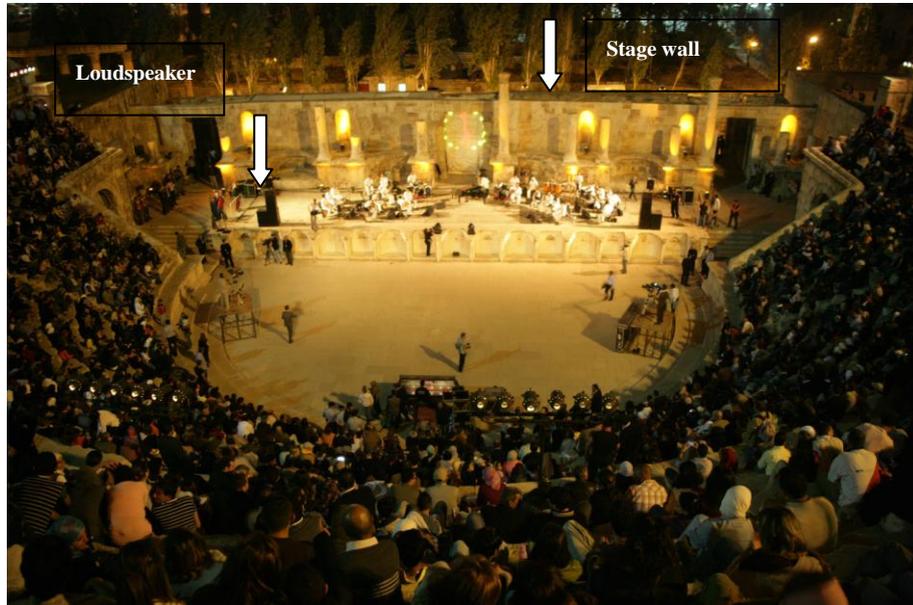


Figure 2: Amman Great Theatre reused for performances. The scene wall was restored but not to its original height. Loudspeakers are placed on the stage.

Thereby, their conservation and restoration can be sustained in serving the purpose for which they were originally designed and enhance the sites with theatres and odea by using them. However, the use to which they are put gives them all their meaning by updating their function such as the reuse of the of the Great Theatre of Amman for contemporary performances (Figure 2). To grant continuation of practices which contribute to the cultural significance of these places within these monuments, and to solve the very delicate issue of conservation and reuse applied to their specific building typology, we have to ensure that the proper use of the theatre site reduces the risks of material damage to the ancient structure by performance.

Ultimately, a balance needs to be struck between conservation and reuse. However, the most important issue in their conservation and restoration is how to create a sense of space, where the acoustical reflections and the visual imagery are essential components in creating this sense of space. A precautionary approach is required, as their cultural significance may be changed. Thereby, their conservation plan has to consider some criteria, which includes not only consideration of the architectural form, the material, the fabric, but particularly the acoustics associated with their use. Following is a debate of the role of ERATO project in conservation and restoration of theatre acoustic qualities, which can assist in theatre sustainability.

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## **4 The ERATO Project and Theatre Conservation**

In fact, conservation principles rarely consider the technology of either the historic artifacts itself or of the acoustical simulation and other scientific technologies to be used in conservation. Technical studies can extract the old technologies that are found in theatre and odea designs such as the acoustic systems, lighting and distribution of seats. Therefore, the use of computers to develop an acoustic model can assist in designing new ways of using theatre space, while providing new information for future conservation and restoration works, especially concerning the acoustical importance of different architectural elements of the ancient theatres and odea. The conservation principles adopted should be appropriate to the technology of the construction, partly to preserve the integrity of the original design, but also for sound and other practical reasons.

### **4.1 Theatre acoustic simulation and auralisation using computer software for conservation**

Until recently the acoustical criteria in conservation were neither observed nor operative, within the context of the engineering pre-design relating to these multiple uses of ancient theatres. In fact, the main issue in conservation and restoration of ancient theatres and odea is how to create a sense of space in the ancient auditoria, where the acoustical reflections and the visual imagery are important components. This requires a more flexible approach and a clearer evaluation of the historical significance of the existing fabric. Moreover, for sensible judgments to be made and appropriate methods of repair to be selected, it is necessary that the technologies of construction be understood.

With the advantage of modern computers and room acoustic simulation software, today we can get further information that can assist in theatre conservation, by modelling them in a virtual environment. The ERATO project makes it possible for the first time to listen to these historical buildings as they sounded in the past. Based on acoustic simulation and auralisation using computer software (Rindel,2002; Vassilantonopoulos et al., 2003; Lisa et al, 2005; 2006; Farnetani, et al,2006; Rindel et al., 2006), many previously unanswered questions relating to the good acoustics of such spaces can be answered by measurement, acoustic simulation and acoustic analysis of the ancient theatre.

It is reported that the unoccupied seats and the heads of the audience also scattered sound to adjacent area. (Shankland, 1973; Rindel et al., 2006). Meanwhile, the columns on the scene wall have a good scattering effect, and reflections from the orchestra floor and the stage, which are observed, are also identified as scattered and reverberant. Disturbing *echoes* can occur in some positions, especially if the scene wall is preserved to its full height (Vallet et al., 2005; 2006; Lisa et al, 2006). In general it can be said that reflections from the stage wall and the roof are more important than the reflections from the orchestra (see Figure 1).

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#### **4.1.3 The Contribution of ERATO project in the revival of the acoustical and architectural theatre heritage**

According to ERATO project, new information has been provided concerning the acoustical importance of different architectural elements of the ancient theatres and odea. From investigations of scaled models, it is found that the different architectural layout in the Greek and Roman periods indeed had been influenced by acoustic parameters. It has become possible to quantify the acoustical properties of the ancient theatres and odea in each condition leading to valuable information regarding the acoustical consequences and degree of authenticity of permanent restorations and temporary amendments (Rindel et al., 2006; Lisa et al, 2006). However, the results of the acoustic simulations in the reconstructed theatres and odea confirm the assumption, that they were dedicated for different purposes (Rindel et al., 2006). The definition and testing of the psycho-acoustical assessment method, of the proposed sounds and acoustics as defined for the modern use of ancient theatres should be refined (Vallet et al., 2005, 2006). This can be based mainly on a public assessment of sounds, measured in existing theatres, and modified sounds, using different levels of the main acoustical parameters that greatly influence the psycho-acoustical aspects of the proposed sounds (Vallet et al., 2006; Haddad, 2007).

Through this assessment we can determine whether the acoustics are sufficiently good or whether there is a need for amplifiers. However, this assessment of the sounds heard in ancient theatres and odea should be performed in a controlled situation in the laboratory. In a more intuitive way, and as an example, in order to answer the question as to what ancient Roman theatres sounded like, auralised sound examples of various theatres can be heard on the ERATO website (<http://server.oersted.dtu.dk/www/oldat/erato>). Actually, according to recent acoustical researches and studies of ERATO project, the overall impression and architectural elements should include: colonnade, stage wall and canopy (Farnetani, et al, 2006; Lisa et al, 2006; Rindel et al., 2006). In terms of the relationship between physical acoustic parameters and public preference, the existence of some architectural elements is of importance in order to improve the listening enjoyment for the public, as in the Roman theatre where the height of the scene building and the decoration with columns and statues are particularly important, but also the colonnade behind the audience is acoustically important (Rindel et al., 2006).

From the simulations it is found that the stage wall is important for providing sufficient intensity and reverberation of the sound. For that, the restoration and anastylosis of the stage building can improve the source loudness and speech intelligibility by reflecting the sound towards the audience and reinforcing the direct sound. Many restored theatres have this deficiency such as in the Theatre of Amman, where the stage wall was restored to one storey only. (Figure 2). While the columns on the scene wall have a scattering effect, which is good for

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the sound distribution, the colonnade improves strength of sound in remote seats. However, the overall preference is higher with the source on the proscenium near the scene wall, than with the source on the orchestra (Vallet et al., 2005; 2006). Thereby the sound sources should preferably be on the *proscenium*, near the scene wall, not in the orchestra. Meanwhile, the restoration and anastylosis of the colonnade portico in the upper part of some theatres, provides a retreat area with shade for the spectators, it improves the loudness of the sound in remote seats (Lisa et al, 2006; Rindel et al., 2006). However, research about the acoustic of the classical theatre, suggests that the lost voice up to 1st diazoma as in the case in Aspendos is 30- 40% (Izenour, 1992). Hence, in order to improve sound reflections from the orchestra floor, the orchestra should not be used as a seating area for the audience, and Loudspeakers should be located in the orchestra to avoid problems with echoes. The present practices in many performances still place the loudspeakers on the stage (Figure 2).

These results were proved according to acoustical measurements through 3D Models in the ERATO project (Farnetani, et al, 2006, Lisa et al, 2005; 2006; Haddad, 2007). Thus, the portico is not only architectonic; it has an acoustic function as mentioned by Vitruvius. The existence of it perseveres the acceptable voice strength to the upper levels. Thereby, re-understanding and re-evaluating Vitruvius main issues on theatre can help in reconstruction, conservation and restoration of the acoustical and architectural heritage of ancient theatres. In conclusion, the distinguishing qualities of the theatre structure (especially the acoustical) and its environment, in their original or earlier settings, should not be destroyed. However, the theatre stage and portico reconstruction is appropriate where a theatre is incomplete through damage or alteration, and only where there is sufficient evidence to reproduce an earlier state of the fabric. In rare cases, reconstruction can also be appropriate as part of a use or practice that retains the (acoustical) cultural significance of these places (Burra Charter, Article 20.1). Meanwhile, in the odea the roof is acoustically most important; however, this does not mean that odea should be fully restored with new roofs.

We can now decide the level of clarity of the sound, which should be high and evenly distributed and the *strength* of the sound that is appropriate or necessary for any theatre. This can be achieved easily by the digital technology especially using the 3D models. This should be the new target for the technical people involved in the digital technology of acoustic. Furthermore, the integrated use of LIDAR, digital photogrammetry and acoustics allows 3D accurate acoustical and metrical models for the conservation, presentation and interpretation of the theatres and odea. However, the advisability of using some sophisticated techniques to stabilize existing structures when more traditional repair methods, even perhaps including rebuilding, might be more appropriate. We should start to take into consideration the issue of improving the theatre acoustic quality in the conservation process, such as the *clarity* of the sound, which should be high and evenly distributed, the *strength* of the sound, which is relatively weak, and decreases with distance, especially for those theatres and odea that are located in

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an urban setting and suffer from modern noise. Therefore there is a need for some anastylosis and restoration of the stage and the portico to their original levels and layout as in ancient times, and to employ the new digital technologies to interpret and understand the distributions of echoes inside a theatre.

## **5 Summary and Conclusion Remarks**

Conservation and restoration of theatres and odea can encourage many activities. These activities can infuse them with their full role as places of cultural and artistic creation, shared enjoyment and emotional needs, while using a combination of old and new technologies. This can assist in producing new ideas for the construction and installation of removable structures, with the aim of establishing regulations on the use of each site with theatres and odea providing information. Any intervention should respect both authenticity and the principles of reversibility taking into account the ancient technologies (e.g. acoustics and light). Such conservation and restoration initiatives will encourage the local authorities to seek funding for conservation and maintenance works, and support studies on the impact of noise vibrations and visitor numbers on ancient theatres. Thereby, the distinguishing qualities of the theatre structure (especially the acoustical) and its environment, in their original or earlier settings can be restored and revived.

Conservation, reinforcement and restoration of the architectural heritage of theatres and odea require a multidisciplinary approach. While reuse is currently used as a means of conservation as well as justification for the enormous costs that restoration and conservation entail, modern use can enhance consistent and conscious decisions aimed at the conservation of such spaces, if the parameter considers, beside the artistic architectural, the acoustic qualities as one related to human comfort.

Conservation and restoration of scene wall of theatres and odea to their original level and layout should be considered as an enhancement to preserve their authentic technical and scientific information. Therefore, the conservators and restorers that belong to the strict portrayal-school should now accept that they have to deal with other new interpretation methods. A dialogue must now be created between the specialized in acoustics and the people involved in the process of theatre conservation. They must now not only aim for artistic and structural requirements, but also for acoustic standards which can now actually be achieved by the modern technology. As a result of the conservation of acoustical characteristics, in conservation works, the restoration and anastylosis of the stage and the colonnade (portico) is required to improve the volume of sound. This can give a new approach for conservation and restoration of theatres

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and odea. Thereby there is a strong need to undertake further comprehensive studies on building design and old technologies such as acoustic and lighting.

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