



MODERN HISTORY OF ACOUSTICS IN GREECE

Michael Taroudakis^{1*}

Athanasios Trochidis²

¹ University of Crete, Department of Mathematics and Applied Mathematics, Voutes University Campus, 70013 Heraklion, Greece

² Department of Civil Engineering School of Engineering, Aristotle University of Thessaloniki, University Campus, 54124, Thessaloniki, Greece

ABSTRACT

Greece has a long tradition in acoustics. Already in the ancient era, the necessity for social gathering and cultural performance in the open air with optimum hearing and appreciation conditions, led the engineers of that time, to study and design theaters, conservatories and other public gathering places with excellent acoustic characteristics.

In the modern era, the acoustic community in Greece is also flourishing, assisted by the close collaboration between industry, universities, and research centers.

The Hellenic Institute of Acoustics (HELINA) is the scientific society of Greek acousticians. HELINA is a very active community, continuously growing in parallel with the continuous evolution of the Greek acousticians and of the acoustic education in Greece. HELINA and Greek acousticians play an important role in international acoustic affairs in both research and administrative issues.

Keywords: *History of Acoustics, Acoustical Education, Acoustical Societies, Greece*

*Corresponding author: taroud@uoc.gr

Copyright: ©2023 Michael Taroudakis, Athanasios Trochidis. This is an open-access article distributed under the terms of the Creative Commons Attribution 3.0 Unported License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

1. INTRODUCTION

Greek acousticians form a very active scientific community in Greece. The acoustic tradition in Greece started in the ancient era, mainly during the classic times when Greek engineers managed to design and construct theaters and odeia, with excellent acoustic characteristics.

The tradition of the Greeks in acoustics continued in the 20th century, assisted by the introduction of acoustic education as a special field in Greek universities. Thus, a new generation of acousticians was created with interests, specialization and activities in various areas of acoustics. Along with their colleagues who received their education abroad, consist now the society of Greek acousticians who have considerable contributions to basic and applied research on acoustics, as well as to engineering applications that include among others, the design of buildings characterized by acoustics of high standards, the design and implementation of noise-control solutions, the design and production of sophisticated material and electroacoustic systems for the enhancement of the acoustic characteristics of the areas requiring optimum appreciation of sound.

This article presents a short review of the history of acoustics in Greece with emphasis to the acoustic education and the activities of the Greek acousticians in modern era. A major part of this presentation is devoted to the Hellenic Institute of Acoustics (HELINA), which is the scientific society of acousticians in Greece. HELINA is very active with many contributions to the national and international acoustics.



2. ACOUSTICS AND ANCIENT GREECE

An inherent part of the ancient Greek civilization was the social gatherings and cultural performances. Social gatherings were held in areas called “agora” (αγορά) while cultural performances were held in open theatres of large size and/or special smaller conservatories (odeia – οδεία). The necessity for a clear appreciation of the speakers or the artists dictated the Greek engineers to study the acoustics of these areas trying to achieve the best possible result. They had to take into account orientation of the building, typical weather conditions in the area, capacity and additional characteristics of the places under consideration and find optimal solutions for the architectural design and the material to be used which included reflecting material such as marble and stone. The result of their studies was the construction of buildings with excellent acoustic characteristics. The acoustics of ancient theatres and odeia remain notorious until today. In addition, in order to achieve optimal appreciation of the dialogues during theatrical performances, especially for audience members in the distant seats, the ancient Greeks introduced the use of special masks that actors should wear during their performance. Thus, the masks had the role of a small loudspeaker.

As additional means to enhance the acoustics of ancient theaters, ancient Greeks and Romans used sound vessels, known as echea (ηχεία) resonators, a term introduced by the Roman architect Marcus Vitruvius Polo. A characteristic example of a Greek ancient theatre, equipped with echea was the theatre of the city of Lyttus in Crete. The acoustics of this theatre, which does not exist anymore, was studied by means of simulation techniques, by Polychronopoulos et al. and they showed that it was similar to that of the famous theatre of Epidaurus [1].

The use of these vessels continued in Greek Orthodox churches that were built, in the late Byzantine era and even beyond. It is noticeable that the acoustics of Greek Orthodox churches has always been an important issue for the architects as the necessity of clear appreciation of the Liturgy and the words of the hymns and sermons [2,3]

It is interesting to note that the issue of noise control was well known at least to the citizens of the Greek city of Sybaris. Sybaris founded in 720 BC was an important city

of Magna Graecia. It was situated in modern Calabria, in southern Italy [4].¹

According to Athenaeus [5], Sybarites (the citizens of Sybaris) were the first people to forbid those who practice noisy arts from dwelling in their city; such as braziers, and smiths, and carpenters, and men of similar trades; providing that their slumbers should always be undisturbed. And it used to be unlawful to rear a cock in their city. Sybarites were notorious for their sense of well-being, so noise control was probably of high priority for them.

It can be inferred from above historical data and by many other witnesses that acoustics was one of the areas of primary interest for Greek engineers in the ancient era. The tradition of Greeks involvement in acoustics is continued in the modern times.

3. ACOUSTIC EDUCATION IN GREECE

Acoustics as a distinct area of university education was introduced to Greek universities in the 20th century. Topics on acoustics began to be taught mainly in the Departments of Architecture of the National Technical University of Athens and the Aristotle University of Thessaloniki, indicating in this way the continuation of the tradition that wants Greeks to be particularly sensitive to building acoustics. Later on, topics on acoustics related to electronic and mechanical engineering were offered in underwater programs of Engineering and Science schools, while topics on acoustics were also introduced in programs of musical studies. In addition, physical acoustics, and computational acoustics were among the courses that were very popular among the students of Science Schools. No complete programs on acoustics in undergraduate or post-graduate level were organized in universities until the end of the previous century. The lack of specialized programs however didn't hinder students to get an enthusiasm in acoustics and proceed with studies and research at a graduate or doctoral level either in Greece or abroad thus strengthening the potential of Greek acousticians.

The first specialized departments on acoustics were established in the Technological Institutes of Crete and of the Ionian Islands, in late 90's. The department in Crete was on Music Technology and Acoustics, while that of the Ionian was on Sound Technology and Musical Instruments. On 2018 the Technological Institutes evolved into

¹ We are grateful to Walter Alfredo Montano (Argentina) for giving us the information on Sybaris.

Universities and the Department in Crete continues with the original name under the Hellenic Mediterranean University, while that of the University of the Ionian was merged with the department of Ethnomusicology, still offering courses on sound technology. The department of Music Technology and Acoustics of the Hellenic Mediterranean University is the only department in Greece specialized in acoustics.

Nevertheless, nowadays, many courses on acoustics are offered in most of the Greek universities that include the Universities of Athens, Thessaloniki, Crete, Patras, Thrace, Thessaly, Ionian Islands and West Attica as well as the National Technical University of Athens. In all these universities topics on acoustics are taught at both undergraduate and post-graduate level and the number of Master and Doctoral theses on the various areas of acoustics is continuously increasing. It should be added that many laboratories, offering sophisticated infrastructure for acoustic experiments (including underwater) have been organized in most major universities and associated research centers. These laboratories combine education with research and development enabling the design and implementation of acoustic innovative solutions. Most of the acoustic laboratories collaborate with the industry, ensuring the link between, education, research and production.

4. GREEK ACOUSTICIANS

In the decade of 90s, a modern framework of standards and specifications for building acoustics, traffic noise, noise and vibration control in workplaces and for acoustical measurements was adopted in Greece. At the same time, a plethora of special buildings (Music Halls, Theaters, Airports) and national highways were constructed within EC projects or by state funding. As a result, there was a great need of experienced people able to implement the new standards. During this period, Greek acousticians worked as consultants to construction companies and played a key role to the construction of high-performance buildings and to the control of environmental noise. As an example of this project the acoustics of Major Concert Halls in Greece (Athens, Thessaloniki, Patras, Heraklion) and Cyprus (Nicosia) have been designed by Greek acousticians and the solutions adopted were implemented in collaboration with Greek companies. The result is superb.

Great progress and know-how were also achieved in the field of Environmental Noise control. Noise was monitored for long periods of time in major highways, airports and cities and noise maps were constructed for the first time in

Greece. Based on noise maps, noise control measures were proposed and constructed (noise barriers, traffic regulations, quiet pavements).

To support all this activity, some Greek industries became active and in collaboration with University Labs developed acoustic materials (absorbers, elastic laminates, sound-insulating elements) and acoustical devices (noise barriers, anti-vibration springs, and mufflers). Both parts benefited from this collaboration a lot. Acousticians became experienced in applications while industry and constructors became familiar with acoustical specifications and developed the necessary technology to achieve optimal solutions.

In addition, Greek acousticians were involved in the research for underwater acoustics in collaboration with the Greek Navy but also in the framework of European projects dealing with marine science and technology. The team of underwater acoustics of the Foundation for Research and Technology-Hellas (FORTH) soon became famous for their contribution in the underwater acoustic research and, as it will be mentioned in section 6, it became by invitation the nucleus of the Hellenic Institute of Acoustics and the first Greek member of the European Acoustics Association.

The activities, of the Greek acousticians today, cover a wide range of topics including Building and Architectural Acoustics, Signal Processing, Underwater Acoustics, Ultrasonics, Musical Acoustics, Electroacoustics, Psychoacoustics, Computational Acoustics, Noise and Vibration Control, Physical Acoustics, Education and Acoustics.

5. ACOUSTICAL SOCIETY OF GREECE

In the mid 70's the persons working in different fields of acoustics in Greece reached a critical number. It was the right moment for the formation of a scientific society related to acoustics and as a result, the Greek Acoustical Society was formed. The members of the society as well as its actions increased. It organized the annual conferences on acoustics, joint conferences with other societies and seminars on special topics. The main achievement, however, was the creation of technical committees which prepared and proposed norms and technical specifications for several fields including building acoustics, noise and vibration control and acoustical measurements. This enabled the construction of special buildings (music halls, theatres, airports) and environmental actions in Greece,

considering acoustical specifications. As a result, acoustical industry, production and consulting benefited a lot. Despite the initial enthusiasm and its achievements, the Greek Acoustical Society failed to achieve further growth and to reconsider its aims and actions. After a period of inactivity, a descended course followed and finally the Greek Acoustical Society suspended its operation. However, most of its members were determined to continue their efforts to work towards a new Greek Acoustical Society and became members of the newly formed Hellenic Institute of Acoustics.

6. THE HELLENIC INSTITUTE OF ACOUSTICS (HELINA)

6.1 History

In 1999, the European Acoustics Association (EAA) was in a development stage. The Board of EAA wanted to add in its membership as many acoustical societies as possible from European countries with long tradition in acoustics but also from countries with an obvious potential in acoustic research and consultancy. The underwater acoustics group of FORTH had already become known to European acousticians and the Board invited the group to the EAA General Assembly held in Berlin that year. The group was represented by Prof. Michael Taroudakis who informed EAA that there have been initial discussions for the creation of a new Acoustical Society in Greece that could be accepted as a full member of EAA. The underwater acoustics group of FORTH was provisionally accepted as associate member of EAA.

At the same time, the conditions for the creation of a new Society in Greece were mature. All started after some meetings of an initiative group of few persons interested in acoustics that included mainly University Professors, Researchers, and officers of the Greek Navy. The outcome of these meetings was that the activities in the field of acoustics need to be further developed within an organized environment of a new scientific society. The initiative group adopted the title “Hellenic Institute of Acoustics” (HELINA) so as not to be confused with the old and inactive Acoustical Society of Greece.

Aiming at fostering the interdisciplinary nature of acoustics it was decided to allow participation of candidate members related to acoustics, coming from varying background and interests without meaningless restrictions protecting at the same time the scientific profile of the Institute. In that vein, the initiative group

appealed to people related to acoustics and informed them about an open organizational meeting which was to be held soon. Thus, HELINA was founded as a non-profit scientific association.

The founding assembly of the new Society was held in 2001. Prof A. Trochidis was elected as the first President of HELINA.

The creation of the HELINA was announced to the EAA officials during EURONOISE 2001 that was held in Patras (GR). The same year, HELINA was accepted by EAA as a full member and M. Taroudakis attended the General Assembly that was held in Rome representing the newly established HELINA.

The (initial) founding members of HELINA were mostly coming from academia and only few from industry. The profile of the Institute, however, changed over the years and now the members come from different backgrounds and interests and include engineers, physicists, architects, musicians, physiologists, psychologists etc.

The headquarters of HELINA, which were initially set in Athens, were moved to Heraklion (Crete) following the decision of the HELINA General Assembly held in 2006.

HELINA joined the International Commission for Acoustics (ICA) in 2012 and is a very active member of both EAA and ICA.

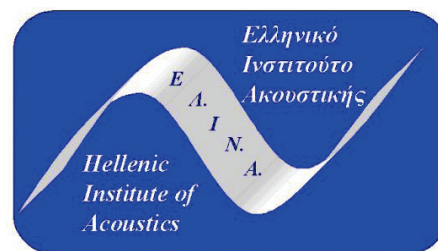


Figure 1. The logo of HELINA

6.2 Objectives

Looking back there is a number of reasons why the idea for a new society of acoustics emerged at that particular time. Active persons and groups in many fields of acoustics already existed mainly in the Greek Universities as well as in industry and administration. All these people were trying to find a way to come together to exchange experiences and

find appropriate solutions to their problems. Furthermore, the need to interact with members of other European acoustical societies and benefit from their experience was obvious.

Based on the above reasoning, the central aims of HELINA are:

- To diffuse and promote scientific knowledge and applications in acoustics.
- To promote collaboration between members from different acoustical background.
- To encourage the interdisciplinary collaboration between acousticians and people coming from different sciences.
- To support education in acoustics on both undergraduate and graduate level.
- To establish scientific relations with international acoustic associations.

6.3 HELINA activities

HELINA organize the National Conference on Acoustics every second year. The National Conferences were held in Patras (2002, 2018), Thessaloniki (2004, 2014, 2022), Heraklion (2006), Xanthi (2008), Athens (2010), Corfu (2012), Piraeus (2016). The Conference that was supposed to be held in 2020 was cancelled due to the pandemic.

The Conferences are attended by acousticians of both the educational/research and commercial sector. It is interesting to note that the number of papers presented in the conferences is continuously increasing and a significant part of the presentations are from graduate students or young acousticians, which is an indication of the continuous interest of the young scientists in acoustics.

In addition to the National Conferences, HELINA has organized international Symposia or Conferences on acoustics. The largest among them was EURONOISE 2018 held in Hersonissos, Crete. Prof. Michael Taroudakis was the chairman of the Conference. It was attended by almost 800 acousticians. EURONOISE is one of the EAA projects.

The Acoustics of Ancient Theatres Conference was another initiative of HELINA. It was organized under the auspices of the EAA in Patras (2012) and was attended by more than 100 acousticians. Prof John Mourtzopoulos was the chairman of the Conference. Presentations made during the Conference formed a special issue of the official journal of

EAA, which at that time was “Acta Acustica united with Acustica”. In 2022 a second edition of the Conference on the Acoustics of Ancient Theatres was organized in Verona (IT) by the Italian Acoustics Association (AIA) in collaboration with HELINA.

HELINA organize regularly workshops and seminars in various aspects of acoustics addressed to both young and experienced acousticians. Also their committees make suggestions for the state legislation in acoustic design and noise control.

Participation of HELINA members in press and information media is continuous, bringing to a greater audience the message that acoustics is a very important scientific area and sound is very important for our lives.

6.4 International contributions

HELINA is very active in all international fora related to acoustics. It has a continuous participation in the EAA and ICA General Assemblies. In recognition of this contribution to International acoustics, Prof. Michael Taroudakis, representing HELINA was elected President of EAA for the term 2013-2016 and President of ICA for the term 2016-2019, remaining in ICA Board as past President for the term 2019-2022. Under this capacity Michael Taroudakis was co-coordinator of the International Year of Sound 2020-2021. Thus, HELINA was present in all major international activities on acoustics.

7. DISCUSSION

The future of the acoustical research, industry and production is looking bright and within the next two decades we will see tremendous changes and achievements. On the other hand, HELINA completed more than 20 years of life. The number of members increase and a high degree of maturity was accomplished. It is the right time to reconsider its aims, its administration and its strategic planning.

The future of HELINA depends on its ability to deal with the incoming challenges. To address and promote emerging special topics new planning and actions are needed. One of the central objectives is to support the new generation of acousticians working on cutting-edge topics. One action is to organize and sponsor small workshops and symposia dedicated to special, innovative fields. Further actions could include prizes for young members with extraordinary

achievements and fellowships for young acousticians to promote excellence.

Most of the members of HELINA are coming from academia. Thus, they could substantially contribute to the improvement of the acoustic education in Greece. A committee could be formed to discuss the existing courses in acoustics in depth and formulate proposals for updated programs in the light of the new developments and needs.

HELINA must find ways to further promote the relation to industry and production related to acoustics. Special workshops can be organized for people working in industry and production covering basic acoustics as well as new, innovative applications, as a long- life education. The aim is to achieve a closer collaboration between HELINA and industry for the benefit of both parts.

It is obvious that finance is very important for the future and a key issue for all the described actions. The membership fees may be enough to maintain the operation of the Institute extra funding is needed, however, to support the future operation.

Closing this brief history of HELINA and of the acoustics in Greece, one can only be optimistic for its future development based on the dynamic new generation of Greek acousticians and its potential to deal with the challenges of the rising new era.

8. REFERENCES

- [1] S. Polychronopoulos, D. Kougias, P. Polykarpou, D. Skarlatos “The Use of Resonators in Ancient Greek Theatres” *Acta Acustica united with Acustica*, **99**, pp 64-69 (2014).
- [2] E.Tzekakis, “Reverberation time of the Rotunda of Thessaloniki” *J. Acoust. Soc. Amer.*, **57**, p.1207 (1975).
- [3] A.Trochidis, “Reverberation time of Byzantine Churches of Thessaloniki” *Acustica*, **51**, pp. 299-301 (1982).
- [4] <https://en.wikipedia.org/wiki/Sybaris>
- [5] Athenaeus: The Deipnosophists, Book XII. <http://www.perseus.tufts.edu/hopper/text?doc=Ath.+12&fromdoc=Perseus%3Atext%3A2013.01.0003>