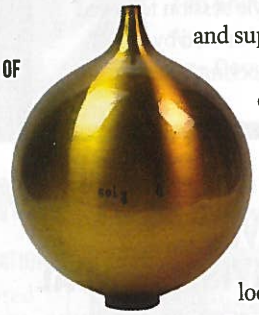
Ancient texts suggest that acoustics in Classical Greek theaters, like the one at Ephesus, may have been enhanced by devices similar to Helmholtz resonators. Photo: Mark Cartwright.

IT SOUNDS HOLLOW

EVER SINCE PRIMITIVE MAN HELD A SEASHELL TO HIS EAR AND WONDERED HOW IT CARRIED THE SOUND OF the sea, humans have puzzled that a hollow vessel with no obvious source of power could seem to produce sound. Today, it is a branch of research.

ASME has a division devoted to vibration and acoustics which studies this very effect along with issues including the quieting of machines and tuning the exhaust of engines.

The seashell phenomenon is cavity resonance, studied in great detail by Hermann von Helmholtz. In the course of his research into hearing he developed resonators that bear his name. Helmholtz used a battery of these vessels tuned to specific frequencies to investigate such questions as the harmonic content of a human voice.



Acoustical engineering has deep roots in antiquity.

The Helmholtz resonator and the seashell demonstrate that a high-quality (i.e., low-loss) spring/mass system can be excited to large amplitude displacements by a vanishingly small exciting force. In the seashell, background noise provides the exciting force.

The traditional analysis of an acoustic resonator regards the air in the neck of a vessel as a mass and the compressible air in the volume of the vessel as the spring.

The Greeks as early as the fifth century B.C.E. had a highly sophisticated system of musical scales and knew that they could tune large brass or ceramic vessels to resonate at specific places in their scale. This was exploited in the design of theaters.

A great deal has been written about the excellent acoustics of Greek theaters, even as they stand today. Vitruvius, a first century B.C.E. Roman architect, soldier, and writer compiled a book on architecture that discussed theatrical design.

He discussed the use of brass or occasionally ceramic vessels, on the order of a meter in diameter, to improve sound quality. It is not clear whether the resonators were intended to improve intelligibility of spoken words or to attenuate the echoes that plagued some areas in Greek theaters. Depending on the phasing, which is a matter of tuning, resonators can either amplify or diminish sound.

None of these resonators has been recovered. Brass was valuable and would be salvaged when a theater was destroyed. In 146 B.C.E., for example, a Roman general, Lucius Mummius, apparently not interested in performing arts, sacked Corinth and packed the sounding vessels back to Rome.

Some authorities believe Vitruvius may never actually have seen a resonator and was just retailing what he read in Greek literature. He does tell us that the vessels were mounted open end down and supported on wedges.

The vessels, mounted in an elaborate geometric pattern related to the Greek musical scale, were put in cavities between rows of the audience. A number of ancient theatres have pits in the right locations specified by Vitruvius.

St. Paul in his epistle to the Corinthians writes that, without charity, "I am become as sounding brass or a tinkling cymbal." In a 1982 paper, " 'Sounding Brass' and Hellenistic Technology," William Harris of Columbia University suggested that Paul was referring to a brass resonance vessel.

The message is that a vessel produces a pleasant sound but in fact contributes nothing. The reference to theatrical hardware could also be an example of ancient wry humor. Paul had a major failure in a theater. He was drowned out by the crowd when he tried to preach in the theater at Ephesus. **ME**

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