Acoustical Designing in Architecture
V. O. Knudsen and C. M. Harris
Acoustical Society of America, New York (1950 and 1978), 408 pp., paperbound, 23.00 USD,
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It has been more than 65 years since the book *Acoustical Designing in Architecture*, written by V. O. Knudsen and C. M. Harris, was first published (in 1950) and this small book, reprinted 1978, is still very useful, relevant and is a very practical contribution, for any young acoustical consultant or architect who seeks perfection in his/her building design work.

Before I start my short review of the book I like to make two short confessions:

1. I bought this book in the mid 80's, almost 30 years ago, and still I love this book as one of the very comprehensive, efficient, basic, professional books available for anyone who deals in architectural acoustics. When I bought it, I heard of the name of Cyril Harris, one of the two authors of the book, as a professor of acoustics in the USA. He and I met in New York City while he taught acoustical courses at Columbia University. The last time we met was in an apartment in Jerusalem, where I live and run my small acoustical firm.
2. My acoustic mentor for my Ph.D. degree, Giora Rosenhouse, taught me, in my early years in the Technicon Institute of Technology in Haifa Israel, that ". . .it is not enough to learn and understand the physical background of basic acoustical knowledge to be a professional acoustical consultant — you still need to know the building material market, their prices and to know the contractors and their experiences. Without those three components, you will never be an expert."

The book we discuss now has almost two of three components needed to become proficient.

In the beginning of the preface of the second edition of the book, Harris wrote ". . .During the thirty years since publication of the original edition of *Acoustical Designing in Architecture*. . . students in my class in Columbia University as well as practicing architects. . . have continued to find the text a valuable tool in the study of principles of architectural acoustics and their applications to the solutions of practical problems. . ." No doubt, 65 years after the first edition of the book was published, it is easy for me to conclude that this small book is valuable to every young acoustical consultant in his/her early stages, and is a very valuable, comprehensive, basic tool to understand or investigate the principles of architectural acoustics and their applications which have a large range of solutions for common and practical problems.

The book does not contain sophisticated mathematics or physics so the average reader can follow it and can easily understand the acoustics presented. To this day, still, no high degree of science background is needed to follow or understand acoustical behavior in different situations in a building, even though it has been many years since this book was written.

The paperbound book contains 403 pages in 20 chapters and three appendices.

The 20 chapters in the book can be divided into three major sections:

I. Basics

1. Properties of sound
2. How to hear
3. Speech and music

II. A few chapters of the general acoustical behavior including the "Reflection and diffraction of sound in rooms"

4. Open-air theaters
5. Background to design
6. Sound-absorptive materials
7. Special sound-absorptive constructions
8. Principles of room acoustics
9. Acoustical design of rooms
10. Noise control
11. Reduction of airborne noise
12. Reduction of solid borne noise
13. Control of noise in ventilating systems
14. Sound amplification systems

III. And last, some architectural acoustics design recommendations for several typical buildings including

15. Auditoriums
16. School buildings
17. Commercials and public buildings
18. Homes, apartments and hotels
19. Churches
20. Radio broadcasting, television, and sound-recording studios.

There is no doubt that this book contains much of the minimum knowledge needed for any architectural acoustical consultant before acquiring any advance studies in acoustics and, just as important, before specializing in the practice under supervision of an expert in one or more areas of this encompassing field. Here are the chapter descriptions:

1. "Properties of sound" starts with short introduction of the basic terms of the sound phenomena and the building — what is sound, propagation of the sound displacement amplitude, the frequency, speed of sound wave, wave form acoustical power, sound intensity variation of pressure and intensity with distance, the decibel, sound level meters, directionality of sound sources etc.
2. "How we hear" discusses the ear structure and the hearing mechanism, the sensitivity of the ear, impaired hearing, loudness and loudness level, effect of noise on hearing etc.
3. "Speech and music" connects the basic terms of noise, music and speech, the speech power, properties of musical sounds, some effects of the room on speech and music etc. to predict and control the behavior of speech and music in rooms and halls.
4. "Reflection and diffraction of sound in rooms" discusses two major basic terms of room acoustics: the reflection of sound and the diffraction of sound in the room and their behavior in the room and produces the acoustical images.
5. "Open air theaters" — from the ancient Greek theater to the Roman with descriptions of the sound propagation in the air, speech articulation test in the open air, the design of open air theaters, the orchestra shells etc.
6. "Sound absorptive materials" discusses how sound is absorbed, the rating of acoustical absorptivity of materials, prefabricated acoustical units, acoustical blankets, perforated facings, mounting acoustical materials, reflection of light from acoustical materials, effect of paint on absorption of sound by acoustical materials, absorption by patches of materials.
7. "Special sound absorptive constructions" — panel absorbers, Helmholtz resonator absorbers, draperies, variable absorbers, and suspended absorbers.
8. "Principles of room acoustics" — one of the best in my mind, deals some chosen principles of room acoustics, including those properties of sound we consider in design of open air theaters and addition principles of reflection, absorption and scattering of the sound and its boundaries of the enclosures, the room resonance, normal modes, sound pressure distribution, the diffusion of sound, the physical and geometry acoustics, the growth of sound in a room, steady-state value of sound pressure, decay of sound in a room, average decay rate, limitations on use of reverberation formulas, sound decay and reverberation time at different frequencies, effects of air absorption upon decay rate and reverberation time, reverberation time nomographs, reverberation in coupled spaces, special acoustical phenomena associated with the shape of rooms.
9. "Acoustical design of rooms" — the reader exposed to several practical aid conclusions to fulfillment as necessary acts in the planning process to rich good acoustics in a building begins with the selection of the building site and continues through 11 basic stages of designing. In the design process the reader must follow the 11 requirements to reach good acoustics. In those 11 requirements, we can find 4 requirements applicable to all rooms that are used for speech and music. These very detailed, specific and practical requirements are highly important to every acoustical consultant. This chapter continues and deals in the rating of speech intelligibility–articulation testing, design of room shape, volume per seat, optimum reverberation in rooms, control of reverberation, checking the completed room, articulation testing and more with great imported data and examples.
10. "Noise control" — the authors obliged the architect to seek for every possible means, any features to impart the building design and construction, for avoiding any effect of noise, base an intelligent approach and implement seven knowledge management rules. This chapter deals with the addition of noise levels, noise in buildings, outdoor noise, acceptable noise level in buildings, siting and planning to avoid of any effect of noise to avoid of any effect of noise against noise, grading and landscaping, building layout etc.
11. "Reduction of airborne noise" — and ways to avoid failures in the design of the building including: how the sound is transmitted, transmission through openings, sound transmission loss, rigid partitions, porous materials, compound wall constructions, windows and doors, noise insulator to avoid of any effect of noise insulation factor, noise insulation requirements, noise reduction by sound absorptive treatment, application of acoustical materials, and some useful tables of data, graphs, figures and equations to calculate or evaluate the sound isolation etc.
12. "Reduction of solid borne noise" — which is considerably different from those of the airborne sound is described in a very simple common way, including special attention to the floors and ceiling, discontinuous construction, isolation of machinery vibration and some useful data tables, clear graphs and figures and equations to calculate or evaluate the sound isolation etc.
13. "Control of noise in ventilating systems" — to ensure quiet operation free of annoying noise

generated by or transmitted through the system. The chapter deals in origin of noise in ventilating systems, noise suppression in ventilating systems, acoustical materials for duct lining, calculation of noise reduction in lined ducts, acoustical filters, elimination of cross-talk, and it include few useful data tables, clear graphs and figures and general equations to evaluate the sound isolation etc.

14. "Sound-amplification systems" include basic and brief practical means for increasing the sound level in rear portions of a room. The chapter deals of the uses of sound amplification, the single-channel sound-amplification system, the microphones, required acoustical power, the loudspeakers, stereophonic sound systems etc.
15. "Auditoriums" is a practical chapter based on the above major principles and recommendations. The chapter opens by describing the history of development of the auditorium, planning of the auditorium, the little theater, the legitimate theater, school auditoriums, civic auditoriums etc. This is a very practical chapter although many years have passed since the book was written.
16. "School buildings" is another very good chapter although it was written more than 65 years, and it deals in some basic definitions, characteristics and recommendations of the design of school rooms like the layout of the school buildings, rooms that require acoustical designing, classrooms, lecture rooms, music rooms, gymnasium cafeteria, library, offices, miscellaneous rooms and corridors.
17. "Commercial and public buildings" is like the two last chapters, a very brief practical and recommendation chapter for implement in any commercial and public building. The chapter includes some introduction, and general discussions about the office, bank and store buildings, libraries, clubs and recreational buildings and museums, legislative, administrative and judicial buildings.
18. "Homes, Apartments and Hotels" — some short practical guiding for homes, apartments, houses, and hotels.
19. "Church buildings" — some basic preliminaries of basic guidelines and important practical recommendations for design small and large churches.
20. "Radio broadcasting, television and sound-recording studios" — some basic and general guidelines for acoustical design.

Appendix 1. Seven different tables of detailed coefficients of sound absorption.

Appendix 2. Six different tables of sound insulation data.

Appendix 3. Several conversion factors and physical constants.

The book is highly recommended for all students, architects or engineers who seek basic comprehensive architectural acoustics knowledge. Further, the book is important for an acoustical professional's bookshelf.

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