

Our
Acoustic
Environment

Frederick A. White

OUR ACOUSTIC ENVIRONMENT

FREDERICK A. WHITE

Professor of Nuclear Engineering
Professor of Environmental Engineering
and Industrial Liaison Scientist
Rensselaer Polytechnic Institute

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SERIES PREFACE

Environmental Sciences and Technology

The Environmental Sciences and Technology Series of Monographs, Textbooks, and Advances is devoted to the study of the quality of the environment and to the technology of its conservation. Environmental science therefore relates to the chemical, physical, and biological changes in the environment through contamination or modification, to the physical nature and biological behavior of air, water, soil, food, and waste as they are affected by man's agricultural, industrial, and social activities, and to the application of science and technology to the control and improvement of environmental quality.

The deterioration of environmental quality, which began when man first collected into villages and utilized fire, has existed as a serious problem since the industrial revolution. In the last half of the twentieth century, under the ever-increasing impacts of exponentially increasing population and of industrializing society, environmental contamination of air, water, soil, and food has become a threat to the continued existence of many plant and animal communities of the ecosystem and may ultimately threaten the very survival of the human race.

It seems clear that if we are to preserve for future generations some semblance of the biological order of the world of the past and hope to improve on the deteriorating standards of urban public health, environmental science and technology must quickly come to play a dominant role in designing our social and industrial structure for tomorrow. Scientifically rigorous criteria of environmental quality must be developed. Based in part on these criteria, realistic standards must be established and our technological progress must be tailored to meet them. It is obvious that civilization will continue to require increasing amounts of fuel, transportation, industrial chemicals, fertilizers, pesticides, and

countless other products and that it will continue to produce waste products of all descriptions. What is urgently needed is a total systems approach to modern civilization through which the pooled talents of scientists and engineers, in cooperation with social scientists and the medical profession, can be focused on the development of order and equilibrium to the presently disparate segments of the human environment. Most of the skills and tools that are needed are already in existence. Surely a technology that has created such manifold environmental problems is also capable of solving them. It is our hope that this Series in Environmental Sciences and Technology will not only serve to make this challenge more explicit to the established professional but that it also will help to stimulate the student toward the career opportunities in this vital area.

*Robert L. Metcalf
James N. Pitts, Jr.
Werner Stumm*

PREFACE

Courses on ecology and the environment have recently become part of almost every college curriculum. However, a survey course on the environmental aspects of sound is rare, despite its relevance and educational merit. This situation can be partially attributed to the lack of textbooks suitable for the nonspecialist. Books are indeed available on such subjects as physical acoustics, underwater sound, and architectural acoustics, and highly technical works on sound and vibration have been written for electrical and mechanical engineers. But there are few single-volume publications for the student who desires an overview of the diverse topics related to environmental acoustics. Of course, many timely and useful publications deal with noise. However, noise refers only to the *unwanted* portion of our sonic environment. The objective, here, is to provide an educational stimulus that is somewhat broader in scope. Hopefully, long after some of the specific noise problems of our society are resolved, the reader of this book will retain an interest in the *desired* sounds of our environment, that is, the sounds of communication and music. These sounds have reflected the thought and culture of every civilization, even though the technology for preserving and reproducing sonic signals did not appear until the twentieth century.

Another objective is to present acoustics for the increasing number of students with interdisciplinary interests. Few subjects provide a broader base than acoustics for revealing the interdependence of the physical and biological sciences, and for demonstrating the connection between science, engineering, and the arts. Acoustics affords a link between art and architecture, electrical engineering and physiology, physics and biology, psychology and the field of medicine, linguistics and computer technology. Even if we limit our attention to topics that can clearly be classified as environmental, we observe a broad overlap of disciplines. The control of loud or intrusive noise, for example, is important because

such noise interferes with speech and music perception, in addition to being a potential hazard for hearing loss. Also, legal aspects of noise abatement cannot be divorced from city planning and other societal problems. Hence, I hope the book will be useful to anyone whose professional assignments require some knowledge of acoustics and acoustic terminology.

The organization of this book into three parts provides options for its use in seminars, minicourses, independent study, or formal presentations. Part I contains an introductory chapter, followed by a discussion of the three *p*'s of sound: (1) sound production, (2) sound propagation, and (3) sound perception. Sound is characterized in simple terms, and the decibel scale is defined and explained. Sound propagation in both outdoor environments and enclosed spaces is discussed in relation to relevant physical phenomena. Sound perception is dealt with in several chapters in order to survey both the physiological and subjective aspects of human hearing, and to identify the instrumentation that permits objective and quantitative sound measurements. Thus, Part I provides the foundation for understanding the applied topics of Parts II and III.

Part II focuses on the contemporary problem of noise. Chapter 8 presents a general overview of this problem, and traffic and aircraft noise are surveyed in Chapters 9 and 10. Chapter 11 includes several topics on industrial noise control. The legal aspects of noise abatement at the federal, state, and local levels are reviewed in Chapter 12. This chapter also summarizes international efforts toward noise control. Considerations of noise in city planning, condensed from the periodical literature, are presented in Chapter 13.

Part III introduces topics that should be of interest to students, not just for a semester, but for a lifetime. Chapter 14 deals with the sounds of speech, the parameters that affect speech intelligibility in usual speaking environments, and the voice spectrograph. Fundamentals of musical acoustics are introduced in Chapter 15, and the special environments provided by auditoriums and concert halls are discussed in Chapter 16. Entire books have been devoted to the subject matter of Chapter 17; the physiological and psychological effects of sound. Hopefully, some students will seek out these more detailed monographs after reading this introductory presentation.

Instructors using this book for a course in environmental acoustics may wish to arrange for complementary demonstrations or field studies. Sound level meters are now available at a reasonable cost, and recordings of environmental sounds can be obtained that permit one to both hear and observe sound spectra via an oscilloscope. Furthermore, there is no

real substitute for the experience of making a few actual acoustic measurements, such as the sound pressure level of traffic noise or the reverberation time of an auditorium. The material of this book may also be augmented through formal assignments, in which students select specific topics of personal concern, pursue extensive reading in the periodical literature, and prepare updated oral reports or term papers.

FREDERICK A. WHITE

Troy, New York, 1975

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F. A. W.

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