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A Study on The Acoustical Foundations of Music by John Backus

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For this project, the book, The Acoustical Foundations of Music, by John Backus, was read and studied. The purpose of reading this book was twofold. The first was to gain a better understanding of how musical sounds are produced and transmitted to the lister. The second purpose was to decide whether or not this book would be suitable to use as a text-book in a course dealing with acoustics as it applies to music. Since it would be impracticle to discuss in the bounds of this paper, all that was learned concerning the subject of acoustics, the topic of discussion will center on how the material was presented and the suitability of the text for a classroom situation.

John Backus, the author of the text in view, is a professor of Physics at the University of Southern California. He is also active as a practising musician. At the time this book was written, Backus was teaching a course in the acoustics of music. The students in this course were mainly muscians who had little or no scientific background. Backus states in his Preface that "this book brings together the material on this subject that I would like to present in such a course..." It is intended primarily for thise with some background in music but little scientific background. "It is therefore

necessary to start the consideration of the acoustics of music with some elementary physics and build up a technical vocabulary as the discussion proceeds." He has tried to avoid using any technical terms without first defining them, and states that it should be possible to start on the section in which a reader is most interested and, as unfamiliar terms are found, to look up the definition in previous chapters.

It is felt that, on the whole, the author carried out his purposes for writing this book very successfully. The text, for the most part, is self-explanatory, requiring very little or no outside help. The discussions and illustrations could be expanded on and demonstrated in a classroom situation, if desired. However, most of the information given can be understood without using these aids. Simple diagrams are used to illustrate explanations of vibrating systems, instruments, and other subjects. These are very clear and easy to understand. Subjects are presented in a straight-forward and interesting manner. There is no "beating around the bush" as is found in many college textbooks. The author has gone to a great deal of trouble to explain things in clear terms, and often, references to previous chapters are given when discussing certain subjects, in case the reader needs to review.

There are only a few criticisms of this book. The first is a criticism of the means used by the author to change a proportionality into an equation. The author stated that this was done by inserting a number called a constant of proportionality and he left it at that. The purpose of this number

or where it came from were not given. It is felt that the author should have at least explained that this number was one worked out by scientists which has to be used in order for the equation to work. This is very confusing to someone with little scientific background.

The only other criticism is one on the number of graphs used by the author. Most of these were very difficult to read and had very little or no meaning to the reader. Many of these could have been omitted without taking away anything of value from the book.

While this is not an actual criticism, it is felt that the usefulness of this text could be enhanced by the inclusion of problems and questions for each chapter in order to give the student a chance to use what he has learned. This would give the student a more solid foundation on which to build.

Other than these few things, which for the most part are insignificant, the book is very well written and could be used effictively in a classroom situation. The main topics that need to be discussed in such a course are included in the book. A detailed outline of the subjects covered is given below.

THE ACOUSTICAL FOUNDATIONS OF MUSIC
by John Backus

I. The Physical and Acoustical Background
    A. Chapter one: The Fundamental Physical Quantities
        1. Introduction
        2. Length
        3. Time

4. Velocity, Speed, and Acceleration
5. Mass
6. Force
7. Pressure
8. Work and Energy
9. Power

B. Chapter two: Simple Vibrating Systems
1. Introduction
2. Simple Harmonic Motion
3. Graphs
4. Effect of Mass and Stiffness
5. Energy Considerations
6. The Tuning Fork

C. Chapter three: Waves and Wave Propagation
1. Introduction
2. The Medium
3. Waves
4. Two-Dimensional Waves
5. Sound Waves
6. Doppler Effect
7. Properties of Waves
8. Beats
9. Energy and Power in Waves
10. Sound Intensity
11. Sound Absorption

D. Chapter four: Complex Vibrations and Resonance
1. Introcution
2. The Vibrating String: Standing Waves
3. Vibrating Air Columns
4. Other Vibrating Systems
5. Sound Radiation from Vibrating Systems
6. Resonance
7. Helmholtz Resonator
8. Resonance Curves

II. The Reception of Musical Sounds

A. Chapter five: The Ear; Intensity and Loudness Levels
1. Introduction
2. Structure of the Ear
3. Sound Intensity and Hearing
4. Intensity Level: Decibels
5. Sound Pressure Level
6. Loudness Level: Phons
7. Loudness: Sones
8. Masking
9. Hearing Loss

B. Chapter six: Tone Quality
1. Introduction
2. Partials and Harmonics
3. Tone Structure
4. Effect of Phase on Tone Quality
5. Analysis of Musical Instrument Tones
6. Formants
7. Vibrato
8. Nonperiodic Tones: Noise
9. Chorus Effect
10. Subjunctive Tones

C. Chapter seven: Frequency and Pitch
   1. Introduction
   2. The Audible Frequency Range
   3. Frequency Range of Musical Sounds
   4. Factors Affecting Pitch
   5. Pitch Discrimination
   6. Absolute Pitch

D. Chapter eight: Intervals, Scales, Tuning, and Temperament
   1. Introduction
   2. Consonance
   3. Intervals
   4. The Pythagorean Scales
   5. Cents
   6. The Major and Minor Thirds
   7. Meantone Tuning
   8. The Just Scale
   9. The Tempered Scale
   10. Other Octave Divisions
   11. Intonation in Performance
   12. The Standard of Pitch
   13. Octave Notation
   14. Intonation of Instruments
   15. Theories of Consonance

III. The Environment of Music

A. Chapter nine: Auditorium and Room Acoustics
   1. Introduction
   2. Sounds in the Open
   3. Sound Enclosures
   4. Reverberation Time
   5. Optimum Reverbaration Time
   6. Calculation of Reverberation Time
   7. Measurement of Reverberation Time
   8. Other factors in Auditorium Acoustics
   9. Acoustical Planning
   10. Sound Amplification

IV. The Production of Musical Sounds: Musical Instruments

A. Chapter 10: The String Instruments
   1. Introduction
   2. Construction
   3. Action of the Bow
   4. The Violin Body
   5. Tap Tones and Plate Resonances
   6. Loudness Curves and Response Curves
   7. Miscellaneous Factors in Violin Tone
   8. The Larger String Instruments: Scaling
   9. The "Wolf" Tone

B. Chapter eleven: The Woodwind Instruments, and Others
   1. Introduction
   2. Edge Tones and Air Column Vibrations
   3. Tone Holes and the Basic Scale
   4. The Flute
   5. The Recorder
   6. Reed Instruments: The Clarinet
   7. The Clarinet Scale
   8. Construction of the Clarinet

3. Fractional Exponents and Logarithms
4. Calculation of Cents

It is felt that this book covers very thouroughly the basic aspects of acoustics and gives the student a good foundation. It is a personal opinion that all music students need a basic knowledge of acoustics in order to really understand what music is all about. No matter how well a person plays an instrument, he can not really appreciate that instrument fully unless he knows why it is constructed as it is and how it produces its sound. This is a very important aspect of music, and one that is not understood by most. Therefore, it is important that a good textbook be used in teaching this subject—one that can explain it in everyday terms for the non-scientist, and one that can also make it interesting. This book, The Acoustical Foundations of Music, does both and would be recommended highly for use in such a course of study.