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The Noise Handbook edited by W. Tempest FREE

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lengths where the frequency is small enough to count by eye. In any event, Benedetti knew about frequency of vibration of strings and concluded that the air would be given "percussions" having the same frequency as the vibration. He also understood that the percussions from simultaneously sounding strings would frequently coincide if the string lengths, and hence the frequencies of vibration, were in a simple integer ratio. This observation marks the beginning of what Cohen calls the "coincidence theory" of consonance, a thread which is followed throughout the remainder of the book.

Vincenzo Galilei (1520–1591) was primarily a musician, a pioneer of the stylistic changes in music which became the Baroque. As such he was principally interested in practical musical problems, particularly the question of what singers actually do when they come upon a "wolf" interval within the context of the tuning. Cohen reviews previous studies of the conflict between Vincenzo and Zarlino on this question, a conflict which was as much personal as scientific. Vincenzo was perhaps the first to show that the vibrational frequency of a string is proportional to the square of the tension.

Galileo Galilei (1564–1642) was Vincenzo's son (and Vincenzio's father). Like his father, and like Benedetti, he was committed in principle to the idea of experiment. In the case of acoustics, however, this commitment may have been honored more in the breech than in the observance. Cohen decides that three experiments, described by Galileo in considerable detail, were really only "thought experiments," because they seem implausible in detail. However, F. V. Hunt (*Origins in Acoustics,* Yale University, New Haven, CT, 1978) reviewed two of these experiments, and by contrast, Hunt takes Galileo at his word. There may be a middle ground on this question. Perhaps Galileo actually did the experiments but decided that it would make a better story if he described them somewhat differently from the way he did them. Experiments similar to those he described are, in fact, possible. One suspects that Galileo's intuition was such that he knew how to fudge the data in order to get the right answers to the experiments as described.

Marin Mersenne (1580–1648) was, of all the experimentalists, the most inclined actually to do acoustical experiments. Like the other three, his approach to the question of the consonant ratios was based upon vibrations and propagation of sound, as opposed to mysticism or human perception of sound. Unlike Galileo, who was usually content to determine laws based upon observed proportionalities, Mersenne performed experiments which gave numerical results, for the frequencies of audible vibrations of strings, and for the speed of sound in air. In the process he discovered overtones and beats. He made limited use of the overtone idea in advancing an explanation for why the interval of the fourth is less consonant than the interval of the third.

Isaac Beeckman (1588–1637) and Rene Descartes (1596–1650) are called the "mechanists" because they proposed to explain all natural phenomena in terms of the motion of matter. They were contemporaries of Mersenne, who served as corresponding secretary for the group. Beeckman, who never published anything, is given more pages in Cohen's book than any of the other scientists. He provided a proof of the inverse relationship between string length and vibration frequency, but the proof does not seem to me to take proper account of string mass. He viewed sound as propagating in small "globules" of air. Sound of higher frequencies corresponded to globules of smaller size which therefore increasingly pierced the ears. Beeckman never grasped the idea that the *rate* of globules determines the musical pitch. He believed that each globule conveyed the essentials of a sound. The confusion is understandable given that, for a periodic waveform, Beeckman was perfectly right.

As to the matter of tuning, Beeckman strongly preferred pure consonances. Fully aware of the impossibility of a general solution to the tuning problem, Beeckman decided that instruments should be retuned for playing different melodies and, equally important, that composers should foremost be aware of the tuning and should avoid intervals which are dissonant within that tuning. Thus Beeckman concluded that most musical compositions were incorrect. One wonders if he had an inkling of how very "incorrect" music was soon to become!

Descartes was Beeckman's neighbor. The two got along well for awhile, until their friendship fell victim to Descartes' colossal ego. Descartes' initial approach to the consonance problem was a geometrical construction of successive bisections of a line, with no physical basis. Apparently, Beeckman introduced him to the idea that sound could be described physically, a point which Descartes readily accepted. What is most striking about Descartes' subsequent work on the consonance problem is his essentially modern views on the importance of individual tastes and the importance of variety in music, including dissonances for building tension. In the end Descartes, the "mechanist," denied a mechanistic solution for the consonance problem or for any other problem in music. Descartes apparently had embraced the Baroque style in a way that none of the other scientists did. His point of view emphasizes the fact that the science of music was developing in parallel with, and partly in response to, changes in musical style and taste, a situation which, in fact, also applies today.

Christian Huygens (1629–1695) appears in this book as an "example from the second generation." He was perhaps the first to observe that simultaneous thirds in the bass sound dissonant, thus introducing a physical relativism which was notably absent in the work of the previous generation. Huygens preferred meantone temperament because of the pure thirds and because different keys could be used for different artistic effects. He developed a 31-note octave which closed the circle of fifths, and implemented it on a movable keyboard with 12 keys per octave. Still troubled by the significance of ratios of small integers, Huygens concluded, or persuaded himself, that ratios made with the number 7, including the tritone at 7/5, were consonant after all. The concluding chapter of the book brings the reader up to date on the central question of consonance which, apparently in this case, means the 19th century and Helmholtz! It includes a retrospective noting, among other things, that although developments in music had a profound influence on the development of musical science in the 16th and 17th centuries, there is no evidence for influence in the reverse direction.

Quantifying Music, by M. H. Cohen, appears to represent a high level of scholarship. The author used entirely original sources and there are 35 pages of dense bibliographical notes in seven languages plus archaic versions thereof. For the acoustician casually interested in the roots of his discipline, the book is a bit on the heavy side and its scope is rather narrowly restricted to the question of musical consonance. The author was clearly capable of writing a book which traced in parallel the origins of acoustics and developments in other physical sciences during the early part of the scientific revolution, but apparently in the history of science, as in other endeavors of higher order, one must specialize.

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The Noise Handbook

W. Tempest, Ed.

Academic, Orlando, 1985.
xiv + 407 pp. Price $68.00 (cloth).

The objective of this book is to give a current picture of the effects of noise on man, as well as the protection afforded both by the law and by the physical reduction of sound through noise control. The book is intended to be useful to acoustical specialists, but the level of presentation makes it accessible to those without previous exposure to the fields of acoustics and noise control.

The book is divided into four parts and consists of fourteen chapters, each prepared by a different contributor. Part I consists of one chapter devoted to the fundamentals of noise measurement and evaluation procedures. Part II comprises five chapters concerned with the effects of noise on humans: nonauditory effects, noise-induced hearing loss, the effects of background noise on verbal communications, the effects of noise on the performance of physical and mental tasks, and the problems of scaling and evaluating annoyance arising from noise. Part III consists of four chapters dealing with the major sources of noise exposure: Noise in industry, noise arising from transportation noise sources, noise levels and their effects on drivers and passengers, and noise in the home. Part IV includes a brief chapter on technical measures for noise control, followed by two chapters dealing with noise and the law in the United Kingdom and the U.S.A., and a final chapter covering European Economic Community directives on noise in the environment.

Although written by 14 different contributors, the style of writing and level of presentation are reasonably consistent throughout. The authors of 12 chapters reside in England, with the U.S.A. and Canada being represented by one chapter each. This is an English handbook which is quite different in style and content from the handbooks which we have become accustomed to on this side of the Atlantic Ocean. This English handbook covers much of the same material as is to be found in "Handbook of Noise Control," edited by Cyril M. Harris, which was published in the U.S.A. in 1979. Harris' handbook is full of charts, nomograms, tables, and other pertinent design data. This work relies more heavily on prose descriptions than would an American handbook.

A large fraction of the citations is to the English literature, and several examples are given which are particularly pertinent to the English culture. For example, in the chapter on noise in the home, the appliances which are described include whistling kettles, electric toasters, and coffee percolators. Americans would not normally associate these sources with noise problems in the home.

While this reviewer is not sufficiently knowledgeable in law in the United Kingdom to comment, there is a major omission in the chapter on noise and the law in the U.S.A. The section which discusses federal statutes to control noise includes the efforts of the Environmental Protection Agency (EPA) to carry out the requirements of the Noise Control Act of 1972. Unfortunately, the activities of the EPA are only taken up through 1978. The termination of the EPA noise control program in 1982 is not described. The reader is left with the impression that the EPA program is still in progress.

The chapter on techniques of noise control is much too sketchy: Nineteen pages long with only four figures and one table. This chapter concludes: "Noise control has always been a difficult and frustrating task... ." Perhaps so, but this will come as no surprise to the acoustical specialist who will have to look elsewhere for definitive practical solutions to noise control problems.

Summarizing, this is a handbook on "noise" rather than "noise control." A large amount of material is covered in a relatively small space. The expository level is largely descriptive; hence, the engineer and designer will need to consult one of the many references given for more detailed information. While this may not be considered the definitive handbook on the subject, it is a volume which many practicing engineers and others concerned with noise may find useful.

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Musical Structure and Cognition

Peter Howell, Ian Cross, and Robert West, Eds.

Academic, London, 1985.
xiv + 338 pp. Price $57.50.

This book constitutes a series of essays on a number of issues concerning musical cognition. Chapter 1, by Cross, provides a brief historical review of pitch structures in Western music, including a discussion of the concept of tonality. In the next chapter, West, Howell, and Cross review a number of formal models of the representation of pitch sequences by the listener. Chapter 3, by Lee, provides an approach to the hierarchical representation of rhythmic patterns. There follows a chapter by Watkins and Dyson, which describes a series of experiments on the effects of tonal structure on ease of processing pitch sequences.

The next chapter, by Cross, Howell, and West, deals with the question of how listeners arrive at a sense of scale in the course of listening to a melody. Next, Sloboda and Parker report a study analyzing the attempts of subjects to recall a melodic fragment that is repeatedly presented. Chapter 7, by Edworthy, presents findings on the detection of differences in interval size and in contour in a melodic framework. Chapter 8, by Costall, considers whether or not pitch identification performance on the part of possessors of absolute pitch differs in principle from that of nonpossessors.

The last four chapters of the book concern performance. Clarke, in Chap. 9, describes a study which examines the timing of events in performances by skilled pianists. Chapter 10, by Baily, argues for a closer examination of the spatiomotor aspects of music as performed on specific instruments. Chapter 11 by Howell, and Chapter 12 by Harvey, examine principles governing voice production and feedback.

The chapter by West, Howell, and Cross, on "Modelling perceived musical structure," addresses a subject of considerable interest. The authors attempt to paraphrase and summarize several formal theories of the representation of pitch sequences by the listener. These include formulations by Simon and Sumner, Deutsch and Feroe, and Lerdahl and Jackendoff. It is unfortunate, however, that the chapter contains a number of errors (such as the substitution of Eb for D# in their recasting of Deutsch and Feroe's Fig. 1). Because of these, the reader is urged to consult the original sources rather than rely on descriptions of the models offered in this chapter.

Two chapters which, in this reviewer's opinion, deserve careful reading, are by Lee and by Clarke, both on the processing of rhythmic patterns. Lee begins with the assumption that when a listener perceives a given rhythm, he represents this as a tree structure that accommodates the notes and rests as terminal symbols. In the chapter, he considers various principles by which the listener arrives at the interpretation of a particular sequence as the realization of a particular rhythm. As Lee himself points out, this approach is concerned only with idealized temporal patterns, and does not consider the deviations from strict timing and fluctuations in tempo that are characteristic of real music (a problem for all existing clock models). This latter question is considered, at least at the level of the performer, in Clarke's study of timing in piano playing. One interesting point to emerge from this latter study is that differences in tempo are associated with differences in patterns of relative duration, since, for example, music is segmented into fewer units at fast tempi. It remains to be determined how the listener, in establishing a structural representation of a rhythmic pattern, incorporates his or her knowledge of the various principles underlying acceptable deviations from strict timing in live performances.

In general, this is a book for the specialist who already has a good knowledge of the existing literature in cognitive psychology and music theory. As such, it provides some interesting new findings in this interdisciplinary field.

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