Journal of Sound and Vibration (1997) **200**(5), 759–765

BOOK REVIEWS

CONCERT AND OPERA HALLS—HOW THEY SOUND; 1996 by Leo Beranek. Woodbury, NY. Acoustical Society of America; Oxford University Press. viii + 643 pp. Price US $49.95, or US $ 39.95 direct from OUP, U.K., if member of academic or professional society. ISBN 1 56396 5305.

This book is as long-awaited and invaluable as Mike Barron's *Auditorium Acoustics and Architectural Design*. It is essentially an update of Beranek's standard reference work on the acoustics of concert halls, *Acoustics*, *Music and Architecture*. The value of Beranek's previous (1962) text had slowly diminished as more new halls were built and old ones refurbished.

The heart of the book remains the individual studies of 76 halls (21 in the U.S.A., 37 European, seven Japanese and 11 others). For readers outside of the U.S.A., the use of metric (as well as English) units is of great benefit. The section for each hall includes photos, scaled plans and sections (of great comparative value) and objective data, including constructional information. Also, for most halls, there is a considered subjective evaluation.

It appeared to the reviewer that fewer of the newer entries benefited from Leo Beranek's personal assessment, but this is perhaps inevitable given the number and geographic spread of new concert halls. To the reviewer also, some of the subjective comments perhaps err on the side of generosity, but this book is very much Leo Beranek's personal view of the halls and their governing acoustical science.

Two editorial quibbles: firstly, the header is the same on every page of the halls section, which does not help the searching reader; secondly, it is infuriating to look up Royal Festival Hall in the index to read "(see London)". Perhaps these can be corrected at the first revision.

By its nature, this book is already out of date. For example, the Free Trade Hall, Manchester, has been replaced by the new Bridgewater Hall, Liverpool Philharmonic Hall has been acoustically reconstructed and the Opéra Garnier has been refurbished. Hopefully the next edition will keep us updated, with a shorter time span than 24 years.

Concert and Opera Halls—How They Sound also includes considerable text describing the theory and practice of concert hall and opera house design. There is a useful summary of the major studies carried out during the past 20 years. As in much of Leo Beranek's work, the approach is less single-mindedly analytical as those of other researchers in the field (this is not a criticism). The approach is also personalized by inclusion of parameters which have perhaps not found general acceptance by other workers in the field; for example, the importance of "Initial Time Delay Gap" as a determinant of acoustical intimacy. One interesting conclusion, based upon comparison of objective data and subjective assessments, is that the average clarity index C_{80} in the 500 Hz, 1 kHz and 2 kHz octave band is "not a useful acoustical attribute for calculating occupied concert hall quality".

The book can entertain as well as inform. Two critics' comments on the Berlin Philharmonie are as follows: "Great acoustics" and "Terrible sound"—similarly, on the Avery Fisher Hall: "Gets my vote as the best I know" and "Dreadful".

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Appendix 4 is an invaluable collation of objective data measured in the halls. Of interest is the scarcity of data for occupied halls, for parameters other than RT and EDT.

Concert and Opera Halls—How They Sound should be in the library of all practitioners of auditorium design, their clients and future clients and students and teachers of the subject. Yet again, Leo Beranek is to be congratulated.

R. HARRIS

FUNCTIONAL ANALYSIS—APPLICATIONS IN MECHANICS AND INVERSE PROBLEMS; 1996, by L. P. Lebedev, I. I. Vorovich and G. M. L. Gladwell. Dordrecht, The Netherlands. 248 pp. Price (hardbound) Dfl 190.00, US $134.00, UK £85.00.

The subject of this book is functional analysis. Clearly, functional analysis is not easy to learn or teach, especially to people more interested in its application than in the mathematical aspects. At worst, it can be seen as a long series of theorems, so long that it is difficult to keep in mind at each stage the logical development.

All of the mathematical results presented in this book are classical. Nevertheless, because the authors are quite aware of these difficulties, they present a kind of "guided tour" in functional analysis, using a "ribbon in the field". That is, they try (and very often succeed) to present all the theorems insisting on the continuity of the ideas, showing in detail how each theorem is necessary in the final construction. This is a very interesting point which makes the book quite attractive.

The book includes eight chapters. The first one is a short and general introduction. The others are entitled: Introduction to metric spaces; Energy spaces and generalized solutions (ch. 3); Approximation in a normal linear space; Elements of the theory of linear operators; Compactness and its consequences; Spectral theory of linear operators; Applications to inverse problems (ch. 8).

Six chapters are mainly devoted to theorems of functional analysis, with some examples arising in mechanics. The other two are dedicated to applications. Chapter 3 presents applications to problems in mechanics (rod, membrane, plate, linear elasticity, etc.) Chapter 8 is especially interesting because the first part presents the difficulties brought by ill-posed/inverse problems (existence and uniqueness of the solution, stability) and explains in detail how the mathematical theorems given through the book can be used to study these difficulties and partly overwhelm them.

At the end of each chapter, a synopsis, a summary of the main results, is presented. A short bibliography is also added and includes some of the main books on functional analysis, with a short comment about what to find in each one. Furthermore, each chapter contains some problems left to the reader.

All of this makes the book very useful to both students and engineers, if they are interested in the mathematical aspects of mechanics and if they already have some knowledge in this field. It is ideal for researchers in mechanics. It will also be a very useful tool for teachers in mathematics and mechanics, who wish to make their students understand the ideas of functional analysis.

As a conclusion, the authors have a "fervent wish": that the readers will find this book instructive and enjoyable. I would say that, as a reader, I find it (quite) instructive and (almost) enjoyable!

D. HABAULT

DYNAMICS OF CIVIL ENGINEERING STRUCTURES; 1996, by W. B. Krätzig and H.-J. Niemann, editors. Rotterdam: A. A. Balkema. xii + 630 pp. Price Dfl 225.00. ISBN 90 5410 624 7.

The book is concerned with various aspects of the dynamics of civil engineering structures from the perspective of the Research Centre for Structural Dynamics at Ruhr University Bochum, Germany. It is a result of the joint efforts of more than 50 scientists and covers a very broad spectrum of important topics, which are of significance to the structural engineer dealing with dynamic phenomena. It is probably interesting to note that Germany is a country without any severe earthquakes. Despite the fact that dynamic problems are not among the main priorities of the civil engineers in Germany, the book is a very successful attempt to present the state of the art in an important area.

The first four chapters cover the basics of the structural dynamics: mechanical and computational models, methods of investigation and basic phenomena; dynamic loading and material properties under dynamic forces; behaviour of steel, reinforced concrete and composite structures, and soil foundations under earthquake forcing. Chapters 5–7 deal in more detail with the structural response to wind, earthquake and impact loads. The last three chapters are devoted to the theoretical study of the occurrence of dynamic instabilities (relying heavily on the concept of Lyapunov exponents), soil–structure interaction and experimental methods of dynamic analysis.

The book is written at a level between a textbook and conference proceedings. On the other hand, due to the wide range of the topics covered it may be used as a "reference manual", but with some caution due to the lack of any index. There is a lot of background material and numerical data which makes the text a valuable reference for teaching purposes and/or for practical structural design.

In conclusion, having in mind the level of the exposition and that there is no other book covering the subject in such a complete manner, I would recommend the book to the readers of *JSV*.

A. A. Popov

MECHANICS OF MUSICAL INSTRUMENTS; 1995, by A. Hirschberg, J. Kergomard and G. Weinreich, editors. Vienna and New York: Springer-Verlag, 369 pp. Price (soft cover) Ff 437. ISBN 3-211-82801-X.

The implications of the title of this book are not clear until its provenance is realized—it contains, in fact, the edited lectures given at an "advanced course" in the subject under the auspices of the International Centre for Mechanical Sciences (CISM), so that "mechanics" should be read in the sense that the term is used in applied mathematics. There is nothing here for piano tuners or organ builders! What we find, rather, is a high level treatment of the sound production mechanisms in a variety of musical instrument types, with emphasis on what is still incompletely understood as well as on what is now firmly established.

After a brief introduction, the book is divided into six chapters. P. Hagedorn (Utrecht) gives a lucid and extensive treatment of mechanical oscillations in general, up to and including bars and plates, with satisfying treatments of non-linearity and phase-space representations. G. Weinreich (Michigan) then covers rather similar material from a different point of view, with emphasis on shells and on sound radiation from vibrating structures. C. Valette (Paris) gives a detailed treatment of vibrating strings, with discussion of longitudinal and torsional as well as transverse modes, damping mechanisms, non-linearity, and interaction with curved bridges. J Woodhouse (Cambridge) then brings us a little closer to actual musical instruments with a detailed treatment of bowed strings and the complexities of possible motions. The final two chapters deal with wind instruments. J. Kergomard (Maine, Le Mans) discusses sound generation by reed vibrations, particularly in clarinet-like systems with single reeds and cylindrical tubes. A Hirschberg (Eindhoven) then treats details of the fluid dynamics of flow through reeds and the generation of sound by air jets in the flues of organ pipes, where vortices and other aerodynamic complexities are important.

This is not a book for the faint-hearted or for those with only a casual interest in musical instruments. The treatment throughout is by world authorities on their subjects and is unashamedly pitched at graduate level. It is eclectic rather than comprehensive, and is written for those who are already well informed on the subject and who want to broaden and deepen their understanding of fundamentals. It is hard to imagine anyone, even with long experience in the field, who would not learn something new and significant from a close reading. I recommend it warmly to those of a mathematical bent who want more details of a fascinating area of research. They will not yet find all the answers, but the remaining questions will become much more clear.

The book shows some signs of its origins, in that the typefaces vary a little from one chapter to another, but this is more than compensated for by its timely publication, and the general production standard is much better than that of many conference or summer-school proceedings. The references following each chapter are adequate for those seeking further enlightenment, although in some cases not very extensive, but I felt the lack of an index or even a detailed Table of Contents.

N. H. FLETCHER

PROBABILISTIC AND CONVEX MODELLING OF ACOUSTICALLY EXCITED STRUCTURES (Studies in Applied Mechanics No. 39); 1994, by I. Elishakoff, Y. K. Lin and L. P. Zhu. Amsterdam, New York: Elsevier, 304 pp. Price (hardbound) Dfl 265.00, US $151.50. ISBN 0-444-81624-0.

This book gives a thorough review of the analytical techniques currently available for the prediction of the response of linear structures to high intensity stationary random pressures. These are directed towards the modelling of the behaviour of aerospace structures subjected to jet or rocket noise pressures.

The first three chapters give a systematic development of the classical normal mode theory for the free vibration characteristics of beams and plates. The second chapter extends the smple theory to two-span and then multi-span beams and works out many examples. These show clearly the form of coupling that occurs between the individual spans and gives a first indication of the mode shapes which will be encountered in coupled plates—a model which can be used to represent stiffened structures such as aircraft fuselages. Chapter three repeats the classical free vibration theory of single flat plates with simple boundary conditions. Brief mention is made of multi-span plates and the pioneering work of Mead. It is disappointing that more is not made of this model, which is capable of giving a much better representation of the behaviour of stiffened structures. Instead, a long chapter is devoted to Bolotin's dynamic edge effect method which, at best, has only limited relevance to aerospace structures.

Chapter five gives a thorough review of the theory of the random vibration of linear structures and the next chapter goes on to consider the response of beam-like structures to high intensity noise environments. Models of the pressure field are discussed and numerical examples worked out for single- and multi-span beams. A lengthy example is also given for a single-span beam which is based on Bolotin's edge effect method.

Chapter seven discusses the use of the finite element method to model the structural response. In the space available there can only be a superficial treatment but a valuable comparison is made between the results for the response of a simple beam to random pressures. A two-element model is used and the results are shown to agree closely with the exact solution.

Up to this point the book has been essentially reviewing existing work and adding many worked examples (something which few other books on the subject include—for obvious reasons!). The final chapter introduces a new and very important topic: How do we allow for the fact that in any real aerospace structure the structural characteristics and noise field are not known precisely? There are small variations in dimensions, attachment forces, damping, etc., as well as uncertainties in the definition of the excitation field. This chapter introduces the theory that Elishakoff has developed and termed "Convex Modelling of uncertainty". Examples are worked out to show the order of magnitude of these effects for simple situations. These points are well made, but I have to admit that I think that it will be some time before we can do a rigorous analysis along these lines for anything approaching a real structure.

In conclusion, I must say that I think that this book gives a very comprehensive review of the "classical" approach to the estimation of the response of structures to random distributed loads. It is well illustrated by many worked examples and as such will be of great value as a postgraduate text. For the practising aircraft designer it gives the essential background to the large software packages such as NASTRAN that he or she will be using.

B. L. CLARKSON

SOUND TRANSMISSION THROUGH BUILDINGS USING STATISTICAL ENERGY ANALYSIS; 1996, by Robert J. M. Craik, Aldershot, Hampshire, England: Gower Publishing Ltd. 261 pp. Price (hardback) £55.00. ISBN 0 566 07572 5.

Robert Craik is Professor of Building Acoustics at the Heriot-Watt University, Edinburgh. He spent over 15 years studying applications of Statistical Energy Analysis (SEA) to buildings. He was thus ideally placed to author a book on this subject.

The book chapter titles are as follows: Getting started—a tutorial introduction; Modelling with statistical energy analysis; Subsystem parameters; Coupling loss factors; Structure-borne sound transmission; Calculating performance using SEA; Applications: direct transmission; Applications: flanking transmission.

The preface states that "The book. . . . is primarily concerned with building structures but all the underlying theories given in the first six chapters are directly relevant to all users of SEA". We might therefore expect a substantial part of the book to be fairly academic and concerned with the fundamental concepts, principles, theoretical models, assumptions and analysis, in the manner of the well known book on SEA by Richard Lyon and Richard de Jong. This, however, is not the case. As indicated by the title, the book focuses exclusively on problems of sound transmission in building acoustics research and practice; SEA is essentially presented as a tool for the job, as in an advanced handbook. Naturally, some of the models and assumptions appropriate to buildings are not universally applicable; in particular, that of very weak coupling between structural subsystems. Numerous well-chosen practical examples serve admirably to illustrate the use of this tool, together with its limitations.

I am less happy with the early chapters of the book as an intended vehicle for introducing to SEA the "new user who, perhaps, has already some experience in the basics of acoustics but is not familiar with the notation of SEA". The "tutorial begins with a table of, as yet, undefined quantities, which lack units and reference values for their dB equivalents, and contains a number of equations "plucked out of the air". The term "power flow" is freely used without explanation of the physical mechanisms involved in the transfer of vibrational energy. The difficult-to-explain division of sound transmission through a partition into resonant and non-resonant, mass-controlled components is introduced, leaving the reader to discover on pp. 32 and 68 that this is a "fix", because SEA really only deals in resonant energy exchange. Response variables are described as parameters. In my opinion, this chapter is less likely to inspire confidence in the uninitiated reader than to reinforce the widespread impression of SEA as "black art".

Chapter 2, on modelling, dispels much of the mystery generated by the preceding chapter, but fails to explain the significance of frequency (or modal-)averaging as a practical substitute for ensemble averaging (previously mentioned). Nor is it made clear that the quoted proportionality relation between power flow and modal energy difference in terms of a modal-average coupling loss factor holds only for broadband excitation. The reader may also be puzzled by the fact that the coupling loss factor is introduced in relation to oscillator (modal) energies, whereas, later in the book, the CLFs are all evaluated on the basis of travelling wave power transmission between non-reflecting systems. A brief account of the physical basis and assumptions of wave-mode duality would have been helpful at this point. I have to admit to a certain amount of reservation with regard to terminological precision and consistency.

Once the author gets into his stride in chapters on subsystem properties, coupling loss factors and structure-borne sound transmission, his breadth of experience in constructing and applying SEA models of buildings, and his appreciation of the need always to test SEA predictions against experimental observation (including the tricky factor or errors), become evident. I would, however, have preferred to have read the third of these chapters before tackling the second, because it sheds light on the physical machanisms and mathematical representations on which structural coupling loss factors are based.

The chapter on calculating performance using SEA contains extremely valuable advice on strategies for minimizing computation time, which are universally applicable), and illustrates the effects on errors in input parameters on the accuracy of prediction. Chapters 7 and 8 on applications are full of useful tips on modelling building components, and are illustrated by a wealth of figures presenting comparisons between measured and predicted performances of many different forms of building component, including examples of flanking transmission. It is unfortunate that some of the interesting graphs lack dimensional data. The value of SEA as a design tool is also illustrated by a large modelling exercise performed by the author for Electricité de France.

It would certainly have been fascinating to discover how the predictions of Professor Craik's computer programs compare with those produced by commercially available SEA packages. Perhaps he might give us that pleasure in the next edition.

The book is boldly printed and the figures are clear. The list of references is adequate, but a bibliography of relevant, but unquoted, research publications on SEA and buildings (e.g. CIB publications) would have been welcome. I detected few typographical errors.

This book is recommended to those concerned with the acoustic performance of buildings, especially for its wealth of practical data. It should certainly be on the shelf of all acoustic consultants.

F. J. Fahy

DYNAMICS OF RAILWAY BRIDGES; 1996, by L. Frýba. London: Thomas Telford, and Prague: Academia. 330 pp. Price (hardcover) £60 U.K. and Europe; £67 overseas. ISBN 0-7277-2044-9.

The author is well known for his book *Vibration of Solids and Structures under Moving Loads*, which appeared in 1972 and serves as a standard reference in the field. In some respects, his new book is a continuation of the first one, but it concentrates on a special subject, the vibration of railway bridges. It contains some results of the former book, so it can be read independently, but most of the material is new and reflects the author's rich experience on the subject.

The book comprises 14 chapters, including an appendix, and a bibliography with 231 references. It can roughly be subdivided into four parts: modelling, characteristic quantities, special effects, and practical considerations. In the first part different bridge and vehicle models are developed, culminating in modelling a bridge and a running train. Then dynamic characteristics such as natural frequencies, damping parameters, dynamic deflection factors and a characterization of track irregularities are given. Besides the primary effects in the vertical direction due to the moving loads, the effects in the horizontal direction caused by longitudinal forces during starting and braking or lateral impacts and centrifugal forces are also discussed. Special attention has been paid to practical problems. The traffic loads and their bridge responses influence fatigue, and thus life expectancy as well as the safety, maintenance and economy of railway traffic. With respect to loading, wind and earthquake excitations have not been considered. However, thermal effects, which create static rather than dynamic problems, are discussed in the appendix.

The purpose of the book mentioned by the author in the preface, namely to present a well founded survey of the dynamic behaviour of railway bridges, to present abundant experimental data obtained on numerous bridges and to describe the methods which have been successfully applied in the field, is fully met.

In summary, at present, as the speed of railway vehicles is steadily increasing, the dynamic effects on railway bridges are also increasing. Here, Frýba's book is very timely. It will be a rich source and valuable reference for civil and railway engineers, as well as for scientists and students working in the field of vehicle–guideway interaction.

K. POPP