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Book Review

Computational Aeroacoustics

J. C. Hardin and M. Y. Hussaini (eds.), ICASE/NASA Series, Springer-Verlag, New York, 1993, 495 pp., $69.00.

This book represents the bound proceedings of the Workshop on Computational Aeroacoustics that was sponsored jointly by ICASE and the Acoustics Division of NASA Langley Research Center in early April 1992. It consists of the text of a short welcoming address, a keynote address by Sir James Lighthill, 27 papers (24 of which are distributed among five sessions), and the report of a final panel discussion. The keynote address reviews 40 years of progress in aeroacoustics. The papers in the five sessions are grouped according to 1) Classical Theoretical Approaches, four papers plus an introduction and review paper by the session chairman; 2) Mathematical Aspects of Acoustics, two papers; 3) Validation Methodology, seven papers plus an introduction by the session chairman; 4) Direct Simulation, five papers plus an introduction and review by the session chairman; and 5) Unsteady Compressible Flow Computational Methods, three papers. There are three additional papers not assigned to the five sessions, which are most closely related to sessions 4 and 5. The contributors include many of the pioneers in aeroacoustics.

Perhaps one of the key issues addressed in the workshop and in the volume is how computational aeroacoustics (CAA) is to be defined. Allan Pierce, in his introduction to the papers dealing with validation methodology, suggests that CAA may have originally provided benchmarks for validation of CAA codes. The section on Classical Theoretical Approaches includes papers by Crighton and Lilley who, with Lighthill, see the acoustic analogy as the method of choice for turbulence-generated noise, at least in the near term. The papers in Direct Simulation and Unsteady Compressible Flow Computational Methods, and the three papers not assigned to sessions, deal with "comprehensively" computational aeroacoustics. A paper by Batina provides a good view of how computational fluid dynamics (CFD) applied to unsteady aerodynamic computations may provide a starting point from which CAA progresses. Papers in Validation Methodology are intended to provide results of computations resulting from idealized model problems that could serve as benchmarks against which CAA codes will be validated. In this regard, the paper by Kambe examining the sound generated by vortices interacting with one another and with solid surfaces reports work that could be immediately useful.

Perhaps due to logistics, some papers seem to have been somewhat arbitrarily assigned to the five categories. For example, a paper by Tam and colleagues dealing with issues of dispersion in finite difference algorithms appears in Classical Theoretical Approaches, and a paper by Hardin, also dealing with algorithms, appears in Validation Methods. Both should be included as contributions to Direct Simulation. Mathematical Aspects of Acoustics has just two papers and is perhaps unnecessary, since ultimately all of the papers are mathematically based. One by Farassat dealing with the use of the acoustic analogy for rotor noise should probably be included in Classical Theoretical Approaches. The second paper, by Kreiss, dealing with issues of different time scales in partial differential equations, has its greatest relevance in connection with direct simulation. The paper by Goldstein and Mankbadi in Validation Methodology, which discusses aspects of the calculation of high Mach number jet noise, is more appropriate for the simulation sessions.

The panel report suggests that CAA may be the foundation of a new era of rapid advance in aeroacoustics. The authors do not minimize the difficulties that are to be faced as we move beyond CFD to CAA. Crighton notes that from the threshold of audibility to the threshold of pain, acoustic intensity varies by a factor of 10^{14}, and the audible frequencies range from 20 to 20,000 Hz, which is 10 octaves. Computational aeroacoustics algorithms must resolve the sound field over at least this range of amplitudes and frequencies. However, even in the face of such daunting requirements, the authors are optimistic that advances in computational power will provide the tools to make great strides.

This volume of collected papers provides an excellent perspective on this new discipline that has just started to blossom. It is not a mature field, and the volume is certainly not a collection of successful applications and working algorithms. It provides in one place the historical perspective of the architects of the first period of explosive growth in aeroacoustics, the perspective and vision of others who are leading the transition from primarily analytical work to the developing CAA, and the experience of leaders in CFD who, perhaps better than anyone, know what will be required to ultimately make CAA a useful tool. The organizational problems that this reviewer perceived are minor, particularly when it is noted that prior to the workshop the definition of CAA was still open to interpretation. The book is recommended for acousticians and workers in fluid mechanics who wish to grow with this new field.

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