

## Implementation of Finite Element Methods for Navier–Stokes Equations

F. Thomasset

This little book contains many results and ideas from the finite element method and will be of interest to applied mathematicians, physicists and engineers involved in computational fluid mechanics. It is based on Thomasset's lectures at the Von Karman Institute in 1980 and so is not completely up to date. For example, his plea in Chapter 4 for the driven cavity flow to be taken up as a standard problem has rather been overtaken by events. Unsatisfactory aspects of this problem as a test led G. De Vahl Davis and I. P. Jones to propose another benchmark, convective cavity flow, which attracted 36 contributions from nine countries for the Venice Conference on Numerical Methods in Thermal Problems in July 1981. Likewise the book's references cover really only the literature to 1979. However, they still form a very useful compilation, especially of European work in the field, a feature which will interest Anglo-Saxon readers. The author has maintained readability with brevity and judicious use of footnotes and references for many of the details. The style of writing and presentation is good considering the amount of technical material and there are no more misprints or Gallicisms than one would normally expect. The latter, for example the usual sprinkling of equations being 'verified' by solutions and an appealing use of 'confort' on page 19, are not at all troubling and indeed add some charm and character to the work. Having read right through the 150 pages of text, I now find myself dipping into the work quite frequently for points and, especially, references which I know to be there. For this role, the book can be recommended.

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## **IMEKO 9th World Congress**

The 9th World IMEKO Congress opened in Berlin appropriately with a fanfare from members of the Philharmonic Orchestra and a welcome from the Regierende Burgermeister Dr Von Weizsäcker. The location chosen, the Internationales Congress Centrum, is ideally suited to such a meeting and approximately 700 attendees could have few complaints about the organization. Interpretation between German and English was excellent; indeed the interpreters often managed to impart a spontaneity to the presentations which the speakers themselves perhaps lacked, understandably as the great majority of the speakers were having to make their remarks not in their mother tongue.

My interest lay in the flow measurement aspects of the Congress; three of the main Sessions were devoted to this subject as well as papers given in the Poster Sessions. In addition there was a session on the subject of heat metering involving as it does the flow measurement of hot water. This meant that over 30 of the 200 or so papers were split into a general session on flow measurement together with one specifically on correlation methods, one on heat

meters and one on laser velocimeter measurements. Attendance was excellent being more than 150 for the first two and around 100 for the third and fourth. It was clear that the interest was demonstrably maintained in that more than 100 stayed on until the afternoon correlation techniques session finished at 1830.

A lively open discussion on the industrial potential for these techniques was held the following late afternoon in a Round Table meeting for which I was responsible as the Chairman of IMEKO Technical Committee No 9: Flow Measurement\*. Speakers took sides in their assessments of the future of correlation methods ranging from the belief that it would never be possible to obtain high accuracy to the viewpoint that while there would be a small place for devices based on this principle they would never take over from the highly repeatable turbine meter or the ubiquitous orifice plate. I suggested that there was a future for a meter using correlation techniques in addition to another principle to meet the need in the next ten years for instruments which are self-analysing and thus capable of monitoring whether the environment and the fluid flowing or the instrument itself has changed. A single meter

<sup>\*</sup> At this meeting it was announced that a flow measurement conference, FLOWMEKO '83, will be held in Budapest on 20–22 September 1983. Abstracts for papers will be invited soon

cannot do this and nor can a twin one such as a double turbine meter since both parts of the meter will change in a similar manner. The consensus of opinion was to see correlation techniques limited to special applications.

The quality of the flow measurement papers to the 9th Congress was varied. It is perhaps inevitable on such occasions that the good intentions of authors become diluted as the dateline for their submission approaches and what is on record in the preprints may sometimes lack the required detail. What was clear from the rain of questions and comments following presentations was that there is no diminution in the demand to have accuracy claims spelled out. While papers in some instances did give brief references to the expected accuracy of the data being presented, none made a serious attempt to analyse systematic and random contributions to the overall uncertainty. The questioners were answered in a fashion but it must be queried whether their demand for such information was based on any full appreciation of the answers they were given. Outside the Congress, users are all too often content to take the manufacturer's statement about the predicted accuracy of his instrument at its face value: indeed they would perhaps prefer to use the claims they are given by the supplier and not look too closely at their own installation and use of the equipment. A relatively brief examination of these will often show that the system is precluded ever reaching anything approaching the accuracy claimed. Nevertheless it is only by such reiterated comments and demands

from users that the developers and manufacturers of instruments will be encouraged to test and check their products. It is a sad reflection on quality control throughout the world that instruments are being supplied with inadequate final inspection. The logic of requiring an authorised certificate to be issued is becoming overwhelming.

A subject which came up a number of times was fuel flow measurement for vehicles. The papers concerned stimulated the most lively of the discussions and while the demand of the car manufacturer that such a flowmeter capable of accurate measurement, almost instant response, subject to arduous environmental conditions in terms of temperature, contamination and tilting, should cost less than 30 DM (about £8) leaves one incredulous, nevertheless the urge to save energy could well inspire success in the device even if the price were significantly higher. It is beyond the scope of this note to go into a detailed discussion of the efforts being made to find solutions but it is hoped that a review can be published in a future issue of this Iournal.

The Proceedings of the Congress will be published by IMEKO in due course: copies of the preprints may be obtained (price per set DM120) from the VDI in Dusseldorf. Well organised, interesting and above all well-timed and located in Berlin sums up my opinion of the occasion.

E. A. Spencer

18-22 April 1982, London, UK

## **27th International Gas Turbine Conference**

The 27th in ASME's series of annual gas turbine conferences was in London for the second time, after a four year interval. Once again the event was cosponsored by The Institution of Mechanical Engineers.

At this year's conference, 324 papers were presented in 84 sessions, each organised by one of the committees of the ASME Gas Turbine Division. Clearly, the papers likely to be of most interest to readers of this journal were presented in sessions organised by the Turbomachinery and Heat Transfer Committees. The latter are reviewed in detail by Brown in an adjoining report.

The 96 papers submitted through the Turbomachinery Committee covered a wide range of topics including:

- 1. Advances in computional fluid mechanics of turbomachinery.
- Aerodynamics of axial flow compressors and turbines.
- Analysis, design and performance of radial flow machines.
- 4. Blade boundary layers and wakes.
- 5. End wall effects and secondary flows.
- 6. Turbulence effects in turbomachinery.

- 7. Unsteady flow effects.
- Losses and effects of design changes on performances.
- 9. Performance evaluation.

The papers on advanced computational fluid mechanics dealt with time marching techniques, quasi three dimensional finite element analyses, rotational flows, viscous and secondary flow effects, three dimensional turbulent flows, and three dimensional effects in transonic and supersonic flows. Viscous flow effects are covered in detail in the adjoining report by Gregory-Smith. The popularity of radial flow machines was evident from the 20 papers presented in 4 sessions which covered the aero-thermodynamics, design and performance of these machines. Inlet flow distortions in impellers and diffusers, boundary layer and end wall influences, secondary flows and mixing losses were some of the topics covered in the sessions. The papers on the axial flow turbines and compressors were mainly of experimental nature.

Two sessions were devoted to turbomachinery performance. The first included papers on losses resulting from imperfections in hardware, and second on improvements that have been achieved