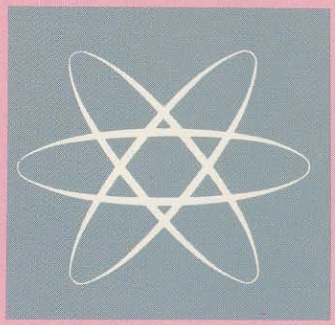
10th
INTERNATIONAL
CONFERENCE

# STRUCTURAL MECHANICS IN REACTOR TECHNOLOGY



**AUGUST 14-18, 1989**
The Anaheim Hilton and Towers
ANAHEIM, CALIFORNIA, USA

## A SHORT HISTORY of SMiRT

*A PERSONAL VIEW*

*by*

**Bruno A. Boley**

The International Association for Structural Mechanics
in Reactor Technology, e.V.
and
The American Association for Structural Mechanics
in Reactor Technology

# A SHORT HISTORY of SMiRT

## *A PERSONAL VIEW*

*by*

*Bruno A. Boley*

**Structural Mechanics in Reactor Technology** is a compact term – and its acronym SMiRT, with the distinctive lower-case "i", an even more compact one – denoting the aggregate of scientific and engineering disciplines involved in the structural aspects of the safe design, construction and operation of nuclear reactors.

Some will find this definition, broad as it is, too confining, others will deem it too comprehensive. Like all definitions of complex entities, it is at one and the same time a little vague, and a mouthful. But the fact is that the field encompassed by it requires that the most advanced concepts of structural mechanics and materials be brought together, under the most demanding operating conditions; and – as the insertion of the word "safe" clearly presages – this must often be done in an international climate which is emotionally highly charged. As one of the two quintessentially modern areas of technology – space exploration being the other – nuclear power generation can credibly be argued to confront today's engineer with the most difficult problems.

It is well to begin an account of the history of SMiRT by plunging into a discussion of its broad scope, because in point of fact this very breadth sprung up full blown with the First SMiRT Conference in 1971. A mere glance at the "Topical Scope" of that Conference (Fig. 1), taken from its First Announcement,

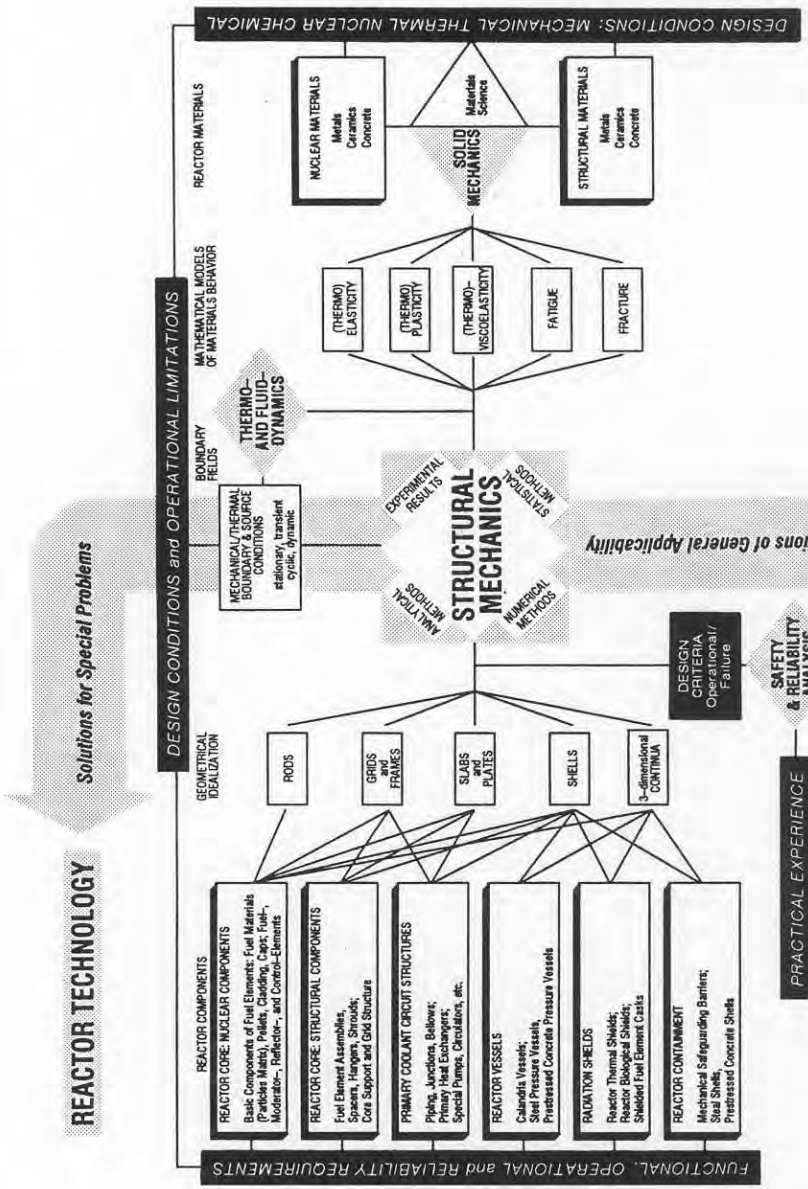



Figure 1 TOPICAL SCOPE OF SMiRT-1

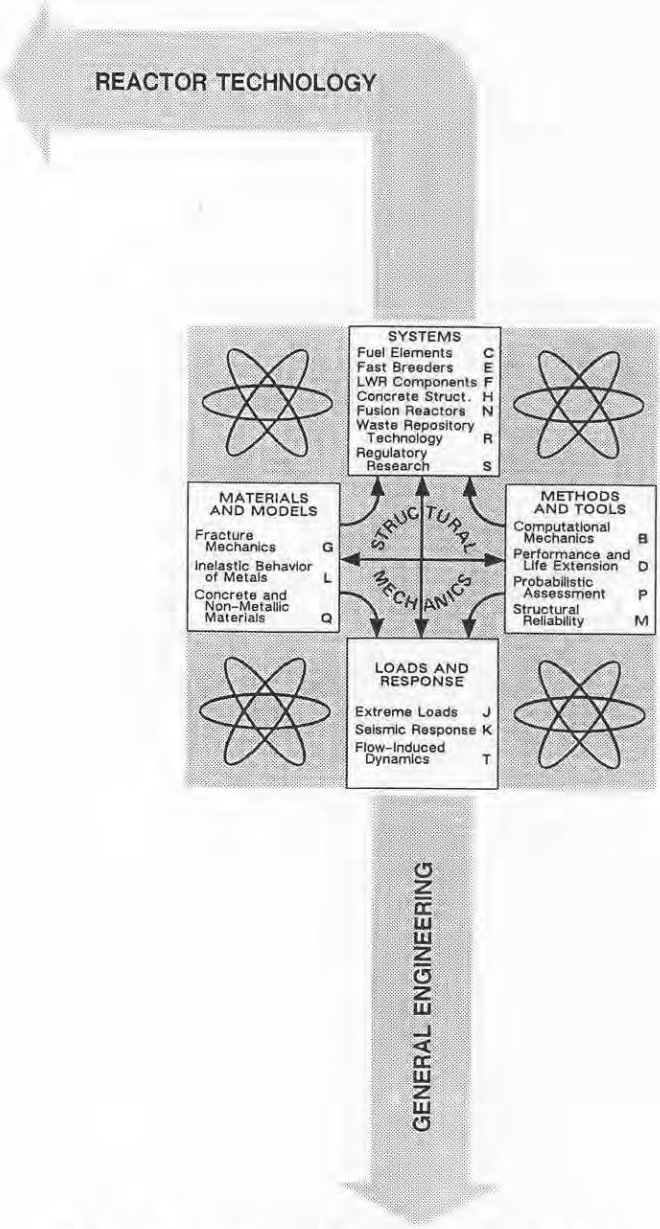



Figure 2 TOPICAL SCOPE OF SMiRT-10

will suffice to convince the reader of this. And it is also true that the description of the scope of the present – the 10th – Conference (Fig. 2) is an update and an elaboration of the original one. It does present some different emphases, of course, as dictated by the experience of 20 years: but in no way contradicts or alters the spirit and intention of the original. We will want to keep in mind this element of continuity and unity, as we trace here the origin and the development of the SMiRT idea over the last two decades. And it may be that this thread in SMiRT will be naturally emphasized by the conceptual (rather than strictly and dryly chronological) path we have tried to follow in this retrospective account.

The writer hopes that the reader will pardon the occasionally personal tone of the narrative, as merely reflecting his long, and necessarily very personal, involvement with SMiRT and its principal players over the 20 years since he first met Tom Jaeger (during the International Conference on Structural Safety and Reliability, which Alfred M. Freudenthal organized in Washington on April 9–11, 1969).

But, to put some order in our tale, we must begin at the beginning. And the beginning belongs indisputably to Tom Jaeger, whose conception, start and implementation of SMiRT still exert a powerful and guiding influence on SMiRT affairs.

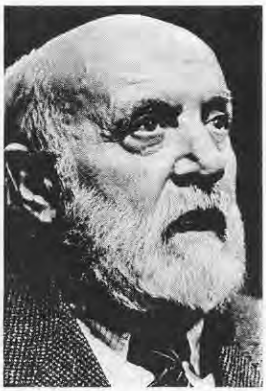
*THOMAS A JAEGER*
*(Breslau, July 5, 1929 – Berlin, August 21, 1980)*

While, as has been said, to the casual observer SMiRT appeared full grown with SMiRT-1, the gestation period of the concept occupied a prominent part of Tom Jeager's professional life for many years. The details of the nucleation and maturation of his ideas have been ably and exhaustively covered in the Jaeger Memorial Volume [1] and therefore need not be repeated here. We should note, however, that process started early in Jeager's career. During his student days at Dresden in the mid-fifties he already foresaw the need of coupling physics and engineering studies in the then emerging field of reactor technology. His book on "Principles of Radiation Protection Engineering" appeared in 1960. For those who like to think of precise dates for the beginning of important trends, perhaps 1964 can be selected for the birth of the field of "Structural Mechanics in Reactor Technology": it was in that year that Jaeger was designated as the first instructor in the field of that name at the Technische Universität Berlin - a name which of course he himself devised (in German, "Kerntechnischer Ingenieurbau").

An important advance in the growth and acceptance of our field was the establishment by Jaeger in 1965 of the journal Nuclear Engineering and Design, of which he served as Editor until his death (from 1966 jointly with Charles F. Bonilla). The idea of an international conference followed directly at that time: again,

*A pre-SMiRT strategy meeting: from the left, Zenons Zudans, J.R. Feldmeier, Tom Jaeger, J.H. Argyris, and Tom's cousin K. Jaeger*

for those seeking specific beginnings, one may note [1] that the first document in which it surfaces is a letter to Prof. Wener Koepcke of the Berlin Technical University dated October 3, 1966 – although it must be also noted that in that very letter Jaeger reveals that the idea had occurred to him during a Radiation Shielding Meeting in Hannover as early as 1962. It is in any case clear that all these innovations – the academic discipline, the journal, and the conferences, were viewed by Jaeger as integral parts of an all-encompassing plan.



*Altiero Spinelli*

The next six years were filled with struggles to obtain support for the conferences from various sources [1], among which the Bundesanstalt für Materialprüfung (BAM) and the Commission of the European Communities (CEC) take a prominent place.

Within BAM, support came from the then President, Max Pfender. In the CEC, influential and encouraging responses were offered by Altiero Spinelli, Vice-President of the Commission Communities, and by Directors – General Rudolf Brée and G. Schuster, as well as Vice President Fritz Hellwig, who delegated SMiRT matters to H. Bentzler. As we shall see, the CEC connection was to be crucial to the conduct of the Conferences, as was emphasized by the direct interest and lasting participation of Raymond K. Appleyard, Director-General for Scientific and Technical Information and Information Management, who succeeded Mr. Brée.

At last, a mere five weeks before the start of SMiRT-1, the long-sought financial backing from the City of Berlin became a reality, with a letter dated August 12, 1971 from Governing Mayor Klaus Schütz. The painstaking preliminaries were now complete, and we can move without further ado to the start of the First Conference itself.

SMiRT-1, 1971
Berlin, Congress Hall, August 20-24, 1971.
Chairman of Executive Committee: Thomas A. Jaeger

*Berlin Congress Hall, with A. Hadjian in the foreground*

The First Conference opened in the Berlin Congress Hall with a plenary session at 9:30 in the morning of Monday, August 20, with a welcoming address by Thomas Jaeger, six general lectures on topics of pre-eminent concern to international policy and strategy in the nuclear power field - and, of course, a musical offering. The latter featured Bach's Second Brandenburg Concerto, and Fig. 3 (page 10) provides tangible evidence that earlier worries about the possibility of securing the services of a good trumpeter were unfounded.

The Opening Session was labelled "Division A", and in this - as well as in its format, scope and spirit - set a precedent which has never been broken throughout the succeeding Conferences. The partitioning of the topical presentation in "Divisions" has also been maintained to this day, although the number and subject of each Division has been modified from time to time, in order to keep pace with new developments. It is interesting to note, however, that the initial list of Divisions (Table 1) is far from outdated.

# Table 1

## TOPICAL GROUPING OF THE CONFERENCE SESSIONS

### REACTOR TECHNOLOGY

**Division A. Opening Session**

| | |
|---|---|
| A 1* | Opening of the Conference; General Lectures |
| A 2* | Power Reactor Development Strategies |

**Division B. Power Reactor Development and Structural Mechanics**

| | |
|---|---|
| B0/1* | Pressurized Water Reactor Development and Its Mechanical–Structural Requirements and Problems |
| B0/2* | Boiling Water Reactor Development and Its Mechanical Structural Requirements and Problems |
| B0/3* | High–Temperature Gas–Cooled Reactor Development and Its Mechanical–Structural Requirements and Problems |
| B0/4* | Liquid–Metal Cooled Fast Breeder Reactor Development and Its Mechanical–Structural Requirements and Problems |

### REACTOR CORE

**Division C. Fuel and Cladding**

| | |
|---|---|
| C 1 | Mathematical–Physical Models for Nuclear Fuel Materials |
| C 2 | Stress and Deformation Analysis of Fuel Element Claddings |
| C 3 | Fuel–Cladding Interaction Effects |
| C 4 | Structural Analysis of Fuel Rods |

**Division D. Fuel Elements**

| | |
|---|---|
| D 1 | Structural Analysis of Fuel Elements |
| D 2 | Stress Analysis of Graphite Fuel/Moderator Elements – I |
| D 3 | Stress Analysis of Graphite Fuel/Moderator Elements – II |
| D 4 | Pebble Bed Reactor Mechanics |

### REACTOR COMPONENTS

**Division E. Shock and Vibration Analysis of Reactor Components**

| | |
|---|---|
| E 1 | Thermal Shock, Pressure Pulse, and Impact Response Analysis |
| E 2 | Dynamics of Fast Reactor Excursion and Containment |
| E 3 | Fuel Rod Vibrations in Parallel Flow |
| E 4 | Reactor Component Vibrations |

**Division F. Structural Analysis of Core Support and Coolant Circuit Structures**

| | |
|---|---|
| F 1 | Structural Analysis of Reactor Core Support Structures |
| F 2 | Structural Analysis of Miscellaneous Reactor Components |
| F 3 | Structural Analysis of Coolant Components – I |
| F 4 | Structural Analysis of Coolant Components – II |
| F 5 | Structural Analysis of Coolant Components – III |

### REACTOR PRESSURE VESSELS

**Division G. Steel Pressure Vessels**

| | |
|---|---|
| G 1 | Stress Analysis of Steel Reactor Pressure Vessels: Shells of Revolution |
| G 2 | Stress Analysis of Steel Reactor Pressure Vessels: Shell Intersections |
| G 3 | Stress Analysis of Steel Reactor Pressure Vessels: Vessel Flanges |
| G 4* | Survey Lectures: Fracture Mechanics Analysis of Steel Reactor Pressure Vessels and Piping |

G 5 Fracture Mechanics Analysis of Steel Reactor Pressure Vessels: Materials Behaviour

G 6 Fracture Mechanics Analysis of Steel Reactor Pressure Vessels: Methods of Analysis

G 7 Crack Detection Measurements

### Division H. Prestressed Concrete Pressure Vessels

H 1 Mathematical–Physical Characterization of Concrete – I

H 2 Mathematical–Physical Characterization of Concrete – II

H 3 Methods for Structural Analysis of Prestressed Concrete Reactor Pressure Vessels

H 4 Design and Structural Analysis of Prestressed Concrete Reactor Pressure Vessels

H 5 Comparison of PCPV Model Test Results with Theory

H 6 Structural Analysis of PCPV Liner and Insulation

## REACTOR PLANT STRUCTURES AND CONTAINMENT

### Division J. Analysis of Shell Structures; Containment

J 1 Analysis of Thin–Shell Structures – I

J 2 Analysis of Thin–Shell Structures – II

J 3 Containment of Power Reactor Plants – I

J 4 Containment of Power Reactor Plants – II

### Division K. Seismic Response Analysis of Nuclear Power Plant Systems

K 1* Survey Lectures: Earthquake Response Analysis and Aseismic Design

K 2 Aseismic Design of Nuclear Power Plant Structures

K 3 Seismic Loading and Interaction Effects

K 4 Aseismic Design of Nuclear Power Plant Piping and Equipment

## STRUCTURAL ANALYSIS AND DESIGN

### Division L. Thermal and Mechanical Analysis

L 1* Survey Lectures: Solid Mechanics Theory

L 2 Heat Generation and Conduction Analysis

L 3 Inelastic High–Temperature Behavior of Metals

L 4 Inelastic Analysis of Metal Structures

L 5 Low–Cycle Fatigue and Shakedown Analysis

L 6 Fracture Mechanics: Special Topics

### Division M. Design, Reliability, Computation Methods

M 1* Survey Lectures: Failure Experience, Reliability

M 2* Survey Lectures: Computer Methods, Mathematical Modeling, Education

M 3* Survey Lectures: Applied Mechanics and Design

M 4 Reliability Analysis of Mechanical Reactor Components

M 5 Finite Element Methods for Structural Analysis – I

M 6 Finite Element Methods for Structural Analysis – II

M 7 Mathematical Models and Methods

*Invited papers.

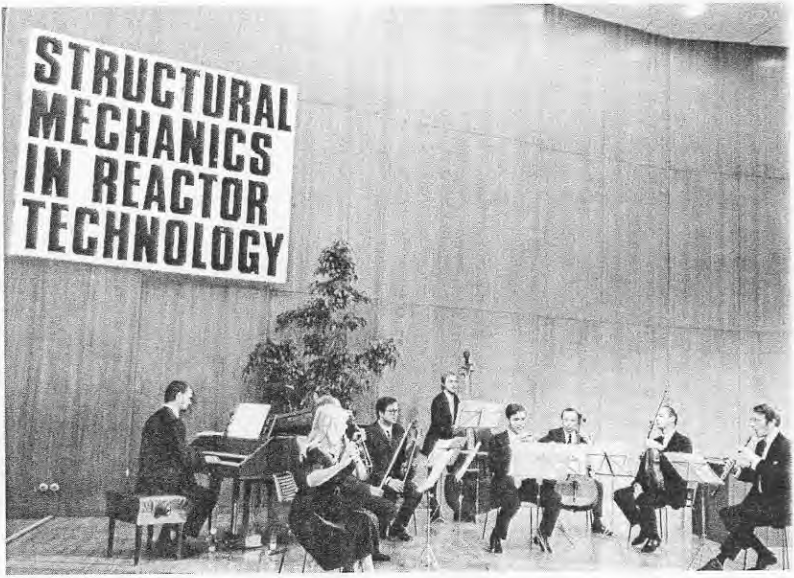
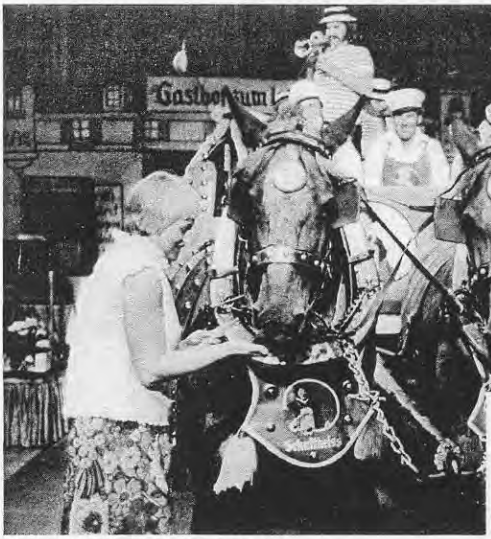



*Figure 3 The Orchestra plays at the opening of SMiRT–1.*

*R. Brée, Tom Jaeger and B. Beine answer questions at a Press Conference during SMiRT–1.*

In one regard SMiRT-1 has never been equaled, namely in that it provided snapshots of most attendees in the List of Participants. That List is remarkable in that it includes a large number of the best-known and most respected names in the broad field of Mechanics. This reflects the comprehensive and demanding nature of the problems encountered, and expected to be encountered, in reactor technology structural mechanics. The coming together of such a large number of researchers, many of whom had known each other well in different circumstances, created a camaraderie that was accentuated by the lavish social program which Thomas Jaeger and his wife Brunhilt planned and implemented with inimitable gusto. Brunhilt, it should be added, acted as her husband's invaluable assistant and helper in virtually all administrative aspects of SMiRT.



*"Night in Old Berlin" – Brunhilt Jaeger gives some sugar lumps to the horses as Tom Jaeger looks on.*

*Brunhilt Jaeger*

## Table 2. SMiRT STATISTICS

| SMiRT | NUMBER OF | | | PROCEEDINGS (*) | |
|---|---|---|---|---|---|
| | Partic'ts | Papers | Countries | Volumes | Pages |
| 1 | 800 | 260 | 33 | 12 | 6000 |
| 2 | 900 | 319 | 28 | 9 | 4442 |
| 3 | 900 | 421 | ? | 9 | 4776 |
| 4 | 1190 | 496 | 26 | 14 | 7014 |
| 5 | 1350 | 745 | 35 | 14 | 5870 |
| 6 | 1400 | 723 | 35 | 13 | 5984 |
| 7 | 1077 | 682 | 26 | 12 | 6064 |
| 8 | 1046 | 844 | 37 | 13 | 5920 |
| 9 | 1052 | 973 | 37 | 14 | 6800 |
| 10 | ? | 734 | 34 | 19 | 5400 |

(*) The figures given for the first 4 SMiRT Conferences correspond to the original issue, including printed Summaries and, for SMiRT-1, some Discussions as well.

Another tradition was set by SMiRT-1 in the preparation, publication and distribution (individually, and before the Conference!) of the Transactions. That this was a monumental task is proved by the sheer statistics of Table 2. It was planned and carried out under the aegis of CEC, under the direction of Mme. Jenny Stalpaert and her staff in Brussels, a practice which continued until her retirement after SMiRT-8. During that period, distribution of the Transactions was arranged with North-Holland, whose Scientific Editor, W. H. Wimmers, had met Jaeger as early as 1964. A significant practice, which deserves mention here, consisted in the use of "Compacts" for the publication of papers, i.e., a format sufficient to include essential details and to stimulate discussion, and yet not such as to preclude the inclusion of the very latest results at the time of presentation.

An important event which took place during SMiRT-1 was the foundation of IASMiRT, the **International Association for Structural Mechanics in Reactor Technology**, for the purpose of organizing future SMiRT Conferences. It was (and still is) registered in Berlin, with the following initial Officers: Jaeger as President, Zenons Zudans as Vice-President, Klaus Brandes as Secretary, and Hans H. Hofmann as Treasurer. Other founding members were B. Beine, C. F. Bonilla, J. R. Feldmeier, Z. J. Holy, A. Huber, W. Matthees, Th. Naehrig, G. Plauk, P. 0. Schildknecht, and W. M. Yoggenreiter. The important role played by the Association in providing continuity to the Conferences will be evident as our history unfolds.

As Chairman of the Executive Committee, Thomas Jaeger single-handedly covered the three roles later to be filled by a General Chairman, a Scientific Chairman, and an Organization Chairman. It was therefore quite natural that he should continue along the same lines two years later for SMiRT-2, although under a slightly modified title.

*Z. J. Holy*

SMiRT-2, 1973
Berlin, Congress Hall. August 10-14, 1973
General Chairman & Technical Program
Chairman: Thomas A. Jaeger

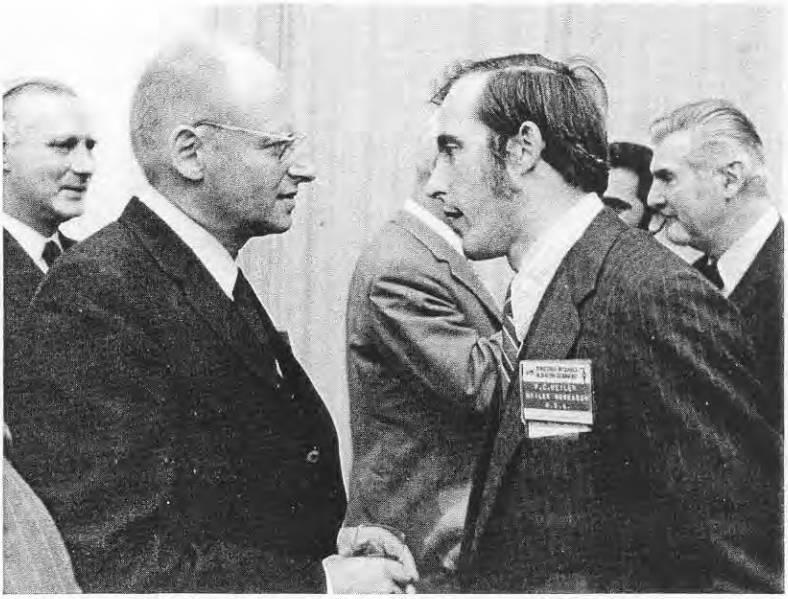
Although the Second Conference followed the general outlines of the First, a few differences may be discovered, which foreshadow later developments. The Opening Session was titled "Toward More Economical Nuclear Power", while Division B specifically dealt with "Nuclear Power Plant Structural Safety and Reliability", and included the first Panel Session (chaired by Howard Gott, who later took on the job of running SMiRT-3). The remaining Divisions underwent some changes in name, but remained substantially the same in coverage, as did the Topical Coverage shown in Fig. 1. Again, an elaborate social program accompanied the technical sessions.


*Jaeger addresses the Opening Session of SMiRT-2.*

*At the Welcoming Reception of SMiRT-2, Jaeger talks to G. Schuster of CEC (center) and A. Sawczuk.*

*Left to right, T. A. Jaeger, Stan Fistedis, and G. D. Stefanou. This picture, like those on pages 16 and 17, were taken at a Reception hosted by the Senate of the City of Berlin, during SMiRT-2, in the Orangerie of the Charlottenburg Castle. The Senate had sponsored a similar Reception also during SMiRT-1.*

The City of Berlin again hosted the Conference, while BAM and CEC were again acknowledged as Organizers. Raymond K. Appleyard, CEC Director-General for Dissemination of Information, assumed responsibility for "Publication Management" to be carried out under the charge of Mme. Stalpaert. CEC's support and cooperation was in fact deemed so crucial to the success of the Conferences, that the venue of the SMiRT-3 could not have been settled without their agreement. This was however obtained even before the start of SMiRT-2, so that the appropriate announcement could already be inserted in the latter's Program.



*Left to right, Roy Nichols, Tom Jaeger, F. C. Weiler, and Stan Fistedis.*

*Klaus Brandes with Mrs. Jaeger and Mrs. Brandes*

*F. J. Vitt with Tom Jaeger*

*Joe Rashid, Tom Jaeger and the Mayor of Berlin*

SMiRT-3, 1975
London, Imperial College, September 1–5, 1975
General Chairman: Howard Gott
Scientific Chairman: Thomas A. Jaeger
Deputy General Chairman: W. J. Prior
Organization Chairman: Henry M. Carruthers

*Howard Gott (right), Mrs. Gott and Henry Carruthers*

The strains of a Brass Ensemble of the Royal Horse Guards and 1st Dragoons, opened the Third Conference, the first to break the ties to Berlin. The next break was to be even wider, since a move across the Atlantic was contemplated. CEC had to be convinced that such a move was quite consistent with the Commission's interests. The writer vividly remembers presenting to Dr. Appleyard his ideas for establishing the positions of Division Coordinators – two per Division – and of Principal Division Speakers. These efforts decentralized a little the planning of the Conferences, and involved directly in all the necessary detailed decisions, a number of important and

concerned people. They were implemented with SMiRT-4 and have remained an important element of all subsequent Conferences - unaltered until SMiRT-10, when they were augmented by the appointment of a number of "Divisional Advisors". This move facilitated the appointment of new people as Division Coordinators, while at the same time it provided an avenue for continued access to the accumulated experience of previous Coordinators and other experts.

*A. Sawczuk (left) with Guilia Maier at the ELCALAP Seminar in 1975 in Berlin*

SMiRT-4, 1977
San Francisco, The San Francisco Hilton Hotel,
August 15-19, 1977
General Chairman: Bruno A. Boley
Scientific Chairmen: Thomas A. Jaeger and Bruno A. Boley
Deputy General Chairman: Thomas A. Jaeger
Organization Chairman: Harvey F. Brush

The list of the first Division Coordinators (Table 3) contains the names of many of the early and devoted participants of these Conferences. It also shows that Division B assumed for the first time a specific technical identity (thermal and fluid/structure dynamic analysis).

A significant addition was provided by the introduction of four Panel Sessions on the following topics (Moderators' names in parentheses):

Fracture Resistance of Reactor Components (P.S.Chopra)
Steel Reactor Pressure Vessel Safety and Reliability (K.E.Stahlkopf)
Status of Research in Structural Design and Analysis (Panel JK, B. S. Browzin)
Structural Mechanics Problems of Fusion Power Reactors (R. W. Conn and W. Wolfer)

*This was one of Tom Jaeger's favorite photos. It shows Bruno Boley, Chairman of the Opening Session of SMiRT-4, looking apprehensively at his watch as Jaeger talks.*

Panels such as these were used to provide forums for in-depth discussions or (as in the case of the last two) to introduce new topics without the necessity of establishing new divisions. The third-listed Panel (JK) grew into a traditional examination of regulatory research, and exemplified the significant degree of support provided by the U.S. Nuclear Regulatory Commission. This subject continues to be vital to the enduring success and progress of SMiRT, and was therefore recently expanded, with SMiRT-10, to the full status of a Division. Similarly, the last-mentioned Panel was the nucleus from which later emerged the full-fledged Division N on fusion problems, starting with the next Conference.

Also significant was the addition to SMiRT-4, of six Post-Conference Seminars - to be "conducted in a workshop atmosphere, for the purpose of providing a forum for extensive in-depth discussions on special SMiRT topics", to quote the SMiRT-4 Program. This was by far the most extensive use to date of Post-Conference Seminars, although certainly not the first. Even after SMiRT-1, in fact, a Post-Conference Meeting on CAFEM (Computational Aspects of the Finite Element Method) was held in Stuttgart under the direction of J. H. Argyris, and at SMiRT-2 the decision was made to hold in Berlin, right after SMiRT-3, the ELCALAP Symposium (on Extreme Load Conditions and Limit Analysis Procedures for structural reactor safeguards and containment structures).

It may be noted that CAFEM Seminars were held (with Joseph F. Gloudeman in charge) in conjunction with all Conferences except SMiRT-9. Two other series of Post-Conference Seminars, which became standard features of succeeding SMiRTs, were the CONFABRE ones (CONtainment of FAst Breeder REactors), organized by S. H. Fistedis and those on "Mathematical/Mechanical Modeling of Reactor Fuel Elements", chaired by Yusef R. Rashid.

*Roy W. Nichols*

# Table 3

## SMiRT-4 INTERNATIONAL SCIENTIFIC COMMITTEE

### Chairmen: Thomas A. JAEGER - Bruno A. BOLEY

**Note:** Each topical division of the 4th SMiRT Conference is headed by two Division Coordinators who have intimate knowledge both of the state of their field as of the workers active in it. The Coordinators' involvement with the selection of contributed and invited papers should insure a high level of the scientific/technical content of the 4th SMiRT Conference.

DIVISION COORDINATORS

**Division B. Thermal and Fluid/Structure Dynamics Analysis**

Professor Dr. Ted BELYTSCHKO, Department of Materials Engineering, University of Illinois at Chicago Circle, Chicago, Illinois 60680, U.S.A.

Dr. Thomas L. GEERS, Lockheed Palo Alto, Research Laboratory, Dept. 52-33, B/205, 3251 Hanover Street, Palo Alto, California 94304, U.S.A.

**Division C. Structural Analysis of Reactor Fuel and Cladding**

Dr. John H. GITTUS, *Research Manager*, Reactor Fuel Element Laboratories, UKAEA Reactor Group, Springfields, Salwick, Preston PR4 ORR, U.K.

Dr. Yusef R. RASHID, *Manager*, Fuel & Structural Mechanics, Nuclear Fuel Department, Nuclear Energy Systems Division, General Electric Co., 175 Curtner Avenue, San Jose, California 95125, U.S.A.

**Division D. Structural Analysis of Reactor Fuel Elements**

Dr. Gilbert MELESE-D'HOSPITAL, *Senior Technical Advisor*, Advanced Reactors Division, General Atomic Company, P.O. Box 81608, San Diego, California 92138, U.S.A.

Dr. Richard W. WEEKS, *Associate Director*, Materials Science Division, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Illinois 60439, U.S.A.

**Division E. Structural Dynamics in Fast Reactor Accident Analysis**

Professor Dr. Donald T. EGGEN, Department of Engineering Sciences, The Technological Institute, Northwestern University, Evanston, Illinois 60201, U.S.A.

Dr. Stanley H. FISTEDIS, *Manager*, Engineering Mechanics Program, Reactor Analysis and Safety Division, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Illinois 60439, U.S.A.

**Division F. Structural Analysis of Reactor Core and Coolant Circuit Structures**

Dr. Robert L. CLOUD, *Manager*, Mechanics & Material Technology, Westinghouse Electric Corporation, Power Systems, PWR Systems Division, Box 355, Pittsburgh, Pennsylvania 15230, U.S.A.

Professor Dr. D.G.H. LATZKO, Laboratory for Nuclear Engineering, Department of Mechanical Engineering, Delft University of Technology, Rotterdamseweg 139 A, Delft, The Netherlands.

**Division G. Structural Analysis of Steel Reactor Pressure Vessels**

Dr. Roy W. NICHOLS, *Deputy Director*, Risley Engineering and Materials Laboratory, United Kingdom Atomic Energy Authority, Risley, Warrington, Lancashire WA3 6AT, U.K.

Mr. Lendell E. STEELE, *Head*, Thermostructural Materials Branch, Engineering Materials Division, Naval Research Laboratory, Washington, D.C. 20375, U.S.A.

**Division H. Structural Engineering of Prestressed Reactor Pressure Vessels**

Mr. Myer BENDER, *Manager of Engineering*, Oak Ridge National Laboratory, Union Carbide Corporation, Nuclear Division, P.O. Box X, Oak Ridge, Tennessee 37830, U.S.A.

Mr. Rex E.D. BURROW, *Chief Design Engineer*, Special Projects Division, Taylor Woodrow Construction Ltd., 345 Ruislip Road, Southall, Middlesex UB1 2QX, U.K.

**Division J. Loading Conditions and Structural Analysis of Reactor Containment**

Mr. Theodore E. JOHNSON, *Head*, Special Structures Group, Bechtel Power Corporation, MET 34, Section B-10, P.O. Box 3965, San Francisco, California 94119, U.S.A.

Dr. John D. STEVENSON, *Vice President and General Manager*, J. D. Stevenson, Consultants, Division of Arthur G. McKee and Company, 6200 Oak Tree Boulevard, Cleveland, Ohio 44131, U.S.A.

**Division K. Seismic Response Analysis of Nuclear Power Plant Systems**

Mr. Asadour H. HADJIAN, *Principle Engineer*, Bechtel Power Corporation, Norwalk, P.O. Box 60860 - Terminal Annex, Los Angeles, California 90060, U.S.A.

Professor Dr. Heki SHIBATA, Institute of Industrial Science, University of Tokyo, 22-1, Roppongi, 7 Chome, Minato-ku, Tokyo, 106, Japan

**Division L. Inelastic Analysis of Metal Structures**

Professor Dr. Antoni SAWCZUK, *Head*, Departments of Theory and Mechanics of Continuous Media, Institute of Fundamental Problems of Technology, Polish Academy of Sciences, Swietokrzyska 21,00-049 Warsaw, Poland

Dr. Zenons ZUDANS, *Vice President*, Engineering, The Franklin Institute Research Laboratories, The Benjamin Franklin Parkway, Philadelphia, Pennsylvania 19103, U.S.A.

**Division M. Methods for Structural Analysis**

Dr. Samuel W. KEY, Applied Mechanics I, Division 1281, Sandia Laboratories, Albuquerque, New Mexico 87115, U.S.A.

Professor Dr. Karl S. PISTER, Division of Structural Engineering and Structural Mechanics, Department of Civil Engineering, College of Engineering, University of California, Berkeley, Berkeley, California 94720, U.S.A.

In keeping with the by-then already established practice of selecting the venue of the SMiRT Conferences four years in advance, Paris was selected as the site of SMiRT-6. But it was also decided that it would be extremely useful to bring all the Division Coordinators together in a Planning Session well in advance of the Conference, so that a consistent and generally-understood scope for the program would be achieved, and suitable arrangements could be agreed upon. The latter extended even to such minute details as the scheduling of technical sessions in adequately-sized meeting rooms. Hence, a Planning Session for SMiRT-5 was organized (it was officially called "CEC-SMiRT International Expert Meeting") for October 2-6, 1978, in Stresa, on the shore of Lake Maggiore in Northern Italy. It proved to be of great value, and therefore similar Planning Sessions continued to be held in the Fall of each even-numbered year, in preparation for the SMiRT Conference in the year following.

It may be appropriate to pause momentarily to remark that the choice of Conference venues has often been a most difficult one, because of the existence of excellent, but regretfully simultaneous and therefore competing, invitations. To mention but one example of this unfortunate necessity of disappointing some of one's warmest friends, we recall here the most attractive and appreciated bids by India in recent years, which SMiRT has not yet been able to satisfy.

*Yoshio Ando*

SMiRT-5, 1979
Berlin, International Congress Center, August 13–17, 1979
General Chairman: Thomas A. Jaeger
Scientific Chairman: Thomas A. Jaeger and Bruno A. Boley
Deputy General Chairman: Bruno A. Boley
Organization Chairman: Thomas A. Jaeger

SMiRT-5 marked a return to Berlin, although the size of the Conference necessitated a move to the larger quarters of the newly opened Congress Center. A much more profound difference, however, was that caused by the seriousness of Tom Jaeger's continuing illness. The difference was deeply felt by all participants, in spite of Tom's valiant efforts to pursue his unusual demanding schedule with his accustomed vigor. As often happens in such cases, he was increasingly anxious to see that things be "done right", and, as a consequence, was at times understandably impatient with the inevitable foibles of his associates. This writer, thrust into the thick of the situation, can attest that it produced, at one and the same time, a general veil of sadness, and a common determination that, whatever happened, SMiRT would continue. Certainly, the pace of the Conference continued unabated, in the technical sessions, in the interactions with the press and the media, and of, course, in the social program.

*Participating at the Opening Session of SMiRT-5 were (l. to r.) Guido Brunner, Peter Fortescue, Tom Jaeger, 2nd Mayor of Berlin Luder, Bruno Boley, and U.S. Congressman Mike McCormack.*

*Raymond K. Appleyard addresses the Opening Session of SMiRT-5.*

*Guido Brunner addresses SMiRT-5.*


*The U.S. Marines Band plays at the Opening Session of SMiRT-5.*

The traditional events were all there. The Opening Session included a concert by the U.S. Marines Band, whose "Stars and Stripes Forever" sounded strangely American in a distant land. Support of the CEC continued, and Commissioner Guido Brunner (who had already delivered an opening-session lecture at SMiRT-4) participated extensively in the Sessions. BAM was joined in sponsoring the Conference by the U.S. Nuclear Regulatory Commission. The number of Post-Conference Seminars (actually, CONFABRE was a Pre-Conference gathering) was increased to ten. The decision with regard to the venue of the SMiRT four years hence was duly made, with the informal understanding that non-European locations would be selected with reasonable frequency in the future. A Planning Session for SMiRT-6 was set to be held in Brussels in a year's time. Thus the orderly transition to a stable arrangement, in the absence of Thomas Jaeger, had thus begun.

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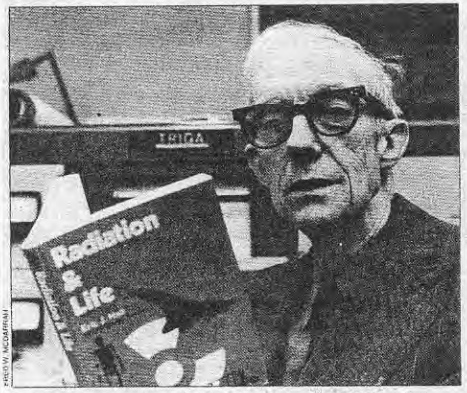
# 'A Harmless Little Reactor That Can't Possibly Have an Accident'




TIMOTHY MCGRATH

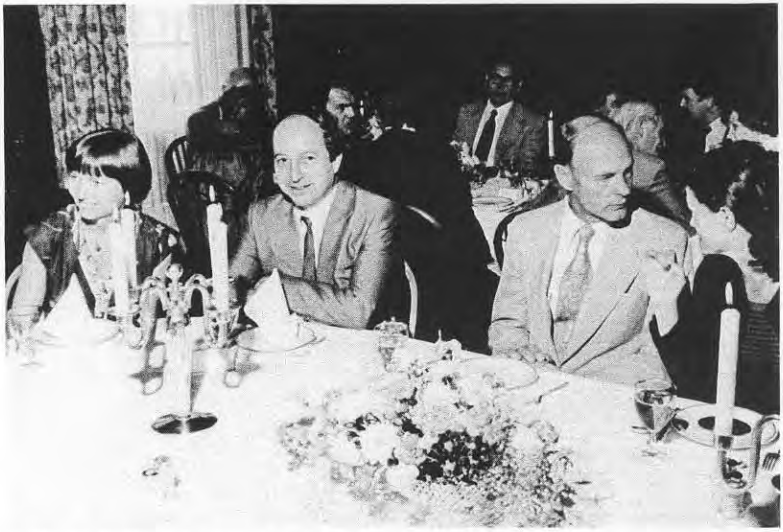
Columbia engineering professor Charles Bonilla with "our little TRIGA."

By Anna Mayo

Backed by powerful pro-nuclear forces, Columbia University is battling for permission to start up its notorious nuclear reactor, TRIGA Mark II. The last remaining barrier to TRIGA operation is New York City's refusal to issue the university a health and safety permit.

Drafted by Dr. Leonard Solon, director of the New York City Health Department's Bureau for Radiation Control, the permit denial makes alarming reading. Solon points out that there is some chance that radioactive TRIGA effluents could contaminate the ancient unpredictable Croton Aqueduct system that runs beneath Amsterdam Avenue, providing a substantial part of the Manhattan water supply. Further, Solon warns that the Morningside Heights/Harlem area is so densely populated that in the event of an accident, timely evacuation would be impossible. He says that "Accident, criminal, or terrorist scenarios which resulted in even one per cent of the (Continued on page 23)

*Charles F. Bonilla*



*Left to right, Nancy Smith, Jean Rastoin, the U.S. Commander in Berlin, Maj. Gen. (ret.) C. B. Benedict, and Jacqueline Rastoin, at a lunch at the Nikolskoe Restaurant during SMiRT-5.*

*Zenons Zudans obviously enjoys his dance with Mrs. McCormack during SMiRT-5.*

SMiRT-6, 1981
Paris, Palais des Congrs, August 17–21, 1981
General Chairman: Jean Rastoin
Scientific Chairman: Jean Rastoin and Bruno A. Boley
Deputy General Chairman: Stanley H. Fistedis
Organization Chairman: Didier Costes

During SMiRT-6, the first after Tom Jaeger's death and the first on the continent of Europe outside of Berlin, a lasting tribute to Jaeger was established, in the form of the Thomas A. Jaeger Prize, to be awarded at each SMiRT to a young contributor deemed worthy of the honor. The first Prize was awarded during this Conference to Dr. Ulrich Schumann of the Institut fur Physic der Atmosphre, KFK Karlsruhe, FRG.

Five Panel Sessions took place, as follows. The U.S. Nuclear Regulatory Commission sponsored one on the important new topic of "Operating Reactor Structural Experience" (grown, by the time of SMiRT-10, to the rank of a full-fledged Division), as well as the continuing Panel JK (see SMiRT-4). "Research Program Plans in Special Fields of SMiRT" were discussed in a Panel, jointly organized by Conway Chan of EPRI. Two other Panels were held, respectively on "Cracks under Cladding" and "Structural Mechanics in Alternative Energy Technologies'. A series of 11 Post-Conference Seminars followed the week's program.

*Michel Livolant*

*Joe and Jean Gloudeman (center), with Jean Rastoin to the left and Didier Costes on the right during SMiRT-6.*

*Donald T. Eggen (left), Jenny Stalpaert, and Roy Nichols.*

A special memorial Session in honor of Tom Jaeger was held, at which time eulogies and reminiscences were presented by Roy Nichols, Antoni Sawczuk, and Zenons Zudans [2]. A segment from one of Jaeger's favorite selections, Bach's Second Suite for unaccompanied cello, was performed by Mme. Barbara Bachmann-Haupt (whose husband, Peter Haupt, had earlier worked with Tom at BAM).

The essential task of the International Association for SMiRT, or IASMiRT, had heretofore been that of the selection the venues of future Conferences. Since it was now imperative to insure that adequate machinery was in place for the smooth planning and operation of the Conferences it naturally assumed a more substantial role. The practice of having the General Chairman of as Conference serve as President of the Association, and the Chairman of the next Conference as Vice-President, was confirmed. A beginning was made toward clarifying the criteria for membership; up to this time, attendance at a Conference alone had been sufficient.

The feeling was expressed by some, that the writer's presence would be desirable in the interest of continuity; and, despite his objections, it prevailed. Accordingly, he eventually proposed that the position of Advisor General be created. He was elected to that post, which implied chairmanship of an Advisory Committee to be appointed later.

*Zdeněk Bažant*

SMiRT-7, 1983
Chicago, Marriott Hotel, August 22–26, 1983
General Chairman: Stanley H. Fistedis
Scientific Chairmen: Stanley H. Fistedis, Jean Rastoin,
Zenons Zudans
Deputy General Chairman: Sergio Finzi
Organization Chairman: Ralph W. Seidensticker
Advisor General: Bruno A. Boley

A well-run Planning Session for this meeting bad been held during the preceding fall at Argonne National Laboratory, an institution which in fact provided strong support throughout the entire Conference. Thus SMiRT-7 was able to mount a most successful return to America after an absence of six years. The program included three Panel Sessions (in addition to Panel JK: see SMiRT-4), on the topics of "Current Issues in Reactor Safety", "Nuclear Robotics", and "Containment Issues for Severe Accidents as Determined by the IDCOR (Industry Regraded Core Rulemaking) Program. Seven Post-Conference Seminars completed the program. The Jaeger Prize was awarded to Professor Ted Belytschko of Northwestern University, with Mrs. Jaeger participating in the presentation.

*Ted B. Belytschko (left) at the Jaeger Prize ceremony, SMiRT-7: S. Finzi at the podium, as Brunhilt Jaeger, B. Boley and S. Fistedis (almost completely hidden) look on.*

This writer regrets that he was unable to participate fully in the Conference activities because of the illness of his own wife, Sara. He nevertheless recalls that the foundations were laid for the preparation of a memorial Volume for Tom Jaeger; these eventually culminated in the publication of Reference [1].

SMiRT-8, 1985
Brussels, Conference Center Albert Brochette,
August 19-23, 1985
General Chairman: Sergio Finzi
Scientific Chairmen: Sergio Finzi, Stanley H. Fistedis,
Andre Jaumotte
Deputy General Chairman: Heinz W. Bargmann
Organization Chairman: L. Hannes Larsson
Advisor General: Bruno A. Boley

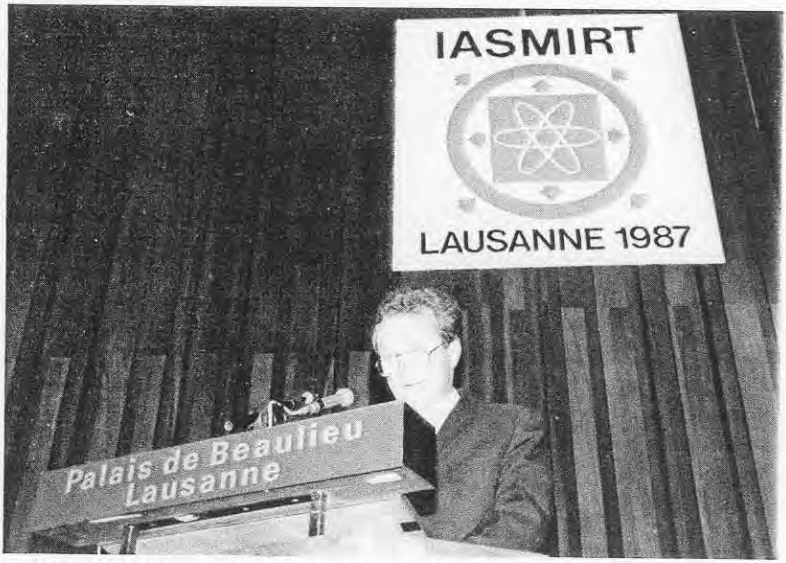
*Sergio Finzi at the Opening of SMiRT-8*

The CEC provided major support for SMiRT-8, held, as it was, on its own home city. A Panel Session on "Safety Issues in Small and Medium Size Nuclear Reactors" was held, in addition to Panel JK. Eight Post-Conference Seminars, and one Pre-Conference Seminar, were scheduled. The Jaeger Prize was awarded to Alan Combescure of the French Commissariat à l'Energie Atomique.

During this Conference, Heinz Bargmann regretfully found it necessary, for a number of personal reasons, to withdraw from his expected chairman-ship of SMiRT-9. The Directors of SMiRT then accepted F. H. Wittmann's proposal to take on that task on short notice. A Brussels Planning Session was scheduled, and matters proceeded on course.

The SMiRT community had again been saddened, this time by the untimely deaths, since the last Conference, of two of its earliest and most influential members, namely Zenons Zudans (1918-1983) and Antoni Sawczuk (1927-1984). A Plenary Memorial Session to honor them was held, during which the writer presented a eulogy and a retrospective view of the progress of SMiRT since its inception.

SMiRT-9, 1987
Lausanne, Palais de Beaulieu, August 17-21, 1987
General Chairman: Folker H. Wittmann
Scientific Chairman: Folker H. Wittmann and Sergio Finzi
Deputy General Chairman: Asadour H. Hadjian
Organization Chairman: O. Mercier
Advisor General: Bruno A. Boley

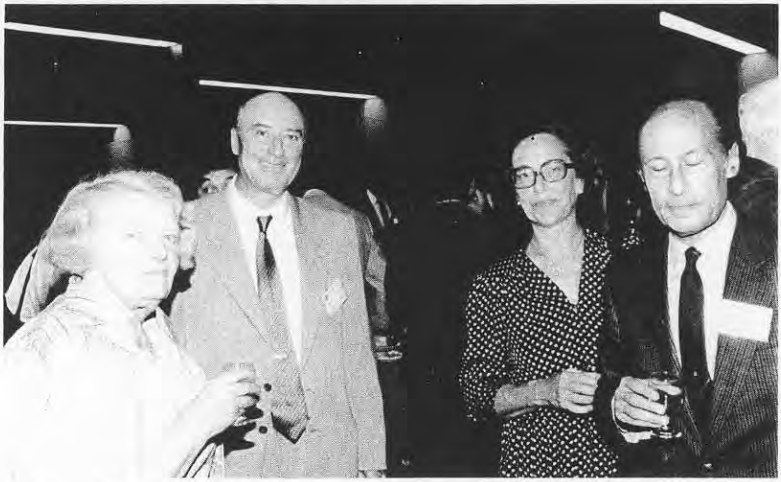



*Folker Wittmann at the Opening of SMiRT-9*

This Conference may be regarded as bringing to a close the transition era to which we had referred, and which had started when Jaeger's guiding hand ceased to be present. The Constitution of IASMiRT was reviewed to its present form. It included provision for a Board of Directors (then composed of President F. H. Wittmann, Vice-President A. H. Hadjian, Secretary L. H. Larsson, and Treasurer John M. Gibb), and an Advisory Board (then composed of a 3-person Directorium - the President, the Vice-President and the Advisor General - and a number of appointed members, who at the time were H. W. Bargmann, S. Finzi, S. H. Fistedis, Roy W. Nichols, J. Rastoin, Karl E. Stahlkopf, and J. Stalpaert). At about the time, an operational (office for IASMiRT, which had been opened in Brussels on June 24, 1982, was deemed to be no longer useful, and was formally closed as of July 31, 1987.

*Stan and Jeanne Fistedis with Karl Kussmaul at SMiRT-9*

The program of the Conference followed well-established lines, but introduced a "first" in the traditional concert during the Opening Session. One of the pieces played was Mozart's Concerto in F-major (K.242) for three pianos; one of these was played by the General Chairman himself!



*Dr. and Mrs. S. Finzi in the center, with Dr. and Mrs. D. G. H. Latzko during SMiRT-9*

*F. H. Wittman chatting with Boley and A. K. Rao at SMiRT-9*

The Proceedings of the Conference were published by A. A. Balkema. The Jaeger Prize was awarded to Dr. Pieter Roelfstra of the Swiss Federal Institute of Technology in Lausanne, again with the participation of Mrs. Jaeger. The Conference included 14 Panel Sessions and 15 Post- or Pre-Conference Seminars. To these one should add the IUTAM/ICM Symposium on "Yielding, Damage, and Failure of Anisotropic Solids" held in Grenoble and dedicated to Antoni Sawzcuk.

The latter event is a sad reminder that once again the SMiRT community must mourn the loss of some of its earliest and most devoted friends. These were Carlos Bonilla, who died on October 31, 1987 at the age of 78, and Stan Fistedis, who died on November 25, 1987 at the age of 62.

Another step intended to put IASMiRT's future on a firm footing was decided upon at this time. It was felt that the establishment of a stable Archival Office for the Association would provide very desirable support for future operations. The formal decision was actually made in Los Angeles in October 1988, during the Planning Session for SMiRT-10, when the CEC Office in Brussels was identified for the purpose. It is also expected that the Advisory Board will play a more active role in the future than it has in the past (current appointed members are Yoshio Ando, Guy A. Arlotto, B. A. Boley, R. W. Nichols, and Jean Rastoin).

*SMiRT General Chairmen past, present, and future: Folker Wittman, of SMiRT-9 seated in the center, Asa Hadjian of SMiRT-10 standing at left, and Heki Shibata of SMiRT-11 seated on the right. Virginia Lewis, SMiRT-10 Administrative Secretary looks on.*

An additional development, which also underlines the solidity of SMiRT's future prospects, is connected with the possible formation of permanent SMiRT-related organizations on a regional basis. In the past, a local entity was set up (more often that not as a formally constituted legal corporation) for the purpose of running a particular Conference, and was disbanded at the completion of that limited task. This practice was broken with the establishment in 1987 of the American Association for Structural Mechanics in Reactor Technology, or AASMiRT, with the establishment in 1987 of the American Association for Structural Mechanics in Reactor Technology, or AASMiRT, with

A. H. Hadjian as its first President. AASMiRT has taken on the responsibility of conducting SMiRT-10 as its first important task; but it will continue to coordinate American SMiRT affairs after that Conference is ended. It will therefore be in a highly influential position for simulating future work in our field. Similar regional affiliated organizations are currently being envisaged in other parts of the world.

Thus, despite the much-publicized current difficulties in the nuclear power industry, our Conferences continue to attract the support and interest of all concerned with the field. There is no question that the fundamental soundness of the basic concept of SMiRT - and its essential role in dealing with the vexing demands of safety in design and operation - will insure that these Conferences continue to be respected and authoritative forums for discussions of new technical developments and of public policy alike. This is all the more true since (as I believe has been well illustrated in this "History") SMiRT has demonstrated to possess the ability to adjust and evolve in the light of new technical demands and new emphases. A good example of the ability to keep current is the attention increasingly devoted to problems related to reactor operation, repair and replacement -- attention which, I would suspect, will become even more pronounced in the next few years as some of our reactors approach the fourth decade of their lives.

The present organizational form of SMiRT is well designed to provide for continuity from one Conference to the next, and it may be well to spell out the details here. The members of the Board of Directors are the President, the Vice-President, the previous and next-to-previous past-Presidents, and the Advisor General. The General Assembly elects the new Vice-President at the conclusion of each Conference, and the Advisory Board elects the Advisor General. The other members of the Board of Directors progress through their respective positions, as the Vice-President becomes the next President. The Advisory Board consists of all past-Presidents but the last two, and of other persons appointed by the Board for periods of two years. Also to be noted is the creation, by the General Assembly, of a Scientific Advisory Board, composed of all past Coordinators who had served for at least three terms – an irreplaceable source of valuable expertise.

On the basis of all that has been said, we feel we have good reason to be confident that SMiRT-10 (which will be in progress when this "History" appears) will fully justify our most optimistic expectations. Certainly, advance indications are extremely encouraging, and we are therefore happy to include it in our listing, even though we must leave to future chroniclers the task of filling in the details.

SMiRT-10, 1989
Anaheim, The Anaheim Hilton & Towers, August 14-18, 1989
General Chairman: Asadour H. Hadjian
Scientific Chairman: Asadour H. Hadjian
Scientific Co-Chairman: Heki Shibata
Advisor General: Bruno A. Boley

*Asadour H. Hadjian*

We note that the number of Divisions has now increased to 18 (Table 4), and that 14 Post-Conference Seminars are planned. But we wish to cast our eye even further ahead, and conclude our formal roster of SMiRT Conferences with:

SMiRT-11, 1991
Tokyo, Keio Plaza Intercontinental Hotel, Shinjuku (Tokyo),
August 18-24, 1991
General Chairman: Heki Shibata
Advisor General: Bruno A. Boley

Although at this point in time it is still in the early planning stages, the location of SMiRT-11 reflects of course the important role that has been played in the nuclear field by Asian countries - a point that will be further underscored by the fact that Post-Conference Seminars are being considered not only for other cities in Japan, but for locations in China and India as well.

## Table 4

### SMiRT-10 DIVISIONS WITH DIVISION COORDINATORS AND DIVISIONAL ADVISORS

(DC = Division Coordinators; DA = Divisional Advisor)

Div. A GENERAL SESSIONS
DC: A. H. Hadjian, B. A. Boley

Div. B COMPUTATIONAL MECHANICS
DC: T. B. Belytschko, K. -C. Hwang; DA: Jean Donea

Div. C FUEL ELEMENTS AND ASSEMBLIES
DC: H. F. Holtbecker, Ichiro Saruyama; DA: Y .R. Rashid

Div. D PERFORMANCE AND LIFE EXTENSION OF OPERATING REACTORS
DC: J. J. Carey, L. J. Reynes; DA: Robert Noel

Div. E FAST REACTOR CORE AND COOLANT CIRCUIT STRUCTURES
DC: Michel Livolant, Akira Imazu; DA: Y.-W.Chang

Div. F LWR PRESSURE COMPONENTS
DC: Fumio Hara, Brian Tomkins; DA: R. L. Cloud

Div. G FRACTURE MECHANICS AND NON-DESTRUCTIVE EVALUATION
DC: S. J. Crutzen, Genki Yagawa; DA: R. W. Nichols

Div. H CONCRETE STRUCTURES
DC: Joseph Eibl, K.T.S. Iyengar; DA: T. E. Johnson

Div. J EXTREME LOADS ANALYSIS
DC: J. D. Riera, N. J. Krutzig; DA: J. D. Stevenson

Div. K SEISMIC RESPONSE ANALYSIS & DESIGN
DC: R. P. Kennedy, Heki Shibata; DA: A. H. Hadjian

Div. L INELASTIC BEHAVIOR OF METALS & CONSTITUTIVE LAWS OF MATERIALS
DC: J. P. Boehler, Erhard Krempl

Div. M STRUCTURAL RELIABILITY
DC: A. H. -S. Ang, G. I. Schüeller

Div. N MECHANICAL AND THERMAL PROBLEMS OF FUSION REACTORS
DC: R. W. Conn, Peter Komarek

Div. P PROBABILISTIC SAFETY ASSESSMENT
DC: G. E. Apostolakis, Peter Kafka

Div. Q CONCRETE AND SPECIFIC ASPECTS OF NON-METALLIC MATERIALS
DC: Z. P. Bazant, Z. -Y. Weng

Div. R WASTE REPOSITORY TECHNOLOGY
DC: Jean Rastoin, C. V. Subramanian; DA: S. W. Key

Div. S RESEARCH FOR REGULATORY NEEDS AND STANDARDS DEVELOPMENT
DC: Robert Bosnak, B. K. Kim

Div. T FLOW-INDUCED DYNAMICS
DC: G.N.V. Rao, T. M. Mulcahy

We look forward with confidence to the Tokyo Conference – and, indeed, why stop there? Let us cast our mind's eye beyond 1991, to any odd-numbered year in the foreseeable future: at some time during the Summer of that year, a SMiRT Conference will be taking place, and will draw strength, we trust, from the work of the two remarkable decades which it has been our pleasure to outline briefly in these few pages.

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*Spring 1989*

## REFERENCES

1. "*Thomas A. Jaeger: A Life at the Crossroads between Technology and Risk*",
by Klaus Brandes with Brunhilt Jaeger and Wolfgang Matthees, eds., IASMiRT and BAM, August 1965 (*).

2. "*Thomas A. Jeager Memorial Session*", held during SMiRT-6, Paris, France,
August 15, 1981; reprinted from Nuclear Engineering & Design. Vol. 69.
No. 3 (1982), pp. 423-437.

(*) A few copies of this Volume are still available from Dr. Klaus Brandes, Bundesenstalt fr Materialprdfung (BAM), Unter den Eichen 87, D-1000 Berlin, Federal Republic of Germany.

*Editor's Note:*

*To reconstruct the pictorial history of SMiRT after the passage of twenty years is not a simple task. It is hoped that the publication of this History will encourage readers to send to the author important photographs for use in a future edition of the Short History of SMiRT.*

*A. H. Hadjian*