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History of the Fluids Engineering Division (FED)

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Preface

The 90th anniversary of the Fluids Engineering Division (FED) of ASME will be celebrated July 10-14, 2016 in Washington, D. C. The venue is ASME's Summer Heat Transfer Conference (SHTC), Fluids Engineering Division Summer Meeting (FEDSM) and International Conference on Nanochannels and Microchannels (ICNMM). The occasion is an opportune time to celebrate and reflect on the origin of FED and its predecessor -- the Hydraulic Division (HYD), which existed from 1926 through 1963. Therefore, the FED Executive Committee decided that it would be appropriate to publish concurrently a history of the Hydraulic/Fluids Engineering Division. Accordingly they commissioned Paul Cooper, C. Samuel Martin, and Timothy O'Hern (Figures 1, 2, and 3) to prepare this paper, which would document the division's past. A brief work in this direction had appeared in the 2010 FED Newsletter **[1]**, and the research by Martin for the present paper had been under way for several years prior to that **[2]**.

Figure 1 Paul Cooper Worthington Medalist, etc.

Figure 2 C. Samuel Martin Life Member ASCE, etc.

Figure 3 Timothy J. O'Hern Chair, Multiphase Flow Committee, 2012-14; etc.

Introduction

Of interest and importance prior to the official establishment of the Hydraulic Division (HYD) was the state of art of hydraulics within ASME. Indeed, who were the players advancing the technology of hydraulics between the founding of ASME in 1880 and the establishment of HYD in 1926?

There were many articles in the *ASME Transactions* and *Mechanical Engineering* (*ME*) between 1880 (ASME Founding) and 1930 (50th ASME Anniversary), as listed in Table 1 from **[3, 4]**.

Table 1 ASME Transactions and ME Articles

Subject	Articles
Flow of Fluids	29
Fluid Meters	64
Hydraulics	31
Hydraulic Turbines	35
Hydroelectric Power Plants	25
Hydraulic Pumps	3
Reciprocating Pumps	11
Rotary Pumps	5
Centrifugal Pumps	22
Pumping Plants	16

The development of hydroelectric power stations necessitated the understanding of hydraulic turbine performance. This technology was a major element in design of hydraulic turbines -- Francis, Kaplan, and Pelton designs.

Moreover, there were issues beyond the design of turbines; namely, water hammer, cavitation, and flow measurement, and technical areas of interest to mechanical engineers (principally ASME). In particular, flow measurement played an important role in the determination of power guarantee.

Figure 4
Lewis F. Moody, hydraulics pioneer. Waterhammer Committee 1935-53, Chair of the Cavitation Committee 1938-48.

The 1930 paper in ME "Fifty Years' Progress in Hydraulics" by L. F. Moody, (Figure 4) and B. R. Van Leer **[5]** had numerous articles, including theoretical hydraulics, water hammer, fluid metering, the Pelton wheel, American hydraulic turbines, and pumping machines.

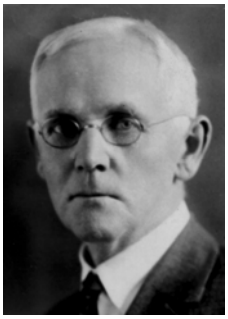

Figure 5 N. R. Gibson, impulse-momentum method, Waterhammer Committee 1935-53.

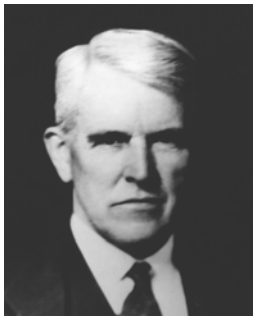

Figure 6 C. M. Allen, Salt-Velocity Method

Because of the promise of power output from hydroelectric power stations, flow measurement was critical, resulting in improvement of various techniques -- impulse-momentum (Gibson Method), Salt-Velocity Method attributed to Allen, (Figures 5 and 6), and Venturi Meter for smaller pipes enhanced by Herschel for smaller piping systems.

John R. Freeman (Figure 7) was the star in hydraulic activity over the 50-year period from 1880 to 1930, conducting experiments on head loss in pipes and determining the characteristics of fire nozzles. He was aware of the fact that European hydraulic laboratories were far more advanced than those in the United States. He set out to remedy the deplorable situation by visits to Europe and the encouragement of these laboratories to encourage visitors from the U. S. as well as write reports of their investigations. This effort led to a comprehensive report **[6]**, an article in German, which was later translated into English **[7]**.

Figure 7
John R. Freeman Honorary Member and 24th President of ASME, Recipient of the ASME Gold Medal, Founder of the ASME Freeman Fund

The ASME Freeman Fund was established in 1926 by John R. Freeman, noted Hydraulic Engineer and Scholar, Honorary Member, twenty-fourth President of ASME, and recipient of the Society's Gold Medal. Mr. Freeman's active life was crowded with achievements in many fields. To an unusual degree he brought the benefits of engineering to his fellowmen in many lands, giving his energy and his money unselfishly to meritorious causes and directing his talents to business and to engineering with an enthusiasm and thoroughness that made his pursuit of both these professions successful. Exemplifying his unselfish character, Mr. Freeman suggested a flexible program for utilization of the ASME Freeman Fund when he gave in trust to the Society securities, valued at $25,000. It was stipulated that income be

devoted in general to research. Mr. Freeman expressed his wish that, for the moment, part of the income from the gift be used to guarantee the publication of the translation and printing of the German work on Hydraulics (representing extraordinary research in that field). He also recommended travelling scholarships for engineering students. In early years it supported fellowships for the study of hydraulic laboratory practice in Europe, later it supported publication of important hydraulic research data, and lately it has been granted to support research programs in hydraulics and fluid mechanics. Up until 1938 an article entitled "Progress in Hydraulics" was published periodically in *Mechanical Engineering* and in the ASME Transactions.

Mention should also be made of Robert Henry Thurston, who was the first president of ASME, as well as an educator and an accomplished mechanical engineer. Little is known about his expertise in the design of steam piping systems for heating in cities and for power plants applications. Moreover, he published an article in ASME Transactions in 1883 regarding water hammer in steam lines that, due to inactivity for a period of time, allowed the formation of condensate **[8]**. Introduction of hot steam in a dormant line with condensate is a current issue, and is termed condensation-induced water hammer (CIWH). Although the application was for single-phase water hammer it should be noted that the first technical committee established under HYD auspices in 1931 was the water hammer committee. The Thurston Lecture is an annual society level award recommended by Basic Engineering Group (BETGOB).

Establishment of the Hydraulic Division (HYD)

For nearly 46 years ASME members with an interest in hydraulics had no home of their own but still met at least once annually at the Winter Annual Meeting (WAM) or with other divisions -- mainly with the Power Division. There was, however a ground swell of interest in establishing a division with interest solely in hydraulics. On November 25, 1925, Dr. Lewis F. Moody led the effort as temporary chairman to formulate a petition for establishment of a professional division entitled Hydraulic Division (HYD), which was endorsed by 146 ASME members without any dissenter. Notable cosigners of the petition were:

C. M. Allen, Worcester Poly
R. L. Daugherty, Caltech
W. F. Durand, Stanford
J. R. Freeman, Industry
N. R. Gibson, Industry
L. F. Harza, Industry
A. Hollander, Berkeley
S. L. Kerr, Industry
J. N. LeConte, Berkeley
C. T. Main, Industry
L. F. Moody, Consulting Engineer
R. S. Quick, Industry

Over the next three decades as the activities of HYD developed, committees were formed to cover specific areas of interest. The establishment and history of the

Water Hammer (1931) and
Cavitation (1937)

committees are found in the section below on *Committee Histories*, as well as of the following committees:

Hydraulic Prime Movers (1938),
Pumping Machinery (1938),
Compressors (1950), and
Fluid Mechanics (1957).

These committees were sometimes called subcommittees at various times over the years.

During the 1930's the HYD continued to be active in the traditional areas of hydraulics; namely, turbine and pump design and performance, but also emerging problems of water hammer, surge tank simulation, and cavitation. Theodore von Kàrmàn, (Figure 8) after arriving at Caltech during 1930, continued to enhance the understanding of turbulence and its effect on fluid resistance, as well as to advise his colleagues in their research endeavors; the main recipient being Robert T. Knapp (Figure 9), to be referred to later. Of note is the fact that von Kàrmàn received the ASME Medal for his contributions to a vast array of fluid mechanics problems.

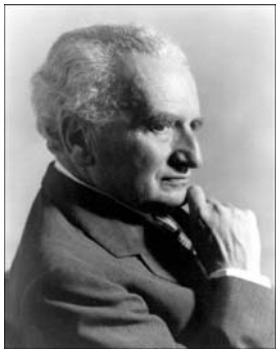

Figure 8
Theodore von Kàrmàn

Figure 9 Robert T. Knapp, Chair (1948-57) of the Cavitation Committee (now the MFTC)

During the decades 1930 and 1940 there was considerable activity devoted to the understanding of surface resistance to flow, in particular pressure loss in uniform flow in pipes. In 1944 L. F. Moody, then a professor at Princeton University, took the friction factor correlations from Colebrook and White and prepared a working graph, which, indeed, is the standard in use today -- called the Moody diagram.

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Renaming of the Hydraulic Division (HYD) to the Fluids Engineering Division (FED)

The Hydraulic Division was aptly named at its inception in 1926, continuing emphasizing activities related to hydraulics as fostered by the six subcommittees. However, industry was changing and topic areas not only embraced hydraulics, but the need for research and development -- principally in the expanding topic area of fluid mechanics - began to have an effect. Opportunities existed in both Industry and university settings. Contract work that existed as a result of World War II continued -- especially in defense-related fields.

Figure 10
Robert C. Dean, Jr., Fluid Mechanics Committee chair, 1957-8; first Editor, FED Newsletter, 1963, first Editor, Journal of Fluids Engineering, 1973

Major research-oriented universities became active during the 1950's, as reported by Rouse (1976), who referred to the next decade or so as "*The Rise in Fluid Mechanics*", leading to the formation of a fluid mechanics committee with R. C. Dean (Figure 10) as the first chair in 1957. Also, the first specialty conference on hydraulics (HYD) was held at the University of Michigan in 1959 – of a total of 20 papers, seven could be classified as fluid mechanics papers. Then in 1963 a newsletter was initiated with R. C. Dean as editor.

Elite universities in New England and California led the way. There was also a groundswell of activity and interest in renaming HYD to more accurately reflect the interest and focus of subcommittee members. The charge to rename HYD to FED was led by Robert C. Dean (MIT) – supported by Stephen Kline (Stanford) (Figure 11), Howard Emmons (Harvard), (Figure 12) with encouragement from A. H. Shapiro (MIT), (Figure 13). There was, however, a cadre of subcommittee members from water hammer and hydraulic prime movers who strongly supported the name HYD, as it suited their activities. As described by Rouse **[9]** a well-respected individual who brought the hydraulic-oriented members and fluid mechanics members together was George Wislicenus, (Figure 14). When the vote was taken the "*Old-Timers*" were defeated as indicated in Table 2, and name was changed from HYD to FED in 1963. Moreover Dean and Kline used their platform to stimulate discussion of unresolved fluid mechanics problems **[10]**.

Figure 11 Stephen J. Kline

Figure 12 Howard Emmons

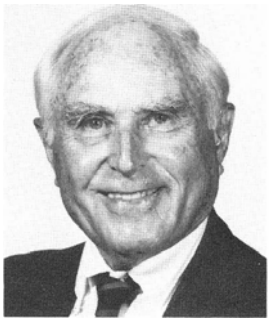


Figure 13
Ascher H. Shapiro

Figure 14
George F. Wislicenus, Chair of the Cavitation Committee (now the Multiphase Flow Technical Committee) 1960-62

Table 2 Vote on Changing the Name to FED

Sub-Committee	FOR	AGAINST
Prime Movers	1	14
Water Hammer	1	6
Cavitation	9	1
Pumping Machinery	16	0
Compressors	16	2
Fluid Mechanics	10	0
TOTAL	**53**	**23**

Chairs of the HYD/FED Executive Committee are listed in Table 3.

At this point, a timeline of significant events or milestones in the history of the FED would be helpful to the reader and would put all the detail of the following sections in the proper perspective. Therefore the major FED milestones are next presented in Table 4.

Table 3. Hydraulic/Fluids Engineering Executive Committee Chairs (HYD renamed FED in 1963)

Year	Chair		Year	Chair		Year	Chair
1926-29	Ely C. Hutchinson		1962-63	R. C. Dean, Jr.		1990-91	Clayton Crowe
1929-30	L. F. Moody		1963-64	A. M. G. Moody		1991-92	Warren Wade
1930-31	William M. White		1964-65	Robert S. Sproule		1992-93	Richard Bajura
1931-32	E. M. Breed		1965-66	Stephen J. Kline		1993-94	Donald R. Webb
1932-33	Blake van Leer		1966-67	W. G. Cornell		1994-95	Michael L. Billet
1933-34	D. J. McCormack		1967-68	J. William Holl		1995-96	Edwin P. Rood
1934-35	Paul Diserens		1968-69	Gino Sovran		1996-97	Hugh W. Coleman
1935-36	C. F. Merriam		1969-70	Warren G. Whippen		1997-98	Thomas B. Morrow
1936-39	S. Logan Kerr		1970-71	Glenn W. Wood		1998-99	Christopher J. Freitas
1939-40	Forrest Nagler		1971-72	Milton S. Plesset		1999-00	Philip A. Pfund
1940-41	F. G. Switzer		1972-73	Jackson E. Fowler		2000-01	David E. Stock
1941-44	E. B. Strowger		1973-74	Forbes T. Brown		2001-02	Timothy J. O'Hern
1944-47	L. J. Hooper		1974-75	George Rudinger		2002-03	Upendra S. Rohatgi
1947-48	R. E. B. Sharp		1975-76	William E. Thompson		2003-04	Ali Ogut
1948-49	J. F. Roberts		1976-77	Turgut Sarpkaya		2004-05	S. Gopalakrishnan
1949-50	George R. Rich		1977-78	Kenneth E. Hickman		2005-06	Stathis Michaelides
1950-51	G. T. Abernathy		1978-79	Jules Dussourd		2006-07	Urmila Ghia
1951-52	R. T. Knapp		1979-80	Allan Acosta		2007-08	George Papadopoulos
1952-53	H. S. Van Patter		1980-81	C. Samuel Martin		2008-09	James A. Liburdy
1953-54	R. G. Folsom		1981-82	William B. Morgan		2009-10	Joel T. Park
1954-55	R. S. Quick		1982-83	Peter W. Runstadler		2010-11	M. H. Hosni
1955-56	J. W. Daily		1983-84	Robert Hickling		2011-12	David W. Halt
1956-57	H. L. Ross		1984-85	Christopher Brennen		2012-13	Jinkook Lee
1957-58	G. F. Wislicenus		1985-86	Paul Cooper		2013-14	Francine Battaglia
1958-59	G. D. Johnson		1986-87	Charles Dalton		2014-15	Bahram Khalighi
1959-60	John Parmakian		1987-88	Walter Swift		2015-16	Keith Walters
1960-61	Howard W. Emmons		1988-89	Blaine R. Parkin		2016-17	Yu-Tai Lee
1961-62	W. C. Osborne		1989-90	Thomas Morel			

Table 4

FED MILESTONES
1925
Hydraulic Division Established
1930
Freeman Award established
Waterhammer Committee Established
1935
Cavitation, Prime Movers, and Pumping Machinery Committees Established
1940
1945
1950
Compressors Committee Formed
1955
Fluid Mechanics Committee Formed (R. C. Dean, Chair)
1960
First National Hydraulic Division Conference
FED Newsletter Established (R. C. Dean, Editor)
1965
Division Name Changed from Hydraulic to Fluids Engineering
Knapp and Moody Awards Established
1970
Journal of Fluids Engineering Formed (R. C. Dean, Technical Editor)
1975
Fluids Engineering Award Approved
1980
Cavitation/Polyphase TC Changed to Multiphase TC
1985
1990
Restructuring of FED; Fluid Appl's & Systems TC formed (FASTC)
1995
2000
Technical Committees (FMTTC, MFTC, CFDTC, MNFDTC)
2005
Gopalakrishnan Flowserve Award established
2010
2015
Celebration of 90th Anniversary of FED

FED Restructuring

By 1989, the fluids engineering landscape had changed sufficiently to merit a significant structural adjustment. Affected were the technical committees (sometimes called subcommittees over the years) and the other functions of the Division. As we have seen, this had happened in varying degrees from the formation of the Division's technical committees in the 1930's through changes of the names of these committees and the combination of some of them into new ones that took on new areas of interest and reduced activity in other areas. Some committees were formed and then disappeared along with activity in the fields they addressed.

So the Fluids Engineering Division Executive Committee (FEDEC), at their meeting in late 1989 proposed a review that would ensure better coordination of their committees and would increase participation of the industrial members of the Division in its technical programs. This would address three trends that characterized the new landscape; namely, a) the increase in fluids engineering industrial applications in addition to traditional fluid machinery (pumps and turbines), b) a fusion of the disciplines of that traditional fluid machinery area, and c) increased research in basic flows in the fluid mechanics discipline.
Accordingly, under the direction of Chair Tom Morel, the FEDEC solicited input from the technical committee and coordinating group chairs, and from this they developed a suggested structure. They asked Paul Cooper and Sam Martin to chair an open meeting of the Division on June 4, 1990, at the ASME Spring Fluids Engineering Conference that was held jointly with the CSME Mechanical Engineering Forum in Toronto on June 3-8, 1990. The purpose of the meeting was for the attendees to examine the operation, structure and mission of the FED and to consider improvements that would maintain and increase the effectiveness of the FED. Tom Morel presented the FEDEC report, and after discussion the members authorized the proposed new committee structure, which is shown in the Organization Chart of Figure 15.

The major change leading to this chart was the formation of two new technical committees, namely the *Fluid Applications and Systems Technical Committee* (FASTC) and a *Fluid Mechanics Technical Committee* (FMTC). Into FASTC were folded the activities and responsibilities of the former *Fluid Machinery Committee*, the *Fluid Transients Committee* and the portion of the earlier *Fluid Mechanics Committee* that pertained to engineering applications of Fluid Mechanics. The new FMTC would emphasize fundamental fluid mechanics. The *Multiphase Flow Technical Committee* (MFTC) continued as before, as did the two coordinating groups – for *Fluid Measurements* (CGFM) and for *Computational Fluid Dynamics* (CGCFD).

The program areas and subcommittee structures within these three committees were defined in a subsequent meeting of members of the Fluids Engineering Division Executive Committee and the subcommittee chairs in October 1990, as shown respectively in Tables 5, 6, and 7.

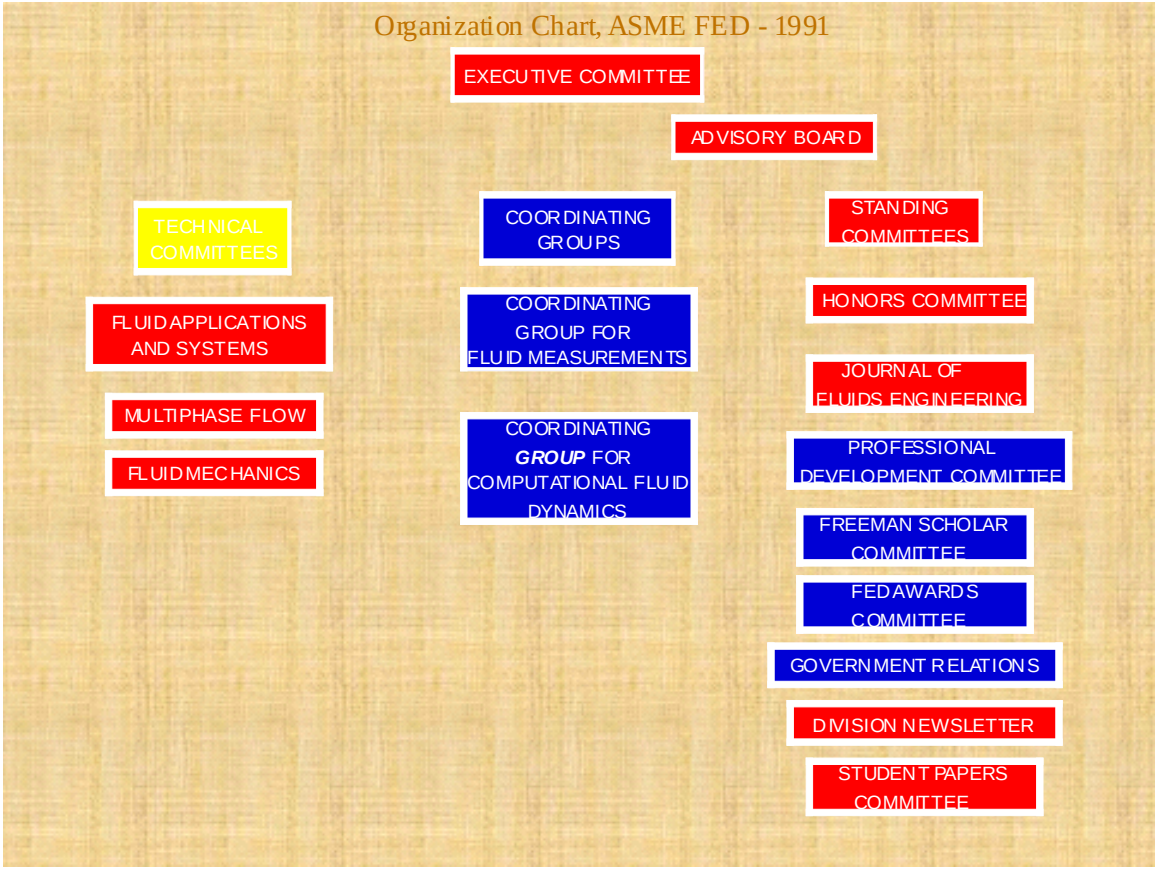


Figure 15 Organization chart, ASME Fluids Engineering Division, November 1991. From Bajura, 1991.

Table 5 Fluid Applications and Systems Technical Committee (FASTC) Program Areas and Subcommittee Structure [11].

1. Fluid Machinery and Components
    a. Turbomachinery (compressors, pumps and turbines
    b. Hydropower
    c. Hydropropulsion (propellers, jet pumps, torpedoes, submarines, hydrofoils, flow noise
    d. Valves, Flow Controllers, and Dividers
    e. Performance of Machines and Components
    f. Other Fluid Machines
2. Fluid Transients and Structural Interactions
    a. Piping System Transients
    b. System Transients
    c. Fluid Transmission Lines
    d. Waterhammer
    e. Flow Induced Vibrations
3. Industrial and Environmental Applications
    a. Positive Displacement Compressors, Pumps, and Motors
    b. Internal Combustion Systems
    c. Fluid Mechanics in Manufacturing Processes
    d. Spray Systems
    e. Energy Conversion
    f. Fluidics
    g. Vehicle Aerodynamics and Hydrodynamics
    h. Municipal, Industrial, and Medical Waste Treatment and Disposal
    i. Mixing Processes and Atmospheric Transport
    j. Spills
    k. Porous Media Flows
    l. Space Systems

Table 6 Fluid Mechanics Technical Committee (FMTC) Program Areas and Subcommittee Structure [11].

1. Turbulence and Shear Flowserve
    a. Boundary Layers
    b. Separated Flows, Jets, Wakes, and Cavity Flows
    c. Bluff Bodies
    d. Turbulence
    e. Transition
    f. Mixing, Dispersion, Plumes, Diffusion
2. Unsteady Flows
    a. Waves
    b. Periodic Flows
    c. Unsteady Boundary Layers, Transition, and Separated Flows
    d. Biological Flows
    e. Vortex Dynamics
    f. Instabilities
3. Aero-Dynamics and Hydro-Dynamics
    a. External Flows
    b. Lubrication
    c. Potential Flows
    d. Shock Waves
    e. Inviscid Flows
    f. Free Surface Phenomena
4. Unconventional and Emerging Topics
    a. Chaos and Non-Linear Dynamics
    b. Liquid Metals
    c. Microgravity
    d. Micro Fluid Mechanics (creeping flows, vapor deposition, crystal growth)
    e. Non-Newtonian Flows
    f. Reacting Flows

Table 7 Multiphase Flow Technical Committee (MFTC) Program Areas and Subcommittee Structure (from Bajura, 1991).

1. Gas-Solid Flows
   a. Particulate Flows and Aerosols
   b. Fluidized Beds
   c. Combustion Products
   d. Air Pollutants
   e. Dusty Flow
   f. Snow Motion
   g. Particulate Plumes
2. Gas-Liquid Flows
   a. Cavitation and Related Areas (noise, inception, performance of propellers, hydrofoils, underwater vehicles, pumps, turbines, valves, and orifices)
   b. Flow Regimes (bubbly, slug, annular, misty, frothy, and film)
   c. Sprays, Droplets, and Atomization
   d. Aeration
   e. Entrainment
3. Liquid-Solid Flows
   a. Slurry Flows
   b. Sewage Flows and Waste Treatment
   c. Muds and Solid Suspensions
   d. Mixing of Powders
   e. Segregation of Solids
   f. Materials Processing
4. Multicomponent Flows
   a. Three-Phase Flows
   b. Stratified Flows
   c. Immiscible Liquids and Gas Mixtures
   d. Related Areas

For the coordinating groups, the CGFM was charged with working in such areas as fluid meters, laser Doppler anemometry, and other optical flow measurement and visualization applications, pressure and temperature measurements, and experimental uncertainty. The CGCFD was to apply computational fluid dynamics techniques to the solution of fluids engineering problems; and program areas included numerical uncertainty, identification of benchmark cases, and cooperation with similar groups from other technical societies. Both groups were to coordinate with the technical committees in their respective areas of endeavor.

Beside the technical committees and coordinating groups, Figure 15 also shows the other committees that were recognized as part of the new structure of the FED. First there are the *Standing Committees* listed in the right-most column of the figure. Up top is the then newly created Advisory Board to the FEDEC, this board consisting of resource persons such as past FEDEC members, past technical committee and coordinating group chairs, senior members of the Division and others familiar with the programs of FED and fluids engineering. They advise the FEDEC in future technical programs, industry, government, and university cooperation, the FED Student Papers Contest, and agendas for special programs and other topics.

With regard to the foregoing changes in the technical committees and coordinating groups, these are simply developments in the evolution that has been a feature of the existence of the FED from the foundation of the Division. This evolution up to the present time can be seen in Figure 16.

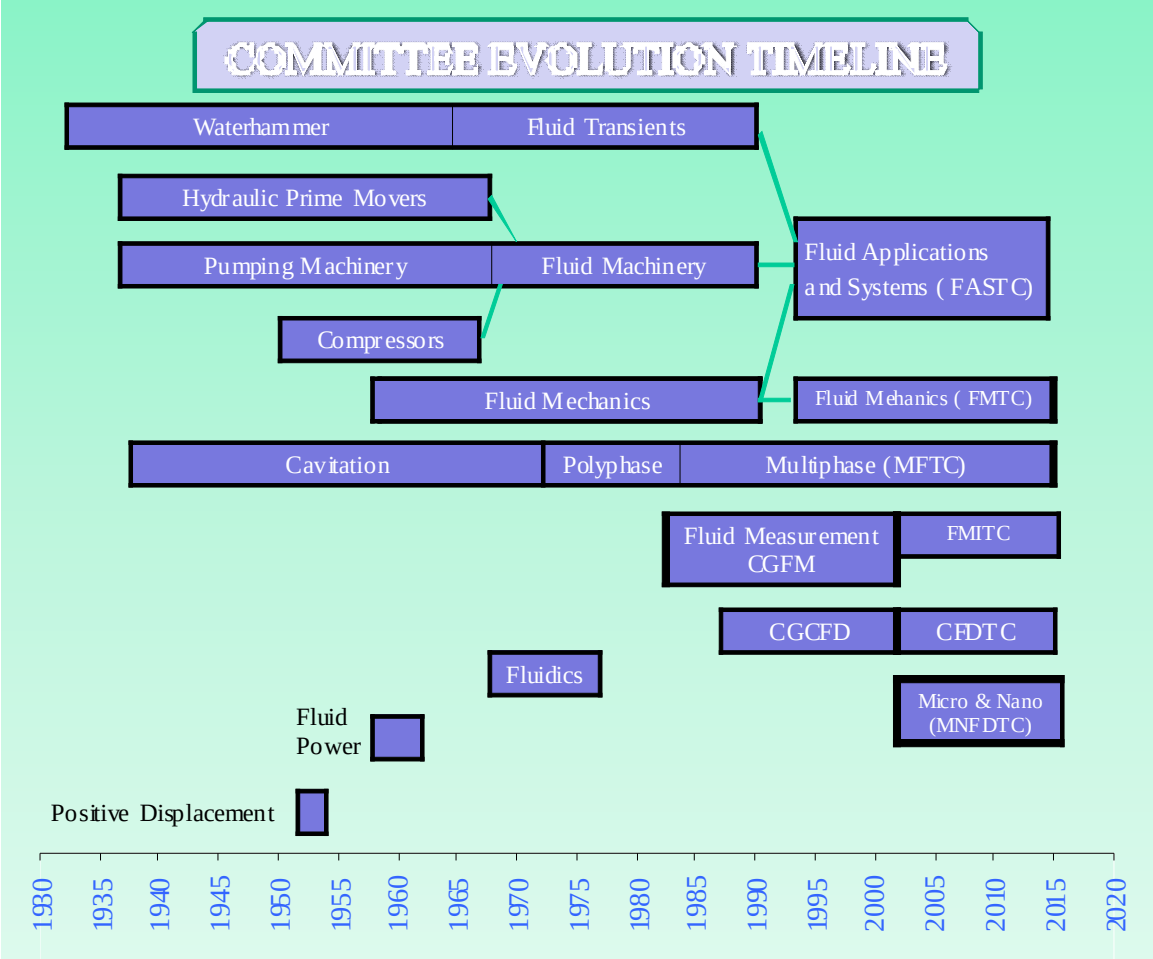


Figure 16 Evolution of the Technical Committees and Coordinating Groups of the FED.

Notice in this figure that the previous significant change was the formation of the *Fluid Machinery Committee* in 1968 by combining within it the activities of the earlier committees on *Hydraulic Prime Movers* (mainly hydraulic turbines and formed in 1938), *Pumping Machinery* (also formed in 1938), and Compressors (1949). The name of the *Cavitation Committee*, (formed in 1937) was changed to the *Polyphase Flow Committee* in 1970 thereby including in its mission all types of flow with more than one phase, cavitation being only one of these. Then, in 1982, conforming to general terminology for such flows, this became known as the *Multiphase Flow Technical Committee* (MFTC).

Finally it will be noted from Figure 16 that the two coordinating groups became technical committees in 2002, namely the *Fluid Measurements and Instrumentation Committee* (FMITC) and the *Computational Fluid Dynamics Committee* (CFDTC). Also at that time the new *Micro & Nano Fluid Dynamics Committee* (MNFDTC) came into existence.

Committee Histories

The 1990 restructuring of the FED Technical Committees and Coordinating Groups was a watershed event in the development history of the FED, not only because of the actual changes that were made but also because it established a mindset that would facilitate further changes if and when future needs might demonstrate a need to do so. In that sense, the lineup of these technical committees and coordinating groups can now be viewed as a snapshot which addressed the prevailing needs of the fluids engineering community at that point in time.

For example, as described above, just 12 years later in 2002, the respective roles, missions and involvements of the two Coordinating Groups – on Fluid Measurements and on CFD – had developed sufficiently to merit upgrading them to full status as Technical Committees.

To get a sense of the dynamics involved in such developments, it is instructive for us to fill out the story of each of these Technical Committees from their foundation to the present day. Of particular note, as seen in Figure 16, 1938 saw a major reorganization of the Hydraulic Division – akin to 1990 in importance – when it added three more committees, another having just been formed in 1937. Thus, for the first time, there were then five fully functioning committees, which for the most part remained active and prominent for the next 30 years.

The FASTC today has its roots in five earlier committees that began in the 1930's and later. These committees were led by distinguished engineers and academicians, and were influential in their time. Also as seen in Figure 16, others underwent permutations and name changes. Still others were formed and later phased out. These developments can be traced by studying the **ASME Society Records, 1927 through 1978 [12]**. The ***FED Newsletters***, which have been published annually in the spring since the first one appeared in 1963 under the editorship of Dr. Robert C. Dean, have carried the record forward to the present. The respective histories of these groups are described in the following paragraphs.

a. Fluid Applications and Systems Technical Committee (FASTC).

As discussed in the previous section on *FED Restructuring*, the FASTC was formed in 1990 from the *Fluid Transients* (FTC) and *Fluid Machinery* (FMaC) Committees and the applied portion of the material handled by the former *Fluid Mechanics Committee*. In turn the FMaC had been formed in 1968 as a combination of the *Hydraulic Prime Movers, Pumping Machinery*, and *Compressors Committees*. The details of these progenitors of the FASTC are next described.

i. Waterhammer/Fluid Transients Committee

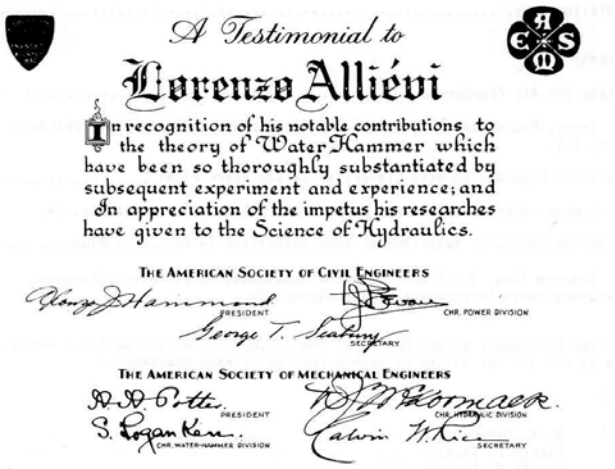
Founded in 1931, this was the first technical committee formed by the *Hydraulic Division*– then just four years old. In those days such committees reported to the Executive Committee, (just as the technical committees do today,) but each was simply called a "committee" (or "subcommittee"). According to the ASME Society Records, they all became "subcommittees" in 1957; however, in 1964 they are listed as "committees" again**.** Finally in 1972, they all officially incorporated "technical committee" in each name, [**12].**

Starting out as the Waterhammer Committee, the name was changed in 1965 to the more general *Fluid Transients Committee*. Committee member and Chair (1980-82), Dave Wiggert, described this committee and its activities as follows **[13]**:

The Society has been active in promoting research and disseminating information related to waterhammer and fluid transients beginning in 1931, when a Standing Committee on Waterhammer was formed. The first Symposium on Water Hammer, jointly sponsored with the American Society of Civil Engineers Power Division was held in 1933, and in 1935 the Waterhammer Committee was officially recognized by the Hydraulic Division.

S. Logan Kerr was the first chairman, and remained in that position until 1956; additional members of the original committee were Messrs. Gibson (Figure 5 and member 1935-53), Strowger, Halmos, Moody (Figure 4 and member 1935-53), and Quick. As mentioned by Kerr in the introduction to the Symposium, efforts of the committee included compiling and translating literature from Europe, reviewing waterhammer theory, and analyzing available experimental data to confirm the various theories and formulas. At the Symposium a testimonial was presented to Lorenzo Allievi in recognition of his contributions to the theory of water hammer, see Figure 17. It is noteworthy to mention that two reprints of the Symposium were made in 1949 and 1961. A second symposium was held in 1937.

In the 1930's, the graphical method of waterhammer analysis was developed in Europe and elsewhere by Schnyder, Bergeron, Angus, and others. ASME sponsored the translation of the treatise by Bergeron titled "Water Hammer in Hydraulics and Wave Surges in Electricity," which elegantly described the graphical method and was published in 1961 by John Wiley and Sons, Inc. In 1965, a third symposium, entitled "Waterhammer in Pumped Storage Projects" was presented. This may be one of the earliest publications to mention the use of digital computation for the analysis of waterhammer. In the same year, with V.L. Streeter as Chairman, the name of the Committee was changed to Fluid Transients Committee (FTC); this was done in part to encompass the diverse interests of the committee members and participants which included topics such as biological, two-dimensional, and two-phase flows; flows in aircraft hydraulic systems, power plant piping, oil pipelines, among others.


A Testimonial to

Lorenzo Allievi

In recognition of his notable contributions to the theory of Water Hammer which have been so thoroughly substantiated by subsequent experiment and experience; and In appreciation of the impetus his researches have given to the Science of Hydraulics.

THE AMERICAN SOCIETY OF CIVIL ENGINEERS

PRESIDENT

CHR. POWER DIVISION

SECRETARY

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

PRESIDENT

CHR. WATER-HAMMER DIVISION

CHR. HYDRAULIC DIVISION

SECRETARY

Figure 17 Testimonial presented to L. Allievi, 1933.

A revitalization of the Committee took place in the 1970's; in addition to traditional waterhammer, its scope was expanded to include unsteady flow, fluid-structure interaction, and vibrations. The impetus for change resulted from a task force study spearheaded by P. Rothe and C. S. Martin beginning in 1975. Recommendations included a broadening of fluid transients topics, outreach to interested industrial practitioners, and an increase in the offering of symposia. A significant number of symposia and forums were sponsored by the Fluid Transients Committee between 1970 and 1990. These are found in the following section on *Conferences, Symposia and Forums*.

Past Chairmen of the *Waterhammer/Fluid Transients Committee* are given in Table 8. The fluid transients component of the *Fluid Applications and Systems Committee* has continued to remain active inasmuch as the discipline continues to evolve, new applications interestingly appear, and practitioners around the world look to ASME to provide leadership in offering venues for disseminating state-of-the-art information.

Table 8 Waterhammer/Fluid Transients Committee Chairs.

Year	Chair
1932-57	S. Logan Kerr
1957-59	Ray S. Quick
1959-62	C. G. Smallridge
1962-64	John T. Kephart
1964-66	Victor L. Streeter
1966-68	W. L. Gibson
1968-70	Benjamin Donsky
1970-72	E. Benjamin Wylie
1972-74	Frank G. DeFazio
1974-76	C. Samuel Martin
1976-78	Michael E. Stoner
1978-80	Constantine N. Papadakis
1980-82	David C. Wiggert
1982-84	Paul H. Rothe
1984-86	Franklin Dodge
1986-88	Hemmat H. Safwat
1988-90	Jack Braun

ii. Fluid Machinery Committee

Although the *Waterhammer/Fluid Transients Committee* was formed officially in 1935, the other major committees of the *Hydraulic Division* were formed in 1937-8; and, as we have seen with the FTC, remained strong contributors to the Division's program up to the 1990 restructuring and beyond. This certainly can be said of the FMaC and its three predecessor committees, namely 1) *Hydraulic Prime Movers*, 2) *Pumping Machinery* – both formed in 1938 – and 3) *Compressors* (1950), all of which were folded into the FMaC in 1968.

1) The *Hydraulic Prime Movers Committee* (HPMC) was chaired by J. Frank Roberts for its first ten years (from 1938). The ASME Records list 10 more chairs up through 1967. For some years they list the members of the committees, the HPMC having had as many as 19 members (1958). Large hydraulic turbines were a major emphasis of the HPMC, and it was in these years that the country saw so much of the development of its hydropower infrastructure.

2) The *Pumping Machinery Committee* (PMC) was chaired by Robert L. Daugherty (Figure 18) for its first ten years, and had various sponsors during that time and always B. F. Tillson and Hans Ulmann as members. When Robert Folsom became the chair in 1948, A. Hollander and A. J. Stepanoff and some others became members for the first time. The committee soon grew to include others, notably George Wislicenus, with 10 members in 1952, when James W. Daily (Figure 19) was Chair. Membership reached 20 in 1959. The PMC and the FTC were perhaps the most important continuing influences within the newly formed Fluid Machinery Committee (1968). It is therefore appropriate at this point to list in Table 9 the chairs of the *Pumping Machinery/Fluid Machinery Committee* from its founding in 1938 until it became part of the FASTC in 1990. This list is a roll call of academicians and engineers who were involved with some of the most important pumps and pump research and technology of their day, such as Prof's. Daugherty, Daily, and Kittredge; and engineers Lewis Kessler, Fred Antunes, Alexander Agostinelli, and Sankaraiyer Gopalakrishnan.

Figure 18 Robert L. Daugherty, *Pumping Machinery Committee* chair, 1938-47.

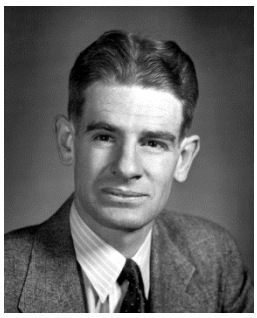


Figure 19 J. W. Daily, *Pumping Machinery Committee* Chair, 1952-3.

Table 9. *Pumping Machinery/ Fluid Machinery Committee* Chairs.

Year	Chair	Prof. Affiliation
1938-48	Robert L. Daugherty	Academia
1948-50	Robert G. Folsom	Academia
1950-52	R. M. Watson	
1952-53	James W. Daily	Academic
1953-55	G. F. Habach	
1955-57	W. C. Osborne	Industry
1957-59	C. P. Kittredge	Academic
1959-61	H. Gartmann	Industry
1961-63	Lewis H. Kessler	Industry
1963-65	Austin H. Church	Academic
1965-67	G. M. Wood	Industry
1967-68	Alexander Agostinelli	Industry
1968-70	J. S. Kurlev	Industry
1970-72	Wilbur A. Spraker	Industry
1972-74	Fred F. Antunes	Industry
1974-76	Charles W. Grennan	Industry
1976-78	P. W. Runstadler, Jr.	Industry
1978-80	Paul Cooper	Industry
1980-82	Walter Swift	Industry
1982-84	Donald R. Webb	Industry
1984-86	S. Gopalakrishnan	Industry
1986-88	Warren F. Wade	Industry
1988-90	John Tuzson	Industry

In later years, the membership and participation in the work of these committees grew to encompass large lists of engineers and academicians in the particular areas addressed.

For example, in 1973, the *Fluid Machinery Committee* consisted of 100 active members and 67 associate members.

3) The *Compressors Committee* was first chaired in 1950 by A. M. G. Moody for three years, successive chairs serving for two years each as seen in Table 10.

Table 10. *Compressors Committee* Chairs

Year	Chair
1950-52	A. M. G. Moody
1952-53	R. M. Johnson
1953-54	Hunt Davis
1954-56	L. W. Bryant
1956-57	E. Schmactenberg
1957-59	Joseph T. Hamrick
1959-61	R. A. Riester
1961-62	H. J. Welch
1962-63	C. Fred Koenig
1963-64	Arden T. Miller
1964-66	G. K. Serovy
1966-68	D. C. Archer

Government and academic researchers such as Joseph Hamrick and George Serovy were among those who served as chairs, and the committee had vice chairs who were responsible for centrifugal, turbomachinery and reciprocating compressors. This committee appears to have been spun off from the *Pumping Machinery Committee*, as the ASME records show several pump engineers such as Stepanoff, Gilman, Church, Folsom and Gartman as members of this *Compressors Committee* (CC) as well as the PMC. However the CC took on a life of its own and reached a membership of 19 in 1958, which is similar to the numbers reported for the HPMC and the PMC.

4) Another, albeit short-lived committee that appears to have been spun off from the PMC – and could therefore be associated with the committees that were eventually folded into the *Fluid Machinery Committee* – was the *Positive Displacement Hydraulic Machinery Committee*, which was formed in 1948 and chaired by W. E. Wilson for three years and had the same 11 members listed for those years, ending in 1950.

5) Another short-lived committee that could be regarded as being under the *Fluid Machinery* umbrella was the *Fluid Power Systems Subcommittee*, which was formed in 1957 and chaired by O. S. Carliss for five years through 1961. It had seven members, including Hemeon, Laird, Messaros and Vaugn.

6) Next, even though fluidics is probably not a fluid-machinery-related subject, we should mention at this point the one remaining relatively short-lived committee shown in Figure 16, namely the *Fluidics Committee*. This committee was formed in 1967 with Forbes Brown as Chair, and it was organized jointly by the FED and the *Automatic Controls Division*. It had a series of chairs that ended with Milton Franke in the 1976, after which the committee was transferred over totally to the *Automatic Controls Division*.

As found in the following section for all the committees, many symposia and forums were sponsored by the *Fluid Machinery Committee*. Those that were repeated periodically

continued to be sponsored by the FASTC after 1990.

Of particular interest to many colleagues who appreciated his leadership in the FED and especially the fluid machinery field within the FASTC, a technical session honoring Sankaraiyer Gopalakrishnan (Figure 20), who had passed away the previous September, was held at the FEDSM-2006 in Miami, FL. **[14].** His genius in fulfilling the ASME mission of the advancement and interchange of technology via projects within his own industry and involving academia and the ASME was chronicled at this session **[15]**, and the first recipient of the Sankaraiyer Gopalakrishnan Flowserve Pump Technology Award was honored at the close of that memorial session in Miami.

Figure 20 S. Gopalakrishnan. Fluid Machinery Committee: Chair 1984-6, member 1978-2005 (FASTC).FED Executive Committee: Chair, 2004-5.

The list of chairs who served from the formation of FASTC in 1990 to date is seen in Table 11.

Table 11. Fluid Applications and Systems Technical Committee (FASTC) Chairs.

Year	Chair	Professional Affiliation
1990-92	Steven Zakem	Industry
1992-94	Thomas B. Morrow	Industry
1994-96	Robert Tsai	Industry
1996-98	Donald F. Elger	Industry
1998-00	Ali Ogut	Academia
2000-02	Adiel Guinzburg	Industry
2002-04	Awatef Hamed	Academia
2004-06	Jinkook Lee	Industry
2006-08	Yu-Tai Lee	Government
2008-10	S. A. Sherif	Academia
2010-12	Keith Walters	Academia
2012-14	Wayne Strasser	Industry
2014-16	Judith Bamberger	Government

(See the listings in the following section on Conferences, Symposia and Forums for all symposia and forums sponsored by all the committees and the section after that on FED Honors and Awards for a presentation of all the FED-related ASME awards and awardees.)

b. Fluid Mechanics Technical Committee

Before moving into the history of the Fluid Mechanics Technical Committee (FMTC), it must be remembered that in 1990 the applied portion of the material handled by this committee was spun off into the FASTC as described in the previous section on *FED Restructuring*. The materials transferred at that time are found under Item 3 of Table 5, wherein Bajura lists the subjects covered under the program area called *Industrial and Environmental Applications.* (*Positive Displacement Compressors, Pumps, and Motors* – the first subject listed – has been added to what otherwise are the "applied" fluid mechanics subjects taken under FASTC cognizance.) Table 6 shows the basic fluid mechanics program areas that were retained by the FMTC and so effectively have remained under its cognizance down to the present.

That said, the FMTC has a long and venerable history, effectively harking back to 1938, when Murrough O'Brien (Figure 21) and others saw the need for research into and understanding of the fluid dynamical principles involved in the hydraulic machinery, installations, etc., that were being developed at the time. Accordingly they formed the *Committee on General Hydraulics*, with O'Brien as Chair. The committee carried on for three years, its concerns apparently having been absorbed into the other committees after 1940, when is ceased to exist.

Figure 21 M.P. O'Brien, Chair of the Committee on General Hydraulics, 1938-1940.

However, it could be argued that Murrough O'Brien had established the precedent for a separate committee dedicated to fluid mechanics. This may have been a factor in the process that led to the establishment in 1957 of the Fluid Mechanics Committee under the Chairmanship of Robert C. Dean (Figure 10). What is indisputable is that Bob Dean was passionate about the many applications and possibilities for applying the science of fluid mechanics that were arising, knowing that progress in this area also required advancement in the science itself. His vision was for the Hydraulic Division to meet this challenge in three ways, the first of which was to establish a dedicated and focused Fluid Mechanics Committee within the division. This inevitably led to the second way, which was to change name of the division in 1963. And finally, in 1973, he would create and become the first editor of the new *Journal of Fluids Engineering*(JFE) – a part of the *Transactions of the ASME*. The Fluid Mechanics Committee was therefore an essential element in the total transformation that Dean brought about by driving this rebirth of the Division to serve the evolving fluids engineering reality that he saw so clearly.

While the Fluid Mechanics Technical Committee (FMTC) started by addressing both the applied and basic subject areas of fluid mechanics as seen in Tables 5 and 6, over the years that followed, it had taken on so much in so many subject areas – namely the basic ones of Table 6 and many of applied areas of Table 5 – that the latter had to be spun off into the FASTC in the 1990 restructuring to maintain a balance in the technical committee structure in order to aid the progress and growth of the FED.

The many symposia and forums sponsored by the FMTC are found in the following section on *Conferences, Symposia and Forums*. The chairs of the committee are listed in Table 12.

Table 12. Fluid Mechanics Committee (FMTC) Chairs

Year	Chair	Prof'l Affiliation
1957-58	Robert C. Dean	Industry
1958-60	Stephen J. Kline	Academia
1960-62	Jackson E. Fowler	Industry
1962-64	James P. Johnston	Academia
1964-66	Helmut E. Weber	Academia
1966-68	George Rudinger	Industry
1968-70	N. J. Lipstein	Industry
1970-72	Jules Dussourd	Industry
1972-74	Victor W Goldschmidt	Academia
1974-76	William B. Swim	Academia
1976-78	Robert P. Lohmann	Academia
1978-80	Charles Dalton	Academia

1980-82	Frank Peterson	Government
1982-84	J. Parker Lamb, Jr.	Academia
1984-86	Thomas Morel	Industry
1986-88	Richard A. Bajura	Academia
1988-90	Philip Pfund	Industry
1990-92	Hugh W. Coleman	Academia
1992-94	Chester J. Blechinger	Industry
1994-96	Craig Dutton	Academia
1996-98	Marty Morris	Industry
1998-00	M. Volkan Otugen	Academia
2000-02	Ganesh Raman	Academia
2002-04	George Papadopoulos	Industry
2004-06	David Davis	Government
2006-08	Khaled Hammad	Industry
2008-10	Francine Battaglia	Academia
2010-12	Javid Bayendor	Academia
2012-14	Kamran Siddiqui	Academia
2014-16	David Davis	Government

c. Multiphase Flow Technical Committee (MFTC)

Active for over half a century as an MFTC Committee Member and Chair (1972-74), William B. (Bill) Morgan (Figure 22) has provided the following detail about this venerable FED technical committee **[16, 17]**.

The founding of the Cavitation Committee came out of sessions devoted to cavitation at the 1935 ASME annual meeting. Mechanical Engineering, November 1935, Vol. 57 included the following information under the Hydraulic Division's report: "At the 1935 annual meeting, two sessions will be devoted to the study of Cavitation and have been arranged in cooperation with the Power Division of the ASCE and the Applied Mechanics Division of the ASME" The two cavitation papers which were presented at the 1935 ASME annual meeting were: "Cavitation Testing of Model Hydraulic Turbines and Its Bearing on Design and Operation" by L. M. Davis and "Cavitation Testing Propeller Pumps" by A. Tenor.

Figure 22 William B Morgan, prominent member and Chair (1972-74) of the MFTC.

Mechanical Engineering, (1937), reported the following: "On June 25 and 26, 1937, there was a joint meeting of the Applied Mechanics and Hydraulic Divisions in Ithaca, New York. On Saturday morning, there was a discussion on the pitting resistance of metal under cavitation conditions and the relative resistance to cavitation erosion by the vibratory method. Saturday afternoon was devoted to a round-table conference by the Hydraulic Division on present status of cavitation research in the United States and Canada. It was an unusual privilege to have representatives from all the groups now engaged in cavitation research present to discuss this problem and to report upon their work and the programs contemplated for the future. The following research investigations were reported upon: Pennsylvania Water & Power Corporation, Massachusetts Institute of Technology, Princeton University, University of Toronto, Shawinigan Water & Power Corporation, Canada, and U. S. Naval Propeller Testing Laboratory. Following the discussion of the research program, the meeting was thrown

open to discussion on the definition of cavitation action, and it was generally agreed that a sharp distinction should be drawn between cavitation itself and the pitting or erosive action resulting from cavitation. A subcommittee of the main Cavitation Committee is to be appointed to prepare a definition, which would be recommended, for general use. Subcommittees are also being organized to prepare recommended methods for determining the relative resistance of materials to pitting under cavitation conditions and also for the recommended methods by which the characteristics of turbines, pumps, and propellers can be established under cavitation conditions."

From this information, one can conclude that the Cavitation Committee of the Hydraulic Division was formed in 1937. The **ASME Society Records, 1927 through 1978 [12]**, Part 1, lists for 1937 the following under the Hydraulic Division: Committee on Cavitation, C. F. Merriam, Sponsor (Chairman to be appointed). The ASME Society Records list the following as in office 1 January 1938: Committee on Cavitation, C. F. Merriam, Sponsor and Lewis F. Moody, Chairman (Figure 4). Moody served as Chairman through 1947. R. T. Knapp (Figure 9) became Chairman and Sponsor in 1948 but by 1950, the position of Sponsor had been dropped. Sponsors during the term of L. F. Moody as Chairman were: 1938 - C. F. Merriam; 1939 - 1943, E. B. Strowger; and 1944 - 1947, R. E. B. Sharp. The role of Sponsor versus Chairman is unclear from the records. Full Cavitation Committee membership was first listed in the Society records in 1941. Besides the Chairman and Sponsor, the following were listed as committee members: R. T. Knapp (Figure 9), J. M. Mousson, W. J. Rheingans, and George F. Wislicenus (Figure 14). There was no change in committee membership, except for sponsors, up through 1947. The ASME Society Records 1948 lists the committee members as R. T. Knapp, Chairman, J. W. Daily, C. H. Hancock, W. B. Hess, W. J. Rheingans, Hunter Rouse (ASCE), R. E. B. Sharp, R. O. Standing, Hans Ulmann, and George F. Wislicenus. In 1959, the committee members were: J. W. Daily (Chairman), C. F. Cheng, W. B. Hess, J. Z. Lichtman, J. Parmakian, K. Pilarczyk, W. J. Rheingans, B. G. Rightmire, L.E. Robinson, Jr., R. S. Sproule, W. W. Weltmer, W. G. Whippen and G. F. Wislicenus. In 1960, the listing of committee members was dropped from the Society records. Chairs of the Committee are listed in Table 13.

The Cavitation Committee has held very few meetings by itself. In 1938, the Cavitation Committee held a meeting in Lancaster and Safe Harbor, PA, with an attendance of fifty. Also, the Cavitation Committee sponsored a Cavitation Seminar on November 11-13, 1955 in Milwaukee at the Allis-Chalmers Mfg. Co. The first annual Hydraulic Division National Conference was held in April 1959 at the University of Michigan. This has become the annual Summer Conference of the Fluids Engineering Division which negated any need for sole meetings of the Cavitation Committee.

Table 13. Multiphase Flow Technical Committee (MFTC) Chairs.

Years	Chair	Professional Affiliation
1937-38	C. F. Merriam	Industry
1938-48	L. F. Moody	Academia
1948-57	R. T. Knapp	Academia
1957-58	W. J. Rheingans	Industry
1958-60	J. W. Daily	Academia
1960-62	G. F. Wislicenus	Academia
1962-64	J. W. Holl	Academia
1964-66	M. S. Plesset	Academia
1966-68	F. G. Hammitt	Academia
1968-70	J. M. Robertson	Academia
1970-72	R. Hickling	Academia
1972-74	W. B. Morgan	Government
1974-76	B. R. Parkin	Academia
1976-78	C. E. Brennen	Academia
1978-80	R. E. A. Arndt	Academia
1980-82	F. G. Hammitt	Academia
1982-84	M. L. Billet	Academia
1984-86	C. T. Crowe	Academia
1986-88	J. W. Hoyt	Academia
1988-90	D. E. Stock	Academia
1990-92	J. H. Kim	Industry
1992-94	M. C. Roco	Government
1994-96	U. S. Rohatgi	Government
1996-98	E. Michaelides	Academia
1998-2000	A. Prosperetti	Academia
2000-02	S. L. Ceccio	Academia
2002-04	G. Tryggvason	Academia
2004-06	S. Balachandar	Academia
2006-08	D. E. Nikitopoulos	Academia
2008-10	M. J. Andrews	Government
2010-12	M. R. Duignan	Government
2012-14	T. J. O'Hern	Government
2014-16	D. V. Pence	Academia

In the April 1970 Newsletter, a proposed name change for the Cavitation Committee was suggested. "The Cavitation Committee is considering changing its name to reflect a broader coverage than that indicated by the word cavitation. Two suggestions under consideration are the 'Poly-Phase Flow' or 'Multi-Phase Flow' Committee. Some prefer Poly-Phase since both words are of Greek origin whereas Multi is a word of Latin origin. Dr. Milton Plesset, former chairman of the Committee and a current member of the Executive Committee, is acting as 'referee' on this question." At the Winter Annual Meeting in December 1970, the Polyphase Flow Committee (PFC) officially came into being. The new technical committee extends the scope of the former Cavitation Committee to the general area of polyphase flow, partly to offset a decline in activity in the field of cavitation and partly to emphasize new areas.

In 1980, the FED Executive Committee formulated a Task Force consisting of Dick Bajura, Clayton Crowe, and Kumar Rohatgi to review the past activity in the PFC and make recommendations concerning future

organizational changes and programs which would broaden both the scope and membership of the Committee. This Task Force reported out in 1982 and recommended a name change to the Multiphase Flow Technical Committee and that the Committee should consider the constituent technologies of the various combined flows of liquids, gases, and solids. Thus, the name was changed to the Multiphase Flow Technical Committee in line with the current usage of term "multiphase." The MFTC held special sessions to celebrate its 75th anniversary at the 2012 FEDSM in Rio Grande, Puerto Rico.

The Committee has sponsored many symposia and forums over the years. Three of these have been large, ongoing symposia at FEDSM's since 1990. (See the following section on *Conferences, Symposia and Forums*.)

d. Fluid Measurements and Instrumentation Coordinating Group/Technical Committee (FMITC). At FEDSM 2002 it was announced that the Coordinating Groups, founded in 1990, were as of that meeting Technical Committees. The idea behind the coordinating groups was that they would represent their technologies (fluid measurements and CFD) across the research and application space of the existing Technical Committees. However, the Coordinating Groups had evolved to operate as full-fledged Technical Committees (organizing sessions, reporting to the FEDEC, etc.). The Coordinating Group on Computational Fluid Dynamics (CGCFD) became the Computational Fluid Dynamics Technical Committee (CFDTC) and the Coordinating Group on Fluid Measurements (CGFM) became the Fluid Measurements and Instrumentation Technical Committee (FMITC). In addition, the Coordinating Group on Industry Technology was converted to an advisory committee called the Industry Technology Committee (not a TC). The FMITC organizes annual sessions on Fluid Measurements and Instrumentation at both IMECE and FEDSM conferences

e. Computational Fluid Dynamics Coordinating Group/Technical Committee (CFDTC).

Similar to the FMITC, the CFDTC became a TC in 2002. Since then, it has organized sessions on topics including Applications of CFD, CFD Verification and Validation, Development and Applications of Immersed Boundary Methods, DNS, LES, and Hybrid RANS/LES Methods, and Algorithm Development in CFD.

f. Micro and Nano Fluid Dynamics Technical Committee (MNFDTC). At the 2001 IMECE a proposal to form the Micro and Nano Fluid Dynamics Technical Committee (MNFDTC) was approved by the FEDEC. This technical committee was formed in response to the significant international interest and high level of activity in both basic and applied micro and nano fluid dynamics. Earlier FED efforts in this area were supported by the FMTC, from which the first symposium on this topic was organized by Promode R. Bandyopadhyay (Application of Microfabrication to Fluid Mechanics, IMECE 1994). Since then there were a series of symposia at the IMECE in 1996 and 1998, then starting in 1999 these became annual events. The scope of the MNFDTC was to coordinate, primarily at IMECE but also at FEDSM, strong participation between numerous divisions within the ASME to organize sessions devoted to all aspects of microelectromechanical systems (MEMS). The first chair of the MNFDTC was Fred K. Forster and its initial meeting was held at FEDSM 2002 in Montreal. The MNFDTC has organized sessions on Fluids Engineering in Micro and Nano systems at IMECE conferences since then.

Conferences, Symposia, & Forums

The first Hydraulic/FED Division conference apart from the Winter Annual Meeting (now IMECE) was held in 1961. At first, these conferences consisted of the presentation of individual papers, arranged in topical sessions. It was soon recognized that the several specific topic areas represented in these papers would command a larger audience if the conferences could introduce one or more symposia of multiple sessions, each symposium consisting of papers on a topic for which the symposium is named, its sessions respectively addressing subtopics. Soon was added the concept of doing this in one or more forums for shorter, often reflecting ongoing research papers. Over the years, symposia and forums became the primary vehicle for the presentation of technical papers at these FED conferences. Because they happened in the summer – so as to supplement a similar presentation format that developed for the multi-divisional "winter" meetings – these conferences came to be known as Fluids Engineering Division Summer Meetings (FEDSM). Eventually they became the primary conferences for FED symposia and forums.

a. Conferences with Other Divisions and Societies

On several occasions these FED conferences were held jointly with those of other divisions of ASME's Basic Engineering Group. These have included the Applied Mechanics (1965, '69, '73, '77, '83, '85, '87), AIAA (1982, '86), Gas Turbine ('60, '72, '76, '80), and other Divisions. The FEDSM's are currently held as joint conferences with other organizations on a rotating 4-year cycle, with the Heat Transfer Division (2016), the European Fluid Mechanics societies (2018), and the JSME/KSME as the Joint Fluids Engineering Conference (2019).

b. Lists of Symposia and Forums Sponsored by the Fluids Engineering Division

Virtually every symposium and forum conducted at a conference has originated with one or more of the FED technical committees, which have been the initial sponsors, organizers, and producers of these events. Each has been approved by the FED Executive Committee, so that in effect the FED has been the overarching sponsor of every symposium and forum. In the following paragraphs, the involvement of most of the individual technical committees in this sponsorship process is described. In most instances, however, lists of symposia and forums sponsored respectively by these committees are not presented in this FED history document.

Nevertheless, FED historical researchers have compiled lists of all these events by conference without reference to the technical committees responsible for them. Past Chair of the Fluid Mechanics Committee, Richard A. Bajura, compiled a list of all FED symposia and forums held from 1962 to 1986 **[18]**. A similar list covers most of the years between 1933 and 1995 and was compiled by C. Samuel Martin– with a few additions up to the present by P. Cooper **[19]**. (The additions are of the Pumping Machinery symposia to date described under the FASTC below.) This last list must be updated for the years 1996 to date and in that regard should be viewed as a work in progress

c. Symposia & Forums Sponsored by Committees

FED technical committees have sponsored symposia at FEDSM's and IMECE's – either individually or in cooperation with other FED

technical committees. Some of these are described and/or listed as follows.

1) Fluid Transients/FASTC. Symposia and forums in the subject area of fluid transients were sponsored by the Fluid Transients Committee and – after the 1990 restructuring – by the Fluid Applications and Systems Technical Committee (FASTC). A significant number of symposia and forums were sponsored by the Fluid Transients Committee between 1970 and 1990 including topics like fluid transients and structural interaction, power plant transients, multi-dimensional transients and multiphase fluid transients. It was during this period that F. Moody and F. Dodge organized the Symposium on Fluid Transients and Fluid-Structure Interaction, which was held with the PVP Division from 1985 to 1987, and P. Rothe and D. Wiggert ran the Forum on Unsteady Flow from 1984 to 1990.

With the restructuring in 1990 the fluid transient subject areas were absorbed into the FASTC and resulted in a refocusing on internal fluids, with external unsteady flow, fluid vibrations, and acoustics continuing to be addressed independently. Nevertheless, the offerings of symposia and forums were meaningful and well received, see Table 14 (found following Table 15 in this document). Significant among them were the three Forums on Fluid Transients between 1996 and 2003 and the highly successful International Symposium on Water Hammer, organized by J. Liou and held jointly with the Japan Society of Mechanical Engineers in 1999 and 2003. The latter was truly an international event with many participants from Asia and Europe in attendance.

2) Fluid Machinery/FASTC. As with fluid transients, the Fluid Machinery Committee – and its earlier predecessors (Pumping Machinery, Hydraulic Prime Movers, and Compressors Committees) sponsored many symposia and forums, and after 1990 the fluid machinery subject area was well represented among the many FASTC symposia and forums. Many of these that were repeated periodically were carried forward into sponsorship by the FASTC after 1990. A prominent example is the *International Symposium on Pumping Machinery* **[20]** started in 1984 and held quadrennially at FED summer meetings since that time, the interval in a recent case being biennial. This symposium addresses both the theory and applications of all categories and sizes of rotodynamic and positive displacement pumps, attracting global participation with typically ten and as many as a dozen sessions in a given conference, including the two most recent Joint ASME-JSME-KSME (AJK) Fluids Engineering Summer Conferences (Hamamatsu 2011 and Seoul 2015).

3) Cavitation/Polyphase Flow/Multiphase Flow Technical Committee (MFTC). The MFTC has sponsored many symposia and forums over the years. The forum, which has been most consistent in yearly meetings, has been the Cavitation Forum, which started in 1966. Traditionally, this forum has been held at the Summer meeting of FED. The name has changed over the years: 1966-1971, Cavitation Forum; 1972, Polyphase Forum; 1973-1982, Cavitation and Polyphase Forum; and, since 1983, Cavitation and Multiphase Flow Forum. The organizers/editors of the Forum over the years are listed in Table 15. In 1985, the organizers/editors, Jack Hoyt and Okie Furuya, wrote a history of this forum for its 20th

anniversary **[21]**. The 50th session of this Forum was held at the AJK2015 meeting.

One symposium which has continued over the years has been the International Symposium on Cavitation Inception. This symposium started out as the Symposium on Cavitation Inception but quickly became an international symposium because of the large international participation. The subject matter of the papers of the symposium has ranged from the fundamental aspects of cavitation inception to practical prediction of cavitation inception. Since this is such a narrow topic, a decision was made to hold the symposia only every four or five years or so. The symposia have been held in 1979, 1984, 1989, 1993, 1999, 2003, 2007, and 2013. The last two have been at the joint ASME/JSME meetings. The organizers for the first three symposia were W. B. Morgan and Blaine L. Parkin. M. L. Billet and W. B. Morgan organized the fourth symposium and M. L. Billet, H. Kato (of JSME) and W. B. Morgan have organized the last two symposia.

Table 15 Organizers/Editors of the Cavitation/ Polyphase/Multiphase Flow Forum

1966-67	F. G. Hammitt
1968	J. M. Robertson
1969	F. G. Hammitt
1970	A. G. Grindell
1971-79	R. L. Waid
1980-84	J. W. Hoyt
1985	J. W. Hoyt and O. Furuya
1986-93	O. Furuya
1994	O. Furuya and J. Katz
1995	J. Katz and Y. Matsumoto
1996-2001	J. Katz and K. Farrell
Since 2002	W. A. Straka et al

4) Fluid Measurements and CFD Coordinating Groups/Technical Committees and the Micro & Nano Fluid Dynamics Technical Committee (MNFDTC). (See the descriptions of these committees in the section on *FED Honors and Awards*.)

Table 14. Symposia and forums sponsored by the Waterhammer/Fluid Transients /Fluid Applications and Systems Technical Committee

Year	Name	Co-sponsor
1933	Symposium on Water Hammer	ASCE Power Division
1937	2nd Symposium on Water Hammer	
1965	Waterhammer in Pumped Storage Projects	
1971	State-of-the-Art Fluid Transients	
1978	Fluid Transients and Acoustics in the Power Industry	
1981	Fluid Transients and Structural Interaction in Piping Systems	
1982	Numerical Methods for Fluid Transient Analysis	
1984	Unsteady Turbulent Boundary Layers and Friction	
1984	Forum on Unsteady Flow	
1984	Multi-Dimensional Fluid Transients	
1985	Unsteady Flows in Biological Systems	ASME Bioengineering Div
1985	Industrial Forum on Fluid Transients	
1985	Fluid Transients and Fluid-Structure Interaction	
1986	Forum on Unsteady Flow	
1986	Measuring and Metering of Unsteady Flows	
1986	1st International Multiphase Fluid Transients	FED Multiphase Flow Comm.
1987	Fluid Transients and Fluid-Structure Interaction	
1987	Forum on Unsteady Flow	
1988	1st International Symposium on Power Plant Transients	FED Multiphase Flow and Fluid Machinery Comm.
1988	Forum on Unsteady Flow	
1989	Forum on Unsteady Flow	
1989	Fluid Transients in Fluid-Structure Interaction	
1989	2nd International Multiphase Fluid Transients	
1990	Forum on Unsteady Flow	ASME PVP Div.
1990	Forum on Fluid Transients	
1990	Power Plant Transients	
1991	Measuring and Metering of Unsteady Flows	
1991	Fluid Transients and Fluid-Structure Interaction	
1992	Power Plant Transients	
1994	Fluid Transients	ASME PVP Div.
1995	International Symposium on Validation of Systems Transient Analysis Codes	
1996	Forum on Fluid Transients	ASME PVP Div.
1999	International Symposium on Validation of Systems Transient Analysis Codes	
1999	International Symposium on Water Hammer	JSME
2001	Forum on Fluid Transients	ASME PVP Div.
2003	International Symposium on Water Hammer	JSME
2003	Forum on Fluid Transients	ASME PVP Div.

Journal of Fluids Engineering

This section; provided by Dr. Frank M. White, (Figure 23,) Editor of the JFE from 1979 to 1990; also appeared as a JFE article **[22]**.

When the American Society of Mechanical Engineers was founded in 1880, the subject of fluids engineering was fractured and awkward. The existing theories were primarily for inviscid fluids and were rarely realistic. Engineers rejected these results and relied entirely upon a variety of experiments, most of which were simply reported in pounds, feet, and seconds. There were no correlating principles.

Figure 23 Frank White, Professor Emeritus, Univ. of RI, Editor of the JFE 1979-90.

In the early 1900's, workers such as Prandtl, Rayleigh, and Reynolds combined theory and experiment into a single discipline, fluid mechanics. In the ensuing century, mechanical engineers have developed the practical and design aspects of fluid flow into a very successful discipline.

For its first 50 years, all ASME research papers were published in a single inclusive publication, the *ASME Transactions*. There were a dozen divisions, but only one journal, although conferences allowed for paper groupings. It was human nature, still active today, for ASME divisions to request their own specialized journals. Currently there are 30 different journals published by the Society. The first non-Transactions periodical for fluids engineers was the *Journal of Applied Mechanics*, which began in 1933. Although primarily devoted to theory, the early JAM published some practical fluids engineering papers, such as flow measurement, duct flow, fluid transients, pumps and turbines. Many such papers of course also appeared in the Transactions.

In 1959, the science-oriented divisions began two new publications, the *Journal of Basic Engineering*, which carried fluids papers, and the *Journal of Heat Transfer* **[23]**. Research in fluid dynamics had expanded beyond traditional hydraulics, and in 1963 the Society changed the old Hydraulics name to the Fluids Engineering Division. Workers such as Robert Dean, Stephen Kline, and George Wislicenus urged the formation of a specialized journal. Finally, in 1973, the Society authorized a new publication, the *Journal of Fluids Engineering*, with Robert Dean as Technical Editor. The first issue was in March 1973.

The choice of Bob Dean as first editor was inspired. He had leadership, wide-ranging knowledge of fluids engineering, and great organizational ability. He assembled an outstanding board of Associate Editors and a rigorous review process. He demanded conciseness and relevance in all submitted papers. His Executive Secretary, Marguerite Blaney, began a detailed log of all papers and set up an efficient system for the entire review process. The journal, under Dean's leadership, quickly took hold and immediately became an important publication on engineering aspects of fluid flow.

Bob Dean was an experimentalist and fully aware that data are not correct to six significant figures. In 1975 he announced a requirement for uncertainty in experimental data that all authors must report in their papers. This was followed in 1986 by a policy, formulated by Associate Editors Patrick Roache and Urmila Ghia, for reporting uncertainty of numerical accuracy in computer solutions. These policies,

still in effect today, are believed to be the first such requirements in any engineering journal.

The emphasis of the JFE has changed with progress in fluids engineering research. The first issue, March 1973, was divided into five areas: Fluid Transients, Fluid Machinery, Fluid Mechanics, Fluidics, and Polyphase Flow. By 1981, Fluidics had vanished, to be replaced by Fluid Measurements, handled by Bob Dean himself. The journal has always published highly regarded review articles. By 1987, associate editors were added for Numerical Methods, and the term Polyphase was changed to the more euphonious Multiphase Flow. In this new millennium, there are too many diverse topics to mention on the masthead. The number of associate editors has doubled to an average of 20. In spite of a heavy workload, all ASME editors are dedicated volunteers.

After Bob Dean, the JFE had three editors with ten-year terms: Frank White, Demetri Telionis, and Joseph Katz. The present editor, M. J. Andrews, took office in 2010. Since ASME papers are limited in length, data are often published just as a few graphs and a short table. In 1993, Professor Telionis established *the JFE Data Bank*, in which the complete data from a study can be stored, available to readers. The JFE was the first Transactions journal to be available online. Presently the entire paper submission, review, and publication process can be achieved online.

The JFE has grown from a quarterly, publishing 600 pages per year, to bimonthly, and now to a monthly, with 1600 pages per year. The 1990's saw the growth of papers on micro-flows, followed more recently by nano-flows. Our new century has seen many CFD papers on large-eddy and detached-eddy results, in addition to direct numerical simulation of turbulence. Although the JFE continues to primarily be an experimental journal, 40% of recent papers have been the results of Computational Fluid Dynamics studies.

The Journal of Fluids Engineering was an initial success and continues to become even better. It has always been profitable for the Society. The Journal is generally thought to be the leading international publication in the field of engineering applications of fluid flow.

FED Honors and Awards.

ASME has two categories of awards; namely, Society Awards and Division Awards. The society as a whole can nominate an individual for the highest level of award, or existing Division Awards can be elevated to society level, being recommended by the FED Honors and Awards Committee.

SOCIETY AWARDS

- **ASME Medal**. The ASME Medal is the highest award that the Society can bestow and is to recognize "eminently distinguished engineering achievement". Table 16 below lists the five individual Medalists with FED affiliation. Of note are John R. Freeman and Robert C. Dean, Jr.
- **Honorary Member**. This level of recognition should be awarded to a person who has made "distinctive contributions" to engineering, science, industry, research, or public service. Sixteen ASME members with FED affiliation listed in Table 17 below have received honorary membership.
- **FED Award**. The Fluids Engineering Award was initiated as a Division-Level award until approval by the FED Honors and Awards Committee and the Society Honors Committee, to be Society-Level, with the first recipient in 1979 being Robert C. Dean, as seen in the list of the 38 recipients in Table 18 below. To be considered for this award one would need to have made "Outstanding contributions over a period of years to the engineering profession -- especially in the field of fluids engineering through research, practice, and/or teaching".
- **Freeman Scholar**. A biennial award to a person of significant expertise to review a coherent topic in their specialty, resulting in a review article for the JFE and a plenary lecture. The 38 ASME awardees are listed in Table 19 below.
- **Thurston Lecture**. To be given annually by an outstanding leader in pure or applied science that stimulates thinking on a subject of broad technical interest to engineers. Eight engineers with FED connections have had been Thurston lecturers as listed in Table 20 below.
- **Worthington Medal**. This Society-Level award is administered by the Petroleum Division for eminent achievement in the field of pumping machinery, of whom nine medalists have FED affiliation as listed in Table 21 below.

DIVISION (FED) AWARDS

- **Fluid Machinery Design Award**. Recipient must excel in the design of fluid machinery involving significant fluid mechanics principles. The ten awardees to date are listed in Table 22.
- **Gopalakrishnan Flowserve Award**. Recipient must have at least 5-10 years of experience in the pump field documented through publications and testimonials of peers and co-workers. The five awardees to date are listed in Table 23.
- **Knapp Award**. For an outstanding original paper resulting directly from analytical or laboratory research. 86 author recipients are listed in Table 24.
- **Moody Award**. For an outstanding original paper useful to the practice of mechanical engineering. 88 author recipients are listed in Table 25.

Table 16

ASME Medalists with FED Affiliation

1922	John R. Freeman
1935	Charles T. Main
1941	Theodore von Kàrmàn
1945	William F. Durand
1996	Robert C. Dean, Jr.

Table 17

ASME Honorary Members with FED Affiliation

1880	Henry R. Worthington	1972	George R. Rich
1932	John R. Freeman	1978	Howard W. Emmons
1934	William F. Durand	1980	James W. Daily
1937	Lorenzo Allievi	1989	Hans W. Liepmann
1939	Charles T. Main	1991	Simon Ostrach
1940	Robert W. Angus	1996	Stephen J. Kline
1944	Charles M. Allen	1996	Ascher H. Shapiro
1951	Lewis F. Moody	2012	Yogesh Jaluria

Table 18

Fluids Engineering (FED) Award

1968	George F. Wislicenus	1991	Frank M. White	2004	Joseph Katz
1972	Howard W. Emmons	1992	Christopher E. Brennen	2005	Andrea Prosperetti
1974	Stephen J. Kline	1993	Roger E. A. Arndt	2006	Wolfgang A. Rodi
1979	Robert C. Dean, Jr.	1994	Graham B. Wallis	2007	Alexander J. Smits
1981	Ascher H. Shapiro	1995	Clayton T. Crowe	2008	Ching-Jen Chen
1983	George Rudinger	1996	Budugur Lakshminarayana	2009	Ronald J. Adrian
1984	Hans W. Liepmann	1997	Virendra C. Patel	2011	John F. Foss
1985	Apollo M. O. Smith	1998	Mike Roco	2012	Gretar Trggvason
1986	Milton S. Plesset	1999	Michael P. Padoussis	2013	Ephraim Gutmark
1987	Mark V. Morkovin	2000	Fazle Hussain	2014	Efstathios Michaelides
1988	Allan J. Acosta	2001	Ramesh Agarwal	2015	Promode R. Bandyopadhyay
1989	William C. Reynolds	2002	Paul Cooper	2016	Patrick J. Roache
1990	Turgut Sarpkaya	2003	Marvin E. Goldstein		

Table 19

Freeman Scholars

1927 Herbert N. Eaton	1982 Simon Ostrach
Blake R. Van Leer	1984 A. K. M. Fazle Hussain
1929 Robert T. Knapp	1986 John B. Heywood
1931 R. Whitaker	1988 Turgut Sarpkaya
1932 G. Ross Lord	1990 Budugur Lakshminarayana
1933 Hugh J. Casey	1992 William A. Sirignano
1935 Victor L. Streeter	1994 David E. Stock
1946 T. H. Chien	1996 Kirti N. Ghia
J. C. Ma	1998 M. Gad-el-Hak
1954 Alexander Rudavsky	2000 Yogesh Jaluria
1966 James F. Wilson	2002 E. E. Michaelides
1968 James P. Johnson	2004 Gary S. Settles
1970 C. S. Martin	2006 Promode Bandyopadhyay
1971 Ronald F. Probstein	2008 J. C. Klewicki
1971 J. W. Hoyt	2008 W. K. George
1974 Jack E. Cermak	2010 Michael C. Reeks
1976 William J. McCroskey	2012 P. Vanka
1978 Benjamin Gebhart	2014 Steven Ceccio
1980 Edward M. Greitzer	2016 Goodarz Ahmadi

Note: Titles of papers written and presented by Freeman Scholars, Thurston lecturers, and recipients of the Knapp and Moody awards (Tables 19, 20, 24 and 25) will be found on the *History Page* of the ASME/FED website.

Table 20

Thurston Lecturers with FED Affiliation

1950	Theodore von Kàrmàn
1973	Henry M. Paynter
1977	Robert C. Dean, Jr.
1980	Milton S. Plesset
1987	Simon Ostrach
1989	Stephen J. Kline
1995	Paul Cooper
2003	Yogesh Jaluria

Table 21

Worthington Medal Recipients with FED Affiliation

1980	Igor Karassik
1981	Warren G. Whippen
1982	Allan Acosta
1983	Calvin Gongwer
1992	Elemer Makay
1993	Paul Cooper
2010	David Japikse
2014	G. Morrison
2015	Jinkook Lee

Table 22

Fluid Machinery Design Award

1981	Warren G. Whippen
1991	Paul Cooper
1993	Widen Tabakoff.
1997	Warren Wade
1999	Raymond B. Furst
2000	S. Gopalakrishnan
2004	Jinkook Lee
2006	Bruno Schiavello
2008	Yu-Tai Lee
2012	Leroy H. Smith

Table 23

Gopalakrishnan Flowserve Award

2006	John Tuzson
2007	Robert O. Kiesow
2009	Edward Bennett
2013	A. Hosangadi
2015	J. Kadambi

Table 24

Robert T. Knapp Awardees

1965	B. R. Parkin, R. S. Grote
1966	Robert Hickling
1967	N. D. Shutter, R. B. Messler
1968	Milton Plesset, R. E. Devine
1969	L. R. Glicksman
1970	J. W. Holl, A. J. Kornhauser
1971	P. N. Shankar
1972	G. Heskestad
1973	V. H. Arakeri, A. J. Acosta
1974	J. P. Johnston
1975	O. Furuya
1976	R. L. Loehrke, H. M. Nagib
1977	A. J. Acosta, C. Brennen
1979	T. Morel
1980	C. Brennen
1981	O. M. Griffin
1985	R. L. Street, J. R. Koseff
1991	R. S. Meyer, M. L. Billet, J. W. Holl
1992	M. A. Leschziner
1993	G. L. Chahine, R. Duraiswami
1993	F..E. McCaughan, H. Bedir
1994	P. Roache
1995	N. Mangiavacchi, R. Gundlapalli, R. Akhavan
1996	C. David Pruett
1997	D. G. Dommermuth, R. C. Y. Mui
1998	N. Sinha, A. Hosangadi, R. Lee, B. York, P. Cavallo, S. Dash
1999	T. Manning, S. K. Lele
2000	S.W. Coppen, C.B. Rogers
2001	C. H. Hidrovo, D. P. Hart
2002	William K. George, Xia Wang, Luciano Castillo
2003	Jeffrey Taylor and Mark N. Glauser
2004	Michael P. Schultz, Karen A. Flack
2005	A. F. Doll, M. Heinrichs, G. Goldschmidtboeing,
2005	H-J Schrag, U. T. Hopt, P. Wolas
2006	Y-C Chow, J. Katz, F. Sorrana, O. Uzol
2007	M. Campolo, A. Cremese, A. Soldati
2008	Y. Abe, S. Matsumoto, S. Awazu
2010	M. Ernst, M. Sommerfeld
2011	J. Hong, J. Katz, M. Schultz
2012	Y. Doron, A. Duggleby
2013	A. Cihonski, J. Finn, S. Apte
2014	J. Gao, J. Chen, D. Guildenbecher, P. Reu

Table 25

Lewis F. Moody Awardees

1965 J. M. Beer, N. A. Chigier	1999 K. Kalumuck, G. Chahine
1966 T. Brook Benjamin	2000 M. Amitay, A. Glezer
1967 T. Sarpkaya	2001 Hafiz M. Atassi
1968 W. Rosenmann	2002 Ganesh Raman, Andrew Mills,Shadi, Othman,Valdis Kibens
1969 P. G. Hill	
1970 D. N. Wormley, H. H. Richardson	2003 S. O. Kraus, R. D. Flack, A. Habsieger,G. T. Gillies, K. Dullenkopf
1971 G. B. Wallis	
1972 H. Ito, K. Nanbu	2004 M. T. Schobeiri, K. Read, J. Lewalle
1973 F. M. White, G. H. Christoph	2005 Gert Kuiper, Evert-Jan Foeth
1974 R. G. Cunningham, R. J. Dopkin	2006 D. You, M. Wang, P. Moin, R. Mittal
1982 F. J. Hatfield, D. C. Wiggert, R. S. Otwell	2007 A. M. Williams, P. V. Vlachos, B. Akle
1984 L. J. Leggat, N. C. Sponagle	2008 M. Boutaous, P. Bourgin, A. Maazouz, P. Chantrennem E, Perot
1991 R. H. Page, R. Kiel	
1992 R. Dong, S. Chu, J. Katz	2009 S. Murali, X. Xia, A. Jagtiani, J. Carletta, J. Zhe
1993 C. Atkinson, H. K. Kytomaa	2010 A. Lahoutl, H. Hangan
1994 F. J. Cabrejos, G. E. Klinzing, M. L. Dibble	2011 B. Timmins, B. Smith, P. Vlachos
1995 A. Demuren, R. Wilson	2012 A. Jayaprakash, C.-T. Hsiao, G. Chahine
1996 H. Aksoy, R. M. C. So	2013 A. Ghanem, T. Lemen, D. Della Valle, H. Peerhossaini
1997 D. T. Walker, C. Y. Cheu	2014 M. Wosuik, N. Dufresne
1998G. Mattingly	

Conclusions

Probably the most significant development within the ASME after its founding in 1880 and its Power Division thereafter was the formation of the *Hydraulic Division* in 1926. This brought together outstanding engineers from industry and academia who addressed the rapidly expanding field of hydraulic machinery and the underlying fluid flows and behavior involved. As the field of fluid flow phenomena and applications expanded, the inevitable change of the name of this division to the *Fluids Engineering Division* (FED) took place in 1963. Today's pattern of technical committees had already emerged in the early 1930's, with the formation of the Waterhammer, Cavitation, Hydraulic Prime Movers, and Pumping Machinery Committees and a short-lived "General Hydraulics" Committee that presaged the 1957 founding of the Fluid Mechanics Committee. These committees developed technical programs in which many landmark papers in the fluids engineering field were presented at conferences they organized and published in the journals of the *Transactions of the ASME*. One of these is the *Journal of Fluids Engineering* (JFE), which started in 1973 and which was and remains dedicated solely to the FED, being produced by FED members who are the editors and associate editors.

These accomplishments were due to a procession of engineers and scientists who have been renowned in the field, and include names like Lewis F. Moody, John R Freeman, Robert T. Knapp, Theodore Von Kàrmàn, Robert C. Dean, et al.

Many more FED members have been recognized by their peers through several awards. First are the "Society" awards, namely the ASME Medal, Honorary Membership, Freeman Scholar, Thurston Lecturer, the Fluids Engineering Award and the Worthington Medal. Then there are the "Division" (FED) awards, namely the Fluid Machinery Design Award, the Gopalakrishnan Flowserve Award, and the Knapp and Moody awards for the authors of outstanding technical papers.

The timeline of the developments of the FED throughout its 90-year history reveals a flexibility and adaptability to engineering and scientific developments in the fluids engineering disciplines that promise to keep the division providing relevance for present and future engineers and scientists who choose to specialize in this field.

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