

# 75 Years of Progress: A History of the ASME Heat Transfer Division

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*This paper presents a history of the ASME Heat Transfer Division (HTD) over the past 75 years. The foundations, birth, growth, and maturation of the division are addressed. An overview of honors and awards is presented and selected developments and trends are discussed. Noteworthy events and workshops, including the 50th anniversary celebration, are considered in some detail. The growing trend toward internationalization is addressed through several conferences and initiatives. Publications, with a focus on the Journal of Heat Transfer, are addressed. The Heat Transfer Division story is told through the contributions and dedicated service of the men and women of the division. The paper concludes with some thoughts about the future. [DOI: 10.1115/1.4023546]*

**Keywords:** heat transfer, Heat Transfer Division, history, honors and awards, conferences, internationalization, publications

## 1 Introduction

In 2013, the ASME HTD celebrates its 75th anniversary. Much has changed over the past 75 years. The ability to make calculations moved from slide rules to hand held calculators to main frame computers to desktop and laptop computers. Communications changed from telegrams and primitive landline telephones to cellular devices. With the advent of the internet our ability to communicate around the world has become easier, quicker, and less expensive; however, the writing of letters and memos has largely become a lost art. And so from its birth in 1938 to the present, the HTD has changed in the past 75 years. This paper captures some of those changes and memories of the past. This version of the HTD is not a repeat of the Layton and Lienhard [1] history; rather, it is a perspective of the division over the past 75 years through a different pair of lenses, revisiting some highlights of the first 50 years with the addition of some details, but with a greater focus on the past 35 years or so. Many individuals have helped make the HTD one of the strongest divisions in all of ASME; regrettably, many deserving contributors are not included here, not because their work isn't important, but simply because of space limitations.

A history of the division cannot be written without an acknowledgement and appreciation of the significant contributions of John Lienhard IV (Fig. 1), not just for his technical and academic work in two phase flow, boiling, and other areas, but for his efforts in history. Starting in 1951, he worked as an engineer and educator and has been active in history since the 1970s. For several years he hosted "The Engines of Our Ingenuity," a daily essay on creativity produced by KUHF-FM in Houston and heard nationally on Public Radio. He then captured his "reflections on the nature of technology, culture, human inventiveness, and the history of engineering" in *The Engines of Our Ingenuity* published in the year 2000 [2]. John is also a knowledgeable, delightful, and gifted speaker, and he has received several awards in recognition of his many contributions.

## 2 Foundations

ASME was founded in 1880 by Alexander L. Holley, Henry R. Worthington, John E. Sweet and others in response to numerous steam boiler pressure vessel failures, and Robert Thurston (Fig. 2)

became ASME's first president. Thurston was an educator who first worked in the machine shop at his father's steam engine manufacturing company, the first of its kind in the United States. He later served as the first president of Stevens Institute of Technology and for 18 years as the first director of the Sibley College at Cornell University. At Cornell, he created a college of engineering with emphasis on scientific classroom work and more laboratory testing. So, from its very beginnings, ASME was involved with processes, i.e., the production of steam, where heat transfer is important.

In the late 1890s and early 1900s it was clear that Europe—England, France, and Germany—especially the Germans, had considerable interest and expertise in heat transfer. In 1900, Max Planck, a theoretical physicist and father of quantum mechanics, postulated that electromagnetic energy could only be a multiple of an elementary unit,  $E = h\nu$ . Ludwig Prandtl in 1904 created the concept of the boundary layer. In 1915, Wilhelm Nusselt proposed the dimensionless groups now known as the principal parameters in the similarity theory of heat transfer. The Hungarian Theodore von Karman, an aerodynamicist who also did important work in convective heat transfer, studied under Prandtl at the University of Göttingen and in 1912, accepted a position as director of the Aeronautical Institute at RWTH Aachen, one of the country's leading universities. Max Jakob, a German physicist born in 1879, made major contributions toward understanding steam at high pressure, measuring thermal conductivity, and the mechanisms of boiling and condensation. Finally, Ernst R. G. Eckert, who was born in Prague, Austria-Hungary in 1904, carried out research dealing with rocket and jet engine science at the Aeronautical Research Institute in Braunschweig.



Fig. 1 John Lienhard IV

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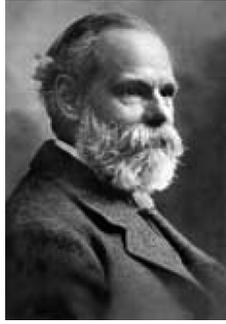


Fig. 2 Robert Thurston



Fig. 4 Theodore von Karman



Fig. 3 Allan P. Colburn

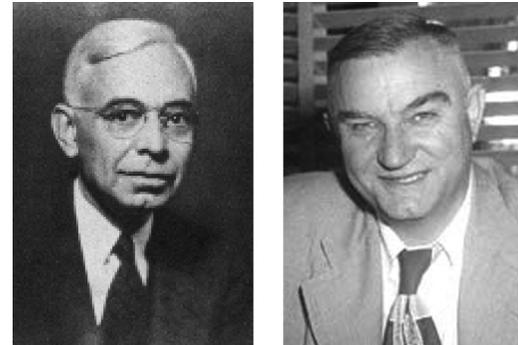


Fig. 5 William McAdams (left) and L. M. K. Boelter (right)

By the early 1900s the U.S. had the world's largest chemical industry with a strong concentration in the Mid-Atlantic region. The Delaware Valley city of Wilmington, alone, had Atlas Powder Company, Hercules Powder Company, and E. I. duPont de Nemours & Company (duPont). Therefore, it is not surprising that the Chemical Engineering Department at the University of Delaware developed a strong program in process engineering and heat and mass transfer. In 1936, Allan P. Colburn (Fig. 3) published a paper in the 1933 AIChE Transactions introducing the "Colburn analogy" and the heat transfer "j-factor." Colburn blended theory and practice, which included mathematically sophisticated design solutions. Colburn's first Ph.D. graduate in 1947 was James Westwater who joined the faculty at the University of Illinois specializing in heat transfer with change of phase. From 1947 to 1963, the ChE Department at Delaware carried out a comprehensive research program on shell-side fluid flow and heat transfer in shell-and-tube heat exchangers under Olaf Bergelin and Colburn. The project started under ASME sponsorship using funds from several organizations including Tubular Exchanger Manufacturers Association (TEMA), American Petroleum Institute (API), DuPont, Exxon, and others. Kenneth Bell, who later spent most of his career at Oklahoma State University, played a key role in this project.

However, in Germany major problems were coming to the fore. When Adolf Hitler became chancellor of Germany in January 1933, his anti-Semitic Nazi regime immediately began the purge of Jewish professionals, resulting in the loss of some of its best scientific talent including fluid and heat transfer specialists. Theodore von Karman (Fig. 4), who was Jewish, accepted an invitation from the California Institute of Technology (Caltech) to an appointment as professor and head of the Guggenheim Aeronautical Laboratory (GALCIT). He had a reputation of being a bit of a character who loved to tell risqué jokes, and he had a habit of turning off his hearing aid whenever he became bored with discussions in meetings. But, von Karman was also a critical thinker and under his leadership, up to and during World War II, Koppes [3] wrote:

The GALCIT group made fundamental breakthroughs in the theoretical and applied aspects of both solid- and liquid-rocketry.

These advances played an important role in converting rocketry from science fiction into respectable science and engineering. Moreover, GALCIT researchers could plausibly claim that they—not Robert Goddard or the German V-2 experimenters—laid the foundation for the development of American rocket and missile technology.

GALCIT was reorganized, expanded, and renamed the Jet Propulsion Laboratory (JPL) in February 1944 and was operated for the Army Ordnance Corps with von Karman as JPL's first laboratory director. He also played a major role in the development of jet assisted takeoff (JATO) and in the founding of Aerojet Corporation. Von Karman left Caltech/JPL in December 1944 to organize the Air Force's Scientific Advisory Board, and JPL went on to become a member of NASA and the nation's premier organization for unmanned exploration of the solar system.

As discussed by Layton and Lienhard [1] there were—at the risk of oversimplification—two different approaches to heat transfer in the U.S. in the early 1930s. On the "East Coast" engineering needs were driven primarily by the process industries mentioned above. On the "West Coast" a younger faculty at Berkeley and Stanford (and later at UCLA) was developing a more analytic approach based on the German literature. Eckert [4] authored a history of heat transfer in conjunction with ASME's 100th anniversary and described the situation this way:

A vigorous activity developed in the United States ... two names stand out among the early scholars in this development: William H. McAdams (Fig. 5, left) of MIT is the author of the book *Heat Transmission* which first appeared in 1933. In this book McAdams collected, screened, and correlated the available information on heat transfer processes, supplemented it by his own research, and presented through three editions an up-to-date, concise, and unified picture of the state-of-the-art. He created a standard text which served the heat transfer community as a reference book through many years. Llewellyn M. K. Boelter (Fig. 5, right) started research in heat transfer in 1930 at the University of California, Berkeley. He had the gift of attracting talented students and implanting in them interest and love for engineering research.

Although McAdams was the focal point for heat transfer in the ChE Department at MIT, he also had support from other faculty such as Thomas B. Drew, who received acclaim for the first systematic use of heat, mass, and momentum transfer fundamentals in industrial applications. McAdams's book [5] ultimately sold 50,000 copies over three editions, which even by today's standards is phenomenal for a technical book.

In contrast, on the West Coast good use was made of the German literature. Boelter began his long career in teaching with his appointment as instructor in electrical engineering at Berkeley in 1919, but moved to mechanical engineering in 1923. He built the heat transfer program at Berkeley with a core faculty of Floyd Cherry, Harold Johnson, and later Robert Martinelli. In 1932, "Heat Transfer Notes" by Boelter, Cherry, and Johnson was published for the students at Berkeley. Although there were discussions about which of the two approaches was best, they are actually quite complementary, and today we use both. Ironically, Boelter is best known in some quarters for the well-known empirical Dittus–Boelter correlation

$$\text{Nu} = 0.023 \text{Re}^{0.8} \text{Pr}^{0.4} \quad (1)$$

**2.1 Heat Transfer at MIT.** At the Massachusetts Institute of Technology (MIT), both the Director of the Heat Measurement Laboratory, Gordon B. Wilkes, and the laboratory itself, previously in the Physics Department, were moved to Mechanical Engineering in 1934. In 1946, Warren Rohsenow (Fig. 6) came to MIT and Professor Wilkes invited him to carry out research in the laboratory. Ten years later Rohsenow took over direction of the laboratory and its name was changed to the Heat Transfer Laboratory, a better description of the work being done in the lab at that time. Laboratory activity increased when funding became more readily available after World War II. In 1956, John A. Clark (who later moved to the University of Michigan) and Peter Griffith joined the faculty. Boris Mikic, Arthur Bergles, and Leon Glicksman joined the faculty in the sixties, and, thus, the groundwork was laid for heat transfer at MIT to become one of the outstanding programs in the U.S. In 1992, the laboratory was upgraded by John Lienhard V, now a senior member of the faculty, and renamed the *Rohsenow Heat and Mass Transfer Laboratory* [6]. Rohsenow's fundamental and applied research touched nearly all modes of heat transfer. His teaching emphasized fundamentals and practice-oriented problems. In the end, heat transfer excellence at MIT had transferred from chemical engineering to mechanical engineering: from McAdams to Rohsenow.

**2.2 Heat Transfer at Illinois Institute of Technology (IIT), Purdue, and Minnesota.** But heat transfer activity was not restricted to just the East and West Coasts, Kezios [7]. ASME invited Max Jakob (Fig. 7) to the 1935 Winter Annual Meeting and arranged for guest lectures at Princeton, Harvard, MIT, University of Illinois, IIT, Caltech, University of California at Berkeley (UC Berkeley), and others. One of the objectives of these visits was to introduce Jakob to a variety of schools for the



Fig. 6 Warren Rohsenow



Fig. 7 Max Jakob

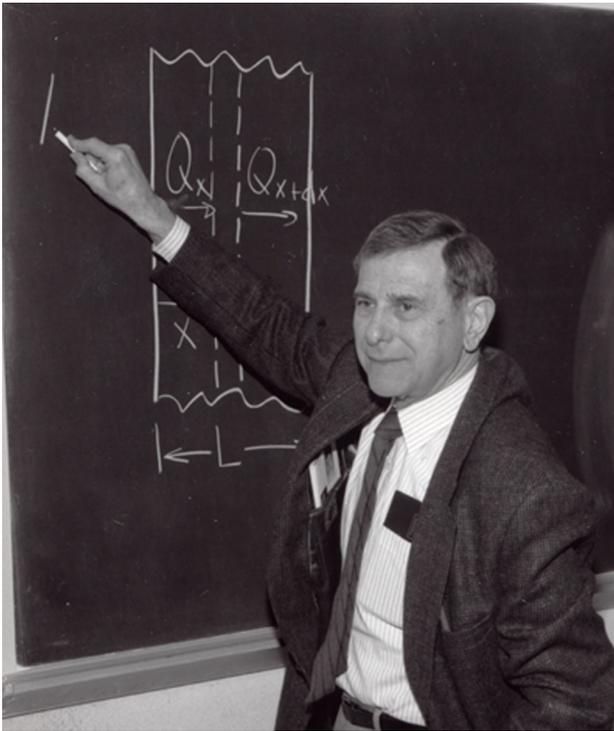
purpose of obtaining a faculty position. Ultimately, Jakob accepted a professorship at IIT which allowed him to serve as director of armour research as well. He quickly established himself as a leading heat transfer figure in the U.S. and authored two classics: *Heat Transfer*, volumes 1 & 2 [8,9]. One of his first students was Stoehe P. (Scotty) Kezios, who carried out his doctoral work under Jakob. Kezios later became one of his faculty colleagues, and completed Jakob's volume 2 after his death. Clearly, Jakob had a major influence on Kezios who became chair of the Heat Transfer Division in 1958–59, the first technical editor of the ASME Journal of Heat Transfer in 1963, and ASME's 96th president in 1977–78.

George A. Hawkins of Purdue University, was sent to Illinois by Dean of Engineering Andrey A. Potter (ASME's 52nd president in 1933–34), to learn more about the fundamentals of heat transfer. Jakob's presentation impressed Hawkins a great deal, and he ultimately drove from the Purdue Campus in West Lafayette, IN (a roundtrip of 448 km) twice a week to attend Jakob's graduate lectures in heat transfer at IIT during the 1937–38 academic year. Hawkins later earned his Ph.D. at Purdue, became dean of engineering, and supervised Richard J. Grosh's doctoral studies in radiation heat transfer. Grosh later became head of mechanical engineering, then dean of engineering at Purdue, which led to the hiring of Peter McFadden, William Cottingham, Raymond Viskanta, David DeWitt, Frank Incropera, and later additions such as Jay Gore and Suresh Garimella, Webb [10]. Viskanta quickly established himself as one of the premier researchers in radiative heat transfer, while Incropera and DeWitt went on to coauthor *Fundamentals of Heat and Mass Transfer* (now in its 7th edition, written by Bergman et al.), one of the most widely used undergraduate heat transfer texts [11]. Collectively, this group built Purdue's heat transfer program into one of the best in the country. And for good measure, Boelter, Eckert, and Jakob all served as visiting professors at Purdue over a period of many years.

After leaving the Aeronautical Research Institute in Braunschweig, Germany, Ernst Eckert (Fig. 8) came to the U.S. with a number of other Germans via Operation Paperclip and began jet propulsion research in 1945 at Wright-Patterson Air Force Base. While there, Robert Drake, Jr. helped Eckert translate his first book *Introduction to the Transfer of Heat and Mass* [12] from German to English. Drake, coauthored Eckert's two later books [13,14]. After a nationwide search Eckert joined the Department of Mechanical Engineering at the University of Minnesota in 1951. Over his career Eckert published more than 550 scientific papers and books, and the Eckert number in convective heat transfer was named after him. Following its founding at Minnesota in 1950, the Thermodynamics and Heat Transfer Laboratory (THTL) under the leadership of Eckert, and with the seminal contributions of E. M. (Eph) Sparrow (Fig. 9), Warren Ibele, Richard Goldstein, and others, the THTL quickly established a national and international reputation and has remained at the forefront of heat transfer research and graduate education to this day. Many of the luminaries of the heat transfer community including James



**Fig. 8** 1982 Photograph, left to right: Michael Ohadi (University of Maryland), Ernst Eckert and Richard Goldstein (University of Minnesota), and John Lloyd (Michigan State University). Ohadi, Goldstein, and Lloyd were Minnesota Ph.D.s.



**Fig. 9** E. M. Sparrow

Hartnett, Thomas Irvine, Terry Simon, Suhas Patankar, Frank Kulacki, and Jane Davidson are, or have been, associated with the laboratory.

**2.3 UC Berkeley Heat Transfer.** After Boelter left Berkeley, mechanical engineering continued its way to a premier heat transfer program with faculty members such as Robert Drake, Jr., Warren Giedt, Ralph Seban, Virgil Schrock, Ralph Greif, Chang-Lin Tien (Fig. 10), Van Carey, Arun Majumdar, and others. Tien, the youngest engineering faculty member at Berkeley, later became department chair, dean, and chancellor of the university. He advised many doctoral students and was extremely active in the HTD. Although small in stature, he projected a “tall shadow” at Berkeley and was universally admired and loved. Among his many technical interests, he became engaged in micro- and nanoscale



**Fig. 10** Chang-Lin Tien

heat transfer. Tragically, his life was cut short due to illness. Richard Buckius, who worked under Tien and spent most of his career at the University of Illinois, commented at Professor Tien’s memorial service on his inspirational style, “He was forever asking, ‘Any new ideas?’ and telling us to ‘Go to extremes’, ... he’d also say ‘You need to dream of your research while you sleep!’”

In *Engines of Our Ingenuity 957*, John Lienhard paid a tribute to one of his special teachers at Berkeley. Here, in part, is what John had to say about Ralph Seban who had a distinguished career and was a recipient of the 50th Anniversary Award:

Ralph Seban, was the smartest and most feared faculty member at Berkeley when I was a student there. Seban was a rude, arrogant, and deeply caring person. ... Seban hungered for intellectual companionship. In his almost desperate impatience he tore visiting seminar speakers apart. In the classroom, details were your problem. You could correct the plus and minus signs. He simply sketched ideas from his encyclopedic memory. You had to go read the details in the journals. What Seban did was to mold students into worthy adversaries. He lured them into debates which, it seemed, they could not win. Then, one day, something remarkable happened. You found that, when you fully engaged your own mind, you could stay with him. And he would hold you there until you collapsed from exhaustion. Seban’s students left Berkeley—left those marathons—with a deep-seated confidence. If Berkeley had used teacher ratings, he would’ve flunked. Yet he was, without doubt, one of the most effective teachers I’ve known.

**2.4 Boelter and UCLA Heat Transfer.** In 1944, Boelter became dean at UCLA, started the School of Engineering, and played a major role in laying a foundation for heat transfer excellence. Along with Herbert Nottage, who wrote an early history of the HTD [15], and Myron Tribus, the faculty grew to include Donald K. Edwards (radiation heat transfer), V. E. Denny (transport processes), Anthony Mills (heat and mass transfer), Ivan Catton (natural convection and nuclear energy), Vijay Dhir (boiling heat transfer and two-phase flow), and Adrienne Lavine (convective heat transfer, manufacturing processes).

Tribus, a most interesting personality and creative thinker, came from the Boelter mold at UCLA. After leaving UCLA, he worked as a design-development officer at Wright Field in Dayton, Ohio and received the Alfred Noble Prize for his work developing a thermal ice protection system for aircraft. As Dean of Dartmouth College’s Thayer School of Engineering, he led the faculty in developing a new curriculum based on engineering design and entrepreneurship. Tribus saw hands-on engineering design as being essential at all levels of the curriculum. He coined the word, “Thermoeconomics,” and also served as director of the Center for Advanced Engineering Study at MIT.

Boelter believed in a general approach to engineering education and did not like the idea of separate departments, so the program became known as the School of Engineering and Applied Science (SEAS). Faculty members with expertise in one discipline were expected to teach courses outside their primary areas. However, after he retired, the school eventually abolished this approach and formed traditional engineering departments. At the June 1966,

UCLA commencement exercises, the University of California conferred on him an honorary Doctor of Laws degree. Dean Boelter's qualities as a teacher and a man were perhaps best described in 1963 by a group of colleagues and former students in the preface to the *Boelter Anniversary Volume on Heat Transfer, Thermodynamics and Education* [16], which stated in part:

It has been written elsewhere that L. M. K. Boelter is known for his integrity, imagination, and vision. We, his colleagues and students, have seen this side of the man. His way of teaching by precept and example has made us feel that these virtues are the requisites for a successful career, and we have grown so accustomed to them as Boelter's traits that we have taken them for granted. The other side of the man, seen only by his associates, has endeared him to us. We refer to his compassion, his way of treading softly to avoid hurting even those who have fought against his ideas, and his willingness to sacrifice himself and his health for the sake of others. These common characteristics must be recorded here for the benefit of those who, less fortunate than we, could not be touched by them directly. We treasure these qualities, for they give life its meaning.

Vijay Dhir served as chair of the Mechanical and Aerospace Engineering (MAE) Department at UCLA from 1994–2000. In 2003 he was appointed the sixth dean of SEAS, and under his leadership both the size and stature of the school have grown significantly. I think Dean Boelter would be very pleased with the changes in engineering at UCLA over the past 10 years.

**2.5 Stanford Heat Transfer.** In the summer of 1938, Louis London (Fig. 11) worked on a master's thesis at Berkeley on cooling towers that resulted in a paper with W. E. Mason and Boelter, at an ASME meeting in San Francisco in 1939. Later, when London was at Stanford and Ralph Seban at Santa Clara University, they had many discussions on heat exchanger design, that led to an unpublished 1942 paper dealing with the  $\varepsilon$ -NTU method. However, the paper was not published until 1980 [17]. Today, the  $\varepsilon$ -NTU method is routinely covered in introductory courses in heat transfer. The first serious attempt to obtain heat transfer and friction factor data for compact heat exchangers began at the U.S. Navy Bureau of Ships in 1944 for a gas turbine recuperator/regenerator. This work continued at Stanford for the next 24 years, until 1971. The classic *Compact Heat Exchangers* by William Kays and London came out of that work, and is now in its 3rd edition [18]. Over his many years on the faculty at Stanford, London had quite a "red ink" reputation. In the preface of Shah et al. [19], Kays wrote:

My principal recollection of that period was continually writing reports for ONR, reports that were widely distributed throughout the country, and I think this series of reports was what originally put us on the map. English composition had always been one of my weak points, but here is where Lou was a teacher par excellence. I would lay out the report and write a draft, and then turn it over to Lou. A few days later he would call me in and we would sit down to go over it. Red ink everywhere! Not a single sentence was left untouched. It was agony, but it was a great learning experience, and one for which I will always be indebted to Lou.



Fig. 11 Louis London

Kays and London became lifelong friends and Kays went on to a distinguished career at Stanford where he served as department head and dean. He wrote *Convective Heat and Mass Transfer*, joining with Michael Crawford and Bernhard Weigand in the latest edition [20]. Ramesh Shah, another of London's students, and London offered a very popular short course on compact heat exchangers. They later published the review article, "Laminar Flow Forced Convection in Ducts" [21] that stands as the most comprehensive resource for classical forced convection in ducts. Another student, Robert Moffat, became well known for his experimental heat transfer research and his short courses on experimental methods. London was active in the ASME Gas Turbine Heat Transfer Division for many years.

**2.6 University of Michigan Heat Transfer.** In the 1950s Edward Vincent gained international recognition for his heat transfer work in gas turbine rotor disks. Under Mechanical Engineering Department Chairman Gordon Van Wylen's leadership, the department established expertise in space technology as a key player in cryogenic research. A solar energy laboratory was developed in 1973 under John Clark. Other important faculty members included Vedat Arpacı, Herman Mertz, Wen-Jei Yang, Gerard Faeth, Michael Chen, and Massoud Kaviany. In the Chemical Engineering Department Donald Katz, Edwin Young, and Stuart Churchill were also involved in heat transfer activities. The two departments thus provided breadth as well as depth in heat transfer at Michigan.

### 3 Birth, Growth, and Maturation of the Division

The Heat Transfer Professional Group within the Process Industries Division took root at the 1938 ASME Summer Meeting. However, the actual formation of the Heat Transfer Division as an independent division did not occur until three years later. The first chairman of the professional group in 1938 was J. H. Sengstaken, and the first chairman of the Heat Transfer Division, in 1941, was E. D. Grimison. However, for historical purposes 1938 is generally considered to be the official beginning of the division. The chairmen during the first 15 years included Thomas Drew, L. M. K. Boelter, Hosmer Norris, Allan Colburn, George Hawkins, and Alfred Mueller. If several of those names sound like chemical engineers you would be correct. The AIChE Heat Transfer and Energy Conversion Division and the ASME HTD worked very closely during those initial years and the partnership continued over the next 50+ years. The chairs for the Heat Transfer Division over the past 75 years, shown in Table 1, include many familiar names. It should be recalled that serving as chair was not just a grueling 1-year assignment, but one had to serve for several years on the executive committee prior to the year as chair, followed by the obligatory year as past chair. But most people who served as chair, on reflection, will say it was more than worth the effort.

**3.1 HTD Programs and Initiatives.** Through the years the HTD explored and implemented many ways to expand its programs and reach both academic and practicing members of the division. The HTD had an exhibits committee, and conference exhibits were held at the National Heat Transfer Conferences (NHTCs) from 1988 through 1992. Although the exhibits broke even or made a small profit, they were never as successful as the division leadership or ASME had hoped; however, the book exhibits sponsored by the publishing companies were always well received. Technical content in the form of "Technical Briefs" was introduced in the division newsletter in 1993 and continued for a few years. This feature was copied by a number of divisions. The division introduced poster sessions as a way to promote and facilitate discussions between authors and participants, especially those individuals who were interested in specific papers. Panel discussion sessions were initiated in an attempt to bring in more industrial participants for whom publications were frequently not an option, for proprietary reasons. In 1992, the division introduced

**Table 1 Chairs of the ASME Heat Transfer Division**

1938–1939	J. H. Sengstaken	1964–1965	J. A. Clark	1990–1991	W. J. Marner
1939–1940	T. B. Drew	1965–1966	P. T. Vickers	1991–1992	J. R. Welty
1940–1941	T. B. Drew	1966–1967	S. Ostrach	1992–1993	J. B. Kitto, Jr.
1941–1942	E. D. Grimson	1967–1968	S. Levy	1993–1994	R. Greif
1942–1943	T. B. Drew	1968–1969	T. F. Irvine, Jr.	1994–1995	R. O. Buckius
1943–1944	L. M. K. Boelter	1969–1970	S. J. Green	1995–1996	S. M. Cho
1944–1945	W. W. Patterson	1970–1971	R. A. Seban	1996–1997	O. A. Plumb
1945–1946	L. M. K. Boelter	1971–1972	W. H. Cook	1997–1998	G. P. Peterson
1946–1947	R. H. Norris	1972–1973	F. Landis	1998–1999	W. Fiveland
1947–1948	C. F. Kayan	1973–1974	L. H. Back	1999–2000	R. Nelson, Jr.
1948–1949	A. P. Colburn	1974–1975	R. J. Goldstein	2000–2001	L. C. Witte
1949–1950	L. B. Schueler	1975–1976	R. W. Graham	2001–2002	J. H. Kim
1950–1951	G. A. Hawkins	1976–1977	V. E. Schrock	2002–2003	Y. Jaluria
1951–1952	G. L. Truve	1977–1978	E. Fried	2003–2004	Y. Bayazitoglu
1952–1953	A. C. Mueller	1978–1979	F. W. Schmidt	2004–2005	R. D. Skocypec
1953–1954	P. R. Trumpler	1979–1980	R. L. Webb	2005–2006	M. K. Jensen
1954–1955	H. B. Nottage	1980–1981	C.-L. Tien	2006–2007	R. W. Douglass
1955–1956	H. B. Nottage	1981–1982	A. F. Rathbun	2007–2008	T. W. Tong
1956–1957	M. Tribus	1982–1983	A. E. Bergles	2008–2009	C. H. Oh
1957–1958	S. Kopp	1983–1984	R. J. Simoneau	2009–2010	V. P. Carey
1958–1959	S. P. Kezios	1984–1985	C. J. Cremers	2010–2011	L. A. Gritzo
1959–1960	W. E. Hammond	1985–1986	R. K. Shah	2011–2012	J. F. Klausner
1960–1961	H. A. Johnson	1986–1987	J. R. Lloyd	2012–2013	R. E. Hogan
1961–1962	W. M. Rohsenow	1987–1988	F. A. Kulacki	2013–2014	S. A. Sherif
1962–1963	K. A. Gardner	1988–1989	J. M. Chenoweth		
1963–1964	J. F. Wachunas	1989–1990	K. T. Yang		

*Heat Transfer—Recent Contents*, a monthly publication consisting of the title pages of relevant heat transfer journals. Although this initiative was financially successful, the advent of the Internet and other search options essentially obsoleted this approach.

**3.2 National Laboratories.** One of Boelter's undergraduate students at Berkeley was Frank Kreith who followed him to UCLA to pursue a master's degree which he received in 1945. Kreith then worked at JPL for four years where he had the opportunity to collaborate with Theodore von Karman. He later accepted a faculty position at the University of Colorado, but was never fully comfortable as an academician because of his interests in the application of "real world" technology. The Solar Energy Research Institute (SERI) was established by Public Law 93-473, The Solar Energy Research Development and Demonstration Act of 1974, and began operation on July 5, 1977 in Golden, CO. The Solar Heat Division was the first branch established and Kreith was appointed as its director. Heat transfer played a central role in the R&D activities of the division and its staff members published many pertinent articles in the literature. The SERI mission included 10 programs, of which four were under the management of the Heat Division: Solar Industrial Process Heat, Active Solar Heating and Cooling, Solar Energy Thermal Storage, and Ocean Energy Systems. One of the highlights of the first year of operation of the Solar Thermal Heat Branch was President Jimmy Carter's visit to SERI on Sunday, May 3, 1978. President Carter (Fig. 12) is shown observing the two-axis tracking solar dish. Kreith is a strong proponent of sustainable energy, especially solar and nuclear energy, and remains active in this field.

Representatives from the National Laboratories have been active in and strong supporters of the Heat Transfer Division for many years. Names that come to mind include Hans Poppendiek, Oak Ridge National Laboratory; Robert Deissler, Robert Siegel, Robert Graham, and Robert Simoneau of Lewis Research Center; Manohar Sohal and Chang Oh, of the Idaho National Energy and Environmental Laboratory; Robert Lyczkowski and Thomas Rabas, Argonne National Laboratory, Russell Skocypec and Leslie Phinney of Sandia National Laboratories; Ralph Nelson and Rodney Douglass of Los Alamos National Laboratory; and Lloyd Back of JPL.

**3.3 Women in Heat Transfer.** Yildiz Bayazitoglu initiated this group by inviting Deborah Kaminski and Adrienne Lavine to lunch at the Rice University Faculty Club during the 1988 National



**Fig. 12 President Carter viewing the two-axis tracking solar dish at SERI on Sunday, May 3, 1978. Left to right: Frank Kreith, Solar Energy Division; President Jimmy Carter; and SERI President Paul Rappaport.**

Heat Transfer Conference in Houston. Since then, the informal group has grown and luncheons are regularly scheduled at ASME meetings and other conferences (Fig. 13). The luncheon meetings are primarily social. This venue gives the women an opportunity to visit, share their experiences, discuss their concerns, and encourage each other. A topic of major interest and discussion through the years has been that of balancing the work environment while having children and raising a family. Leslie Phinney [22] of Sandia National Laboratories shared her thoughts regarding the luncheons:

The Women in Heat Transfer luncheons are an event that I have looked forward to at ASME conferences since I was a graduate student. Women get together for an informal lunch at Summer Heat Transfer Conferences and ASME IMECES. The senior women are very welcoming and inclusive to more junior colleagues. The lunches are wonderful opportunities to meet and maintain contact with colleagues from a variety of institutions and backgrounds. As my career progressed, my appreciation for these luncheons deepened upon learning from women colleagues in other research areas that such events are not a part of the conferences that they attend.

This fun and enjoyable support group includes a university president, deans, and department chairs as well as faculty members engaged in teaching and research.



**Fig. 13** Women in Heat Transfer luncheon at November 2004 IMECE in Anaheim, CA. Left to right: Laura Schafer, Jennifer Lukes, Leslie Phinney, guest, Zhou Chenn, Ann Anderson, Debbie Kaminski, Christina Amon, Yildiz Bayazitoglu, Obdulia Ley, and Pam Norris.

**3.4 Society Leadership.** The HTD has had a long and impressive record of leadership within the division from its inception. However, the division has also provided a strong contingent of leadership for the entire society going back at least to the 1970s. L. S. Fletcher (Texas A&M), Nancy Fitzroy (General Electric), S. P. Kezios (Georgia Tech), Richard Goldstein (University of Minnesota), and Arthur Bergles (RPI) all served as ASME presidents, the highest volunteer position in the society. Gad Hetsroni (Technion Israel), James Welty (Oregon State), Jack Lloyd (Michigan State), Yogi Goswami (University of Florida), J. B. Kitto, (Babcock & Wilcox), and Robert Simoneau (Lewis Research Center) all served on the Board of Governors (BOG), and Webb Marnier (JPL/UCLA) served on the BOG twice, once as a governor and more recently as the society's 2008–2012 secretary and treasurer. Fitzroy, Fletcher, Goldstein, Goswami, Kitto, Lloyd, and Simoneau also served as senior vice presidents. Each of these individuals made unique contributions to the society, Heat Transfer Division, and engineering profession.

**3.5 Current Status.** From a single professional group in 1938, the division has grown significantly. There are currently 13 technical committees and several administrative committees including the Executive Committee. As of September 2012, the primary membership of the division was 3,892 (including 562 students), with a secondary membership of 3,771 (including 42 students). A total of 14,345 ASME members have designated heat transfer as one of their top five technical divisions. The division is taking on a more international character; for example, at the 2012 National Heat Transfer Conference in Puerto Rico the participants represented 37 different countries.

## 4 Honors and Awards

The division sponsors a number of awards and participates in several society awards; however, space limitations permit only a brief background and a partial description of them. The awards are administered through the seven-person Honors and Awards Committee.

**Heat Transfer Memorial Award.** Herb Nottage of UCLA served two terms as HTD chair in the fifties: 1954–55 and 1955–56. During his term of office he “urged a serious effort to prepare and maintain a Heat Transfer History.” He also wrote, “Continuity and leadership in the spirit-entity of Heat Transfer calls for discerning judgment in recognizing the lasting values of creative contributions thereto” [15]. Soon thereafter Myron Tribus and Sigmund Kopp, who served as HTD chairs immediately after Nottage, led the award-creation effort.

The original concept was to have a Heat Transfer Division Memorial Award to recognize excellence in literature and creative activities. The original concept included two parts: (a) An award to recipients to recognize excellence in reference literature and creative activities, and (b) a memorial booklet to memorialize those who had given generously and effectively of themselves to benefit the division. It was decided that the memorial award could be given in two categories: *Art* and *Science*. Later a third *General* category was added. The award was initially a division award which also called for the establishment of a custodian fund to support the award. The first award was given in 1961 to N. Zuber and other early recipients of the award included Eph Sparrow, Louis London, and Ralph Seban. It was elevated to a society level award in 1974, and an annuity to provide support for the awards was eventually established through division funding. Today, it “is bestowed on individuals who have made outstanding contributions to the field of heat transfer through teaching, research, practice and design, or a combination of such activities.” One award may be given annually in each of the award categories.

**Max Jakob Memorial Award.** Internationally, the Jakob Award is the most prestigious of all the heat transfer awards and is a society award. It is administered by a joint ASME-AIChE Committee: the chair plus three representatives from both societies. The award is bestowed in recognition of eminent achievement of distinguished service in the area of heat transfer. It is made annually without regard to society affiliation or nationality. The award was established by the HTD in 1961 in honor of Max Jakob, who passed away in 1955, commemorating his outstanding contributions as a researcher, educator, and author. From 1961 through 1964, the first four recipients of the award were Eckert, Boelter, McAdams, and Ernst Schmidt from Germany. Of the 50-award recipients, the majority have gone to U.S. citizens; however, the Jakob Award has also been presented to representatives from Germany, United Kingdom, USSR, Japan, Switzerland, Russia, and China. The past two recipients were Ivan Catton, UCLA, and Amir Faghri of the University of Connecticut.

**Best Conference Paper Award.** The third award established by the original committee was the Best Conference Paper Award for each National Heat Transfer Conference.

**Yeram S. Touloukian Award.** This society award was established in 1997 and is bestowed triennially to recognize outstanding technical contributions in the field of thermophysical properties. Funding for the award was provided by Purdue University to honor the contributions of Yeram Touloukian. The first recipient was Akira Nagashima in 2000.

**Bergles–Rohsenow Young Investigator Award in Heat Transfer.** This society award is given to a young engineer who is

under 36 years of age, received a Ph.D. or equivalent, and who has demonstrated the potential to make significant contributions to the field of heat transfer. It was established by the HTD in 2003, and the award was funded through the efforts of Art Bergles and Warren Rohsenow, both well-known for their heat transfer research and mentoring of young researchers. The first recipient was Srinath V. Ekkad in 2004.

**Division Awards.** The **Heat Transfer Division Distinguished Service Award** was established in 1981 to recognize distinguished service to the HTD with Bob Graham of NASA Lewis as the first recipient. It is perhaps surprising that this award has been bestowed only a few times, given the number of individuals who have provided outstanding service to the division. The **Warren M. Roshenow Award** is sponsored by the Gas Turbine Heat Transfer Committee. The **Clock Award** is sponsored by the Heat Transfer in Electronic Equipment Committee and the Electronic & Photonic Packaging Division. The **Undergraduate Research Award** is sponsored by the Education Committee. The division also sponsors a Best Paper Award, Best Poster Presentation Award, Classic Paper Award, and Undergraduate Research & Design Award.

## 5 Selected Developments and Trends

With the many division and committee activities, it is impossible to present even a cursory overview of the past 75 years. However, a few selected highlights including recent trends are summarized here.

**5.1 Computational Heat Transfer.** In the early 1960s when mainframe computers became available, there was an explosion in the amount of work done in numerical solutions. The computer allowed previously intractable problems to be revisited. Investigators of that era will remember the required stack of IBM cards and the challenge to get as many runs during a day as possible. Some of the earliest and best work was done by Stuart Churchill (and his students at the University of Michigan). He later moved to the University of Pennsylvania. Much of that work was focused on natural convection. In the early work, investigators wrote their own finite difference programs; later, more generic codes were written. Issues of stability and especially convergence were addressed on an ad hoc basis. Other names that come to mind in this area include Suhas Patankar (Minnesota), Brian Spalding (Imperial College of London), Richard Pletcher (Iowa State), Graham de Vahl Davis (University of New South Wales), and Yogesh Jaluria (Rutgers). Of course, many others were involved.

**5.2 Radiation Heat Transfer.** Over the history of the HTD, radiation heat transfer research moved from methods to aid in the design of industrial furnaces to space applications and solar energy. The search goes on for the most efficient numerical techniques to handle multimode heat transfer where radiation is a significant contributor. All of these continue to drive active research, but recently, much research has centered on microscale and nanoscale effects. Key contributors to the radiative heat transfer activities within ASME include Hoyt Hottel, Jack Howell, Donald Edwards, Robert Siegel, Eph Sparrow, Raymond Viskanta, Michael Modest, Chang-Lin Tien, Richard Buckius, Yildiz Bayazitoglu, Pinar Mengüç, and Alfred Crosbie.

**5.3 Heat Transfer Equipment.** The Heat Transfer Equipment Committee is one of the few committees where there has been strong industrial participation. This committee focuses on applications where heat transfer equipment is an essential component and provides a strong link between heat transfer art and science. Relevant topics include enhanced heat transfer, fouling, compact heat exchangers, heat transfer equipment in the power and process industries, and flow maldistribution. Alfred Mueller was an early participant, and Ramesh Shah (Harrison Radiator), John B.

(Bucky) Kitto (Babcock & Wilcox), and James Chenoweth (Heat Transfer Research, Inc. (HTRI)) were mainstays of the committee for many years. Kitto was also very active in ASME, serving at one time as vice president of Region V (and in many other capacities), and is coeditor of B&W's classic *Steam: Its Generation and Use* [23]. James Welty (Oregon State) and Wen-Jei Yang (Michigan) were two academicians who participated on a regular basis. Later participants also included James Robertson (UK), Michael Jensen, Zahid Ayub, Raj Manglik, and Larry Swanson.

HTRI was organized in 1962 as a for-profit, industrially owned consortium by users, designers, and manufacturers of heat transfer equipment to promote systematic, application-oriented research in the field of heat transfer. The company was originally located at C. F. Braun & Company in Alhambra, California. Jerry Taborek was the first technical director and the driving force in the company for over 20 years. James Chenoweth, a member of the HTRI staff, was very active in the ASME Heat Transfer Equipment Committee and served as 1988–89 HTD chair. Joseph Palen and Stanley Kistler were for many years key technical resources in the firm. HTRI—a very active participant in the ASME-AIChE National Heat Transfer Conferences for many years—is now located in College Station, Texas with about 1500 corporate member sites in 62 countries.

**5.4 Microchannels and Minichannels.** One of the major paradigm shifts within the HTD during the last decade relates to microscale and nanoscale heat transport. At the Grenoble International Heat Transfer Conference, a few researchers including Gian Piero Celata (Italy), Peter Stephan (Germany), Stephane Collin (France), and Masahiro Kawaji (then in Canada), and Satish Kandlikar (Rochester Institute of Technology) discussed their new findings on single-phase flow in microchannels. It became apparent that there was much more to learn. Y. Guo's keynote lecture asserted that advanced experimental techniques were needed to accurately understand microscale transport. It was enthusiastically agreed that an international conference on this subject should be pursued. The very next year, the First International Conference on Microchannels and Minichannels was hosted in Rochester, NY. It became a meeting ground for researchers worldwide. Later, under the ASME umbrella, nanochannels were added to the conference theme. The conference was hosted in Rochester (twice), Toronto, Ireland, Mexico, Germany and Korea. The HTD and ASME Fluids Engineering Division came forward in 2009 to host the conference in alternate years. It went to Canada in 2010 and 2011, and then to Puerto Rico in 2012. As a direct outcome of the conference, more than 2000 technical papers have been presented, many of them published later in technical journals.

**5.5 Enhanced Heat Transfer.** The subject of enhanced heat transfer has reached a significant level of stature within the division and the heat transfer community. This development is due primarily to the efforts of Arthur Bergles and Ralph Webb (Fig. 14). Bergles was the pioneer in this area and when Webb moved from the Trane Company, where he had gained a wealth of practical experience in applied heat transfer, to Penn State he pursued this topic with vigor. Bergles and Webb developed a popular course in enhanced heat transfer, which began about 1975, through ASME and the HTD. Many sessions on this subject were conducted through the years, and they always generated considerable interest. Webb initiated and became the first editor of the *Journal of Enhanced Heat Transfer*, and also wrote the well-regarded *Principles of Enhanced Heat Transfer* [24]. A festschrift for Bergles was held at Georgia Tech in 1996 [25]. Allan Kraus, who did a lot of work in extended surfaces, an important enhancement technique, coauthored the well-known Kern and Kraus [26].

**5.6 Micro- and Nanoscale Heat Transfer.** Due to the importance of future energy solutions and other emerging needs, thermal engineering research has been growing, as evidenced by

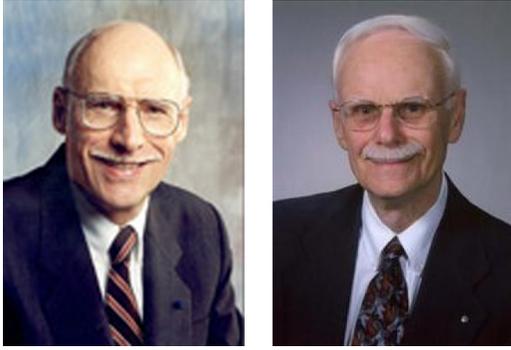


Fig. 14 Arthur Bergles (left) and Ralph Webb (right)

the increase in participants and presentations at recent heat transfer conferences. One of the most active research areas in thermal engineering is micro/nanoscale heat transfer. For example, the biannual international conference series on microscale and nanoscale heat and mass transfer (MNHMT) has been held three times with an attendance exceeding 300 each time. Many advocates and researchers have become involved with micro- and nanotechnology, but none has made a greater impact than Arun Majumdar.

The situation was quite different back in the early 1990s, when some rather pessimistic viewpoints existed on the future of heat transfer research, from “heat transfer is a mature research area” to “heat transfer is dying.” This changed as a result of a forum at the 1992 IMECE in Anaheim organized by Yildiz Bayazitoglu of Rice University and G. P. (Bud) Peterson, then with the Texas A&M University, on “Fundamental Issues in Small Scale Heat Transfer.” Along with several other distinguished speakers, C.-L. Tien gave a talk on the challenges and opportunities in microscale heat transfer.

At the 2002 IMECE in New Orleans, the Heat Transfer Educational Committee sponsored a panel session on “Teaching Nano-Micro Heat Transfer.” Five panelists shared their educational experiences including Van Carey (Berkeley), Gang Chen (MIT), Ken Goodson (Stanford), Arun Majumdar (Berkeley), and Zhuomin Zhang (then at Florida). Several new textbooks have been published since then, and many universities now offer courses in micro/nanoscale heat transfer and energy transport. Recently, a new Committee on Nanoscale Thermal Transport was established within the HTD to coordinate and promote interaction and activities in the micro/nanoscale heat transfer areas. It is expected that the field of micro/nanoscale thermal transport and thermophysics will continue to develop and play a key role in energy technologies for many years to come.

An important sub-area that had received less attention than its counterparts, until recently, is nanoscale thermal radiation and radiative properties of nanostructures. Due to its importance in harvesting solar energy, this sub-area has grown rapidly in the past decade. Two mini-symposia were held at the 2005 and 2006 IMECES organized by Zhuomin Zhang (Georgia Tech) and Pinar Mengüç (then at the University of Kentucky), and a special issue was published in the January 2007 issue of the *Journal of Heat Transfer*. The First International Workshop on Nano-Micro Thermal Radiation, co-chaired by Shigenao Maruyama of Tohoku

University and Zhang, was held in May 2012 in Japan. This is a multidisciplinary field, coupled strongly with recent advances in photonics and metamaterials.

**5.7 Thermal Sciences.** Science is an evolutionary design in which what we know—what is true and what works—becomes simpler, more accessible, and easier to teach. The merger of mechanics with caloric theory into thermodynamics in the 1800s was not the end of this morphing by simplification and replacement. The caloric line continues to this day as thermometry, calorimetry and heat transfer. Although the first two were incorporated unchanged into thermodynamics, heat transfer developed into a self-standing discipline, with a major impact on applied mathematics, fluid mechanics and aerodynamics. Still, its proper place is in thermodynamics along with all the other caloric teachings. Bejan predicted the merger of heat transfer with thermodynamics in the preface of his 1982 book [27], and his prediction came at least partially true in the two decades that followed. Some heat transfer journals became journals of “thermal sciences” (heat transfer + thermodynamics), and in many universities the heat transfer and thermodynamics courses were combined into a single course on thermal sciences.

**5.8 The Constructal Law.** The science of heat transfer expanded in new directions, most vigorously in constructal theory and design. The constructal law was first stated in 1997 by Bejan [28], where he formulated the volume-point heat flow problem, which unveils an evolving tree-shaped architecture (Fig. 15) that is entirely deterministic. The constructal law is a law of physics that unifies science (physics, biology, engineering, and social sciences), and places the concepts of life, design and evolution in physics:

“For a finite-size flow system to persist in time (to live), its configuration must evolve in such a way that provides easier access to the currents that flow through it.”

The constructal law field is expanding rapidly. In September 2012, the entry “constructal” on ISI revealed 6,000 total citations, and 2,000 articles and books on Google Scholar.

## 6 Noteworthy Events and Workshops

The HTD was involved in conferences even before the division was formed through participation in ASME annual meetings. Upon its formation, the HTD moved quickly to initiate the National Heat Transfer Conference with strong participation from AIChE. Soon after, the International Heat Transfer Conference (see Sec. 7) was begun, and the division has actively participated in many national and international conferences through the years.

**6.1 AIChE-ASME National Heat Transfer Conference (NHTC).** By 1938, the society had developed a tradition of conducting two technical meetings each year: a spring or summer meeting and a winter meeting. That year the ASME held the National Spring Meeting in Los Angeles, the first national meeting held in the far west in many years. One of the 25 technical

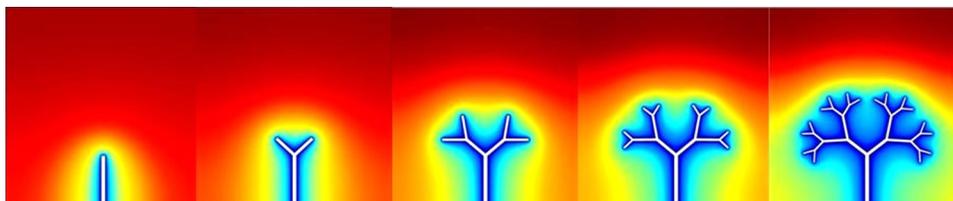


Fig. 15 Constructal invasion of a conducting tree into a conducting body

papers was presented by L. M. K. Boelter on “Heat Transfer Research at University of California” [29].

By the mid-fifties, the technical divisions were being encouraged to hold summer meetings. At the 1955, Winter Annual Meeting, plans were made to hold a National Heat Transfer Conference in August 1957 at Pennsylvania State University with George (Dusie) Dusenberre of Penn State in charge. AICHe was approached immediately, as were several other groups, for joint participation in the conference. Arthur Rathbun, the HTD’s 1981–82 chairman, fresh out of school and working for Bettis Atomic Power Laboratory, remembers participating in the first conference (Kenneth Bell also attended) that was dedicated to McAdams, marking his retirement from MIT. Rathbun recalls “... the conference was headquartered in the Nittany Lion on the Penn State campus. Participants slept in the student dorms and ate in the cafeteria. Sessions were held in various buildings across the Penn State campus” [30]. It was agreed that AICHe would host the even-numbered years and ASME the odd-numbered years, a pattern that lasted nearly 50 years. The chemical engineers brought diversity and a strong applications perspective to the conference, especially through the process industries; non-Newtonian flow and heat transfer; fouling of heat transfer surfaces; and mass transfer. Knudsen [31] discusses the first and early NHTCs as well as the organization of the AICHe Heat Transfer and Energy Conversion Division, with Alfred Mueller as the 1958 founding chairman.

In 1974, the AICHe established the Donald Q. Kern Award “in recognition of expertise in a given field of heat transfer or energy conversion without regard to society affiliation or nationality.” The widespread use and understanding of the term “process heat transfer” dates back to the publication of Donald Kern’s 1950 book, *Process Heat Transfer* [32], which is still in print after 62 years! Kern was a member of both ASME and AICHe, a founder of the AICHe Heat Transfer and Energy Conversion Division, and a recipient of the ASME Heat Transfer Memorial Award. The first three recipients of the Kern Award were Charles Gilmour, who spent most of his career with Union Carbide, Al Mueller of duPont, and Jerry Taborek of HTRI. Several ASME members including Arthur Bergles, Ralph Webb, and others have received the award. Until the last few years, the presentation of the Kern Award was a staple feature of the NHTC, along with presentation of the Jakob Award.

**6.2 25th National Heat Transfer Conference, Houston, TX.** In 1988, the HTD celebrated its 50th anniversary with a variety of activities. There was a special edition of the *Journal of Heat Transfer*, a convocation, several history sessions at the 25th National Heat Transfer Conference, and a *History of Heat Transfer: Essays in Honor of the 50th Anniversary of the ASME Heat Transfer Division* edited by Edwin Layton, Jr., and John H. Lienhard [33]. This volume included the “History of the Heat Transfer Division” [1] and several other papers. Elizabeth Jakob wrote a biography of her famous father, Max Jakob. Frank Kreith wrote about L. M. K. Boelter “... as seen through the eyes of his students.” E. R. G. Eckert authored, “Ernst Schmidt—As I Remember Him” (Fig. 16) and K. C. Cheng and Tetsu Fujii included a history of their own, “Review and Some Observations of the Historical Development of Heat Transfer from Newton to Eckert (1700–1960).”

July 26, 1988 was a typical hot, humid summer day in Houston; however, in the early evening of the 26th, in the air-conditioned comfort of the Hyatt Regency Hotel, a very special event took place: the HTD’s 50th Anniversary Honors Convocation. The master of ceremonies was L. S. Fletcher, a long-time member of the division and the ASME’s 104th president. ASME President Ernest Daman was there to extend the society’s congratulations in his opening remarks. James Chenoweth, the division chair, who always took care of details, designed a 50th anniversary logo for the occasion.

Chenoweth recognized the division’s past chairs with 24 of the 50 present (Fig. 17). Of the 50, several served more than one



**Fig. 16 Ernst Schmidt (left) and Ernst Eckert (right) taken at Los Angeles International Airport**

term. Thomas B. Drew served three terms: 1939–1943 and Herbert Nottage two terms: 1954–1956. Norris, Mueller, and Nottage all played key roles in the formation of the division. A total of 18 past chairs were deceased by 1988.

Fletcher presented the 50th Anniversary Awards to 23 of the 31 recipients who were present (Fig. 18). Of the 31 living recipients only three were unable to attend. The citation read as follows:

On the occasion of the 50th Anniversary of the Heat Transfer Division the Executive Committee of the Division recognizes the many members who by their contributions and service have established the excellent stature that the Division has attained. In particular the Committee, by the 50th Anniversary Award, cites for their special and distinguished contributions (31 individuals):

The individuals shown in Figs. 17 and 18 (note that there were quite a few past chairs who also received the 50th Anniversary Awards) collectively have helped bring the Heat Transfer Division to its present stature. Individually, they have made unique and significant contributions to the division, ASME, and the engineering profession. It is simply impossible to adequately acknowledge the magnitude of their efforts in this short history. However, bits and pieces of their contributions are scattered throughout this history, and it is hoped that the reader will get at least a glimpse of their greatness.

After the recognition of the past chairs and the presentation of the 50th Anniversary Awards, Past Chair Frank Kulacki made Special Recognition Awards to Hemisphere Publishing Corporation and Scripta Technica, Inc. for their contributions to the HTD. William Begell of Hemisphere (Fig. 19) and Frank Cerra of John Wiley gratefully received the awards on behalf of their respective organizations.

David Miller of Argonne National Laboratory (ANL) then gave an interesting and informative slide presentation on “A Review of the Heat Transfer Division,” and the attendees shared the birthday cake provided by AICHe. In the annals of the ASME Heat Transfer Division, the 50th Anniversary Convocation was certainly one of the most impressive events of its history.

**6.3 AIAA-ASME Thermophysics and Heat Transfer Conference.** This conference was begun in 1970s and is held every 4th year during the year when an IHTC is held. ASME participation in this conference was not as great as that for the NHTC and became a casualty for several years, though one is planned for 2014.



**Fig. 17** Photograph of Heat Transfer Division chairmen. Seated in front row: R. L. Webb, R. H. Norris, S. P. Kezios, R. W. Graham, J. A. Clark, V. E. Schrock, S. Levy, and A. C. Mueller. Standing: M. Tribus, J. R. Lloyd, J. M. Chenoweth, F. A. Kulacki, R. A. Seban, R. J. Goldstein, C.-L. Tien, F. Landis, S. Ostrach, R. J. Simoneau, T. F. Irvine, Jr., A. S. Rathbun, Jr., R. K. Shah, A. E. Bergles, L. H. Back, and W. M. Rohsenow. Photo by Bill Ashley.



**Fig. 18** Photograph of the 50th anniversary award recipients. Seated in the front row: R. H. Norris, E. M. Sparrow, R. W. Graham, J. S. Clark, V. E. Schrock, W. H. Giedt, and A. C. Mueller. Standing: S. P. Kezios, A. L. London, R. A. Seban, R. H. Sabersky, R. J. Goldstein, C.-L. Tien, T. F. Irvine, Jr., S. Ostrach, E. R. G. Eckert, F. Landis, R. K. Shah, A. E. Bergles, J. P. Hartnett, L. H. Back, S. Levy, and W. M. Rohsenow. Absent: E. Fried, F. W. Schmidt, and H. B. Nottage. Deceased: L. M. K. Boelter, A. P. Colburn, G. M. Dusenberre, T. B. Drew, and K. A. Gardner. Photo by Bill Ashley.

**6.4 Symposium on Thermophysical Properties.** This symposium is a very important conference in which the HTD has participated since 1959. The paper by Kezios [34] in 1999 and the later paper by Haynes et al. [35] in 2002 provide excellent histories of the conference. It was initiated at Purdue University which, at the time, was home to the *Thermophysical Properties Research Center* (TPRC) founded and managed by Y. S. Touloukian. The Committee on Thermophysical Properties (K-7) has primary responsibility for the organization of this conference, while the National Institute of Standards and Technology (NIST), previously known as the Bureau of Standards, provides

the institutional support and sponsorship of the event. This symposium has been held every three years since its inception with the most recent being the 18th at the University of Colorado, Boulder in July 2012. The Yeram S. Touloukian (Fig. 20) Award was established in 1988 to honor Touloukian's contributions in the field of thermophysical properties. In addition to Touloukian and Kezios, key players in the symposium through the years include Jan Sengers (University of Maryland), A. Cezairliyan (NBS), C. Y. Ho (Purdue), Mickey Haynes (NIST), and Richard Jacobsen (INEEL) among others. About Jacobsen, Kezios wrote in his 1999 article:



**Fig. 19** Past HTD Chair Frank Kulacki presents Special Recognition Award to William Begell of Hemisphere Publishing Corporation for his contributions to the HTD. Photo by Bill Ashley.



**Fig. 20** Y. S. Touloukian

Richard Jacobsen I must single out as a long-time associate, who is commended for his constant demeanor of fairness and balance over the years he chaired K-7. His skillful handling of a number of critical situations kept the K-7 Committee ... and ... its focus intact.

It is doubtful that anyone who has had the pleasure of working with Jacobsen would disagree with Kezios's generous assessment.

**6.5 Workshops.** The HTD and the National Science Foundation (NSF) have been closely intertwined since the Engineering Division, later the Directorate for Engineering, was formed over 40 years ago. Heat transfer research has been funded primarily through the Thermal Transport and Thermal Processing (TTTP) program, and a long series of "rotating" program directors have helped to sustain TTTP as a foundational partner with HTD. Included among these distinguished icons and national leaders in engineering research and education, were Eph Sparrow (Minnesota), G. P. Peterson (now president of Georgia Tech), Jack Howell (Texas), Richard Buckius (now vice president for research at Purdue), Alfonso Ortega (now vice president for research at Villanova), Timothy Tong (now president of The Hong Kong Polytechnic University), and Theodore Bergman (now department head at Kansas). Together, HTD and TTTP have striven to identify the frontiers of research in transport phenomena.

Several major workshops have been conducted over the years, providing venues for researchers, educators and policy-makers to debate and identify frontier challenges and associated opportunities in heat and mass transfer. For example, a 1991 workshop held in Chicago and sponsored by NSF identified the critical technologies of the day: manufacturing, heat exchanger technology, materials processing, energy, aerospace technologies, environmental issues, digital data processing, bioengineering and biotechnology,

and nano- as well as microtechnology (which, when viewed in retrospect, received surprisingly little attention) [36]. A subsequent and larger NSF-sponsored workshop was held in 2007 at the University of Connecticut [37] with the top priorities being energy systems, nanotechnology, heat transfer education, and biological systems. A comparison of the 1991 and 2007 priorities demonstrates the heat transfer community's impressive achievements and remarkable versatility and adaptability. The 2007 Storrs workshop also led to several broad-based suggestions including the need to: (a) Carefully navigate the evolving terrain of globalization and university-industry-government interactions, (b) assume a leadership role to address the grand challenges facing society [38], and (c) understand the physical coupling between heat transfer phenomena at the smallest scales to the megascale in order to tackle and solve challenges ranging from climate change to safe and affordable water.

Through the years many other workshops have been held under the auspices of NSF, U.S. Department of Energy, Office of Naval Research, and other governmental agencies.

## 7 Internationalization of the Heat Transfer Division

**7.1 International Heat Transfer Conference (IHTC).** The first IHTC was held in London, England in 1951. Ten years, later a second conference was held in Boulder, Colorado where the terminology "International Heat Transfer Conference" was first used. The current four year cycle began with the 3rd IHTC held in Chicago, Illinois in 1966 where the Assembly for International Heat Transfer Conferences (AIHTC) was established to oversee the IHTC.

The 3rd IHTC in Chicago was cosponsored by the Energy Conversion and Transport Division of AIChE (the host society) and the HTD. James Westwater (Illinois) of AIChE served as chairman and Thomas Irvine, Jr. (SUNY) was secretary. D. Q. Kern, A. D. Kraus, S. Levy, S. Ostrach, and S. P. Kezios were among those who served on the committee. The Institute of Mechanical Engineers, UK, also was a major participant in the conference. Special lectures were given by R. S. Silver (Scotland), S. Churchill (Michigan), S. Ostrach (Case Institute of Technology), and S. S. Kutateladze (Academy of Sciences, USSR), along with 18 technical sessions on a broad variety of topics. Richard Goldstein (Minnesota), 1974–75 HTD chair and 115th ASME president in 1996–97, recalls attending a gathering during the 3rd IHTC in Chicago at the home of James Hartnett (University of Illinois, Chicago). He remembers that Warren Rohsenow (MIT) was there and played the piano for everyone.

The 1978 IHTC was the first time poster sessions were used extensively and that conference had a total of 36 keynote lectures including Goldstein on measurement techniques, Geoff Hewitt (AERE, Harwell) on "Critical Heat Flux in Flow Boiling," Arthur Bergles (RPI) on "Enhancement of Heat Transfer," and Ivan Catton (UCLA) on "Natural Convection in Enclosures." The 2006 conference in Sydney, the first IHTC held in the southern hemisphere, had 836 participants from 18 different countries. Seven discussion panels were organized including one on heat transfer education in which Frank Kulacki (Minnesota) participated. Other IHTCs were held in Tokyo (1974), Munich (1982), San Francisco (1986), Jerusalem (1990), Brighton (1994), Grenoble (2002), and Sydney (2006). The most recent one was the 14th held in Washington, DC, with more than 1,100 participants on hand, making it one of the largest IHTC conferences ever held. There were 850 posters, 38 keynote lectures, and participants from 50 countries, about  $\frac{1}{3}$  from Europe,  $\frac{1}{3}$  from North America, and  $\frac{1}{3}$  Asia/Australia. Avi Bar-Cohen of Maryland (Fig. 21) is currently the AIHTC chair. Poster sessions, along with the invited lectures, make for a very nice format given that the participants are from many different countries, making communication a challenge. This conference should not only survive, but actually thrive in the future with a global interest in heat transfer.



Fig. 21 Avram Bar-Cohen

**7.2 ASME-JSME Thermal Engineering Conference.** The First ASME-JSME (AJTEC) Conference was held at the Hawaiian Regent Hotel in Honolulu, HI, March 20-24, 1983. The attractive venue was chosen primarily as a convenient location between the two sponsoring countries. The HTD and the Japan Society of Mechanical Engineers were joint sponsors with Wen-Jei Yang (Michigan) and Yasuo Mori (University of Tokyo) as co-chairmen. Among the keynote speakers were Paul Marto (Naval Postgraduate School), Kenneth Torrance (Cornell), C. K. Law (Princeton), Gerard Faeth (Penn State), Win Aung (NSF), and K. Nishikawa (Kyushu University). The conference was well attended with a total of 71 technical sessions. Since that first conference, ASME and JSME have developed a successful series of joint conferences on thermal engineering at four-year intervals. Follow-on conferences in this series were held in Honolulu (1987); Reno, NV (1991); Maui, HI (1995); San Diego, CA (1999); Hawaii Island, HI (2003); and Vancouver, Canada (2007). The 8th AJTEC was again held in Honolulu with key themes of "Fundamental" and "Interdisciplinary" with a vision for the future of thermal engineering. The Korean Mechanical Engineering Society (KSME) will participate in the upcoming conference in 2015.

**7.3 Collaboration Between the Former Soviet Union Countries and the U.S.** In 1961, engineers from the U.S., Soviet Union, and Europe gathered in the Soviet Union for technical discussions, socialization, and the launch of collaboration efforts. Key Soviet scientists were A. V. Luikov and S. S. Kutateladze who represented the new generation of heat transfer leaders. They began interactions with western leaders such as J. P. Hartnett, T. F. Irvine, and E. R. G. Eckert of the U.S., A. J. Ede and D. B. Spalding of the UK, U. Grigull and K. Stephan of Germany, and E. A. Brun of France (see Figs. 22 and 23). Eventually, the International Journal of Heat and Mass Transfer, the International Heat Transfer Conference (IHTC), and the International Center for Heat and Mass Transfer were keys to bridging the East-West scientific communities.

As a result of visits and communications, J. R. Lloyd of Michigan State University became part of a research team, led by S. P. Malysenko and Leontiev, focused on hydrogen energy storage. Students from Moscow Power Engineering Institute came to Michigan State for extended stays and research.

Subsequently, under an NSF grant obtained by Lloyd, five final year Ph.D. students and their faculty mentors were supported to attend the A. I. Leontiev School for Young Scientists and Specialists in Kaluga, Russia. Students came from Michigan State, Maryland, Minnesota, Georgia Tech, and Texas-Austin. Connections were made with the students from Moscow who had visited Michigan State plus the top selected students from Russia. Today, research collaboration between the U.S. and Russia is growing rapidly. Some Russian scientists and engineers have now moved to the U.S. Russian heat transfer scientists and engineers are beginning to take a role in the leadership of the HTD, as evidenced by the appointment of Yaroslav Chudnovsky, now with Argonne National Laboratory, to the HTD Executive Committee.



Fig. 22 Left to right: A. I. Leontiev, J. P. Hartnett, E. R. G. Eckert, unidentified, and C.-L. Tien at the 1994 International Heat Transfer Conference in Brighton, England



Fig. 23 Photo by A. I. Leontiev on red square. Left to right: Natalia Medvitskaya, Brian Spalding, Thomas Irvine, Sandra Irvine, James Hartnett, Jack Lloyd. Front: then, student Yaroslav Chudnovsky.

## 8 Publications

ASME was founded in 1880 and the Transactions of the ASME were initiated that year as well. The early history of publications by ASME was discussed in Lienhard and Layton [1]. They noted that only eight heat transfer papers were published during the first 32 years of the Transactions of the ASME. After 1922, publications started to pick up; in particular, between 1941 and 1958 several classic papers such as

- T. von Karman, "The Analogy between Fluid Friction and Heat Transfer," Vol. 61, 1939, pp. 705–711.
- R. C. Martinelli, "Heat Transfer in Molten Metals," Vol. 63, 1941, pp. 447–455.
- K. A. Gardner, "Efficiency of Extended Surface," Vol. 67, 1945, pp. 621–631.
- W. M. Rohsenow, "A Method of Correlating Heat-Transfer Data for Surface Boiling Liquids," Vol. 74, 1952, pp. 969–975.
- N. Zuber, "On the Stability of Boiling," Vol. 80, 1958, pp. 711–720.

were published and by 1958 the Transactions were publishing about 35 heat transfer papers per year. Also, the Journal of Applied Mechanics (JAM) had become a separate journal during this time, and heat transfer articles were published in JAM as well. In 1945, the Transactions included an entire symposium on heat transfer in fins.

**8.1 HTD Newsletter.** The division's newsletter is published online on a yearly basis. It contains a lot of very useful information including details about division leadership, conferences, awards, and other details. Taken as a group, the newsletters provide a running history of the division.

**8.2 ASME Journal of Heat Transfer (JHT).** Soon after the HTD was formed, the leadership started pushing for its own journal based on the steady increase in heat transfer papers being produced. After about 15 years, ASME announced in 1958 that the Transactions of the ASME would be split up into four different journals; however, none of the four was a heat transfer journal. But, thanks to some last minute heroic efforts by Scotty Kezios, the Journal of Heat Transfer (JHT) was added as a fifth transactions journal. So, the first issue of the journal was published in February 1959 with 15 articles (Fig. 24). Among the familiar authors of papers in the maiden issue were Eph Sparrow, Robert Siegel, Sol Levy, Ralph Greif, R. G. Deissler, and George Dusinberre. For the first three years J. J. Jacklitsch of the ASME staff served as editor with Kezios as consulting editor. In 1963 the position of senior technical editor was established (later changed to technical editor with an editorial board of associate editors in 1968). The JHT disseminates information of permanent interest in the areas of heat and mass transfer. Contributions may consist of results from fundamental research that apply to thermal energy or mass transfer in all fields of mechanical engineering and related disciplines. The journal is available in both print and electronic format, but within the next few years only the electronic format will be available. From the very beginning the division established a rigorous peer review process which remains to this day, and the contributions of the reviewers in maintaining high standards is

**Table 2 Editors of the Journal of Heat Transfer (1959–present)**

1959–1962	J. J. Jacklitsch (with S. P. Kezios as Consulting Editor)
1963–1969	S. P. Kezios
1970–1972	W. H. Giedt (R. A. Seban completed second year due to Giedt's illness)
1972–1980	E. M. Sparrow
1980–1984	K. T. Yang
1985–1989	G. M. Faeth
1990–1994	J. R. Howell
1995–1999	R. Viskanta
2000–2004	V. K. Dhir
2005–2010	Y. Jaluria
2010–present	T. Simon

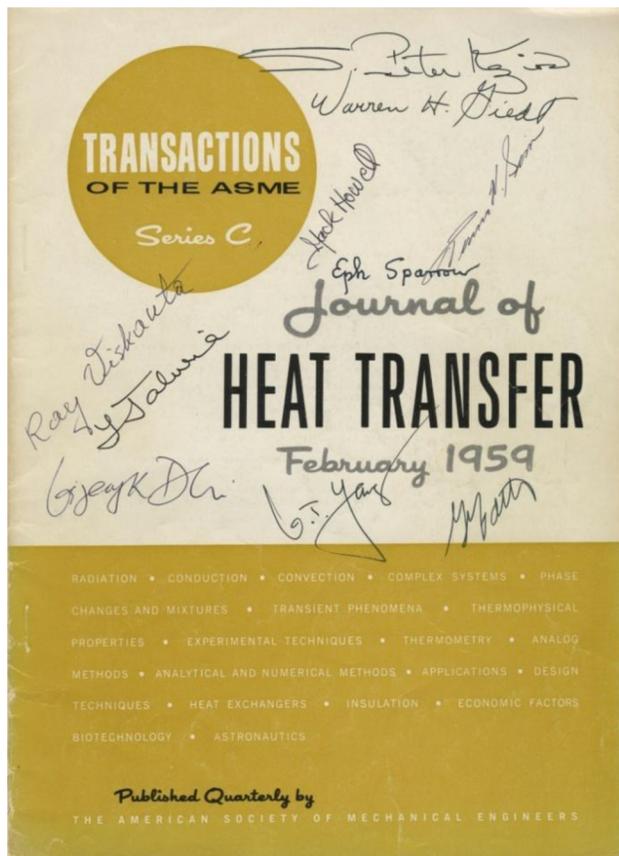
regularly acknowledged. Today, there is a general consensus that the ASME Journal of Heat Transfer is the world's premier journal in its field.

The past and current editors of the Journal of Heat Transfer are listed in Table 2. The JHT editors have all been academicians with a strong record of research and service; however, there has been participation by industry, national laboratories, and government through the associate editors. In 1988, there was a special fifth issue of volume 110 of the JHT prepared as part of the division's 50th anniversary with a total of 20 review articles on a range of topics. A number of hardbound copies of this edition were published as well those in the usual format. More recently, there have been several other special issues, i.e., Electronic Cooling (January 2005), Gas Turbine Heat Transfer (May 2005), Boiling, Two-Phase Flow Heat Transfer, and Interfacial Phenomena (December 2006), Nano/Microscale Radiative Transfer (January 2007), Computational Heat Transfer (April 2007), Micro/Nanoscale Heat Transfer (April 2008), Micronanoscale Heat Transfer (March & April 2009), Recent Advances in Porous Media Transport (October 2009), Molecular-to-Large-Scale Heat Transfer With Multiphase Interfaces (December 2009), Radiative Heat Transfer (February 2010), Recent Advances in Microchannel Heat Transfer (April 2010), Heat and Mass Transfer in Biosystems (January 2011), Advanced Thermal Processing (March 2011), Thermal Issues in Emerging Technologies (March 2012), Heat Transfer in Nanochannels, Microchannels, Minichannels (February 2012), and Microscale Heat and Mass Transfer (May 2012). A careful review of this list of special issues clearly indicates the primary focus has been in the area of micro- and nanoscale heat transfer.

Another feature was introduced in the May 1997 issue of JHT: the Heat Transfer Photogallery. This section features photographs, many in beautiful color, illustrating a variety of heat transfer phenomena. This addition helps to visualize heat transfer and brings real meaning to the old term that "a picture is worth a thousand words." And, it might be added that "a color picture is probably worth at least two thousand words."

Since the 1980s, the JHT has moved from four issues per year, with a significant publishing delay because of a backlog of quality papers, to bimonthly issues. Finally, submission pressures allowed the present monthly format. The editors took the lead in coordinating a common symbol list among the major heat transfer journals, and many journals now allow authors to provide only a list of those symbols not on the common list. This approach resulted in a significant savings in pages over the years.

**8.3 The ASME Journal of Thermal Science and Engineering Applications (JTSEA).** This relatively new journal focuses on the dissemination of information of permanent interest in applied thermal sciences and engineering and is intended to be complementary to the JHT. Thus, the Journal directly addresses the concern of some HTD members who feel that the Journal of Heat Transfer has become "too theoretical." Contributions must have clear relevancy



**Fig. 24** Cover of the first (February 1959) issue of JHT with the signatures of all ten technical editors. The JHT editors were honored at the Heat Transfer Division dinner at the 1990 Winter Annual Meeting in Dallas, TX.

to an industry, an industrial process, or a device. While the processes and phenomena discussed may be complex, the results must have a relatively straightforward or feasible path to application. Subject areas can be as narrow as a particular phenomenon or device or as broad as a system. Papers are sought that have long-term relevance to specific applications including: original research of an applied nature; application of thermal sciences to processes or systems; technology reviews; and identification of research needs to solve industrial problems at all time and length scales. The founding editor was Michael Jensen of Rensselaer Polytechnic Institute, a position he still holds. The journal is published quarterly.

**8.4 Other Journals.** With the explosion of publications in the field of heat transfer, a number of important journals have appeared. The International Journal of Heat and Mass Transfer is published by Pergamon Press and was started in 1960. The founding editor was James Hartnett, a position he held for many years, and W. J. (Wally) Minkowicz (University of Illinois, Chicago) is the current editor-in-chief. A sister publication, Letters in Heat and Mass Transfer, renamed International Communications in Heat and Mass Transfer was started a few years later. Heat Transfer Engineering had an interesting beginning. Kenneth Bell, Jerry Taborek, Ernst Schlunder, and William Begell met at the New Otani Hotel at the 1974 International Heat Transfer in Tokyo. They agreed on the need for a journal that would encourage publication of applied heat transfer papers while meeting the quality standards of archival literature. So, volume 1, issue 1 was published in 1979 by Hemisphere with Ken Bell as editor-in-chief and the journal is now in its 33rd year. Numerical Heat Transfer: Part A Applications and Part B Fundamentals is published by Taylor and Francis with Minkowicz as editor-in-chief. Experimental Heat Transfer was started in 1987 with C.-L. Tien as the founding editor and is published by Taylor and Francis. Dimos Poulikakos (Swiss Federal Institute of Technology) is the current editor. The Journal of Enhanced Heat Transfer, published by Begell House, was started in 1994 with Ralph Webb as editor, a position currently held by Raj Manglik (University of Cincinnati). The Journal of Thermophysics and Heat Transfer is published by the American Institute of Aeronautics and Astronautics with Alfred Crosbie, Missouri University of Science and Technology, as editor. Experimental Thermal and Fluid Science, published by Elsevier, started publication in 1988 with Ramesh Shah as cofounder and editor, a position he held for several years. Lawrence Kennedy (Ohio State, Illinois—Chicago) then served as editor from 1995–2008. Current editors-in-chief are G. P. Celata (ENEA, Italy) and I. Kennedy (UC Davis).

## 9 Concluding Remarks

This retrospective on the Heat Transfer Division ends with a recognition of the ASME staff, a personal story, and a glimpse into the future that reflects the division as well as thermal science and technology.

First, it goes without saying that in order for the ASME and HTD to be successful, there must be good rapport between the staff and volunteers. It takes hard work, dedication, understanding, and a continuing effort to achieve desired objectives. So, on behalf of the volunteers, we say “Thank You” to the staff for its support of the division over the past 75 years.

Second, here is a story that illustrates the professional and personal attachment that many of us have experienced through our association with the division and ASME. It is told through the recollections of Erwin Fried who served as HTD chair in 1977–78 [39].

One of the most memorable activities during the annual heat transfer conferences and similar events, was the nightly gathering of heat transfer activists in the Hemisphere Publishing hospitality suite, provided by William Begell. It was a place where books were hatched, friendships were made, stories were told, and refreshments were consumed. But the most memorable part was Allan Kraus

telling jokes. He could go on for hours, and they were quite good. I recall that one time in San Francisco, when Allan was ready to go back to his hotel, he asked me to hold his wallet, because some attendee had been held up and robbed and he did not want to be a victim on his way to his room.

Of course, Allan had a distinguished career and was an expert in extended surfaces and cooling of electronic equipment. Begell, a real friend of the Division, served on the ASME Board of Communications as a representative of Hemisphere Publishing and later Begell House. Although both Allan and Bill, and so many others, are no longer with us, they are still remembered for their contributions to the HTD.

The story continues with Thomas Rudy who earned his Ph.D. at Penn State under Ralph Webb, spent his entire career with Exxon, and was active in both HTRI and HTFS. He was also an active member of the Heat Transfer Equipment Committee and served on the Executive Committee in the early 1990s. He recently shared a nice story [40]:

One of my earliest remembrances of heat transfer division activity occurred at my very first attendance at an HTD meeting at the AIAA/ASME Thermophysics and Heat Transfer Conference in Palo Alto, California in May 1978. I was still new in the heat transfer community and did not know any of the meeting participants. Most seemed to know each other, though, and were enjoying catching up on events since their last meeting. I was about to leave after the sessions to go have dinner on my own when I heard someone say, “Hey where are you going?” I turned to the person and said that I had no plans so he immediately said that I should come along with him and a group of friends. That night I made many new acquaintances and it was the start of more than 40 years of activity in the Heat Transfer Division and local ASME Sections. That person who got me started was Irwin Fried. I will never forget his kindness in bringing along a new engineer. Whenever I have seen him at meetings, I have made a point to thank him and tell him that since that initial kindness of his, I’ve tried to do the same thing in meetings I’ve attended. This is a great habit to adopt to strengthen our Division.

Tom’s story is a reminder that while it is always great to see our heat transfer friends, it is also good to reach out to those we don’t know, especially the young people. I’m sure we all remember going to our first meeting and being in awe of people that we had read about or perhaps studied their works.

Finally, the HTD has gone through many changes in its impressive 75-year history. In another 25 years, the division will celebrate its 100th anniversary. Many current seniors will not be present for that celebration, but we can speculate about upcoming changes.

A number of people have lamented the demise of the ASME-AIChE National Heat Transfer Conference. In the early days the chemical engineers were closely aligned with process heat transfer and had strong ties with industry. This relationship helped to ensure a strong link between heat transfer art and science. Without their participation we have lost an important partnership.

Others are concerned with the level of industrial participation in the HTD and a lack of industrial experience by the current faculty, due in part to the extreme pressure to obtain funded research. The division, for most of its existence, has always had an academic majority; however, the leadership has done a very good job in alternating division chairs between academic and non-academic representatives. It is very important that the division retain representation from industry and national laboratories among its ranks.

As the quantity of research being carried out has exploded, so have the number of publications—not just in ASME journals but in many others as well. The other day I heard someone comment, in this regard, that we seem to have become better writers than readers. And, here is a related subject that is sure to get the attention of the division’s researchers: Since the government is supporting much of this work, there is a minority (currently) arguing that all publications based on such work should be in the open

domain, i.e., that journals should be “free.” At the present time, however, we can certainly celebrate the fact that the Journal of Heat Transfer continues to be the top journal in its field.

Looking to the future, internationalization will have a growing impact on ASME and the HTD. Micro- and nanotechnology research, development, and education will continue unabated, although some in the heat transfer community have expressed concern about the balance of work in this area and just about everything else. They argue that many heat transfer problems remain in traditional areas. A portion of our research efforts will, undoubtedly, become more multidisciplinary in the future because real-world problems are not neatly packaged into single disciplines. Medical and health issues will continue to mount and costs will continue to escalate; therefore, a closer alliance in the future with the Bioengineering Division is inevitable. And, I am sure that we will hear a lot more about the constructal law in the years to come. Finally, energy will continue to receive strong attention, as sustainable energy sources are sought, but the U.S. is likely to remain a petroleum-based economy for quite some time. Along with energy issues, there will be a growing attention on maintaining an adequate supply of clean water.

So, on the occasion of its 75th anniversary, the ASME Heat Transfer Division can celebrate a glorious past, basking on a solid foundation of superb technological advances, built by an incredible group of collegial, innovative, hardworking people—both researchers and practitioners. I have no doubt that the division will move on to even greater achievements in the future. The heat transfer road ahead will be bumpy, have some potholes, and a lot of curves, but the next generation will be up to the challenge.

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## References

- [1] Layton, E. T., Jr., and Lienhard, J. H., 1988, “A History of the Heat Transfer Division,” *History of Heat Transfer: Essays in Honor of the 50th Anniversary of the ASME Heat Transfer Division*, E. T. Layton, Jr., and J. H. Lienhard, eds., ASME, New York, pp. 1–23.
- [2] Lienhard, J. H., 2000, *The Engines of Our Ingenuity*, Oxford University Press, New York.
- [3] Koppes, C. R., 1982, *JPL and the American Space Program: A History of the Jet Propulsion Laboratory*, Yale University Press, New Haven, CT.
- [4] Eckert, E. R. G., 1981, “Pioneering Contributions to Our Knowledge of Convective Heat Transfer: One Hundred Years of Heat Transfer Research,” *ASME J. Heat Transfer*, **103**(3), pp. 409–414.

- [5] McAdams, W. H., 1933, *Heat Transmission*, McGraw-Hill, New York.
- [6] Lienhard, J. H., V, 2003, “A History of the MIT Heat Transfer Laboratory,” *Heat Transfer Eng.*, **24**(2), pp. 3–17.
- [7] Kezios, S. P., 1981, “Personalities and Progress in Heat Transfer and Fluid Dynamics,” John Orr Memorial Lecture, South African Society Mechanical Engineers, pp. 166–183.
- [8] Jakob, M., 1949, *Heat Transfer*, Vol. 1, John Wiley, New York.
- [9] Jakob, M., 1957, *Heat Transfer*, Vol. 2, John Wiley, New York.
- [10] Webb, B. W., 2003, “Legends of Purdue Heat Transfer,” Celebration of Heat Transfer Event Proceedings, School of Mechanical Engineering, Purdue University, West Lafayette, IN, pp. 13–17
- [11] Bergman, T. L., Lavine, A. S., Incropera, F. P., and DeWitt, D. P., 2011, *Fundamentals of Heat and Mass Transfer*, 7th ed., John Wiley, New York.
- [12] Eckert, E. R. G., 1980, *Introduction to the Transfer of Heat and Mass*, McGraw-Hill, New York.
- [13] Eckert, E. R. G., and Drake, R. M., Jr., 1959, *Heat and Mass Transfer*, McGraw-Hill, New York.
- [14] Eckert, E. R. G., and Drake, R. M., 1972, *Analysis of Heat and Mass Transfer*, McGraw-Hill, New York.
- [15] Nottage, H. B., 1968, “The ASME Heat Transfer Message,” Winter Annual Meeting, ASME, New York.
- [16] Johnson, H. A., ed., 1964, *Heat Transfer, Thermodynamics and Education. Boelter Anniversary Volume*, McGraw-Hill, New York.
- [17] London, A. L., and Seban, R. A., 1980, “A Generalization of the Methods of Heat Exchanger Analysis,” *Int. J. Heat Mass Transfer*, **23**, pp. 5–16.
- [18] Kays, W. M., and London, A. L., 1984, *Compact Heat Exchangers*, 3rd ed., McGraw-Hill, New York.
- [19] Shah, R. K., Kraus, A. D., and Metzger, D., eds., 1988, *Compact Heat Exchangers: A Festschrift for A.L. London*, Hemisphere, Washington, DC.
- [20] Kays, W. M., Crawford, M., and Weigand, B., 2004, *Convective Heat and Mass Transfer*, 4th ed., McGraw-Hill, New York.
- [21] Shah, R. K., and London, A. L., 1978, “Laminar Flow Forced Convection in Ducts,” *Advances in Heat Transfer, Supplement 1*, J. P. Hartnett, and T. H. Irvine, eds., Academic Press, New York.
- [22] Phinney, L., 2012, personal communication.
- [23] Kitto, J. B., and Stultz, S. C., eds., 2005, *Steam: Its Generation and Use*, Vol. 41, Babcock & Wilcox, Barterton, OH.
- [24] Webb, R. L., 1994, *Principles of Enhanced Heat Transfer*, John Wiley, New York.
- [25] Manglik, R. M., and Kraus, A. D., 1996, *Process, Enhanced and Multiphase Heat Transfer: A Festschrift for A.E. Bergles*, Begell House, New York.
- [26] Kern, D. Q., and Kraus, A. D., 1972, *Extended Surface Heat Transfer*, McGraw-Hill, New York.
- [27] Bejan, A., 1984, *Entropy Generation Through Heat and Fluid Flow*, John Wiley, New York.
- [28] Bejan, A., 1997, “Constructal-Theory Network of Conducting Paths for Cooling a Heat Generating Volume,” *Int. J. Heat Mass Transfer*, **40**, pp. 799–816.
- [29] Donnelly, F. J., 1976, *Over 60 Years of Mechanical Engineering, 1914–1976*, American Society of Mechanical Engineers, Los Angeles, CA.
- [30] Rathburn, A., 2012, personal communication.
- [31] Knudsen, J. G., 1998, “A History of the AIChE Heat Transfer and Energy Conversion Division,” Annual AIChE Meeting, Miami, FL, Paper No. 190c.
- [32] Kern, D. Q., 1950, *Process Heat Transfer*, McGraw-Hill, New York.
- [33] Layton, E. T., Jr., and Lienhard, J. H., eds., 1988, *History of Heat Transfer: Essays in Honor of the 50th Anniversary of the ASME Heat Transfer Division*, ASME, New York.
- [34] Kezios, S. P., 1999, “Foundations of the Symposium on Thermophysical Properties With a Historical Perspective,” *Int. J. Thermophys.*, **20**(6), pp. 1605–1628.
- [35] Haynes, W. M., Sengers, J. V., Jacobsen, R. T., and Friend, D. G., 2002, “History of the Symposium on Thermophysical Properties,” *High Temp. -High Press.*, **34**, pp. 369–378.
- [36] Jacobs, H. R., and Hartnett, J. P., 1991, “Thermal Engineering: Emerging Technologies and Critical Phenomena: Future Needs of Thermal Engineering Research,” Report, NSF, Washington, DC.
- [37] Bergman, T. L., Faghri, A., and Viskanta, R., 2008, “Frontiers in Transport Phenomena Research and Education: Energy Systems, Biological Systems, Security, Information Technology and Nanotechnology,” *Int. J. Heat Mass Transfer*, **51**, pp. 4599–4613.
- [38] “NAE Grand Challenges for Engineering,” <http://www.engineeringchallenges.org/>
- [39] Fried, E., 2012, personal communication.
- [40] Rudy, T. M., 2012, personal communication.