Max Jakob Memorial Award

The Max Jakob Memorial Award is bestowed in recognition of eminent achievement and or distinguished service in the area of heat transfer. Made annually, without regard to society affiliation or nationality, the award consists of a bronze plaque, an honorarium, and an embossed certificate. The award was established in 1961 by the ASME Heat Transfer Division in honor of Max Jakob, a pioneer in the science of heat transmission, commemorating his outstanding contributions as a research worker, educator and author. In 1962, AICHE joined in the award, which is administered by a board of seven, three from each Society, and the past chair.

Max Jakob, 1879–1955

Scientist, engineer, educator – Max Jakob belongs to that group of remarkable individuals whose talents and achievements earned German science a position of eminence in the latter part of the 19th century and the early part of the 20th century. Although his accomplishments in his native country had already given him worldwide recognition, they were followed by a second distinguished career in the United States.

Max Jakob was born on July 20, 1879 in Ludwigshaven, Germany. After completing the gymnasium, he attended the Technische Hochschüle München where he received an electrical engineer degree in 1902, a Diplom-Ingenieur in Applied Physics degree in 1903, and the degree of Doktor Ingenieur in 1904. In 1910 he embarked on a 25 year career at the Physikalisch-Technische Reichsanstalt, during which he founded and directed applied thermodynamics, heat transfer, and fluid flow laboratories.

He wrote over 200 technical papers, and was a prolific source of critical reviews, articles, and discussions. When he left Germany in 1936 fleeing Nazi persecution, he had already gained great stature as a scientist-engineer.

After a one-year lecture tour sponsored by ASME, Dr. Jakob became research professor of mechanical engineering at Illinois Institute of Technology (IIT) and consultant in heat research at the Armour Research Foundation. In 1942, he founded and became the first director of IIT's Heat Transfer Laboratory.

He was active in research, teaching, consulting, and writing, and became one of America's educational and scientific leaders. His books, an elementary textbook and a two-volume treatise on heat transfer, have had a profound influence on education and research. His formal honors include an honorary degree of Doctor of Engineering from Purdue University in 1950, and the Worcester Reed Warner Medal of ASME in 1952.

His colleagues and his students loved and admired him for his warm personality, subtle wit, and rare humility of spirit. When he died on January 4, 1955, they had lost a great friend, and humankind had lost one of its truly outstanding members.

Max Jakob Memorial Award Board (2012)

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2012 Max Jakob Memorial Award

Presented to: **Wataru Nakayama**

Lecture title: **Heat in Computers: A Note on Applied Heat Transfer for Information Technologgy**

July 17, 2013

Heat Transfer Division

2013 Summer Heat Transfer Conference

July 14–19, 2013
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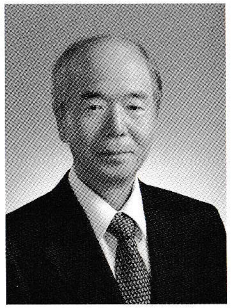

Wataru Nakayama

WATARU NAKAYAMA has been a heat transfer researcher and educator for fifty years of his career in industry and academia. He started his heat transfer studies when he enrolled in the graduate school of Tokyo Institute of Technology (Tokyo Tech) in 1961. He received the doctoral degree in 1966, and after a few years of experience in Canada, joined Hitachi, Ltd. in 1970. At Hitachi he conducted and supervised heat transfer research for a wide range of products including electrical machines, heat exchangers, and computers. In 1989, he became the Hitachi Chair Professor at Tokyo Tech, a position he held until his retirement in 1996. At Tokyo Tech he taught and conducted research on microelectronic packaging with a focus on power and thermal management of computers. After his retirement from Tokyo Tech he served as a visiting professor at the University of Maryland until 2001. He is currently working for a research project on the reliability design of electronic equipment, in an industry/academia consortium organized under the auspices of Japan Society of Mechanical Engineers.

Throughout his career Dr. Nakayama has applied heat transfer science to overcome various technological barriers facing the industry. He also made contributions to the understanding of heat transfer processes in industrial equipment by the fundamental studies he conducted with his colleagues. He has been particularly active in the following areas of research: thermal management of electrical and electronic equipment, and enhancement of boiling and forced convection heat transfer. His first work at Hitachi was cooling design of a large-capacity electric generator, in which he applied the analytical technique he developed during his thesis work at Tokyo Tech. The oil crisis in the early 1970s motivated his team of researchers at Hitachi to improve the design of an evaporator used in a refrigeration machine. He developed an analytical model to explain the mechanism of enhanced boiling heat transfer on the structured surface of an evaporator tube, and used the result of analysis to optimize the surface structure. Since the 1980s onward until today the focus of his research has been on thermal management of electronic equipment. He participated in the research and development of cooling devices and systems for the mainframe computers of the 1980s. In recent years he has been advancing the methodology of thermal design analysis to aid designers of compact electronic equipment. His current research topics include hot spot occurrence on many-core processor chips, heat conduction in complex structures, and modeling of electrical-thermal coupled systems.

While he worked in industry Dr. Nakayama was active in sharing the industrial needs for research with the heat transfer community through publications, seminars, and lectures. Some of his review articles on thermal management technology published in ASME *Applied Mechanics Reviews* and elsewhere have served as tutorial materials for graduate students and engineers in industry. The list of his invited lectures is long, including the keynote lecture on 'Enhancement of Heat Transfer' at the 7th International Heat Transfer Conference in Munich (1982), the Hawkins Memorial Lecture in Heat Transfer 'Thermal Frontiers of Electronic Technology' at Purdue University (1988), and the recent one at the University of Texas at Arlington (2010). After he joined academia he continued his commitments to the development of the thermal management community through the organization of conferences, editorial work on journal issues, and various committee works. He co-chaired the InterPACK in 1995, and has participated in the development of this conference series. He also co-organized the Japan-US Joint Seminar on 'Computers in Heat Transfer Science and Engineering' in 1991.

Dr. Nakayama served on the editorial board of various journals such as *Heat Transfer Engineering, International Journal of Heat and Mass Transfer, Journal of Enhanced Heat Transfer,* and *Experimental Thermal and Fluid Science.* The list of his administrative activities in professional societies includes: president of the Heat Transfer Society of Japan (1994), chair of the JSME Thermal Engineering Division (1990), chair of ASME Japan (1990-1992), and executive committee member of the International Center of Heat and Mass Transfer (1994-2002).

Dr. Nakayama has received many awards for his contributions to the advancement of heat transfer science and engineering as well as the development of the thermal management community; the best paper awards from ASME Heat Transfer Division (1981) and JSME (1965, 1980), the ASME Heat Transfer Memorial Award (1992), the ICHMT Fellowship Award (1996), the ASME Electrical and Electronic Packaging Division Award (1996, now Allan Kraus Medal), the JSME Award for Longstanding Contributions to Mechanical Engineering (1997), the ITHERM Achievement Award (2000), the InterPACK Achievement Award (2001), the Thermi Award (IEEE Semi-Therm, 2006), the JSME Funai Special Award (2007). Dr. Nakayama is a Fellow of ASME, a Life Fellow of IEEE, a Life Member of JSME, an Honorary Member of the Heat Transfer Society of Japan.

Citation

For original, transdisciplinary, fundamental research in heat transfer, including pathbreaking research into nanoscale phenomena, and their societal applications ranging from energy conversion to thermal energy reuse.

Abstract

Heat Transfer is but a means to better serve relevant engineering applications, both old and new. - Max Jakob

In the 1960s when I started my heat transfer studies, relevant engineering applications were concerned mostly with large industrial equipment such as heat exchangers in power plants and nuclear reactors. There is a notable distinction for the computer as a subject of heat transfer research compared with other industrial equipment. The term 'computer' invokes an image of a box, but the details inside the box are in a state of constant evolution. Miniaturization of circuit elements, modularization of circuit assemblies, and construction of a system on multi-level assembly of components are being pursued in all classes of computers. Concomitant changes in heat generation density and heat transfer paths pose fresh challenges to thermal management. I recollect my experiences in cooling of the mainframe computers of the 1980s, where the system's morphological transition allowed the adoption of water cooling. After presentation of the historical account the past experience is recaptured from a generic viewpoint, and the future of supercomputer is projected in a chart of technological evolution. The projection points to the need to reduce the space for coolant flow to an extremely small scale. We, however, note that the shrinkage of coolant space is not a distant possibility but already undergoing in various computers today. In densely packed equipment the coolant flow paths become complex, posing a challenge to a user of CFD simulation code. In highly integrated circuits the paths of electric current and heat become coupled, and coupled paths make the electrical/thermal co-design an extremely complex task. These issues of increasing complexity will be illustrated using the examples of a consumer product and a many-core processor chip. Removal of high heat flux has been a popular research topic in the past decades, where an ample space for coolant flow is often tacitly assumed. Such convenient assumption will be hard to apply in future generation computers.

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