

Foreword

In Honor of Dr. M. M. Yovanovich



Michael Yovanovich was born in Montreal, Quebec. After three years in northern Quebec, his family moved to and settled in St. Catharines, Ontario, about 15 miles from the US border. Michael received a classical high school education: he took all the mathematics and science courses, as well as French, German, and Latin. He was in the actors guild and had minor parts in three plays.

He obtained his B.A.Sc. in Mechanical Engineering from Queen's University in Kingston, Ontario, Canada, in 1957. The four years were uneventful, except for spending one year with the Queen's University actors group. He then spent six years with Foster Wheeler Limited of St. Catharines, where he was involved with sizing small and large steam generators. During this time he commuted to Buffalo, NY, to obtain his M.Sc. in Mechanical Engineering from the University of Buffalo, which became the State University of New York at Buffalo in 1963. The Mechanical Engineering Department offered Michael a teaching position with an opportunity to get his Ph.D. on a part-time basis. Rather than take this offer, he decided to go elsewhere for further graduate studies.

Michael was advised to apply to several schools to ensure that one would accept him. He applied to M.I.T., Cornell, University of Michigan, Purdue, and Cal Tech, hoping that at least one would accept him. He was surprised and pleased that all five accepted him. He chose M.I.T. hoping to study boiling for Nuclear Reactors. However, Warren Rohsenow and J. J. Henry convinced Michael that Thermal Contact Resistance would challenge him and that he would enjoy researching this relatively new area of heat transfer.

During the period 1963–1967 while at M.I.T., Michael worked on some issues of Thermal Contact Resistance with Henri Fenech of the Department of Nuclear Engineering. Then he collaborated with Michael Cooper who was on sabbatical leave from Cambridge University and Bora Mikic on writing a seminal paper on Thermal Contact Resistance published in the *International Journal of Heat and Mass Transfer* in 1969. This paper has since become one of the most referenced papers in the field of Thermal Contact Conductance. During this period he spent one year with Dynatech Corp. managing a contract on Electrohydrodynamics for Lockheed Space and Missile Corporation of

Palo Alto, CA. He completed the writing of his thesis and graduated in 1967 with the Sc.D. In the same year, Michael married Marjorie D'Amato, who was Warren's secretary for graduate students.

In September 1967, Michael and Marjorie left Boston for Poitiers, France. Michael accepted the generous offer of Henri Cordier, considered the father of Thermal Contact Resistance in France, to join his research group in ENSMA as a post-doctoral fellow. To everyone's surprise the bureaucrats in Paris offered Michael a position as Associate Professor at the University of Poitiers, attached to ENSMA.

In January of 1968, Lisa Simone was born in Poitiers. Marjorie and Michael were elated.

While at ENSMA, Michael prepared and taught two courses: one on boiling and condensation and the second on thermal contact resistance theory to the senior students. At the invitation of M. Poncin, often called the father of ENSMA, Michael presented five day-long lectures on the theory of thermal contact resistance to the graduate students at the University of Paris. One of the graduate students subsequently arranged for Michael to present two day-long lectures to the engineers of IBM near Paris.

The international events of 1968 created a situation at ENSMA such that all teaching stopped and very little research was accomplished as everyone (students, staff and some faculty) went on strike in sympathy with the students in Paris and elsewhere. Henri Cordier, who was now Dean and totally occupied with daily discussions with staff, students, and faculty, recommended that Michael use the free time to travel around France and get some work done. Michael completed his book on Conduction and wrote several papers.

In 1969, Michael, Marjorie, and Lisa left Poitiers for Boston and then Waterloo, Ontario. In September of that year, Michael joined the Department of Mechanical Engineering at the University of Waterloo, as Associate Professor, expecting to spend only a few years. Five years eventually became 30 years.

In 1970, Michael got his first three graduate students: Val Cecco, Steve Cividino, and William Kitscha. All three had major scholarships and undertook research in Thermal Contact Conductance.

In 1972, Michael became Full Professor. Also that year, Linda Susan was born and once again Marjorie and Michael were elated.

Over the next 30 years spanning 1969–1999, Michael supervised 45 M.A.Sc. and Ph.D. students producing 50 theses. Many of these students held scholarships from industry, university, and government agencies. Their names are listed at the end of this biography. At least eight former students (Schneider, Simeza, Hegazy, Antonetti, Culham, Jafarpur, Mantelli, and Muzychka) have continued their research as faculty at universities worldwide while many others have gone on to successful careers in the nuclear, microelectronics, automotive and aerospace industries as thermal engineers with such well-known companies as: Intel, Alcatel, Nortel, Hewlett Packard, IBM, DANA Corp—Long Manufacturing Division, General Electric, and Pratt and Whitney.

Whether the research is at M.A.Sc. or Ph.D. levels Michael has always ensured that the work was some combination of model development, analysis, and experiment, and that all work must be publishable. Whenever possible, the students have traveled to conferences to make presentations of their own work. Michael also invited faculty from other departments (L. Chow and J. Raulston of Electrical Engineering, C. Thompson and G. Gladwell of Civil Engineering, and F. Goodman of Physics) to help in advising some of the graduate students. Michael also had close collaboration with other Mechanical faculty (A. Strong, T. Hollands, G. Raithby, and C. Hermance) on conduction and convection problems. In addition to the large number of students supervised, several Postdoctoral Fellows have collaborated with Michael and are also listed at the end of this biography.

Michael has conducted extensive research in several areas: analysis of steady and transient thermal spreading resistance, modeling and experimental thermal contact resistance, modeling natural convection from isothermal convex bodies and heat sinks, modeling internal natural and forced convection with applications to electronics cooling. Michael's approach to modeling physical problems is simple and direct. It is based on scale analysis to obtain the appropriate dimensionless relationships, the selection of an appropriate length scale, and the use of asymptotic solutions to develop a comprehensive solution. In the early 1970s Michael first observed that the choice of the square root of the active surface area as characteristic length brought the analytical and numerical results for spreading resistances into a half-space close together. Subsequently he successfully introduced this length scale into spreading resistances in flux tubes and channels, conduction shape factors for isolated isothermal convex bodies, natural and forced convection from isothermal convex bodies. Recently, it has been demonstrated that the length scale based on the duct cross-sectional area can be used for internal friction and heat transfer problems for laminar flow in ducts of arbitrary cross section.

Over the years Michael has received many University and International Society awards. These include:

1995 Distinguished Teacher Award, University of Waterloo.

1994 Best Paper Award of AIAA Thermophysics for Paper entitled *Modeling Transient Conduction From Isothermal Convex Bodies of Arbitrary Shape*, by M. M. Yovanovich, P. Teertstra and J. R. Culham.

1992 Fellow, American Institute of Aeronautics and Astronautics.

1989 Best Paper Award of IEEE Transactions on Components, Hybrids and Manufacturing Technology for Paper entitled *Thermal Modeling and Experimental Techniques for Microwave Bipolar Devices*, by K. J. Negus, R. W. Franklin and M. M. Yovanovich.

1989 Fellow, American Association for the Advancement of Science.

1986 Fellow, American Society of Mechanical Engineers.

1984 AIAA Thermophysics Award, *For an outstanding technical or scientific contribution by an individual in thermophysics as related to the properties and mechanisms involved in thermal energy transport by conduction, convection, and radiation.* Awarded to M. Michael Yovanovich for his sustained and significant contributions to the advancement in the fundamentals of Thermal Contact Resistance Theory.

1983 AIAA Thermophysics Best Paper Award for Paper entitled *An Accurate Universal Contact Conductance Correlation for Conforming Rough Surfaces with Different Micro-Hardness Profiles*, by M. M. Yovanovich and A. Hegazy.

1974 Associate Fellow, American Institute of Aeronautics and Astronautics.

Michael has also been a long-time active member of many societies. These include American Society of Mechanical Engineers (ASME), American Institute of Aeronautics and Astronautics (AIAA), American Association for the Advancement of Science (AAAS), American Academy of Mechanics (AAM), Society for Industrial and Applied Mathematics (SIAM), American Mathematical Society (AMS), International Electronics and Packaging Society (IEPS), Sigma Xi (MIT Branch), Canadian Applied Mathematics Society (CAMS), Canadian Society of Mechanical Engineers (CSME).

For over 30 years Michael has served on ASME and AIAA technical committees.

For AIAA, Michael has worked on the Thermophysics Committee, organized numerous technical sessions for Thermophysics and Aerospace Science Conferences, and served as General Chairman of the Thermophysics Conference held at Boston in 1974. Michael was the 10th recipient of the AIAA Thermophysics award and the first person from outside the United States to receive it. The award is made for “an outstanding technical or scientific achievement by an individual in Thermophysics, specifically as related to properties and mechanisms involved in thermal energy transport by conduction, convection, and radiation.”

For ASME, Michael has chaired numerous technical sessions, organized panel workshops and has been an active member of the K-8 Committee on Theory and Fundamental Research and the K-16 Committee on Electronic Cooling, in addition to being a past member of the K-18 Committee on Cryogenic Heat Transfer. Michael has served as the Senior Technical Editor of the ASME Journal of Electronic Packaging in addition to being a member of four other Editorial Boards on International Journals. He has organized and chaired numerous sessions on conduction, thermal contact resistance, composite materials and convective heat transfer at the ASME I.M.E.C.E. and National Heat Transfer Conference. Michael was the General Chair of the first joint AIAA/ASME Thermophysics and Heat Transfer Conference, Boston, MA, July 1974. He was editor and co-editor of several ASME HTD Volumes during the period 1981–91. He was Technical Editor of ASME *Journal of Heat Transfer* (1984–1986) and Associate Technical Editor of ASME *Journal of Electronic Packaging* (1988–1990). Michael was a Member of Editorial Board for *Advances in Transport Processes* (1980), Advisory Editor of the *International Journal of Heat and Fluid Flow* (1985–1987) and currently Advisory Editor for the *Journal of Thermophysics and Heat Transfer*.

Michael has authored or co-authored over 300 journal papers and conference papers, and five chapters in books. One chapter is Chapter 3 *Conduction and Thermal Contact Resistances (Conductances)* of the latest edition of the Handbook Heat Transfer (McGraw-Hill, 1998). Publications include those in the ASME *Journal of Heat Transfer*, ASME *Journal of Electronic Packaging*, AIAA *Journal of Thermophysics and Heat Transfer*, *International Journal of Heat Mass Transfer*, *IEEE Transactions on Components, Hybrids and Manufacturing Technology*, *WEAR* and several other international journals. He is currently in the process of preparing four books including “Advanced Heat Conduction” and “Thermal Contact Resistance,” in addition to a text on modeling of heat transfer in electronics applications and one on heat transfer and fluid flow in internal flow geometries.

His original approximate analytical thermo-fluid models which combine conduction and convection for cooling of devices, packages, boards and systems are recognized internationally and used by microelectronics cooling practitioners. He has written reviews and treatises for both the design engineer and the specialist. Thus knowledge gained in 35 years of comprehensive and intensive study is being made readily available to the next generation.

In 1999 Michael retired from active teaching, and in 2000 he became Distinguished Professor Emeritus of the University of Waterloo. Michael continues to be active in supervising students and collaborating with former students in industry and academia. Currently, he is the Principal Scientific Advisor to the Microelectronics Heat Transfer Laboratory at the University of Waterloo, which provides an opportunity to co-supervise graduate students and participate in ongoing research. He is also presenting one and two-day short courses on Thermal Contact Resistance and consulting with industry. During his 30-year tenure as a Professor at the University of Waterloo, he has supervised 45 graduate students, including:

Ph.D.

Y. Ogniewicz, 1975
Gerald Elmore Schneider, 1977
S. S. Burde, 1977
Vince Antonetti, 1983
Adel Hegazy, 1985

M.A.Sc.

V. S. Cecco, 1971
S. E. Cividino, 1975
Edward C. Schewen, 1976
Chir-Hsin Tien, 1978
Ken Martin, 1980
Lameck Mbonani Simeza, 1986
Jacob William DeVaal, 1988
Seaho Song, 1988
Seri Lee, 1988
Kevin James Negus, 1988
J. Richard Culham, 1988
Ki Man Nho, 1990
Khosrow Jafarpur, 1992
Gamal Refai-Ahmed, 1994
M. R. Sridhar, 1994
Marcia B. H. Mantelli, 1995

C-S. Wang, 1997
Yuri S. Muzychka, 1999
Peter Teertstra, 2002

Postdoctoral Fellows

Helmi Attia
S. S. Burde
Gamal Refai-Ahmed
M. Sridhar
Ahmed Zaghoul
Yuri S. Muzychka
William Kitscha, 1982
Glen R. McGee, 1982
Jake Zwart, 1983
Jacob William DeVaal, 1983
John Saabas, 1985
Nigel Fisher, 1985
Leonard Walter Kula Jr., 1985
Peter John Turyk, 1985
Kevin James Negus, 1985
Thomas Frank Lemczyk, 1986
Christopher Eric Lane, 1986
Ki Man Nho, 1987
C. C. LoChoy, 1988

John Burgers, 1988
Louise C. Martin, 1988
David Werner Fast, 1988
Gamal Refai-Ahmed, 1990
Bonnie Lynne Mack, 1991
William D. Jeakins, 1992
Tracy Smith, 1992
Peter Teertstra, 1992

Yelu Huang, 1993
C-S. Wang, 1993
Yuri S. Muzychka, 1995
V. Au, 2000
M. Stevanovic, 2001
E. Chan, 2001
R. Ripley, 2002

Prepared by J. R. Culham and Y. S. Muzychka (in consultation with M. M. Yovanovich)