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Stephen H. Davis

7 September 1939 – 12 November 2021

Stephen H. (Steve) Davis, one of the most recognizable names in the fields of fluid mechanics and solidification over the last fifty years, passed away November of 2021 from complications following triple-bypass cardiac surgery. Steve had only recently retired as the McCormick School Institute Professor and the Walter P. Murphy Professor of Engineering Sciences and Applied Mathematics at Northwestern University and was looking forward to a retirement of travel and relaxation with his wife of 56 years, the former Suellen Lewis, of Dallas, Texas. In honor of his contributions to both Northwestern and his scientific community, Northwestern had inaugurated an annual Stephen H. Davis Symposium in 2019, shortly before the coronavirus pandemic brought the world—and Steve's and Suellen's travel plans—to a halt.

This article will be focused on the more personal side of the life of Steve Davis. A forthcoming article in *Annual Review of Fluid Mechanics* will delve more deeply into his scientific contributions. Many other anecdotes and descriptions of Steve's contributions may also be found in a biographical article (Neitzel 2010) written for a special volume of *JFM* to commemorate his 70th birthday.

Steve was born in the fall of 1939 in New York City, but when he was three years old, the family moved to the town of Long Beach on Long Island, where he was raised, along with his younger brother, Jeffrey. Steve was a precocious student who entered Rensselaer Polytechnic Institute (RPI) in Troy, New York at age 16, receiving his first degree there in electrical engineering. Although he had the opportunity to attend school closer to home at Brooklyn Polytechnic on a full scholarship, he decided he wanted the experience of being a bit further from home that RPI would provide. Steve was no one-trick-pony as an undergraduate—he even found time to co-captain the Institute's bowling team, along with another future fluid mechanician, the late Don Boyer (whom Steve always joked would drop the ball behind him on his approach, a fact that Don denied vociferously!).

Following receipt of his bachelor's degree, Steve switched to applied mathematics for his graduate education, taking his PhD in 1964 under the direction of Lee Segel,

Steve in his Northwestern University Office.

writing a dissertation entitled, 'The Effect of Property Variations and Surface Curvature on Bénard Convection'. Steve's initial foray into hydrodynamic stability and flows involving interfaces is something that would occupy a good portion of his career. The applied mathematics group at RPI at that time was one of the finest around, with faculty like Dick DiPrima and George Handelman, in addition to Segel. The bonds there between faculty and graduate students were close, exemplified by stories of graduate students sometimes sleeping on the floor at the Handelman's following an evening social event there. One of Handelman's young daughters once proclaimed that she would one day marry Steve, so clearly, his infectious personality materialized in him early.

Following the receipt of his PhD in 1964, Steve moved to California to take a job with the Rand Corporation, where he would remain for two years. It was in October of that year that he met bank employee Suellen Lewis, his partner in life, at a Beverly Hills party one evening. In 1966, Steve received an offer of a lectureship in the Department of Mathematics at Imperial College, London, and told Suellen that he would like her to join him. When she protested that her parents would never agree to her accompanying him as a single woman, he told her that this was not what he had in mind. Although this was indeed a proposal of marriage, Steve had not thought ahead and purchased an engagement ring so instead gave her his old fraternity pin. They married shortly thereafter in a simple ceremony in Carmel, California. The total size of the wedding party, including the presiding official, was five persons, including future University of Arizona chemical engineering professor Joe Gross, who served as Steve's best man. Joe actually had a short piece of 8 mm movie footage he had taken at the wedding which was able to be incorporated into a video presentation for an international conference entitled Interfaces for the 21st Century (Smith *et al.* 2002) held in honor of Steve's 60th birthday in Monterey, California, a stone's throw from the site of the wedding. Neither Steve nor Suellen had seen or even known of the existence of that footage prior to that evening.

After a mere two years at Imperial, Steve accepted an offer of an assistant professorship from the Department of Mechanics at The Johns Hopkins University in Baltimore, Maryland, and it is there that his career truly blossomed. That department was an unusual one, with fluid mechanicians such as Stanley Corrsin, Leslie Kovasznay, Kim Parker, Robert Long and Bill Schwartz, a rational mechanics group consisting of Clifford Truesdell, Jerald Ericksen, and James Bell, and others such as metallurgist Bob Pond, and materials scientist Bob Green. The graduate students in the department used to joke that the faculty consisted of ten individuals organized into ten factions. Fortunately, at that time there were others with interests in various aspects of fluid mechanics scattered in various departments at Hopkins, including Owen Phillips, Francis Bretherton and Bruce Marsh in Earth and Planetary Sciences and Lucien Brush and Jerome Gavis in Geography and Environmental Engineering, so the environment was a stimulating one for Steve. The closest bond of all was the one between Steve and Stan Corrsin, who, together, would hold court at 10 a.m. each weekday for coffee, in the basement of Maryland Hall next to Stan's wind tunnel. One of the graduate students each week would be assigned to start the coffee (ground fresh every day in Stan's office) brewing sometime after 9, to ensure it would be ready by 10 and Stan would bring fresh or leftover pastries from his office for all to share. The affair was an exercise in egalitarianism, with faculty, staff, students and visitors, all on a first-name basis, with topics of conversation ranging from television to film to politics and, occasionally, science. The table at which all sat was covered with magazines, including a large number of issues of *Punch*, to which Stan had a subscription. Stories of occurrences during coffee abound which cannot be related here out of consideration to the subjects of those stories who are still with us. Virtually every fluid mechanics graduate student who experienced this hour of phenomenal camaraderie and who later took an

Steve and Suellen celebrate an early 65th birthday of Stan Corrsin with Geneviève Comte-Bellot and John Lumley in the fall of 1984.

academic job attempted to institute such a tradition at his new institution, without success! It was the Davis/Corrsin glue that enabled it to thrive.

At Hopkins, Steve continued his work in hydrodynamic stability. Much of his earlier research focused on flows with time-dependent basic states, both oscillatory as well as those started from rest. Steve recognized the ability of energy-stability theory, often dismissed because of its inability to predict reasonable stability boundaries for shear flows, to yield results of interest for flows with instability mechanisms that were less local in character than the critical layers of shear-flow. In the mid-1970's he also began to examine other aspects of flows with free surfaces, in particular, the dynamics of contact lines and flows driven by surface-tension gradients. He also became interested in flows associated with the process of solidification

His work on contact-line motion with Elizabeth Dussan V. (Dussan V. & Davis 1974) is particularly noteworthy because, through a set of careful, but simple experiments, they were able to show that a droplet moving on a surface undergoes a 'rolling' motion of sorts and that the physically unrealistic unbounded forces caused by multi-valued velocities at contact lines may be remedied by slip models, as long as the results of their use are in reasonable agreement with measured physical quantities. Subsequent work by Steve led to his consideration of static and dynamic rivulets and their instabilities. At Hopkins he also first became interested in the problem of solidification through his co-advising of doctoral student Jonathan Dantzig, and this area became dominant in his later work.

In December of 1978, Steve made the decision to leave Johns Hopkins for the Department of Engineering Sciences and Applied Mathematics (ES&AM) at Northwestern University. Also holding appointments in both mechanical and chemical engineering, he began working with faculty such as George Bankoff, Peter Voorhees and Mike Miksis. Grae Worster joined the faculty of ES&AM in 1989 and, although they

published but one paper together, served as a valued friend and colleague, given their mutual interests in solidification.

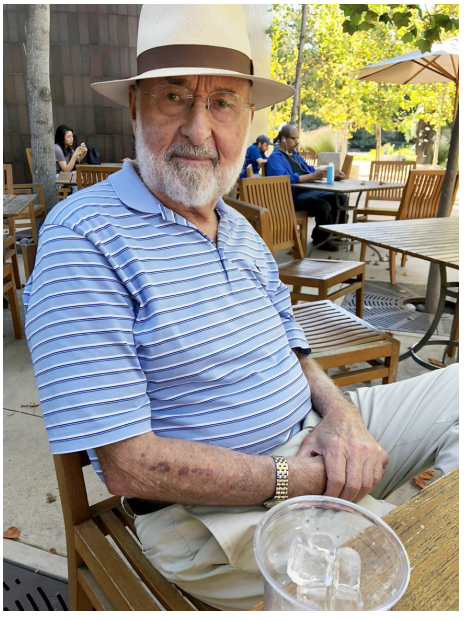
In the fluid-mechanics arena, early work done at Northwestern on thermocapillary convection is of particular interest. At this time, in the late 1970's and early 1980's, the National Aeronautics and Space Administration (NASA) was very interested in the idea of growing crystals of semiconductor materials such as silicon in the weightless environment of Space, hoping that the absence of buoyancy might prevent the appearance of unwanted 'striations' of dopant materials observed in terrestrially grown material. Steve and his student Marc Smith studied the stability of thermocapillary convection in a layer with differently heated/cooled endwalls, finding a new instability which they termed a 'hydrothermal wave' (Smith & Davis 1983). This instability is unrelated to the presence of buoyancy, so takes on *increased* importance in the so-called 'microgravity' domain. This instability has come to be known as the Smith & Davis instability and continues to be a source of research to this day.

At Northwestern, more of Steve's attention was now placed upon various aspects of materials science, a subject ripe for the attention by an individual with Steve's background in problems relating to stability. Steve and Peter Voorhees, along with student Brian Spencer (Spencer, Voorhees & Davis 1991, 1993), examined morphological instability during thin-film growth. In rapid solidification, Steve showed that instabilities could be triggered by increased solidification rates and subsequently subdued by yet higher rates. He also investigated the interaction between flow and morphological stability, evidenced by work with students Kirk Brattkus (Brattkus & Davis 1988) and Gerry Young (Young & Davis 1986), the latter paper concentrating on the role of buoyancy. Steve's work in this area led to his publication of a monograph, *Theory of Solidification* (2001). Those of us who had earlier worked with him at Hopkins in the area of hydrodynamic stability covet the notes he wrote for the course he taught there and are sad that these, too, did not lead to a monograph on the subject.

Steve was a popular advisor for doctoral and postdoctoral students alike. He had a knack for identifying interesting, timely problems that were amenable to analysis, computing and/or experimentation. These problems were also ones that were solvable with minimal 'rabbit holes' to be explored, as well as both appropriate for and of interest to a particular student. The Mathematics Genealogy Project (https://www.genealogy.math.ndsu.nodak.edu/) lists 40 doctoral 'descendants' of Steve, many of whom have gone on to distinguished careers of their own in both academia and industry.

Steve's love of research was matched only by his love of travel, particularly that which brought him together with other like-minded researchers and collaborators who, unfailingly, became his friends. His reputation afforded him the possibility of visiting institutions all over the world. In the 1980's he spent several periods at both École Polytechnic Fédérale de Lausanne with Philippe Metzener and at Kernforschungszentrum Karlsruhe (now part of Karlsruher Institut für Technologie) working with Ulrich Müller. When I was his student in the 1970's Steve spent a bit of time in Australia with Simon Rosenblat at the University of Melbourne. (This was a challenging time for me, given that our only means of communication was through what we now call 'snail mail', which could take several weeks in each direction!) Simon later moved to the Illinois Institute of Technology, where he and Steve interacted regularly.

Winters in Evanston can be brutal and Steve and Suellen enjoyed spending several of them in southern California at the University of California, San Diego with Paul Linden, the University of Southern California with Tony Maxworthy and others, the University of California, Los Angeles with Bob Kelly and Pirouz Kavehpour, the University of California, Santa Barbara with Bud Homsy, and Caltech with Dan Meiron, Beverley



Steve at Pasadena's Norton Simon Museum in September, 2018.

McKeon, Tony Leonard and Sandra Troian. Many an evening during these visits was spent with Suellen and Steve's colleagues and their spouses over an outstanding meal accompanied by fine wine.

Steve has been the recipient of many honors and awards, among them being elected to both the National Academy of Engineering (1994) and the National Academy of Sciences (2004) along with the American Academy of Arts and Sciences (1995). He was a Fellow (1978) of the American Physical Society (APS) of which he was the two-time chair of its Division of Fluid Dynamics and a recipient of the APS Fluid Dynamics Prize in 1994. He is a recipient of a Humboldt Research Award for Senior Research Scientists (1994) and, in 2001, received the G. I. Taylor Medal from the Society of Engineering Sciences, the same year he was awarded the D.Sc. (*honoris causa*) by the University of Western Ontario. He has delivered several invited, distinguished lectures both in the United States and abroad.

In terms of service to the community, Steve certainly did more than his fair share, including serving as Assistant (1969–75) and Associate (1975–89) Editor and Editor (2000–10) of *JFM* for more than forty years, Editorial Board Member (1994–99), Associate Editor (1999–2002) and Editor (2003–2021) of *Annual Review of Fluid Mechanics*, as well as an advisor in several capacities to both to the National Science Foundation and NASA. These jobs were always done conscientiously and with the best interests of the research community in mind.

These accolades, however, do not begin to do justice to the memory of one who has contributed so much through his incredible intellect and his ability to make lasting, fundamental contributions to the problems he undertook. What those of us who knew Steve personally will miss most is his kindness toward all, his patience and willingness to help others succeed, and his incredible sense of humor.

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G. PAUL NEITZEL
G. W. Woodruff School of Mechanical Engineering,
Georgia Institute of Technology,
Atlanta, GA 30332-0405, USA
Correspondence to: paul.neitzel@comcast.net