



*P.O. Faye*

P. OLE FANGER

1934–2006

Elected in 2001

*“For significant interdisciplinary research on the influence of indoor environment on human comfort, health, and productivity.”*

BY ARTHUR E. BERGLES

**P**AVEL OLE FANGER, widely considered the world’s leading expert on the effects of indoor environments on human comfort, health, and productivity, died September 18, 2006, at the age of 72, during his second visit to Syracuse University in his new role as a University Professor. The cause of his sudden, premature death was an abdominal aortic aneurism.

Ole Fanger was born in Vejlbj, Denmark, on July 16, 1934, attended local schools, including the Marselisborg Gymnasium in Arhus, and entered the Technical University of Denmark (DTU), then called Danmarks Tekniske Højskole. He received the Cand. Polyt. degree (M.S.) in civil engineering in 1957 and subsequently served in the military for two years. He then began a lifelong association with DTU, with an initial academic appointment as Adjunkt (Assistant Professor). Then, as Lektor (Associate Professor) from 1967 to 1977, he received his Dr. Techn. (D. Sc.) for a thesis entitled “Thermal Comfort,” which became a best-seller among technical books. In 1977, he was promoted to Professor, and, after his retirement in 2004, he was active as Senior Professor. He guided more than 100 M.S. and Ph.D. students, published 12 books or book chapters, was author or co-author of more than 300 technical papers, and presented more than 300 invited lectures.

Not one to shy away from administrative responsibilities, Fanger established the International Centre for Indoor Environment and Energy (ICIEE) at DTU in 1998 and was director of the center until 2004. The facility, funded by a 10-year grant from the Danish government for 10 million euros, had unique environmental chambers that attracted numerous world-class researchers from many disciplines, including classical engineering disciplines, medicine, chemistry, and psychology. The personnel, from some 15 nations, now number more than 50, including 30 graduate students. In 2003, an international evaluation declared ICIEE to be the best facility in the world for studying indoor environment and energy.

Fanger first demonstrated his flair for international activities when he spent a year as a research associate at Kansas State University (1966–1967) at the new Institute of Environmental Research. Under the mentorship of icons Press McNall, Fred Rohles, and Ralph Nevins, he began his investigations of the human effects of thermal comfort. The construction of the environmental chamber at Kansas State was sponsored by the American Society for Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), and Fanger became a member of that organization in 1968. For the next 40 years, he attended most of the biannual meetings, where he could frequently be seen with his many friends and colleagues in the networking lounge.

Fanger spent his second sabbatical year, 2000, at the National University of Singapore (NUS) as Distinguished Visiting Professor. During that year, he initiated collaborative research and development studies between NUS and ICIEE on the impact of indoor environments in different climates on human comfort, health, perceptions, and productivity.

Fanger's research, which was focused almost exclusively on people's responses to indoor environments, established the importance of indoor environments to the quality of life. In the 1960s, he introduced indices for quantifying thermal sensation and comfort. The thermal environment can be characterized by temperature (air and radiant surface), humidity, air velocity, and personal parameters (clothing and activity level). Subjective factors obviously influence satisfaction/dissatisfaction with certain

conditions (e.g., a draught and the associated turbulence intensity). Discomfort can also be caused by radiant asymmetry and vertical air-temperature gradients.

The index Fanger developed for measuring indoor environments is now used worldwide and is included in many national and international standards for the design of buildings. The specifications for thermal environmental-control systems (heating, ventilating, and air conditioning) are based on models he developed. His work has been extremely useful for the establishment of energy requirements for buildings.

In the 1980s, digging even deeper into human physiology, psychology, and subjective behavior, he introduced sensory units for perceived air quality. In his puckish Danish way, these units were designated the “olf” and “decipol.” An olf is the emission rate of air pollutants (bioeffluents) from a standard (sedentary) person. A decipol is one olf ventilated at a rate of 20 cubic feet per minute of unpolluted air. Based on extensive experimental data, Fanger developed a curve that gives the percentage of dissatisfied persons as a function of ventilation rate per olf.

The olf concept can also be applied to other sensory sources, such as building materials and even personal computers. Extensive field studies have shown that indoor air quality can be improved and the ventilation requirement decreased by reducing superfluous sources of pollution. Fanger and his associates were the first to identify the significant impact of indoor air quality on productivity (office workers, factory workers, etc.) and on the symptoms of sick-building syndrome.

Fanger was very active in professional societies. He was president of the Scandinavian HVAC Societies since 1984 and president of the International Academy of Indoor Air Sciences from 1996 to 2002. He was vice president of both the Federation of European Heating, Ventilating and Air Conditioning Associations and the International Institute of Refrigeration. Between 1974 and 2006, he served on 18 ASHRAE committees and panels, often as the international representative.

Ole Fanger’s outstanding accomplishments did not go unrecognized. In fact, he was arguably the most “decorated” Dane in scientific and technical affairs. He was elected to the Danish

Academy of Technical Sciences (member, 1975), International Academy of Indoor Air Sciences (founding member, 1990), Royal Academy of Engineering (foreign member, 1994), Russian Academy of Architecture and Building Science (foreign member, 1995), Royal Society of Health (fellow, 1997), International Academy of Refrigeration (member, 2001), and NAE (foreign associate, 2001). In addition, he was an honorary member of 17 engineering societies in Europe and Asia. He was the recipient of eight awards from ASHRAE, including the two highest awards given to living members. He was awarded nine honorary doctorates from universities in nine different countries and was honorary professor at six major Chinese universities. In addition, he was awarded 28 medals, plaques, and prizes by engineering societies throughout the world. A Festschrift was prepared in his honor on the occasion of his “retirement” from DTU.

From early on, Fanger promoted international collaboration and the dissemination of research results and publications to a wide audience. He attracted more than 100 international postdoctoral students and visiting professors to his research group at DTU, and he was recognized worldwide and in the English-speaking press as one of the top Danish researchers. In 2002, the Queen of Denmark made him Knight of the Order of Dannebrog, Premier Degree. After receiving this honor, accolades poured in from everywhere, and he felt very fortunate to be thought of so highly in his lifetime.

Fanger was married to Britt Eva Hellieson in April 1958, who predeceased him in April 2006. He is survived by two daughters, Bine (and two grandsons) of Copenhagen, and Tone of Frederiksberg.

