Princeton University

Honors Faculty Members Receiving Emeritus Status

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The biographical sketches were written by colleagues in the departments of those honored.

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Philip John Holmes

Philip Holmes, an intellectual leader who works at the intersections of applied mathematics, mechanical engineering, and neuroscience, is retiring after 42 years as a professor, including 20 years at Princeton. Before that he was on the faculty at Cornell University. Phil is the Eugene Higgins Professor of Mechanical and Aerospace Engineering, a professor of applied and computational mathematics, and associated faculty in the Department of Mathematics and the Princeton Neuroscience Institute. These affiliations are some indication of his magnificent intellectual breadth; he has made research contributions throughout his career to a wide variety of problems using the insights and tools, some of his own invention, from the mathematical fields of dynamical systems and nonlinear mechanics.

Phil was born in Lincolnshire, U.K. After completing his B.A. in engineering science at the University of Oxford, Phil took a long walk. He originally planned to travel from Salzburg, Austria, to India, but his trajectory detoured by chance to a kibbutz in Israel where he met his wife, Ruth.

After his return, Phil earned a Ph.D. in engineering at the University of Southampton in 1974. He obtained his first academic position in theoretical and applied mechanics at Cornell, where he began his long and impressive career making original contributions to dynamical systems and nonlinear mechanics, from bifurcation theory and chaos to applications in celestial mechanics and turbulence. Phil made a mid-career move to Princeton in 1994, where he continued to write seminal papers and break new ground, including in recent years making significant contributions in mathematical neuroscience and neuromechanics of biological locomotion. During Phil's remarkable academic career, he supervised 37 Ph.D. and three M.S. theses and mentored 25 postdoctoral fellows.

He has been recognized with fellowships in the American Mathematical Society, the American Physical Society, and the Society for Industrial and Applied Mathematics. He is a member of the American Academy of Arts and Sciences and in 2001 was elected an honorary member of the Hungarian Academy of Sciences. Most recently he received an honorary degree (*doctor honoris causa*) from the Budapest University of Technology and Economics with the citation: “Philip Holmes is a scientist of outstanding authority and influence in applied mechanics and mathematics. He is a key figure of the field worldwide, and a foreign member of the Hungarian Academy of Sciences who has been in close connection with Hungarian scientists for three decades.”

The field of dynamical systems, or nonlinear dynamics, is concerned with the (time) evolution of systems, usually described by differential equations or difference equations. Although it may seem that the final goal of the study of such problems should focus on the detailed solution trajectory, Phil’s expertise was built around methods of analysis of the equations themselves that yield qualitative and quantitative insights even if the detailed solutions were not available. These ideas of nonlinear dynamics include the characterization of “chaos.” Phil’s early work focused on engineering systems and fluid and solid mechanics; his publications include research papers important to understanding instabilities, studies of turbulence, as well as other papers relevant to the buckling of beams. In fact, it is rare to find researchers who work on problems in both of these two classic field theories (fluid and solid mechanics)—one more way in which Phil stands out from the crowd.

Significantly, Phil’s research addressed problems for their applications as well as the opportunity for new, fundamental mathematical results. His curiosity led him to study problems on biological locomotion (e.g., legged insects) as well as neuroscience questions concerning cognitive processes. In fact, his first exposure to questions of mathematics applied to biological problems began early in his career at Cornell, when he had a chance meeting at a copy machine with a scientist studying the action potentials of motor neurons. Shortly after moving to Princeton, while out for a morning walk, he met a neighbor, neuroscientist Jonathan Cohen, which soon led to mathematical models in neuroscience and joint research papers in decision making and other topics of mutual interest. A little bit of uncertainty and chaos in trajectories, both in travel and conversations, can lead in interesting directions when it comes to the curiosity-driven Phil Holmes!

Phil's ability to synthesize the main ideas of the field led him to write several books. He is coauthor, with John Guckenheimer, of an enormously influential textbook, *Nonlinear Oscillations, Dynamical Systems, and Bifurcations of Vector Fields,* which, at the time of the writing of this essay, had been cited more than 16,000 times according to Google Scholar. This book was honored with the 2013 American Mathematical Society's Leroy P. Steele Prize for Mathematical Exposition. In addition, he coauthored with John L. Lumley and Gal Berkooz a monograph on low dimensional models of turbulence titled *Turbulence, Coherent Structures, Dynamical Systems, and Symmetry* (Phil's departmental colleague Clancy Rowley joined the team for the second edition); with Florin Diacu the book *Celestial Encounters,* which provides a historical account of the people and ideas at the roots of "chaos theory"; and, with Robert Ghrist and Michael Sullivan the monograph *Knots and Links in Three-dimensional Flows*. These books highlight Phil's interest in the mathematical structure of the many aspects of nonlinear dynamics, his desire to describe the historical roots of ideas, and his ability to apply mathematical ideas to a wide range of practical problems in engineering and the sciences.

It will come as no surprise that Phil is an extraordinary teacher. He is famous for his ability to sketch exquisite pictures of intersecting manifolds and the dynamics they orchestrate; these concepts are central to understanding nonlinear systems, and developing the intuition one gets from geometry. It is common to hear compliments about his "masterful expositions" and his "delightful turn of phrase."

Phil is also an accomplished poet. He has published four collections of poetry; the second won an Eric Gregory Award (U.K. Society of Authors) in 1975 and the third, *The Green Road,* was a Poetry Book Society recommendation for 1986. His fourth collection, *Lighting the Steps,* was published by Anvil Press in 2002. Those familiar with his mathematics will also recognize the poetry of his insights in nonlinear dynamics.

The Department of Mechanical and Aerospace Engineering and the Program in Applied and Computational Mathematics, as well as his colleagues in other departments and programs at Princeton, have benefited from Phil's intellectual depth and breadth and his community spirit. We look forward to his continued engagement with our activities.