Dr. Olivier Coussy, Scientist and Engineer of the Mechanics and Physics of Porous Materials, is dead at 56

Dr. Olivier Coussy, the prominent scientist and engineer who developed the fundamentals of poromechanics theory that were transformational in many applications of civil, environmental and petroleum engineering, bioengineering and sustainable development of materials and structures, died January 15, 2010 at his home in Vanves, close to Paris, France. The cause was a heart attack.

When Dr. Coussy started his career in the 1980s in the field of poromechanics, in wave propagation in saturated porous media ("Acoustics of porous media", with T. Bourbié and B. Zinszner, Editions Technip, 1987), a small number of researchers in different countries had recognized the potential impact of M.A. Biot's consolidation theory for engineering applications. Trained as an engineering scientist in the best vein of the French mechanics school, "La Mécanique Rationnelle", Dr. Coussy recognized that the development of the vast field of engineering applications of poromechanics still lay ahead; and required a comprehensive macroscopic theory of the mechanics and physics of porous materials. Over the next 25 years, in three monographs he laid the foundation for and advanced many engineering application of what became to be known as the Biot-Coussy theory of poromechanics. He was one of the founders of the Biot Conference on Poromechanics in 1998.

Olivier Coussy was born on November 3, 1953, in Marseille, France. His father was an Engineer, his mother dedicated to the education of 6 children. He graduated from Ecole Nationale des Ponts et Chaussées, Paris, in 1975, received a PhD degree in 1978, and a Docteur ès Sciences Degree in 1985, both from University Pierre et Marie Curie, Paris. He became an engineering scientist at the Laboratoire Central des Ponts et Chaussées, last as director of the Institut Navier and of UR Navier at Université Paris-Est, a joint research unit between Ecole des Ponts, Laboratoire Central des Ponts et Chaussées and CNRS with fifty permanent scientists in mechanics and physics of materials and structures. Over the years, Dr. Coussy worked in various fields of Applied Mechanics, such as limit analysis and yield design, wave propagation, dynamics of cracked materials, and dynamics of structures; before shaping and defining the field of poromechanics. He was a much sought partner and consultant for the Oil and Gas, Cement and Construction Industry, Nuclear Power and Nuclear Waste Agencies.

Dr. Coussy broke new grounds in Applied Mechanics with his first monograph entitled "Mécanique des Milieux Poreux" (Editions Technip, 1991), and its English translation

and extension “Mechanics of Porous Continua” (J. Wiley & Sons, 1995). In this monograph, Dr. Coussy developed a consistent thermodynamics theory of poromechanics, by considering porous continua, at the macroscopic scale of engineering applications, as open thermodynamic systems in which the addition of one or several fluid phases changes the energy and entropy balance of the solid system. The theory provides a seamless extension both of classical continuum mechanics theory of solids to porous materials, and of M.A. Biot’s infinitesimal deformation poroelasticity theory to finite deformation thermoporoelasticity, poroplasticity, poroviscoelasticity and poroviscoplasticity of saturated porous media. His groundbreaking approach was quickly recognized by the community as the lingua franca of poromechanics.

In the late 1990s and 2000s, Dr. Coussy extended the poromechanics theory of saturated to partially saturated porous media, including chemically reactive porous materials and other phenomena where the physics and chemistry of solid and fluids cause deformation of materials and structures. Many of these scholarly contributions were driven by the need for the development of predictive engineering models for large scale engineering applications, such as early-age concrete behavior, drying shrinkage of concrete, swelling of clay, front propagation in calcium leaching and chloride diffusion, and so on. In this spirit, his second monograph entitled “Poromechanics” (J. Wiley & Sons, 2004) completed the development of the thermodynamics and constitutive models of materials subjected to coupled phenomena, at the intersection of mechanics of porous solids and physical chemistry. All this led the way for poromechanics to open up a whole new field of applications in chemomechanics and durability mechanics problems of materials and structures.

In his recent research, Dr. Coussy returned to the very foundations of the thermodynamics approach of poromechanics, in advancing a theory that distinguishes energy and entropy contributions from the solid, the fluid and the interfaces. In his most recent seminal works, this new framework was key to solving many puzzles past and future, be it hardening plasticity for unsaturated porous materials; confined phase transitions in porous media (freezing materials, in-pore crystallization of salt); or adsorption-induced swelling of coal for Carbon sequestration applications. For this new set of challenging engineering problems, poromechanics provides the host theory to formulate the macroscopic constitutive equations of partially liquid-saturated porous materials; while the physics of interfaces, informed by Molecular Dynamics simulations of adsorption phenomena in nano- and micropores, provides a means to analyze and quantify the multiscale effects of interface energy and interface tensions on macroscopic deformation. These recent developments have as common denominator the “Mechanics and Physics of Porous Solids”, the title of his third monograph on poromechanics, which went to press in late 2009 (J. Wiley & Sons, 2010). With Dr. Coussy’s unique signature of rigor and depth and a new vision for poromechanics at the intersection of continuum mechanics and interface physics, this last monograph holds yet again the promise to shape the future of poromechanics.

Throughout his distinguished career, Dr. Coussy was a dedicated educator, an inspiring instructor and a generous mentor. He taught both foundational subjects such as Fluid

Mechanics at Ecole Polytechnique, and Solid Mechanics at the University of Marne-la-Vallée, which inspired the textbook “Mechanics and Durability of Solids. I. Mechanics of Solids” (with F-J. Ulm, Prentice Hall, 2002); as well as advanced graduate subjects such as Thermodynamics at the University of Marne-la-Vallée. Last, he was a Professor at Ecole des Ponts ParisTech, where he developed and implemented an innovative education and research program, the Master of “Materials Science for Sustainable Construction” as a joint venture of Ecole des Ponts ParisTech, Ecole Polytechnique and Lafarge. This combination of research and education was a hallmark of Dr. Coussy’s career and true to his principle that “La bonne recherche finira dans l’enseignement” (good research ends up in education). This left a lasting impact on all his students and associates; be it in the class room, on the drawing board in his office or in the 5 books and more than 100 scholarly papers he authored and co-authored.

For his contributions, Dr. Coussy received many recognitions; among which the Jean Mandel Award (1985) from the French Association of Mechanics; the Plumey Award (1999) from the French Academy of Sciences; the Knight of the National Order of Merit (2000); and the Biot Medal (2003) from the American Society of Civil Engineers, of which he was the first recipient.

Dr. Olivier Coussy is survived by his wife, Sandra Jonquières-Coussy, and daughter, Flavia Coussy.

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