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LESSONS LEARNED FROM PROFESSOR BRIAN SPALDING

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ABSTRACT

It was a privilege to work closely with Professor Brian Spalding. In addition to the actual details of his research work, the spirit of the research and its methodology were very important attributes. This presentation will describe those aspects. They are far more valuable and long-lasting than the particular choices made in developing the computational methods. One characteristic of Spalding's approach is to aim at complete generality. He did not focus on just the velocity components and temperature. His ultimate goal was to predict, in addition to these variables, the concentrations of all chemical species undergoing multiple chemical reactions, the relevant properties of turbulence, radiation fluxes, multi-phase flows, and so on. Even when appropriates models for complex situations were not available, he would proceed by bold generalization of known concepts. Interestingly, along with his focus on full generality, he was able to work with extreme simplification to understand and test a new idea. Thus, he would apply a new formulation to one-dimensional heat conduction. He would consider local equilibrium in turbulence, where the local rate of turbulence production was equal to the local rate of dissipation. He worked with a delightfully simple model of combustion, in which he used a composite mass-fraction variable (made up of the concentrations of fuel and oxygen) that had a zero source term. Further, by introducing the concept of a fast chemical reaction, he was able to extract the separate concentrations of fuel and oxygen. His invention of upwind differencing was not just a numerical contrivance; he based it on a simple physical model known as the tank-and-tube model. This type of focus on the physical meaning and physical outcome ran through all his work on constructing numerical methods.