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### **John Lumley's Contributions to Turbulence Modeling**

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We recall the contributions that John Lumley made to turbulence modeling in the 1970s and 1980s. In these early days, computer power was feeble by today's standards, and eddy-viscosity models were prevalent in CFD. Lumley recognized, however, that second-moment closures represent the simplest level at which the physics of turbulent flows can reasonably be represented. This is especially true when the velocity field is coupled to scalar fields through buoyancy, as in the atmosphere and oceans. While Lumley was not the first to propose second-moment closures, he can be credited with establishing the rational approach to constructing such closures. This includes the application of various invariance principles and tensor representation theorems, imposing the constraints imposed by realizability, and of course appealing to experimental data in simple, canonical flows. These techniques are now well-accepted and have found application far beyond second-moment closures.