Flying Qualities

CONTAINED in this issue is a special section devoted to aircraft flying qualities. By collecting these eight papers, we hope to provide greater understanding of the role of flying qualities in the design of aircraft and, most particularly, their control and display systems. Furthermore, it is hoped that communications will be improved and interactions strengthened between pilots, flying qualities engineers and control/display system designers.

Flying qualities are those characteristics of an aircraft that govern the ease and precision with which a pilot is able to perform his mission. They involve complex dynamic interactions between the pilot and his vehicle. A pilot's expectation for vehicle dynamic response is dictated by his mission, his aircraft type, and his operational environment. His performance is influenced by the control system and cockpit displays, and by his training, anxiety level and motivation.

The first paper by Harper and Cooper introduces the concept of pilot-vehicle dynamic analysis and provides a historical perspective of flying qualities research starting from the early flight experiments of the Wright brothers. Considerable insight is provided into means of assessing pilot-vehicle system quality and in the design of piloted flight experiments. This paper was delivered as the Wright Brothers Lecture in Aeronautics in 1984.

When a vehicle is found to possess flying qualities deficiencies, it has become common practice to remedy the situation using the flight control system. As a result, a new class of vehicles has emerged which can be said to be control configured. Advances in the state of aircraft design insure that each new generation of aircraft will possess a unique set of pilot-vehicle dynamic response properties. Thus, the flying qualities database required continual expansion to encompass the new response properties. Furthermore, the control-system design methodologies must also advance to provide the necessary stability and control augmentation for vehicles of increasing complexity. The next three papers describe methods for control-system synthesis in order to satisfy flying qualities objectives. The paper by McRuer, Johnston, and Myers and the paper by Chalk provide two contrasting views of this problem. The paper by Blight, Gangsaas, and Richardson describes a control-system design procedure involving linear quadratic Gaussian synthesis.

Flying qualities are also strongly influenced by the degree of sophistication in the display devices available to the pilot. The interaction between display sophistication, control-system complexity, and flying qualities is clearly illustrated in the fifth paper by Franklin, Hynes, Hardy, Martin, and Innis. The specific application is to the precision instrument approach task in a powered lift vehicle.

With the design trend toward high order and digital flight control systems has come increasing concern for the detrimental effects of time delay on flying qualities. The last three papers in the special section discuss this problem. Space Shuttle longitudinal flying qualities and a unique adaptive stick gain device are discussed in the paper by Powers. Berry's paper describes a flight experiment on the NASA F-8 aircraft that documented the detrimental effects of time delay on flying qualities for several flight tasks. Finally, Smith and Sarrafian discuss new flight test results which suggest that allowable time delay may be a function of the feel system and the initial aircraft response shape.

All the coordination and extra effort required to make this special issue possible was done by Professor Dominic Andrisani of Purdue University Research Center and Dr. J. Victor Lebacqz of NASA Ames Research Center. Gentlemen: Thank you for your able assistance in making this section a reality.

Donald C. Fraser
Editor-in-Chief