

WORKING SESSION
ADVANCED AIRCRAFT CONCEPTS AND CONTROLS
MODERATOR: MARTIN T. MOUL, NASA/LARC

This discussion centered on advanced systems possible with the incorporation of flight computers and fly-by-wire concepts and the applicability (or inapplicability) of MIL F 8785-B to such systems. With the flight computer and avionics capability now available the designer can contemplate a myriad of control system configurations for a given airplane and flight mission. Some significant parameters in advanced systems are command augmentation form (control law defining airplane state being commanded by a controller), cockpit controllers, direct-force-producing controls, feedback loops for control and stabilization, shaping networks, filters, scheduling of gains, filter constants, and control laws as functions of flight condition or task as well as operational considerations such as failure detection, redundancy management, and system reconfiguration. Of the above topics CAS (command augmentation systems), cockpit controllers, feedback loops, and parameter scheduling received the major emphasis of this group. Topics such as pilot-modeling, PIO, and equivalent dynamic systems, though significant, were disregarded because each of these was a major theme of another group.

One dominant recurring conclusion from much of this group's discussion was that advanced systems will at best be described by a high order characteristic equation and will produce output responses indescribable by classical flying qualities. It appears that each candidate system will have to be examined on its own basis with the government and the contractor negotiating specific requirements.

Particular discussion topics and results from this meeting follow:

Controllers - Design and human factors data and requirements are needed for advanced cockpit controllers. For some systems being considered controllers for leading and trailing edge flaps, spoilers, speedbrakes, engine nozzles, etc., as well as for command functions or blending of surfaces are required. As an example advanced velocity control might blend speed brakes with engine throttle to provide a rapid deceleration capability and the designer would require some guidance on desired or required controller characteristics.

CAS Moding - Advanced designs will allow law switching as a function of flight condition. For example a control system might provide pitch rate control at high speed and flight path control at low speed. Requirements are needed for the satisfactory implementation of such capability.

Control margin - The provision of adequate control margin for highly augmented control systems is an obvious requirement. However the vehicle and mission conditions selected as requirements for demonstrating control margin must be carefully selected so as to avoid serious over design in maximum control capability.

Contrails

Roll rate requirements - The perennial complaint of roll rate requirements being too high was made. Comments were that "maximum roll rates should be restricted to lg flight and certain critical flight conditions rather than require the maximum capability at all points within the operating flight envelope." Or "if the final concern is for trajectory control or some other state, express the requirement in terms of this final state rather than roll rate." For example, direct lift and direct side force control can be used for precision tracking in lieu of rolling and pitching.

In summary it is not possible at this time to establish detailed quantitative requirements for future advanced control systems. The generation of requirements will perforce be a continuing process as experience in the design, development, and analysis of these system is acquired.