FIGHTER AIRCRAFT FLIGHT CONTROL TECHNOLOGY DESIGN REQUIREMENTS

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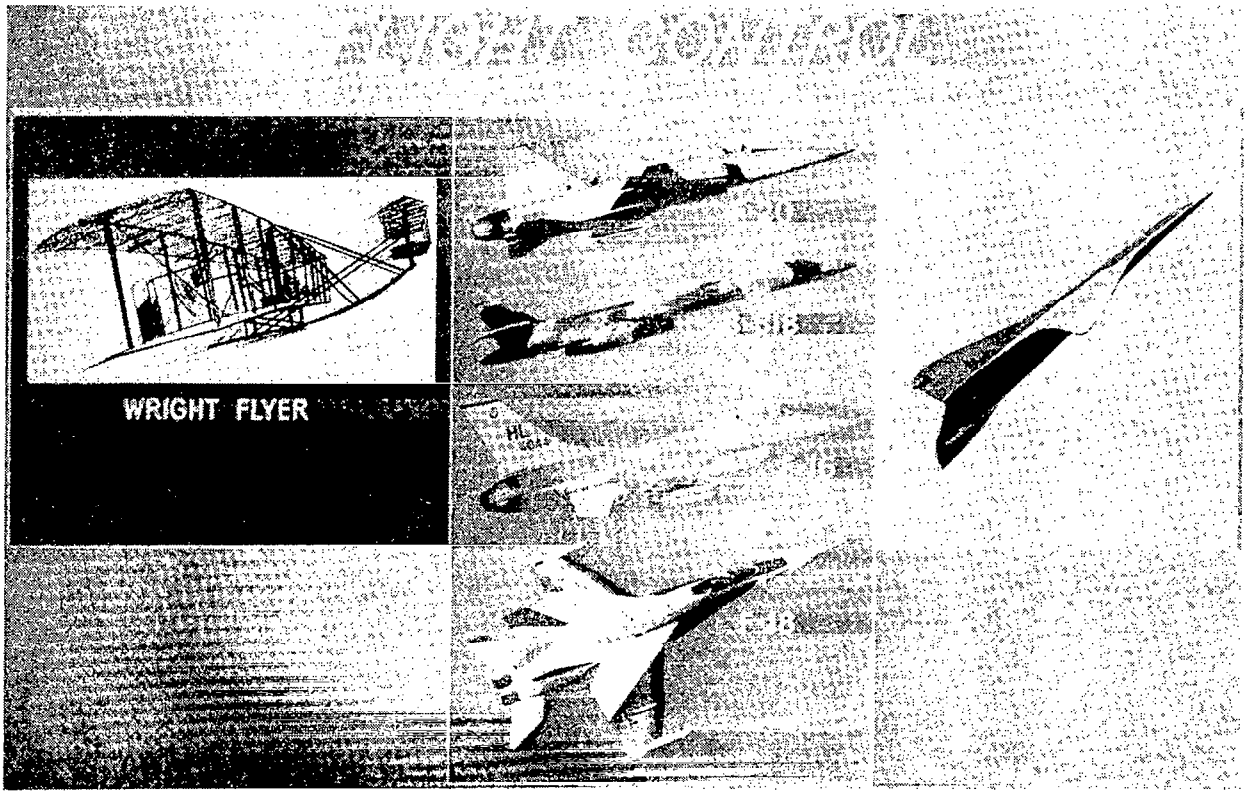
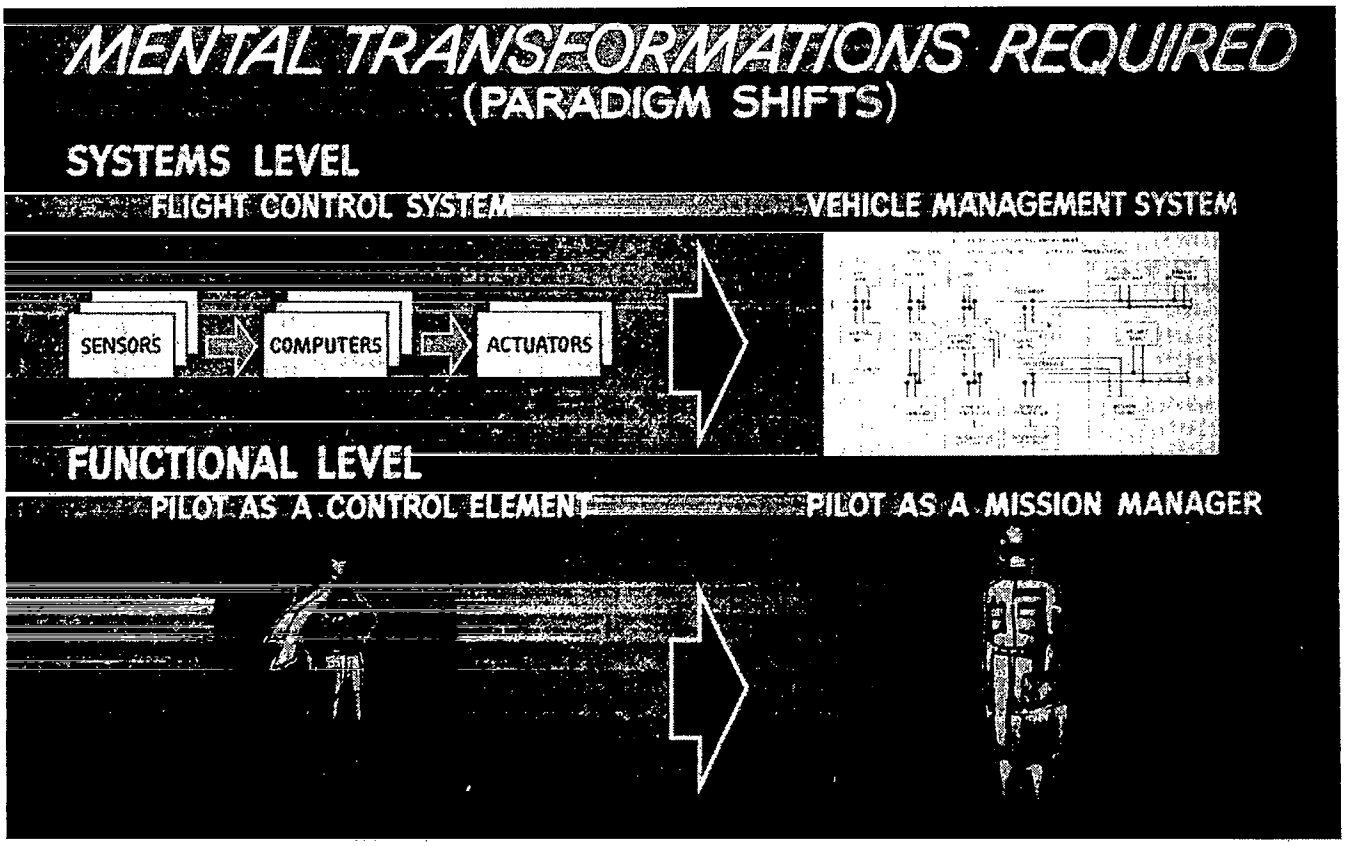
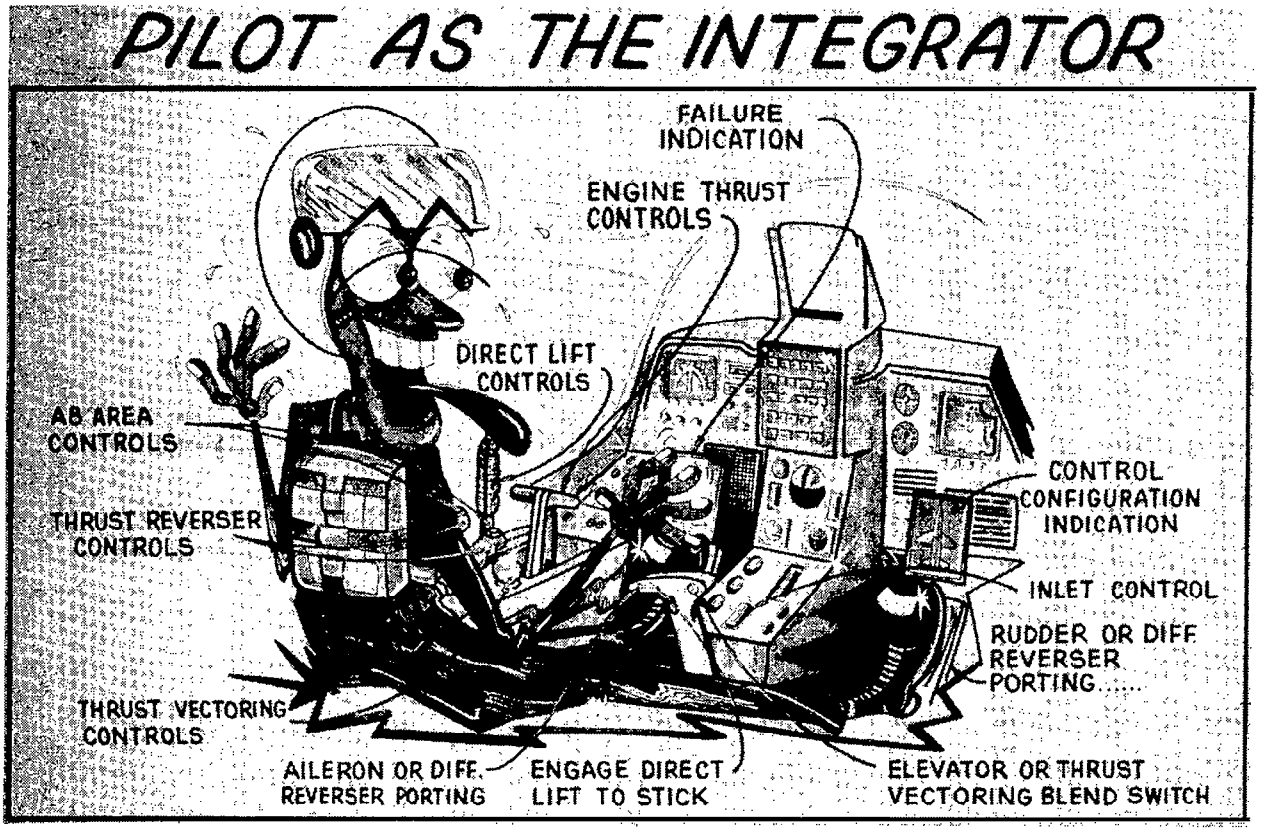
This figure represents the evolution of control technology. As we compare the current day fighters with the Wright brothers' airplane, we notice that they had achieved control technology and mastered their applications without electronics. But the future demands further emphasis of pursuing the aspects of control with the extension of research going into exotic concepts such as vortex management.



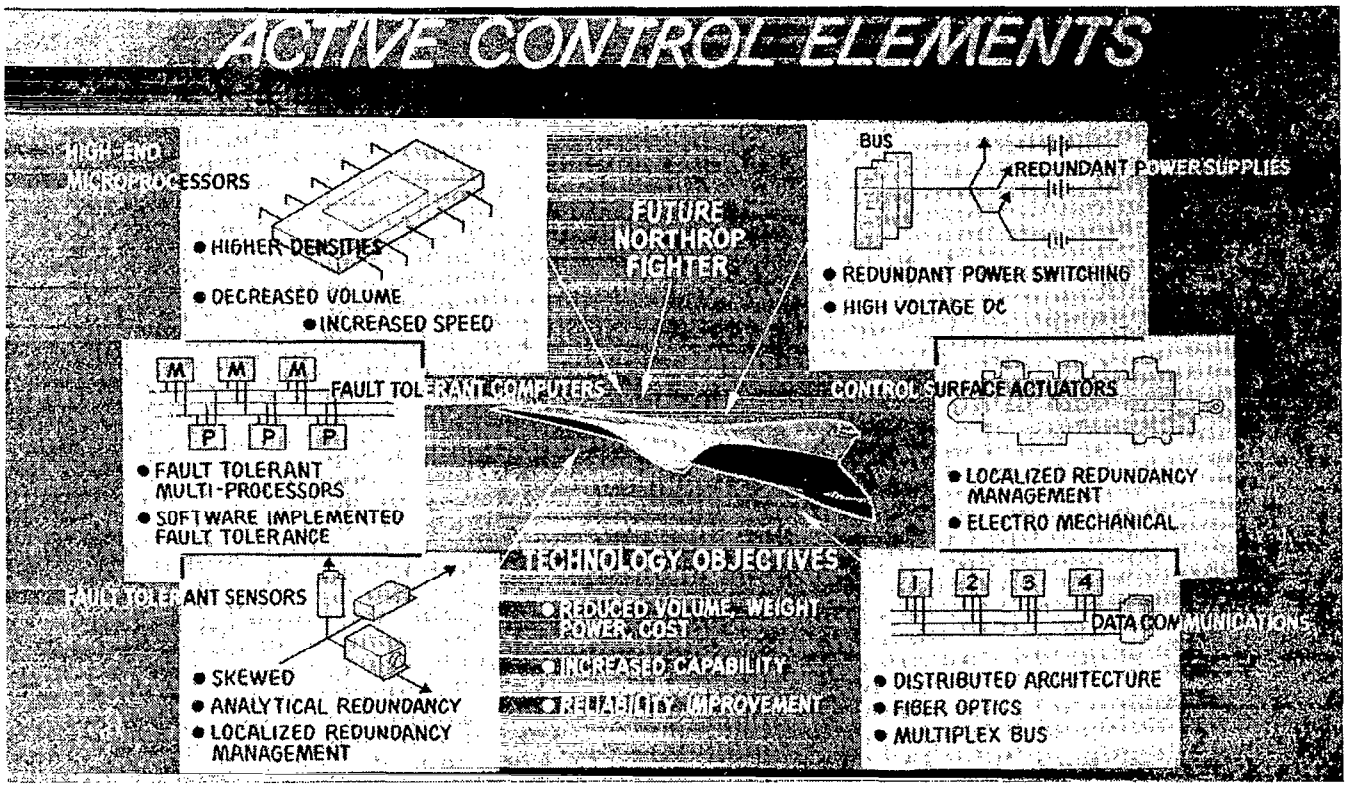
Truly, the day of the pilot controlling the aircraft will diminish. As weapon system integration and flight path and navigational integration become more heavily automated, the pilot will become a manager. His primary task will be selecting the right functional requirements; his secondary task will be as backup. He will act in the fashion he presently performs, that of a pilot.



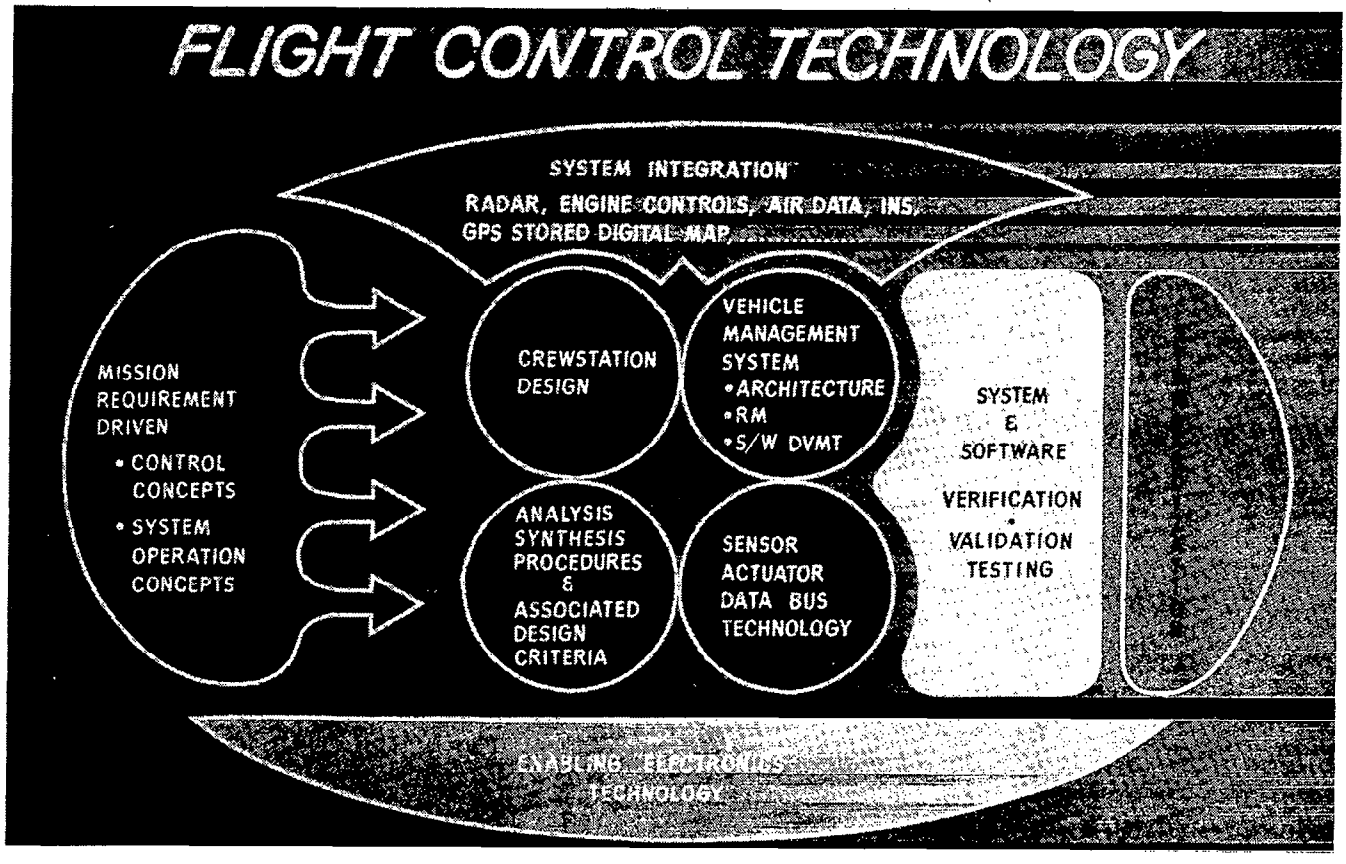
This figure humorously depicts the challenge the future pilot will have. However, it is not unattainable, as work on the AFTI and the present F-18 has demonstrated. The research needed is to establish standards that the designer can utilize to evaluate his concepts.



Active control elements in flight control technology encompass many technical disciplines. Electronic chip development will result in achieving potential architectures of control laws operating in real time during flight. The high densities and improved computation times will allow greater design flexibility for fault-tolerant applications. Data communications, actuation technology, and electrical power concept, when combined with the elements of the computer, will lead to the indicated technology objectives.

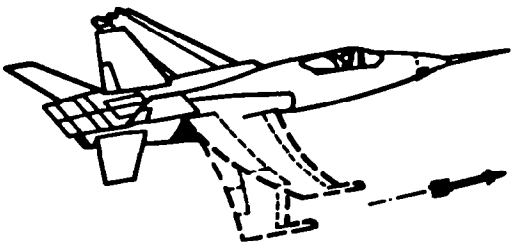


Flight control technology has evolved to a total systems engineering discipline as depicted in this figure. The mission requirements set the needs. The available electronic technology provides the capability. The interface with all avionic and other aircraft subsystems increases the flexibility of the control capability. But hidden inside the effort is an item that can deter the design performance, the validation testing. Thus, a need exists for design standards to relate the desired methods and procedures to be used in the design effort of future vehicles.



Here is a specific example of a control application that is in its infancy. The payoff on potential aircraft can be related into reduced structural weight. However, further research is needed to explore various concepts and to demonstrate them in both wind tunnel and flight tests.

BATTLE DAMAGE CONSIDERATIONS FOR ADAPTIVE FLUTTER SUPPRESSION



OBJECTIVE

- SUSTAIN FLUTTER FREE OPERATION FOLLOWING AN ARRAY OF BATTLE DAMAGE STATES
- ENHANCE THE EXISTING ADAPTIVE ALGORITHM BY SELF-REPAIRING CONCEPTS

PAYOFF

- IMPROVED COMBAT EFFECTIVENESS
- RAPID BATTLE DAMAGE REPAIR
- REDUCED PEACE TIME COST

- INCREASED SOFTWARE COMPLEXITY
- COMPUTATIONAL (FRAME TIME) PENALTY

APPROACH

- DEVELOP ALGORITHMS FOR BATTLE DAMAGE
  - DETECTION – VOTING SCHEME
  - ISOLATION – VARIANCE COMPARISON
  - CONTROL RECONFIGURATION – REDUNDANT CONTROL SURFACE OPERATION
- EMPHASIS ON YF-17 WIND TUNNEL TEST MODEL
- CREW INTERFACE ISSUES

The role of "in-flight simulation" needs to be revived. This area is valuable to relate new design features of control law, systems operation, and interaction with the pilot in a near real-life environment and to reflect the needed design changes into the new vehicle before a large change impact of cost and schedule is imposed on the project. A new airframe platform is needed to replace the antiquated T-33.

FUTURE FLIGHT CONTROL SYSTEM NEEDS - IMPROVED IN-FLIGHT SIMULATION

- VARIETY OF HANDLING QUALITIES ISSUES NEED FURTHER STUDY - LATERAL SENSITIVITY, CONTROL HARMONY, PILOT MODES, CRITERIA
- AVIONICS/PROPULSION INTEGRATION REQUIRE FLIGHT INVESTIGATION
- HIGH "G" CAPABILITY REQUIRED
- SOFTWARE INTENSE SYSTEMS REQUIRED

"Artificial intelligence" (AI) is now the term used to mean what we once referred to as computer capability. However, much effort needs to be applied in this area to determine the best approaches and resulting payoffs in using the AI concept during real-time computer operation. The figure indicates examples of applications.

APPLICATION OF AI METHODS TO FCS AND AIRCRAFT TECHNOLOGIES (NEAR AND LONG TERM)

- PVI, PILOT DECISION AIDING, PILOT AS SYSTEM MANAGER
- FAULT-TOLERANT COMPUTING (REAL TIME)
- ANALYSIS/SYNTHESIS PROGRAM (NON-REAL TIME)
- INTEGRATED PROPULSION/CONTROL SYSTEMS
- ADAPTIVE CONTROLLERS
- OPTIMIZATION WITH REGARD TO HANDLING QUALITIES, TERRAIN FOLLOWING AND AVOIDANCE, TURBULENCE, FLUTTER SUPPRESSION AND LOAD ALLEVIATION, ETC.
- "SUPER-MANEUVERABLE" AIRCRAFT
- AVIONICS
- ROBOTICS
- MANUFACTURING
- QUALITY ASSURANCE AND CONTROL
- INDUSTRIAL CONTROL
- FACTORY OF THE FUTURE