BAE SYSTEMS
INSPIRED WORK

Active Inceptor Systems

The world leader in active inceptor systems

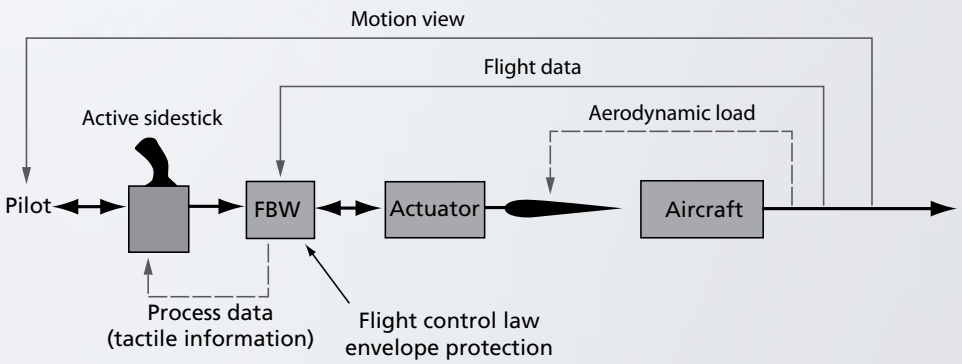
BAE Systems is the world leader in active inceptor systems. These systems reduce pilot workload while ensuring that the pilot remains the ultimate decision-making authority for the aircraft's control. These inceptors – the sidesticks or centersticks used to direct and maneuver aircraft – are line-replaceable, unit-based, self-contained systems that enhance pilot-vehicle interface with variable feel, damping, inertia, friction control, and shaker functionality, allowing for tactile cues and soft stops.

BAE Systems is the only supplier of flight-worthy active inceptors, with programs including F-35, T-50, UH-60MU, CH-53K, KC-390, and MH-47G.

These inceptors meet the highest levels of reliability and integrity.

The company's experience in fly-by-wire (FBW) control systems has led to significant knowledge and expertise in fault-tolerant designs and safety-critical systems.

- Commonly referred to as "sticks," inceptors cover a variety of pilot controls on fixed- and rotary-wing platforms including side sticks, center sticks, throttles, cyclics, and collectives.
- Inceptors traditionally are connected to directional aircraft surfaces and power controls through mechanical linkages.
- On fly-by-wire aircraft, the inceptors transmit pilot inputs to the flight control computer, which translates them instantaneously to commands that adjust directional surfaces and power.
- Active inceptor systems feed back information from the aircraft's fly-by-wire system to the pilot through the inceptor (see diagram below). This "tactile cueing" is one of the many benefits of an active inceptor system.




Reduced pilot workload
and enhanced operation
in degraded visual environment
Improved mission
effectiveness

Benefits of active inceptor systems

- Reduced through-life cost
- Improved safety and performance through use of tactile cues
- Carefree handling and reduced pilot workload through intuitive human-machine interface
- Lower system weight through electrical linking
- Reduced mechanical complexity
- Enhanced mission success and survivability
- Future growth capability through programmable features

Development of these safety features has made active inceptor systems as reliable as traditional, mechanically linked systems – at lower cost and with less maintenance

Active technology

BAE Systems is the world leader in flight-cleared active inceptors, the latest advancement in pilot inceptors. Active inceptors have many of the cost and weight savings associated with passive-inceptor fly-by-wire systems and can provide more tactile information to the pilot.

A passive inceptor is essentially a conduit through which pilot inputs are collected and transmitted to actuators via the fly-by-wire system. The only feedback the pilot receives is the tactile information from a springbox, which has fixed characteristics.

The key difference with active inceptors is that the flow of data is no longer one-way. In addition to the pilot's physical inputs being translated and transmitted to the aircraft's actuators, the fly-by-wire system provides dynamic feedback to the pilot through tactile information. This is achieved through the insertion of a programmable model linked to a servo motor actuator system.

The inceptor model (see force deflection curve diagram on the next page) dictates the level of resistance the pilot will feel at any given stick displacement, depending on the programmed characteristics.

Since these characteristics – such as stiffness, damping, and inertia – are variable, they can be controlled dynamically in flight, in real time.

Resistance levels also can be programmed to mimic the feel of the aircraft that pilots had lost with the advent of fly-by-wire technology.

However, the potential uses of active stick technology far exceed simple feel simulation. Where known recommended limits exist, the model can include a sharp increase in resistance to inform the pilot that demanding more from the aircraft will exceed operational or design limits of the airframe, gearbox, or engine.

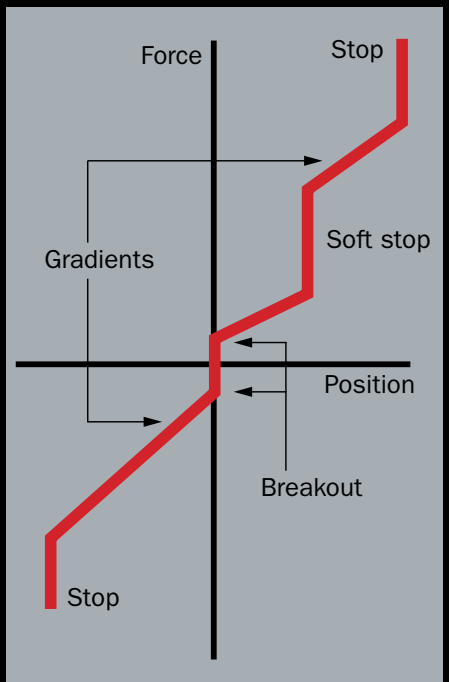
These points of increased resistance are referred to as "soft stops" and act as tactile cues to the pilot. These cues inform the pilot that he or she has reached the advised limits for normal flight, but do not prevent the pilot from exceeding these limits if the situation dictates.

A primary advantage of these tactile cues is reduction in pilot workload. Active inceptor characteristics are programmable, and many can be dynamically controlled via the flight control computer interface to provide the pilot with tactile cues appropriate to flight conditions. The programmable nature means they are ideally suited to future upgrades and enhanced mission cues as they evolve.

25 years at the forefront of technology

The active inceptor difference

- Increased pilot awareness of flight mode and conditions through tactile feedback
- Improved handling in hover, low-speed flight and degraded visual conditions such as "brown out and white out"
- Improved flight deck accommodation options
- Line-replaceable, unit-based design removes the necessity for mechanical linkages, reducing aircraft complexity, maintenance requirements, life-cycle costs, and control systems volume
- Electronic linking of two inceptors across the cockpit between pilot and co-pilot avoids issues inherent with non-linked passive inceptors
- Additional cues and limits related to mission systems are easily programmable
- Removal of complex mechanical linkages, control runs, and feel systems significantly reduces weight
- Greater mission success
- Reduced exceedances of airframe, gearbox, and engine limits extend maintenance intervals, which reduces costs through increased task accuracy and precision of controls
- Reduced pilot workload



Linked technology

In an active inceptor system, two inceptors are electronically coupled as if they were mechanically linked. Dual-pilot aircraft can thus benefit from the additional feel and cueing capabilities without the weight and through-life cost penalties of actual mechanical linkages.

Collectives and throttles

Active collectives and active throttles also benefit from this technology. Programmable friction levels are readily incorporated into this technology and are included in collective units and throttles. These maintain the inceptors at positions set by the pilot.

The possibilities for active inceptors are diverse and numerous. Because the system is software driven, it can incorporate inputs from any electrical system. For example, the active inceptor can communicate target acquisitions, caution and warning panel alerts, hostile fire warnings, and inputs from defensive aids to the pilot through its cues.

Survivability

Pilot inceptors are flight-critical; so active inceptor systems are designed to attain the same level of integrity as that achieved with earlier mechanical systems. Multiple signal sources and lanes of computing are included to provide redundancy.

Thus, should a fault occur with one processor, a second seamlessly takes over. In the unlikely event that all the processors fail, a passive back-up mode ensures the pilot can guide the aircraft to safety. A comprehensive built-in test capability ensures that the system is safe to fly prior to each flight and can identify and locate failures in real time.

F-35 throttle

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