Integrated “Intelligent” Hydration through Next Generation Aircrew Helmet

The MR100 and MR200 Next Generation helmet will seamlessly integrate the FluidLogic Active Hydration system being developed for aircrew. And given specified NATO requirements and development funding, integration can be adapted through O2 Mask or however specified for delivery to pilot.

FluidLogic systems are found today in most motorsport racing vehicles and offroad moto racing to ensure drivers can maintain peak hydration during grueling endurance racing, delivering water direct to their lips through the helmet at the push of a button, hands free. Fluidlines connect to the helmet via a leak free magnetic coupling which allows easy attach/detachment as well as safe emergency break-away without snag risk. Each system is driven by an algorithm that tailors hydration protocol to each user based on their biodata and operating environment. The system notifies the user via haptic vibration, visual or audible alert when its time to drink, then when the user presses the drink trigger the system’s pump delivers a precise amount of water to their helmet. The repeated process of taking small “micro” sips every 2-3 minutes allows the body to absorb it quickly and fully and minimize any waste, almost entirely eliminating the need to urinate when using the FluidLogic system.

Hydration Problem – Why hydrate Aviators?

Current hydration practices in the military present a critical issue particularly considering the persistent incidence of heat-related illnesses among service members. According to the *Medical Surveillance Monthly Report* (MSMR), heat exhaustion and heat stroke continue to affect military personnel, with thousands of cases reported annually despite existing hydration protocols (*Maule et al., 2024*). These findings suggest that current hydration strategies may be inadequate in preventing heat-related injuries, particularly in high-temperature training environments and especially in aircraft where operations are generally hot, pilots heart rates are elevated and they are mission focused.

Furthermore, studies have demonstrated that hypohydration, or insufficient body water levels, is a significant issue that impairs both cognitive and physical performance, Studies have demonstrated that even mild dehydration (1–2% body weight loss) can result in declines in attention, memory, motor coordination, and reaction time, as well as reduced muscle strength, endurance, and thermoregulation.

Traditional ad hoc fluid intake (when thirsty) frequently results in involuntary dehydration, where fluid losses are not fully replaced due to delayed or insufficient thirst responses. In aviation, it is typical for pilots to “tactically dehydrate” to avoid urination. This is especially concerning in hot environments, where high sweat rates cause rapid and significant fluid loss. In such conditions, drinking to thirst often underestimates actual hydration needs, leading to progressive dehydration. This compromises thermoregulatory function, increases core body temperature and cardiovascular strain, and ultimately impairs health, safety, and both physical and cognitive performance.

In contrast, fluid intake matched to sweat losses supports euhydration, preserves plasma volume, and maintains heat dissipation via sustained sweating and skin blood flow. For individuals engaging in prolonged or intense activity in the heat, fluid replacement based on sweat rate is critical to reducing the risk of heat-related illness and optimizing physiological function. However, accurately estimating and timing fluid intake is complex. A device such as FluidLogic eliminates guesswork, providing real-time fluid delivery directly into the helmet to ensure optimal hydration.

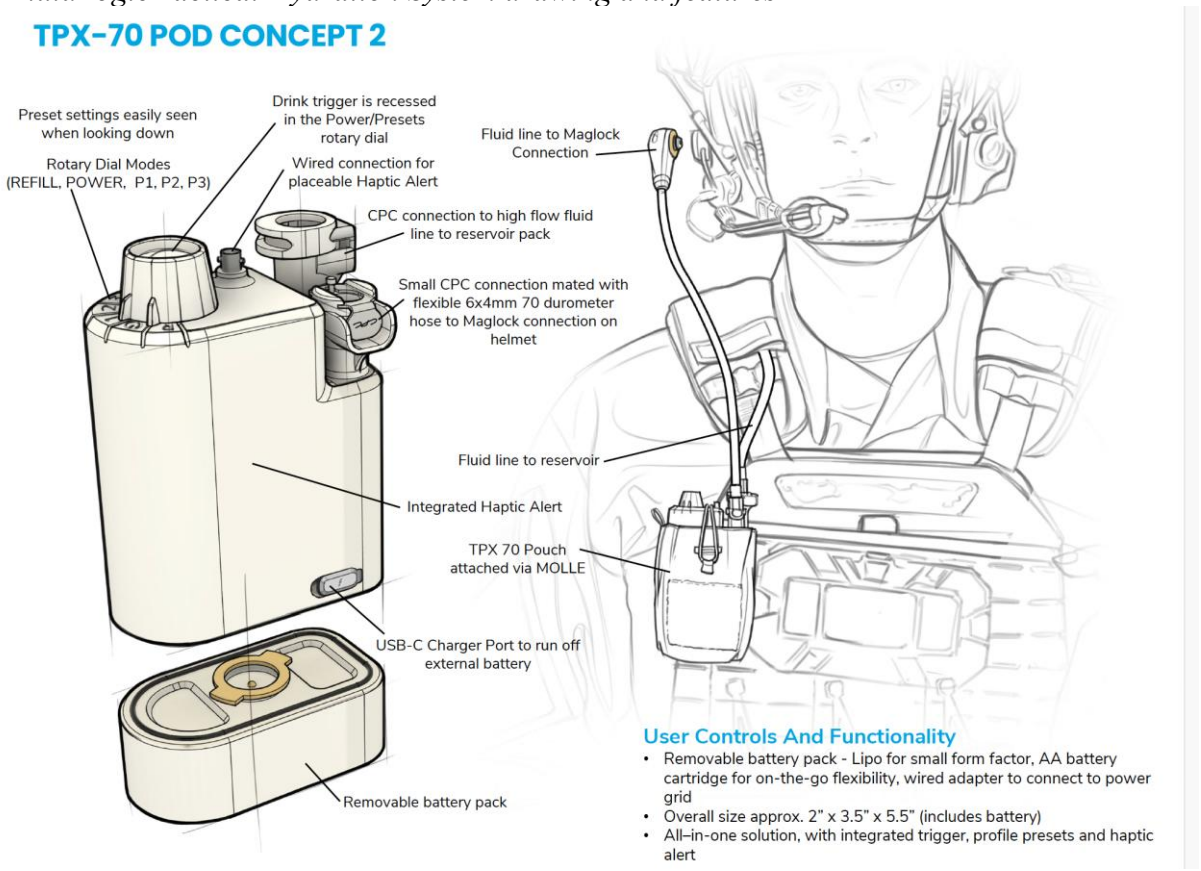
FluidLogic is currently funded to concduct R&D and working with USAF to develop an advanced modular hydration system plus accessories for a special warfare tactical environment. Graphics of this system are shown in figures 1-4 below. These systems will be complete in early 2026 and can be available for demonstration in prototype form in late 2025. Other R&D efforts are ongoing to adapt this modular system into a pilot's carry-on equipment set and integrate into common multi-role helmets and communication systems.

Hydration is a critical yet challenging factor for pilots, especially during the rigorous demands of military operations. The unique environment in which pilots operate presents specific obstacles to maintaining optimal hydration levels, impacting their focus, alertness, and overall health. This, in turn, affects mission readiness and safety. Here are the challenges specific to Air Force pilots:

- **G-Forces and Cabin Pressure:** Pilots are subjected to high G-forces and varying cabin pressures, which can affect bodily fluids and increase the rate of dehydration. Additionally, the pressurized environment of an aircraft can lead to faster moisture loss from the body.
- **Cockpit Environment:** The confined space of a cockpit and the constant attention required for aircraft operation can limit the opportunities pilots have to drink water. This can result in reduced water intake and subsequent dehydration.
- **Communication Barriers:** The need for uninterrupted communication and wearing oxygen masks can make it cumbersome for pilots to hydrate regularly, leading to prolonged periods without water intake.
- **Absence of Hydration Monitoring Systems:** Most aircraft lack systems that monitor the hydration levels of pilots, making it difficult to recognize and address dehydration until symptoms impact performance

Figure 1. *FluidLogic notionally mounted in side-carry pouch as pilot steps to aircraft. Fluidline integrates to deliver water through helmet, mask, or headset boom.*

Figure 2: *FluidLogic Tactical Hydration System drawing and features*



Hypohydration, or insufficient body water levels, significantly impairs both cognitive and physical performance, especially in high-stress environments like military operations. Even mild dehydration (1–2% body weight loss) reduces sustained attention, working memory, and executive function due to decreased cerebral blood flow and altered prefrontal cortex activity, leading to slower decision-making, impaired focus, and increased mental fatigue (Ganio et al., 2011; Kempton et al., 2011). Additionally, dehydration negatively affects psychomotor speed, coordination, and mood, exacerbating cognitive decline and psychological strain (Cian et al., 2001; Armstrong et al., 2012). Physically, it compromises endurance, strength, and thermoregulation, increasing the risk of heat-related illnesses such as heat exhaustion and stroke (Adan, 2012; Cheuvront et al., 2010). Studies show that structured hydration strategies enhance performance and reduce thermoregulatory strain more effectively than self-regulated drinking (Bardis et al., 2017; Cheuvront & Kenefick, 2014). Military research highlights the operational risks of dehydration, with nearly 44.7% of soldiers exceeding 2% dehydration within four hours

Micro-dosing water intake via the FluidLogic Active Hydration System presents a cutting-edge solution to these hydration challenges by integrating real-time monitoring and automated fluid delivery, ensuring that warfighters maintain optimal hydration levels. Unlike traditional hydration strategies that rely on subjective thirst perception or scheduled water breaks, FluidLogic employs biodata-driven hydration management capabilities to assess individual hydration needs and deliver precise fluid intake accordingly. A study involving elite professional race car drivers demonstrated the system's effectiveness in mitigating hypohydration under high-stress, high-temperature conditions, resulting in better thermoregulation, reduced physiological strain, and improved performance (Ferguson et al., 2023). The FluidLogic system has undergone further development through the Air Force SBIR program with the 711 Human Performance Wing and has the potential to provide a scalable and adaptive hydration solution for military applications.

Figure 3: *Magnetic connection to helmet AND secondary trigger system. Also showing connectivity to larger water reservoir to refill the user's 50oz reservoir.*

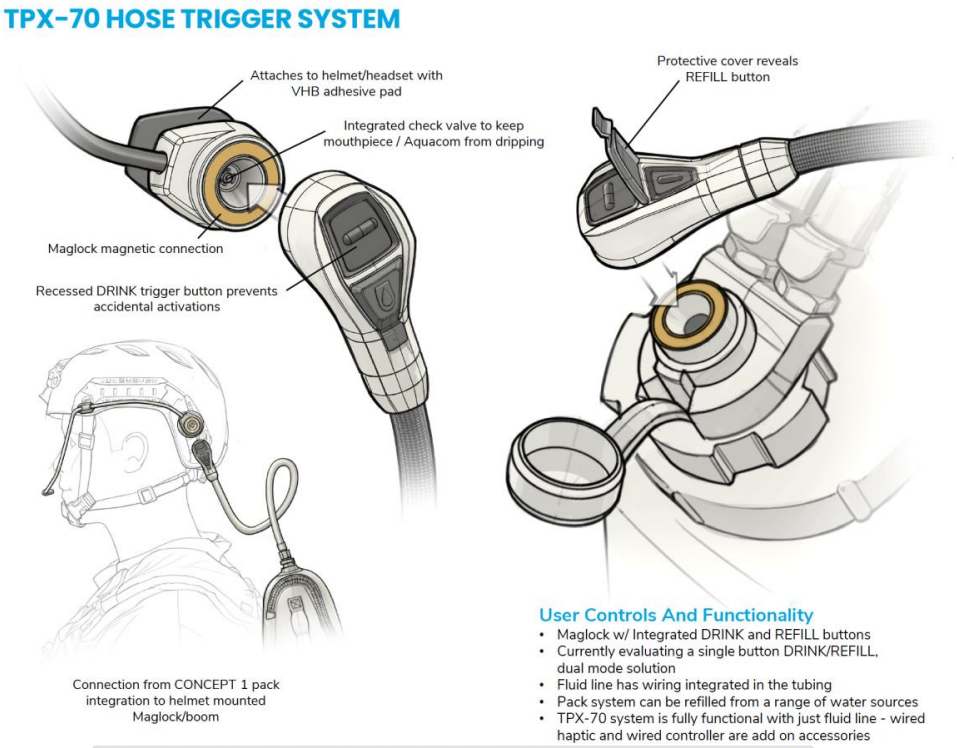
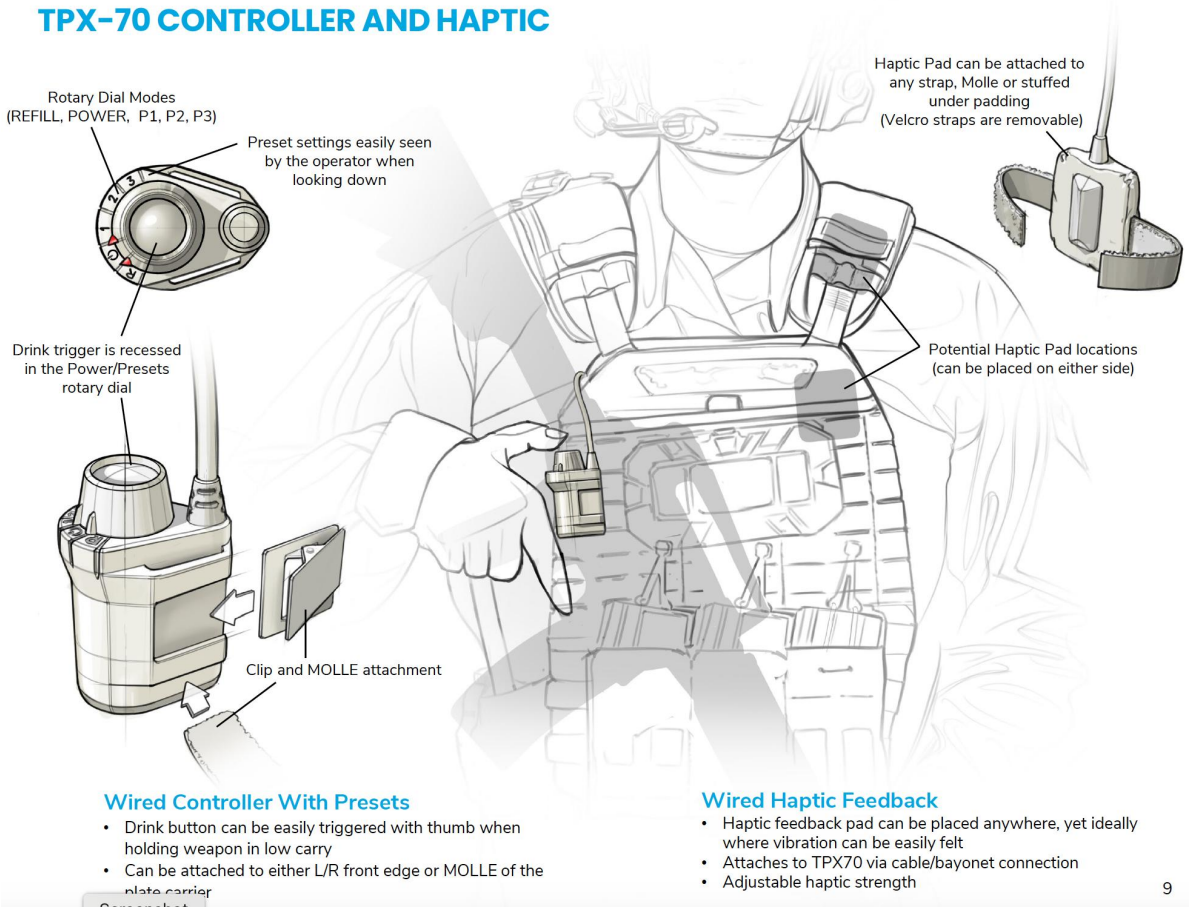


Figure 4: *Remote trigger for cockpit or life support vest mount. Enables control of hydration system while stowing reservoir and FluidLogic TPX-70 POD out of pilot's reach.*



1. Product Name: APX-50 Concept Prototype

2. Product Overview: The Fluid Logic Aviation Carry-On Hydration System (APX-50) is a portable hydration solution specifically engineered for commercial and military aviation pilots, aircrews, and essential personnel. Leveraging the principles of hands-free delivery of timed micro-dosing hydration, the system aims to enhance endurance, cognitive performance, reaction time, and overall operational effectiveness in demanding aviation environments. While drawing conceptual similarities to the FluidLogic GPR-50 system, this new design prioritizes durability, crew safety, efficiency, and compliance with rigorous aviation engineering and certification standards. The system is designed to be stowed securely during flight operations yet remain readily accessible.

3. Target Market:

- **Commercial Helicopter Operations:** HEMS, Aerial Firefighting, SAR, Law Enforcement, Utility/Pipeline Patrol, Agriculture, Tourism, Offshore Transport, Forestry/Logging, External Load Operations.
- **Commercial Fixed-Wing Operations:** Agricultural Application, Pipeline/Infrastructure Patrol, Aerial Surveying/Mapping, Photogrammetry, Wildlife Monitoring, Maritime Patrol, Cargo/Logistics, Airborne Firefighting, Banner Towing, Utility/Remote Operations Support.
- **Military, Government, and Public Service Rotary- and Fixed-Wing Operations:** CSAR, Special Operations, Troop Transport, Attack Helicopter Units, Training Commands, Shipborne Helicopter Detachments, Light Tactical Transport, ISR Aircraft, Forward Air Controllers, UAS Ground/Flight Crew, Remote Sensing/Atmospheric Research, Electronic Warfare, Specialized Support, CBP Air and Marine Operations, U.S. Coast Guard Aviation, DHS Aviation Units, FEMA Aviation Support, State/Local Law Enforcement Aviation, National Guard Aviation, Civil Air Patrol, U.S. Forest Service Aerial Firefighting.
- **Special Market Considerations:** Extended mission durations, remote operations, high heat/altitude/desert environments, congested cockpits favoring modular/wearable systems (when stowed).

4. Key Features and Design Criteria:

- **Reservoir Capacity:** 1–2 liter hydration reservoir, optimized for flight endurance without excessive weight or bulk.
- **Attachment Mechanism:** Durable hanging strap with a carabiner-type attachment for securement to approved aviation tie-down or stowage points.
- **Semi-Wearable Design:** Lightweight, ambidextrous cross-body sling pack design with a potentially storable or removable strap for versatile use in and out of the cockpit.
- **Operational Versatility:** Enables easy transport of hydration during flight and non-flight critical duties (pre-flight, ground support, maintenance, emergency response).
- **Storage Compartments/Pockets:** Multiple interior and exterior compartments of various sizes for increased operational modularity. Integrated MOLLE strap systems for flexible configuration and secure storage/rapid access to mission-essential items (survival equipment, communication devices, checklists, etc.).
- **FluidLogic Smart Hydration Hardware Integration:** Securely integrated pumps, sensors, Bluetooth (BT) trigger modules, and control interfaces. Routing of cables/wires/tubing prioritized for snag-free installation, secure stowage, and intuitive access. Control panels/interfaces protected to maintain functionality without interfering with storage, crew movement, or emergency operations. System designed for durability, reliability, and safety during all aviation and ground activities.
- **FluidLogic Bluetooth (BT) Hydration Remote:** Multiple retention options:
    - Velcro hook-and-loop attachment for mounting to approved surfaces/gear/straps.
    - Finger/thumb-worn silicone ring-type retention for rapid, intuitive activation.

- **Maglock Hydro-Connector Headset/Helmet Mount and Hydro Line:** Interface for rapid, secure attachment/detachment to aviation headsets/helmets without impeding flight equipment, oxygen masks, PPE, or communication systems. Hydro line routed to minimize snag hazards and interference. Low-profile, durable mount resistant to vibration/turbulence, allowing intuitive one-handed connection/disconnection (even with gloves). Hydro line and connection assembly designed for durability, flexibility, and aviation safety standards in various mission environments.
- **Headset/Helmet Hydro-Tube and Hydro-Nub (Optional):**
    - **Option 1: Helmet-Mounted (Gen1 Style):** Rugged, integrated hydro-tube and nub for secure helmet installation, interfacing with the Maglock connector. External routing along the helmet frame with low-profile clamps/retainers to minimize snags and maintain access to communication/oxygen systems.
    - **Option 2: Lightweight (Oxygen Cannula Style):** Lightweight, low-profile hydro-tube for headset integration or light helmets, emulating oxygen cannula form factor. Secured with lightweight clips/flexible mounts, prioritizing comfort and rapid donning/doffing. Compatible with the Maglock connector.
    - Both options ensure snag-free routing, compatibility with flight gear, non-interference with cockpit operations/emergency egress/safety systems, and durability under operational stresses.
- **Haptics (Optional):** Non-intrusive, user-configurable alerts for hydration reminders and system status with 3-5 selectable intensity settings. Haptic hardware suggested for integration into the cross-body sling shoulder strap or a modular clip-mounted control unit. Design ensures secure/comfortable contact, insulation from ambient vibrations, and full compatibility with other system components. Must not interfere with flight gear, restraint systems, or emergency egress.
- **Battery:** Integral, rechargeable battery supporting hot-swapping and in-system charging via USB-C.
    - Rechargeable lithium-ion or lithium-polymer technology with robust protection.
    - Snag-free, internally routed power cables.
    - User-accessible USB-C charging port with dust cover.
    - Minimum 8 hours continuous operation (10 hours ideal).
    - Meets applicable aviation and portable electronic device safety standards. Protected from interference with storage, reservoir space, or emergency egress.
- **Soft-goods Construction:** Rugged, aviation-grade materials emphasizing durability, potential crashworthiness/fire-resistance, and compliance with aviation safety requirements.
- **User Ergonomics and Safety:** Prioritizes minimal cockpit interference, ease of use with flight gear, and quick/intuitive fluid access. **Critical Safety Note:** The system shall **never** impede or interfere with aircraft safety restraint devices, personal protective equipment (PPE), or emergency egress/evacuation operations.

5. Applicable Standards (for Testing and Design Guidance):

- **RTCA DO-160G:** Environmental Conditions and Test Procedures for Airborne Equipment (select sections for vibration, temperature/altitude, fluid contamination resistance, EMI/EMC).
- **MIL-STD-810H:** Environmental Engineering Considerations and Laboratory Tests (supplementary testing for high vibration, thermal changes, dust/sand/fluid ingress).
- **FAA AC 25-13:** Crashworthiness Standards for Airborne Systems (principles for secure stowage and prevention of injury hazards).
- **MIL-STD-1472G:** Human Factors Engineering (select provisions for accessibility, ease of use, and non-interference).
- **Internal Fluid Logic Engineering Guidelines and Best Practices.**
- **UN 38.3 Testing Guidance (for Battery Safety).**

6. Objective (of Testing Program):

To evaluate the environmental durability, functional reliability, user ergonomics, and operational safety of the aviation carry-on hydration system under conditions representative of military and civilian helicopter and fixed-wing operations. Specific goals include:

- Verification of system resilience to typical aviation operational stresses (vibration, altitude, temperature, fluid exposure).
- Assessment of system usability by aircrews (stowage, accessibility, non-interference).
- Confirmation of regulated, incremental fluid delivery supporting performance and safety without impeding crew functions.
- Validation that the system meets Fluid Logic's operational goals for entering the aviation sector.

7. System Description (of the Unit Under Test):

- **Hydration Pack:** Lightweight, soft or semi-rigid, wearable pack designed for aviation durability and compactness, easy stowage, and rapid accessibility.
- **Hydration Tubing:** Aviation-rated quick-connect tubing with a magnetic coupling mechanism for secure and easy connection/disconnection.
- **Smart Pump Module:** Compact, internally mounted system for regulated fluid doses with automated scheduling and manual override.
- **Internal Rechargeable Battery:** Integrated smart-charging system for pump and Bluetooth module, ensuring reliability without excessive weight.
- **Bluetooth Connectivity:** Built-in functionality for hydration tracking via connected devices or cockpit monitoring tools.
- **Construction and Materials:** Ruggedized, aviation-grade materials resistant to vibration, altitude, temperature, and fluid exposure, ensuring crashworthy and safe integration. Designed for modular deployment across various aviation operational profiles.

8. Test Phases (Summary):

- **Phase I: Laboratory and Bench Testing:** Focuses on environmental durability, mechanical reliability, electrical safety, and system robustness under simulated aviation conditions.
    - Mechanical Fit and Function Test
    - Temperature and Altitude Test (RTCA DO-160G Sections 4/5)
    - Vibration Test (RTCA DO-160G Section 8, MIL-STD-810H Vibration)
    - Shock and Crash Safety Test (RTCA DO-160G Section 7, FAA AC 25-13 reference)
    - Waterproofness and Fluid Resistance Test (RTCA DO-160G Sections 10/11)
    - EMI/EMC Susceptibility Test (RTCA DO-160G Section 20)
    - Battery Safety Test (Internal Standards / UN 38.3 Testing Guidance Reference)
- **Phase II: Operational Ground and Flight Testing:** Validates system ergonomics, usability, and functional integration during real-world operations.
    - Ergonomics and Usability Test
    - In-Flight Operational Test
    - User Feedback Survey