High Altitude Platform Aircraft at NASA
Past, Present and Future

John H. Del Frate
NASA Dryden Flight Research Center
HAP Applications Symposium
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Agenda

- NASA’s Dryden Flight Research Center
- Past
  - Significant Accomplishments from Environment Research and Sensor Technology (ERAST) Project
- Present
  - HAP Applications: Needs and Opportunities
  - NASA Aeronautics Focus Shift
  - HAP Non-aeronautics Challenges
  - Current HAPS Capabilities at NASA
- Future
NASA's Dryden Flight Research Center

Our Vision:
To Fly What Others Only Imagine

Our Mission:
Advancing Technology and Science Through Flight

Mission Elements:
Perform flight research and technology integration to revolutionize aviation and pioneer aerospace technology,
Validate space exploration concepts,
Conduct airborne remote sensing and science observations,
Support operations of the Space Shuttle and the ISS
Located in the Mojave Desert in southern California

Tenants on Edwards U.S. Air Force Base

Linked to Vast Western Range

350 Test Days/Year

- **Perseus A**
  - Proof of Concept Vehicle
  - Propulsion Technologies

- **Pathfinder**
  - Solar-powered HALE Technologies
  - Crop, Forest and Coral Reef Imaging Science Missions
  - 1994-1997

- **Raptor D2**
  - OTH Communications with Tracking & Data Relay Satellite System
  - 1998

- **Centurion**
  - High Aspect Ratio Flight Characteristics
  - Solar-powered HALE Technologies
  - 1997

- **Altus I**
  - Platform Development
  - Propulsion & Performance Concepts
  - 1997

- **Pathfinder Plus**
  - Solar, Aerodynamics, Propulsion & Systems Demos
  - Telecommunications Relay Demo
  - Coffee Harvest Imaging Science Mission
  - 1997-1998

- **Perseus B**
  - Validate/mature: Propulsion System
  - Avionics
  - Command & Control
  - Payload Integration
  - 1998-1999

- **Helios**
  - HALE Technologies Demonstrator
  - Lightweight Supplementary Energy Systems
  - 1998-2003

- **Altus II**
  - Validate/mature: Propulsion System
  - Avionics
  - Command & Control
  - DoE Atmospheric Radiation Science Missions
  - 1998-2002

- **Proteus**
  - Optionally Piloted Vehicle
  - OTH Command, Control & Communication
  - Detect, See & Avoid
  - 1999-Present

- **Altair**
  - Enhanced Avionics Systems
  - OTH Command & Control
  - Earth Science Platform
  - 2003-Present
A Solar Powered HAP - Helios

A World Record for Altitude of 96,863 ft (29.5 km) was set for a non-rocket powered aircraft.

Footage from 2001 deployment to the Hawaiian island of Kauai.
HAP Applications, Needs and Opportunities

**Science & Weather Forecasting**

- In-situ real-time global atmospheric information 24/7
- Sharply reducing uncertainties in atmospheric and weather models & forecasting

**Resource Management**

- World-wide low-cost coverage of agriculture, water resources, forests, etc.

**Surveillance & Disaster Monitoring**

- Reliable, low cost, flexible surveillance and communications platform

**Commercial**

- Global high quality communications that truly connect the world
NASA Aeronautics Focus Shift

- NASA priorities have shifted towards Space Exploration.
- New Aeronautics Program has shifted its emphasis toward fundamental aeronautics:
  - Hypersonics
  - Supersonics
  - Sub-Sonic Fixed Wing
  - Sub-Sonic Rotary Wing
  - Integrated Vehicle Health Management (IVHM)
  - Integrated Resilient Aircraft Controls (IRAC)
  - Intelligent Integrated Flight Deck (IIFD)
  - Aircraft Aging & Durability (AAD)
  - Next Generation Transportation System (NGATS)
  - Airportal

- More information can be found at:
  - www.aeronautics.nasa.gov
Non-Aeronautical HAP Challenges in the U.S.

- **Access to U.S. Airspace**
  - 2006 a turning point with the Federal Aviation Administration (FAA).
  - FAA reorganizing to better address a very high demand for UAV flight approvals from the military, government agencies, and commercial companies.

- **Access to Spectrum**
  - Ku-type Satellite Communications is very expensive and over-subscribed.
  - When possible, UAV operators are taking advantage of Iridium and INMARSAT for both command and control and data.
  - The situation will likely worsen as more UAVs become operational.

- **Liability and insurance.**
Current HAP Capabilities at NASA

ER-2

Altair/Ikhana (Predator B)

Global Hawk (ACTD)

WB-57
Altair/Ikhana Project Overview

Background & Status
- Altair is a Predator B variant; Ikhana is a Predator B.
- Ikhana to be delivered to NASA this month.

Missions
- Earth Science
  - USFS Fire detection mapping in 07
  - UAV AVE satellite validation in 08
- Unmanned Aerial System technology testbed
  - Fiber-optic Wing Shape Sensing
  - Collision Avoidance

Ikhana Airborne Research Test System
- 3 processor research flight control and/or mission computer
- Able to autonomously control the aircraft and some systems
- Able to host research control laws

Ikhana Capabilities
- Endurance: 30 hours
- Ceiling altitude: ~ 50,000 ft (15.2 km)
- Payload: 2,400 lbs (1,089 kg)
- Ku satcom for over the horizon missions
2005 NASA/NOAA UAV Demo

- 5 Missions using Altair
  - Durations up to 18.6 hrs
- Sensors
  - Ocean Color Sensor/
    Passive Microwave Vertical
    Sounder
  - Gas Chromatograph/
    Ozone Instrument
  - Cirrus Digital Camera
    System
  - REVEAL
  - EO/IR Skyball
- Objectives
  - Atmospheric river sampling
  - Marine sanctuary
    surveillance/enforcement
  - Channel Island mapping
  - Ocean color profile
- Objectives achieved
2006 NASA/USFS Western States Fire Mission

- Multi-spectral camera to locate and map known and unknown forest fires.
- Thermo geo-rectified imagery provided to the National Interagency Fire Center in near real-time.
- Long duration (~20 hours) over-land operation in the NAS will provide challenges.
Example of Sensor Images for Fire Mission

Castaic Fire, CA (8/26/96), 25m res., 65,000 ft AGL

Altair-acquired imagery = 17m res. @ 45,000 ft and 9.5m at 25,000 ft
Global Hawk Overview

**Background & Status**
- Original Global Hawk prototype aircraft built (#1 and #6).
- USAF is in the process of transferring the aircraft to NASA.
- The aircraft could be operational as soon as 2008.

**Missions**
- Communications systems testing
- Earth Science
- Payload development and testing
- In-situ measurements and collection
- Hurricane tracking

**Capabilities**
- Endurance: > 30 hours
- Ceiling altitude: 65,000 ft (19.8 km)
- Payload: > 1,500 lbs (> 680 kg)
- Ku Satcom and/or Iridium for over the horizon missions
ER-2 Overview

Background & Status
- Two aircraft (806 and 809); variants of the military U-2 aircraft.
- Serving NASA since the early 70’s.

Missions
- Remote sensing
- Satellite calibration/validation
- In-situ measurements and atmospheric sampling
- Instrument demonstration, test and evaluation

Versatility
- Multiple locations for payload instruments
- Pressurized and un-pressurized compartments
- Standardized cockpit control panel for activation and control of payload instruments.
- Iridium communications system

Capabilities
- Endurance: > 8 hours
- Ceiling altitude: > 70,000 ft (21.3 km)
- Payload: 2,600 lbs (1,180 kg)
- Range: > 4,000 miles (> 6,400 km)
WB-57 Overview

**Background & Status**
- Two aircraft available.
- Serving NASA since 1969.

**Missions**
- Remote sensing
- In-situ measurements and atmospheric sampling
- Instrument demonstration, test and evaluation
- Space Operations launch video support.

**Capabilities**
- Endurance: approx. 6.5 hrs
- Ceiling altitude: > 60,000 ft (> 18 km)
- Payload: 6,000 lbs (2,721 kg)
- Range: approx. 2,500 miles (4,000 km)

**Versatility**
- Removable pallet for ease of payload installation
- Pressurized and un-pressurized pallet locations are available.
NASA Near Term and Long Term Plans

- **Near Term**
  - NASA will use the existing fleet of HAPs to conduct a variety of missions.
  - NASA expects to take advantage of access to the U.S national airspace.
  - Operations of our HAPs are expected to yield valuable operational experience that can be used to further improve these aircraft systems.

- **Long Term**
  - Scientists at NASA and other U.S. agencies are meeting routinely to plan different missions that will take advantage of these special aircraft.
    - Hurricane tracking missions.
    - Polar missions to monitor the state of the ice caps over long periods of time.
  - A return to HAP technology development is always a possibility.
Contact Information

John Del Frate

- Director for Planning and Business Development
- john.delfrate@dfrc.nasa.gov
- (661) 276-3704 (w)
- (661) 810-6988 (c)