High Altitude Platform Aircraft at NASA
Past, Present and Future

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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
NASA - Dryden Flight Research Center Location

• 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** 1991-1994
  - Proof of Concept Vehicle
  - Propulsion Technologies

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

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

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

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

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

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

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

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

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

- **Altair** 2003-Present
  - Enhanced Avionics Systems
  - OTH Command & Control
  - Earth Science Platform
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

**Commercial**

Global high quality communications that truly connect the world

**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
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.
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