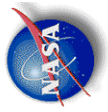


NASA Dryden UAS Perspective

Unmanned Aerial Vehicles Conference
San Diego, CA
May 1-2, 2006

Gary Cosentino
External Projects Mission Directorate
NASA Dryden Flight Research Center
(661) 276-3512



HELIOS

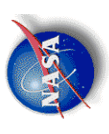
Helios Prototype Record Altitude Flight

96,863 feet

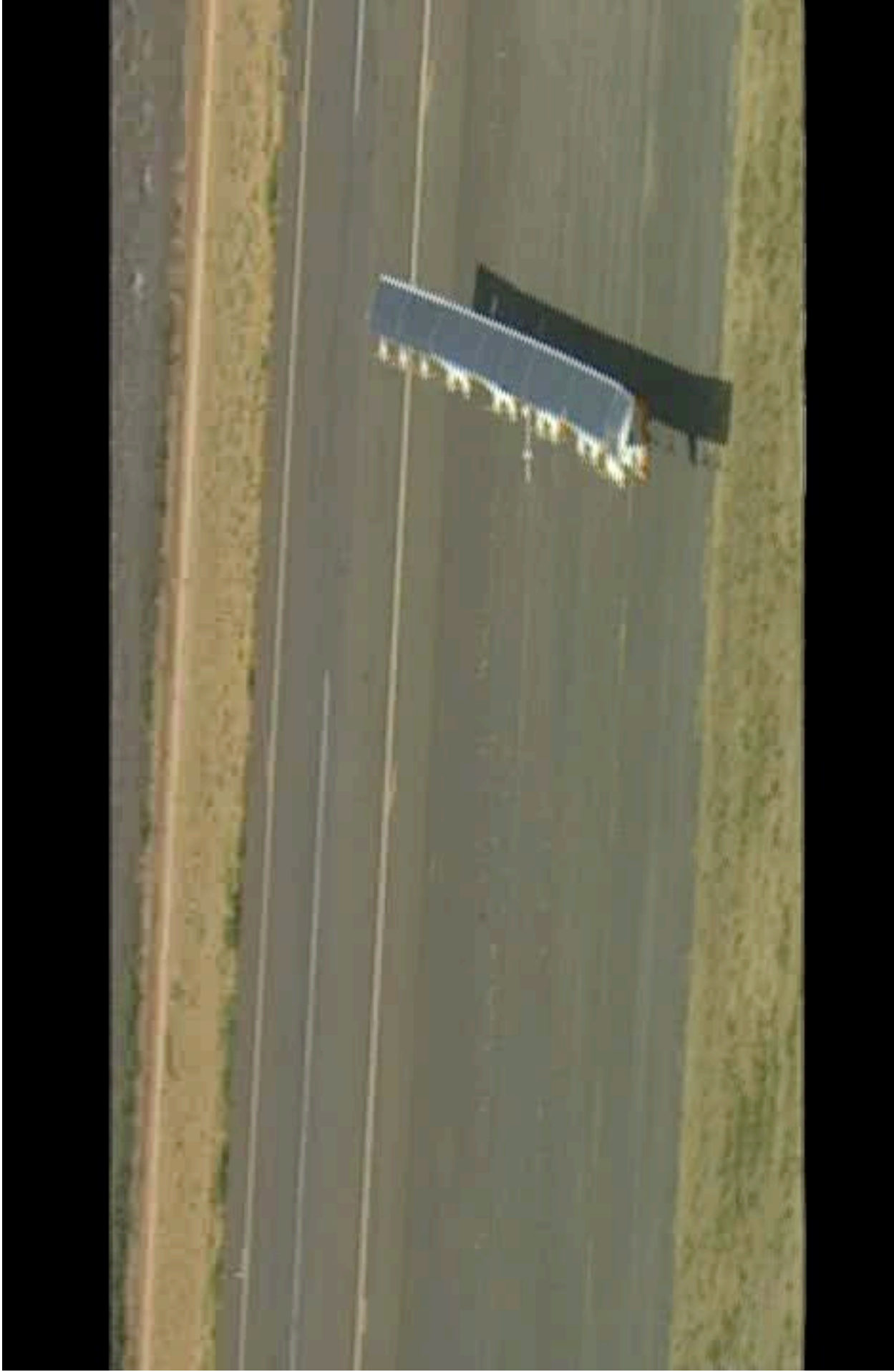
August 13, 2001

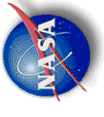
Dryden

Flight Research Center



HELIOS



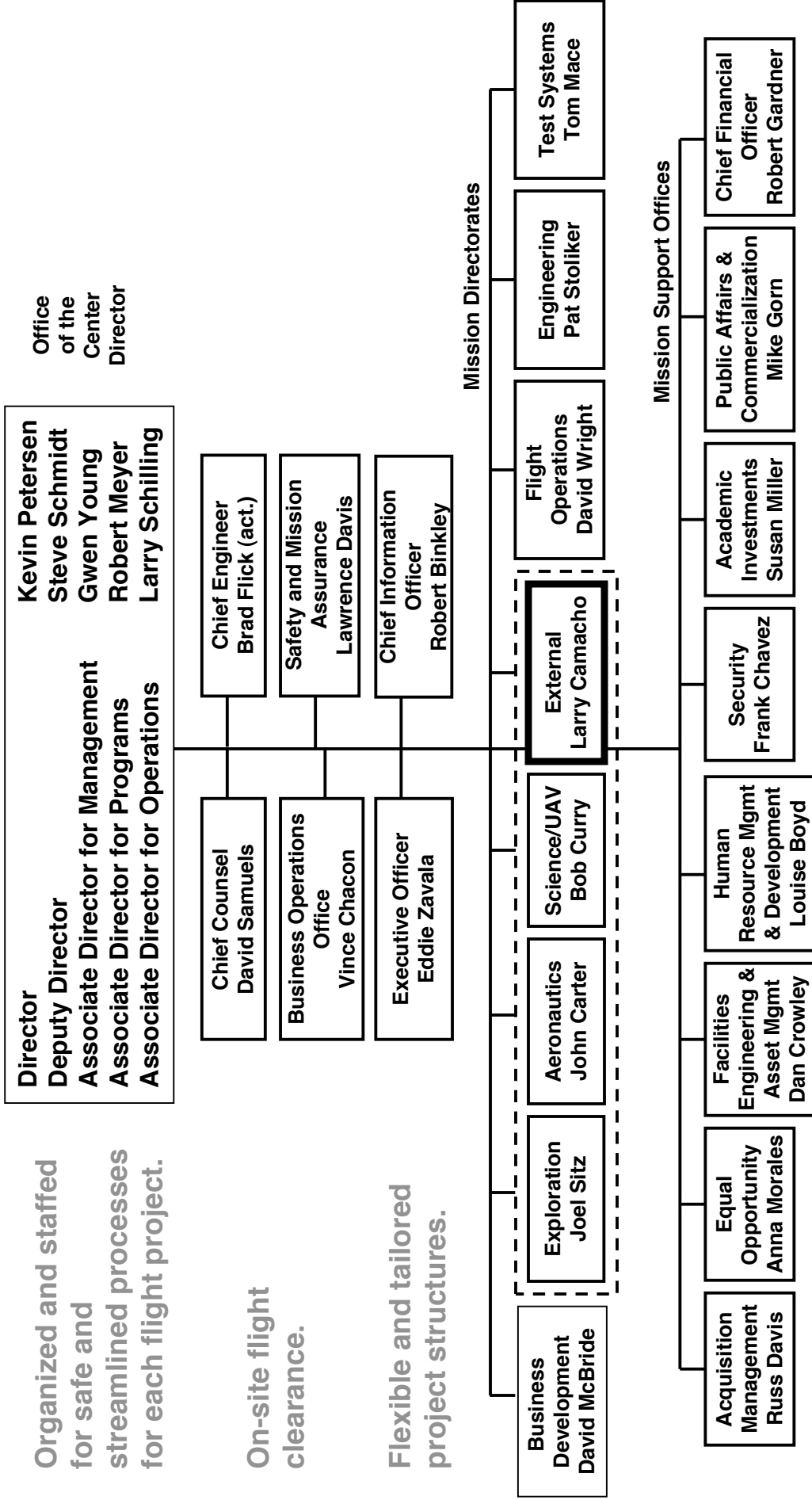


Where I “Fit” in the Dryden Organization

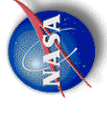
Organized and staffed for safe and streamlined processes for each flight project.

On-site flight clearance.

Flexible and tailored project structures.



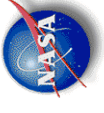
Overview



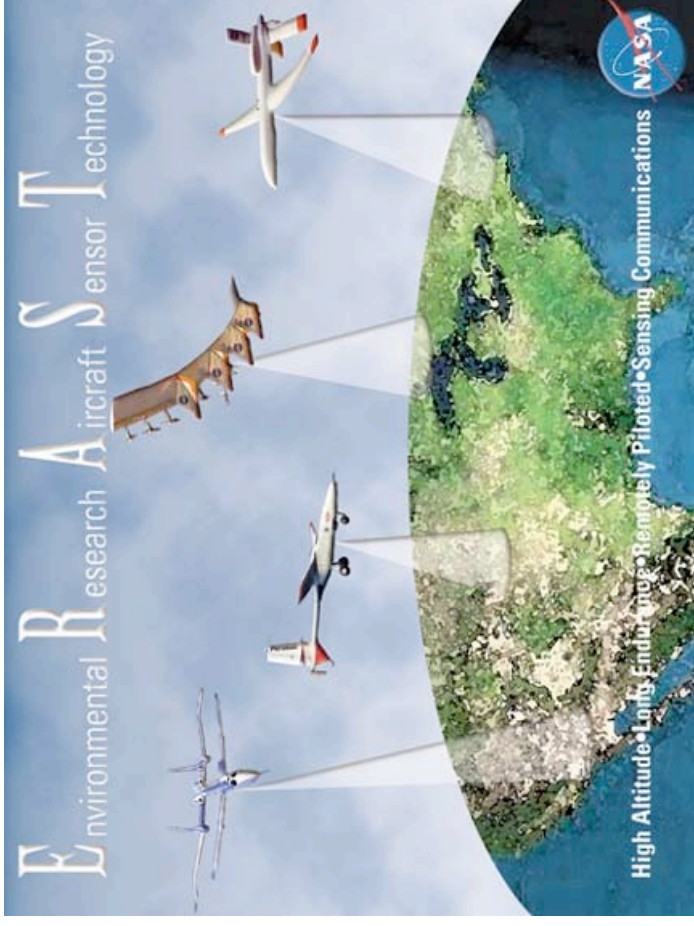
- NASA's UAV Legacy
- NASA Dryden Capabilities & Facilities
- Concluding Remarks
- Questions

NASA's UAV Legacy: "ERAST"

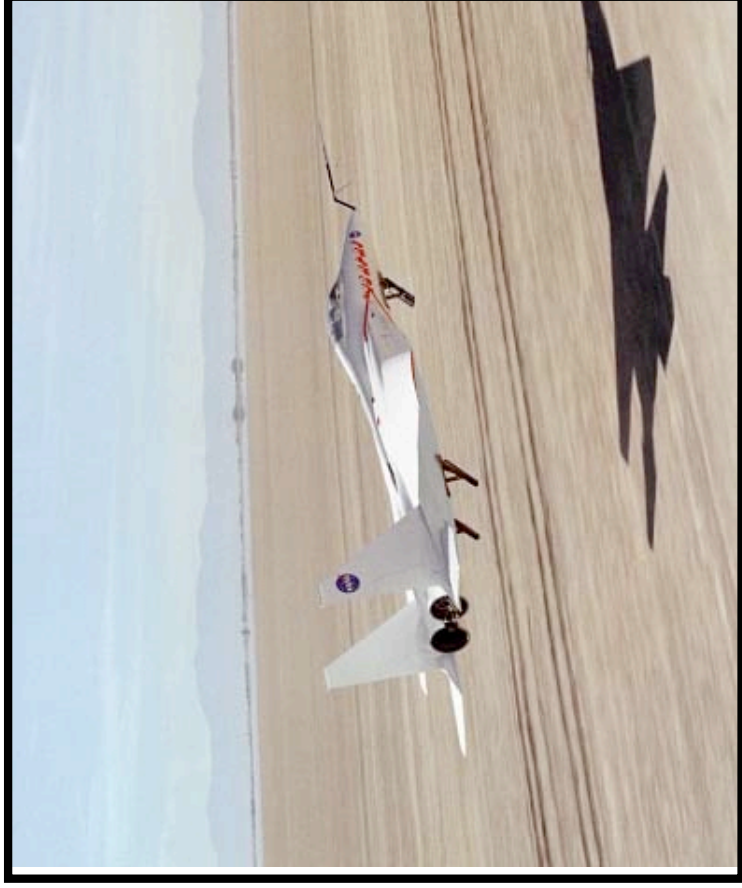
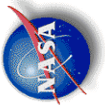
Environmental Research Aircraft Sensor Technology Program



- Several (8) platforms flew during the program life
- Yielded at least four high altitude records
- Developed enabling technologies for NAS integration and over-the-horizon operations
- Demonstrated utility of HALE platforms for science applications
- Provides the launch point for the next high altitude long endurance generation capabilities

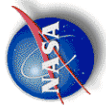


Remotely Piloted Research Vehicle 1975-1977



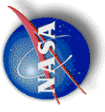
- Remotely-piloted Command & Control Concepts
- Low-risk High Angle-of-Attack Research

HiMat 1979-1993



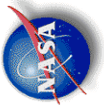
- **Flight Controls Technology**
- **Advanced Aerodynamics, Integrated Controls**
- **Test Maneuver Auto-pilot**

Perseus A 1991-1994



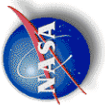
- Proof of Concept Vehicle
- Propulsion Technologies

Pathfinder 1994-1997



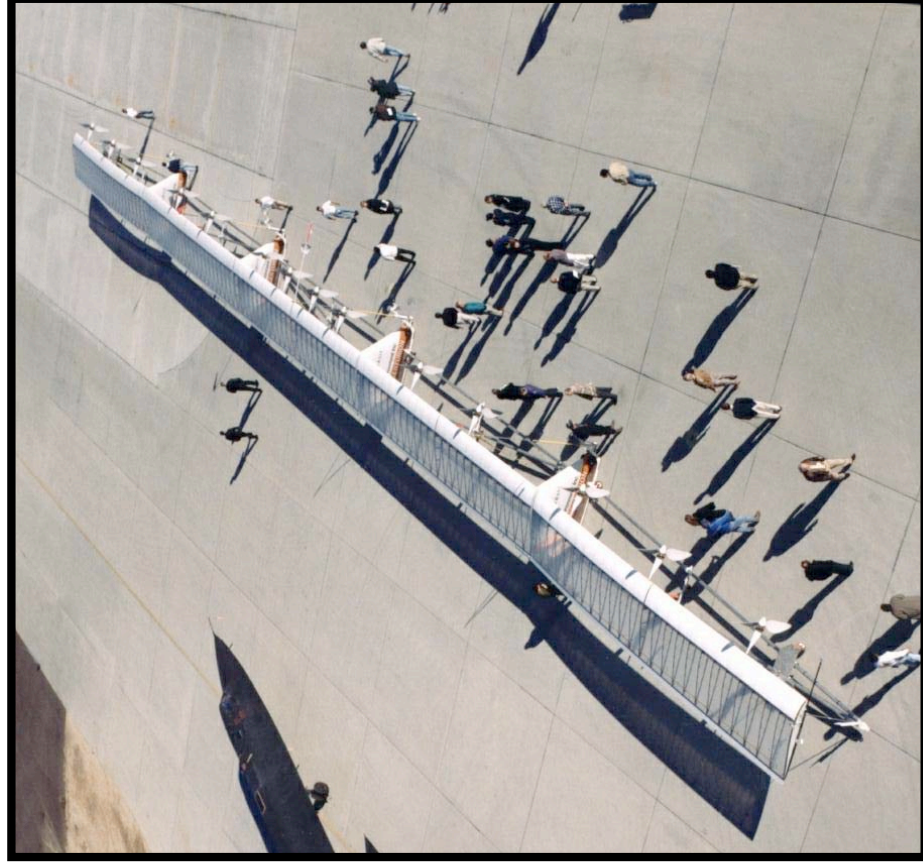
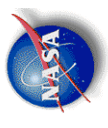
- **Solar-powered HALE Technologies**
- **Crop, Forest and Coral Reef Imaging Science Missions**

Raptor D2 1996



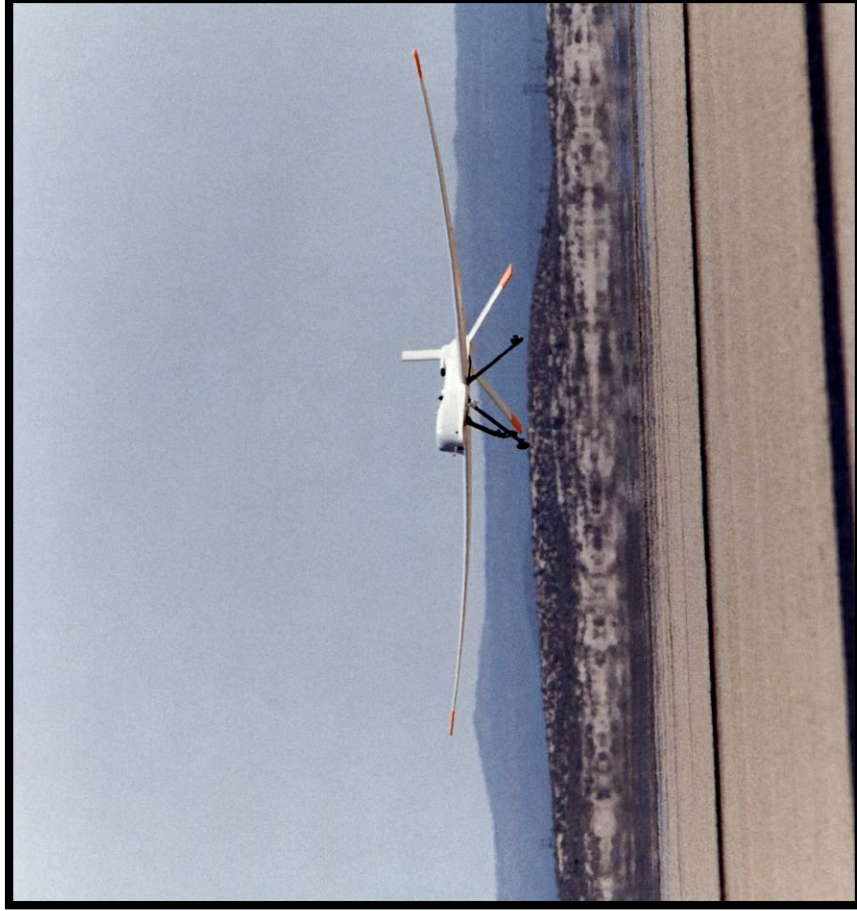
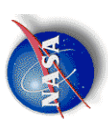
- OTH Communications with Tracking & Data Relay Satellite System

Centurion 1997



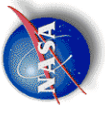
- High Aspect Ratio Flight Characteristics
- Solar-powered HALE Technologies

Altus I 1997



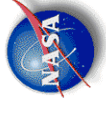
- Platform Development
- Propulsion & Performance Concepts

X-36 1997



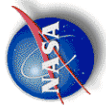
- Tailless Fighter Design

Pathfinder Plus 1997-1998 (2005)



- **Solar, Aerodynamics, Propulsion & Systems Demonstrations**
- **Telecommunications Relay Demo**
- **Coffee Harvest Imaging Science Mission**

Perseus B 1998-1999

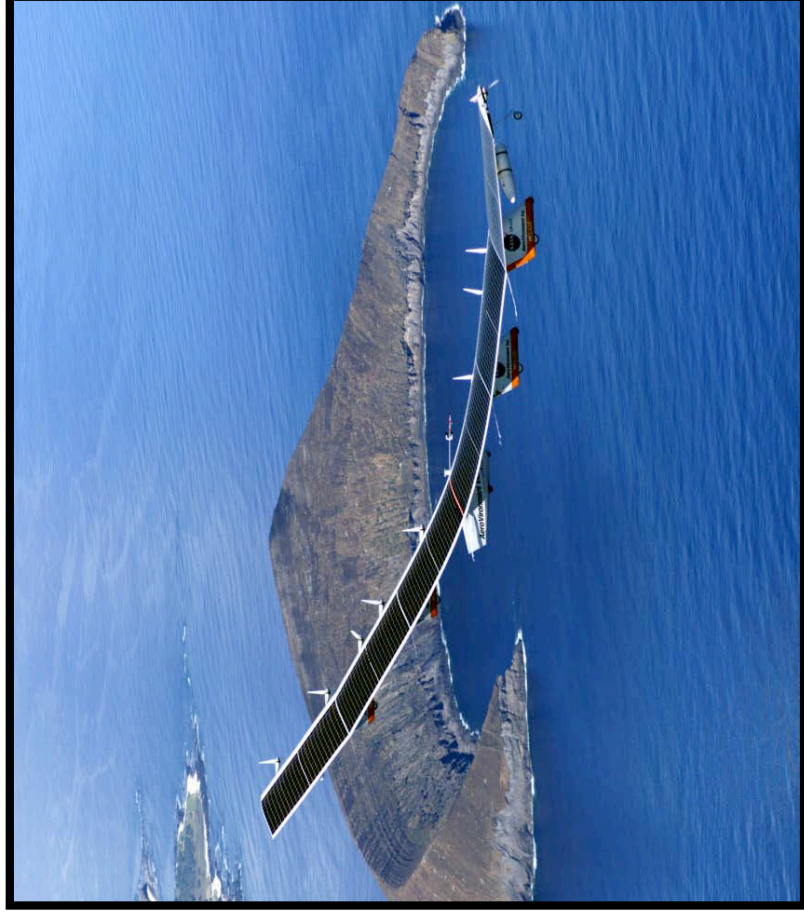
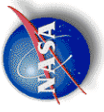


Validate/mature:

- **Propulsion System**
- **Avionics**
- **Command & Control**
- **Payload Integration**

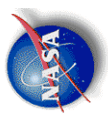
Helios

1998-2003



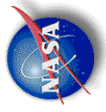
- HALE Technologies Demonstrator
- Lightweight Supplementary Energy Systems

Altus II 1998-2002



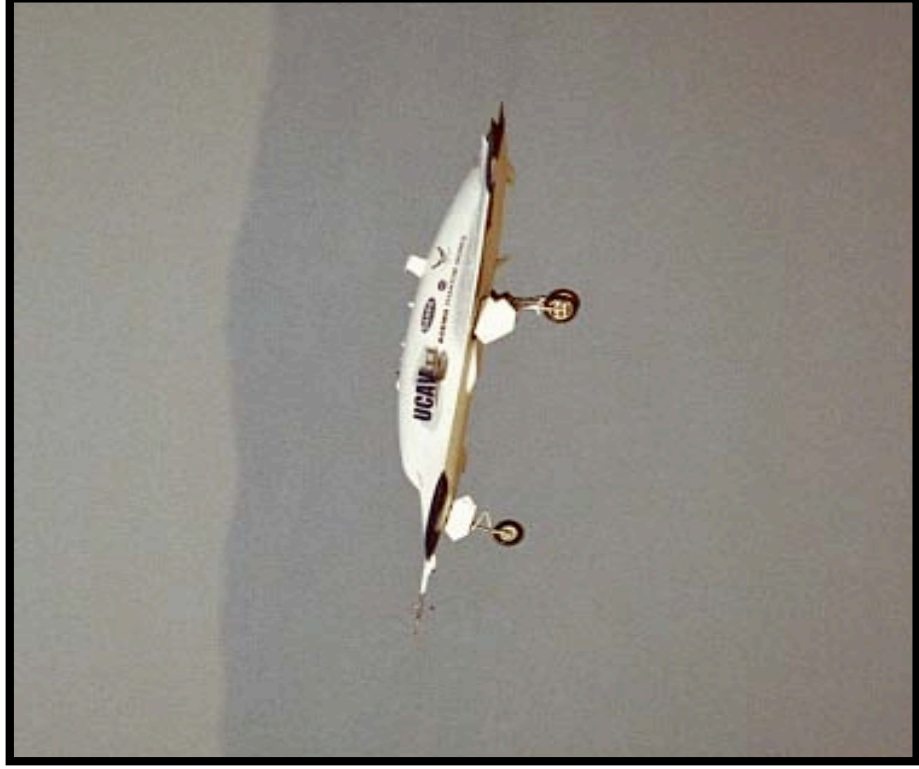
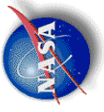
- **Validate/mature:**
 - **Propulsion System**
 - **Avionics**
 - **Command & Control**
- **DoE Atmospheric Radiation
Science Missions**

Proteus 1999-Present

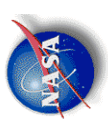


- **Optionally Piloted Vehicle**
- **OTH Command, Control & Communication**
- **Detect, See & Avoid**

X-45 2000-Present



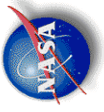
- **Mission Control**
- **Distributed Control**
- **Communication Loss Demo**
- **4D Navigation**
- **Formation Ops**



X-45

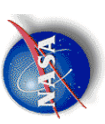


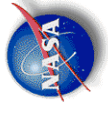
Altair (Predator-B) 2003-Present



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

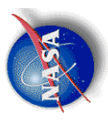
Altair (Predator-B)



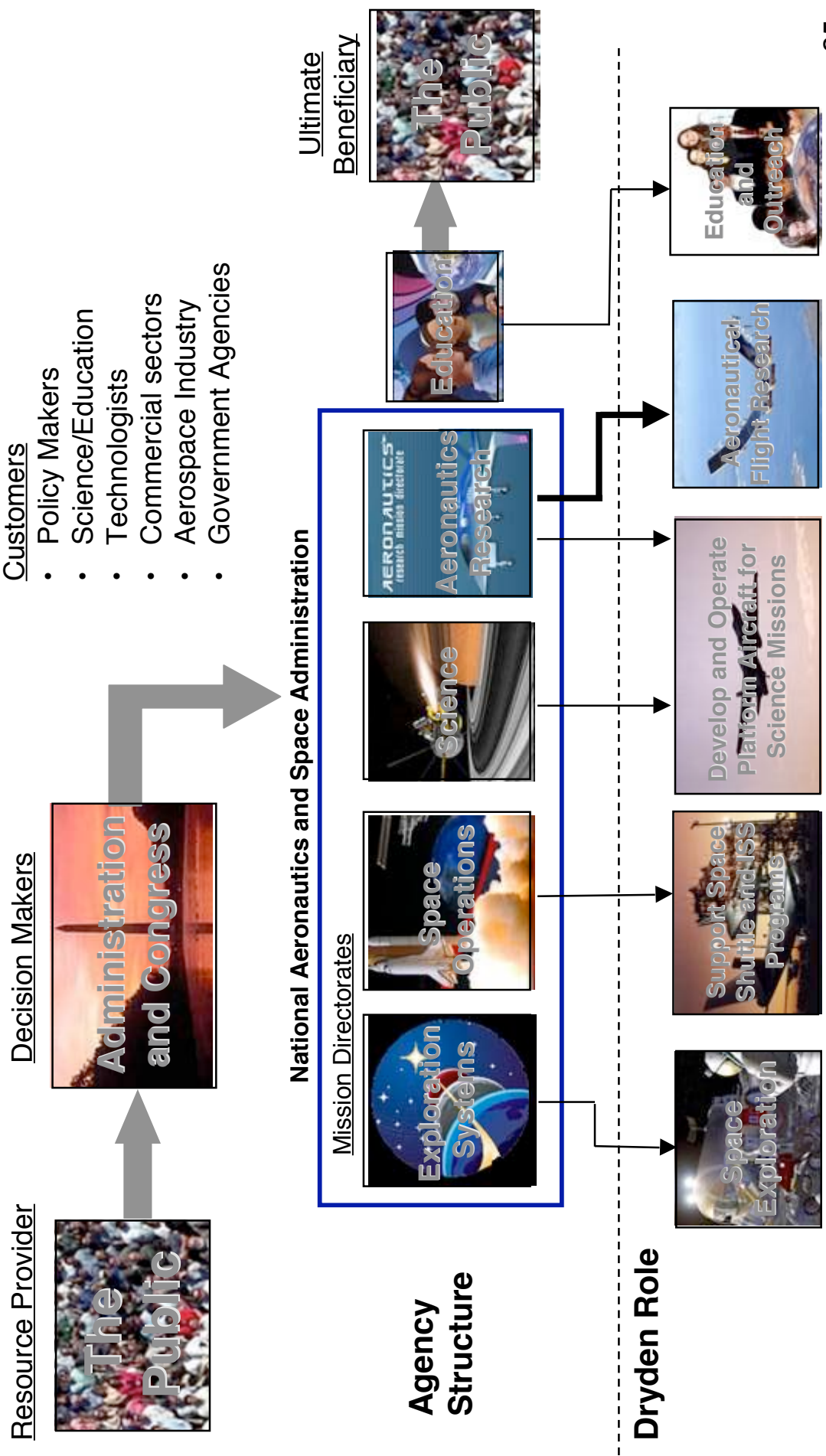


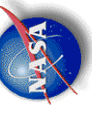
Performance Summary: ERAST Platforms

Air Vehicle	First Fit (Year)	Wingspan (feet)	Weight (lbs)	Payload (lbs)	Max Altitude (feet)	Duration (hours)
Pathfinder	1994	98	56	100	71,000	14
Centurion	1997	206	1,900	-	-	-
Proteus	1998	78	15,800	4,000	65,000	18
Altus II	1998	55	2,250	330	55,000	12
Perseus-B	1998	71.5	2,200	260	60,000 16,000	1 18
Pathfinder-Plus	1998	121	700	150	80,000	14
Helios	1999	247	2,000	725	97,000	17
Altair	2003	86	7,000	700	65,000	32



Dryden's Role in NASA

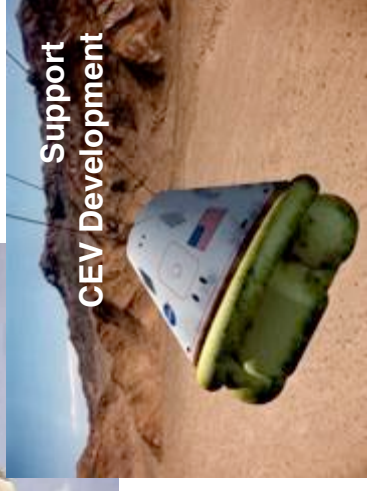




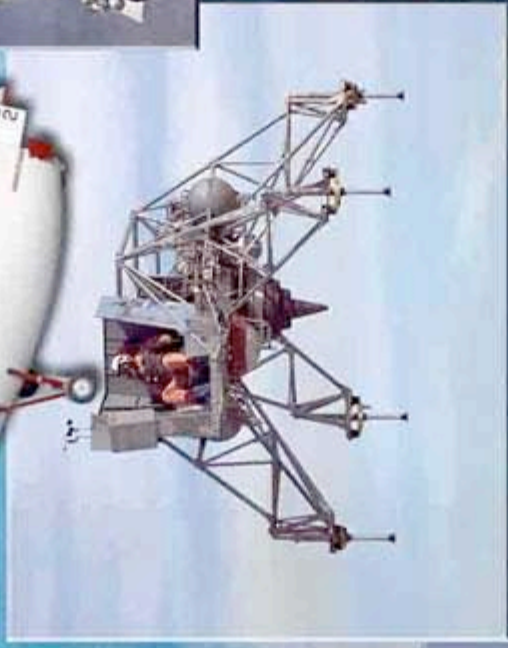
Dryden's Mission: Advancing Technology and Science Through Flight

- 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

... for NASA and the Nation.



Dryden's Vision: To Fly What Others Only Imagine



Rich Tradition of Successful and Cost-Effective Flight Projects

Unmatched Environment for Experimental Flight Test

Dryden Flight
Research Center

- ✓ Premier Edwards AFB Range
- ✓ Linked to Vast Western Range
- ✓ 350 Test Days/Year
- ✓ Unmatched experimental test range

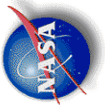


Unmatched Environment for Experimental Flight Test

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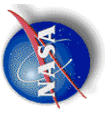
Dryden Flight
Research Center





Dryden Core Competency

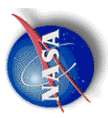
- **Atmospheric flight research and test**
 - **1. Flight Safety and Risk Management**
 - Robust airworthiness and flight readiness expertise
 - Development and application of tools and techniques to assure Range Safety
 - Application of fundamental risk management concepts
 - Disciplinary expertise
 - **2. Flight Project and Mission Management**
 - Translation of customer and stakeholder needs and constraints into efficient and effective plans
 - Balancing cost, schedule, and technical risk
 - Ability to define and coordinate complex operations at local or remote sites
 - **3. Flight Research Technology**
 - Expertise in advanced state of the art instrumentation and flight test techniques
 - Application of physics, engineering and manufacturing to test systems or subsystems
 - Ability to translate science and engineering requirements into practical flight experiments and test plans
 - State of the art disciplinary expertise
 - Engineering research test pilot expertise
 - Svstems intearation of complex svstems



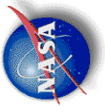
Dryden Core Competency

- Atmospheric flight research and test
 - 4. Flight Test Operations
 - Scheduling, Maintenance, Quality Assurance/Quality Inspection
 - Ground testing expertise, Flight operations engineering
 - Engineering Test Pilots
 - Logistics support, Configuration management
 - Systems integration
 - Access to required infrastructure to support vehicles in ground and flight test
 - 5. Experimental Aircraft - Piloted and Unpiloted
 - Unique aerodynamic configurations and one-of-a-kind aircraft
 - Experimental fabrication and maintenance shops
 - Develop operational procedures and technical guidelines for unique vehicles where no precedence exist
 - Ability to characterize unique configurations
 - Communication networks to assure positive control and data acquisition
 - Ability to integrate unique sensors with vehicles
 - Systems for safely and effectively operating and controlling unique and remotely operated and autonomous vehicles
 - Expertise to assure Range Safety, Integrated system of facilities

Extensive Experience, Expertise, and Facilities

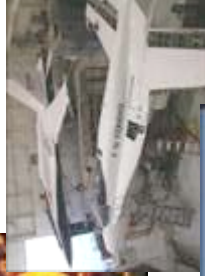


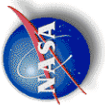
- ✓ **World-Class aerospace technical expertise-all disciplines**
- ✓ **Deep experience in one-of-a-kind flight projects**
- ✓ **Connections to other government labs for support**
- ✓ **On-site timely safety clearance**
- ✓ **Experimental labs/shops for mod, repair, instrumentation, test, and qualification**



System of Facilities

- Dryden utilizes a “system of facilities” to support its mission.
 - Each facility brings a unique and needed capability to the “system”
 - Results from one facility often feed analysis in another
 - Facility elements are designed and managed as an integrated system.
- Approach offers capabilities and efficiencies not possible with stand-alone facilities. The result is greater than the sum of the parts.
 - Practical because facilities share a common customer base.

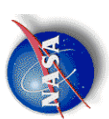




Testbed Aircraft

- Testbed aircraft augmenting Dryden's one-of-a-kind research aircraft are available to support a wide variety of research missions. Predator, F/A-18, F-15, T-38, T-34, King Air, and G-3 provide platforms for sensor validation, for aerodynamic, system, and propulsion research.





High Performance Aircraft

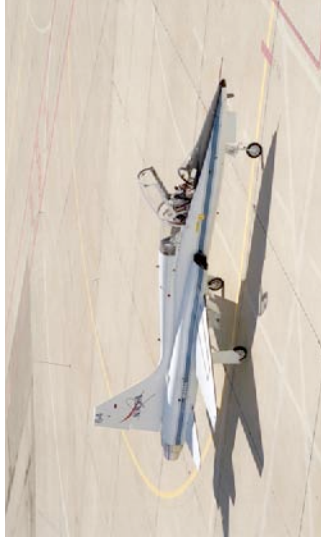
F-15



F/A-18

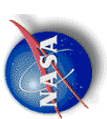


• T-38



• ER-2





Unmanned Aircraft Systems

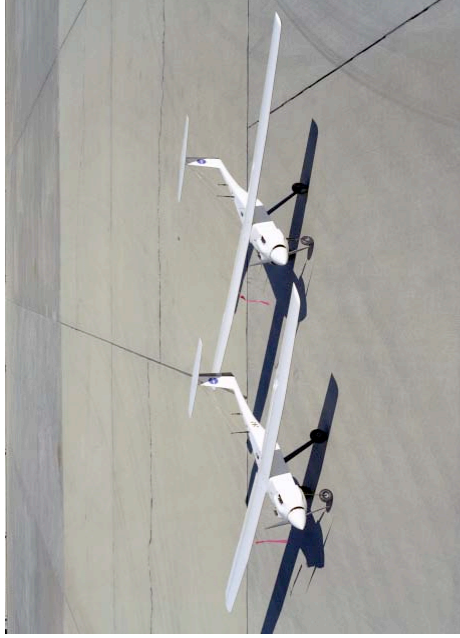
- Ikhana (Predator-B) • Altair

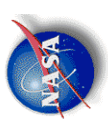


- Global Hawk



- AVP-3





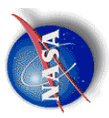
Turboprop Aircraft

- KingAir



- T-34





Transport

- Gulfstream G-3



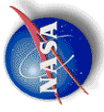
- Boeing 747 SCA



- Boeing C-17



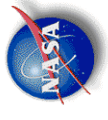
AERO Institute



Aerospace Education, Research and Operations Institute

- The AERO Institute serves as innovator, facilitator and integrator for joint NASA, University and Industry projects
 - Leverages the assets of NASA, other government agencies, academia and industry
 - Creates strategic private/public partnerships
 - It focuses on:
 - Human Capital development
 - Educational outreach
 - Applied Research and
 - Operations Improvement





Summary of Capabilities

- Core Competencies
 - Atmospheric Flight Research and Test
 - Flight Safety and Risk Management
 - Flight Project and Mission Management
 - Flight Research Technology
 - Flight Test Operations
 - Experimental Aircraft - piloted and unpiloted

Facility Capability

- Flight Operations & Engineering Staff
- Experimental and Testbed Aircraft
- Unmanned Aircraft Systems
 - Extensive experience in securing Certificates of Authorization (COA) for UAS flights
 - Extensive UAS flights conducted in National Air Space (NAS) without a chase

- Airborne Science Platforms
- Range and Aircraft Test Facilities
 - Western Aeronautical Test Range
 - Research Aircraft Integration Facility
 - Flight Loads Laboratory

On-Going Partnerships

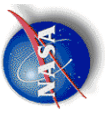
- Other NASA Centers: ARC, GRC, LaRC, JSC, KSC, MSFC
- DoD Partnerships: AFFTC Alliance, USN, AFRL, DARPA
- Other Government Agencies: DOT, NOAA, DHS, ...



FY06 Vital Statistics:

Civil Servant Staff 480

On-site Contractors ~600



Dryden as a Partner

- Performance
 - Rapid ramp-up to meet customer/partner needs
 - Experienced project managers for cost and schedule
 - Technical expertise to solve problems on-site
- Safety
 - Proven and effective safety assurance processes
 - Tailored processes for each project
 - On site safety clearance
- Technical Capability
 - Expertise and experience in aerospace disciplines
 - Expertise and facilities to support simple-to-complex tests
 - Extensive experience in manned and unmanned systems

Questions?

