Small Aircraft Transportation System
The Vision for Wings on America

NASA Langley Research Center and Daily Press Colloquium and Sigma Series Seminar

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September 10, 2002

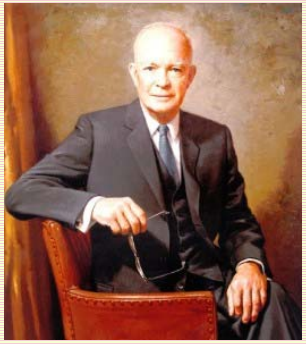
Outline

- **Historical and Technical Context for a Vision for Wings on America**
- **Enabling Technologies and Notional SATS Life Cycle**
- **Disruptive Innovation, Innovation Life Cycles, Value Networks, and NASA's Role**

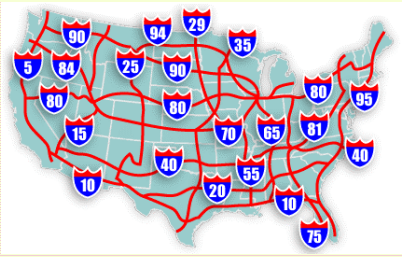
American Transportation System Innovations
Historical Context of Visions and Legacies

Jefferson sends Lewis and Clark to search for a path for commerce

The Transcontinental Railroad connects east and west

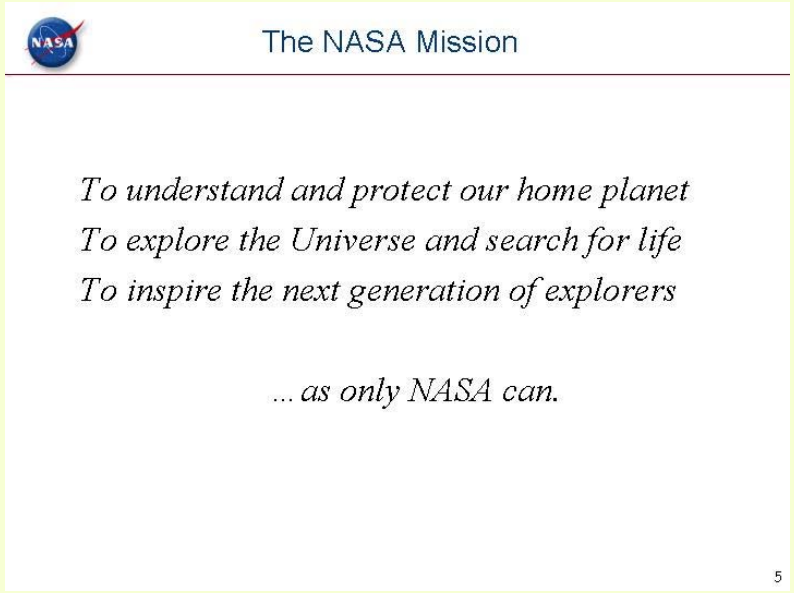


The Interstate Highway system connects the nation's cities



Technical Context for SATS

- **Moore's Law on microprocessor performance**
- **Gilder's Law on bandwidth performance**
- **Metcalf's Law on network performance**
- **The unwritten law of abundance**
- **The unwritten rule of gridlock**
- **Kurzweil's Law of Accelerating Returns**
- **The Golden Rule of the information age**

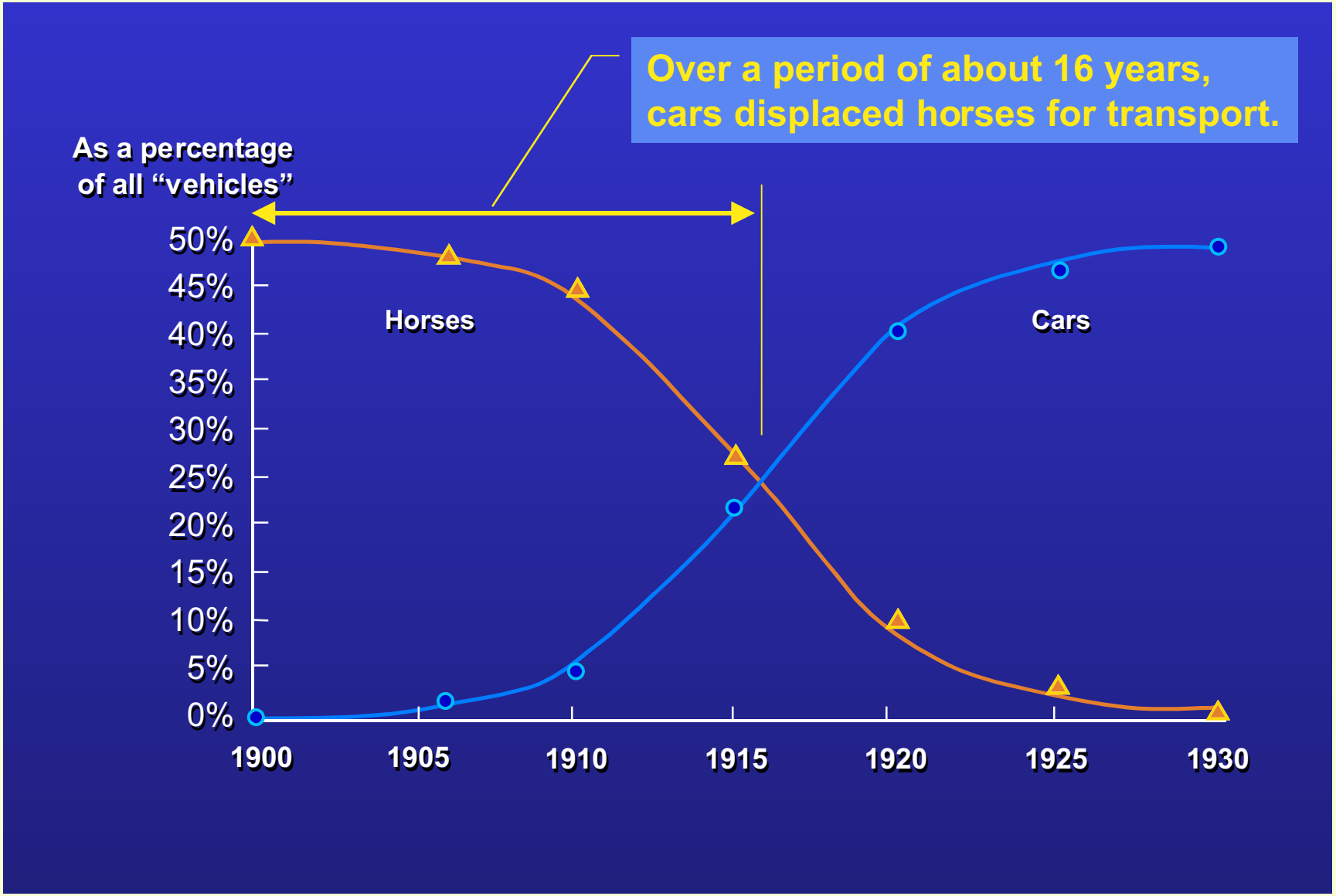


The Difficulty About Predictions…

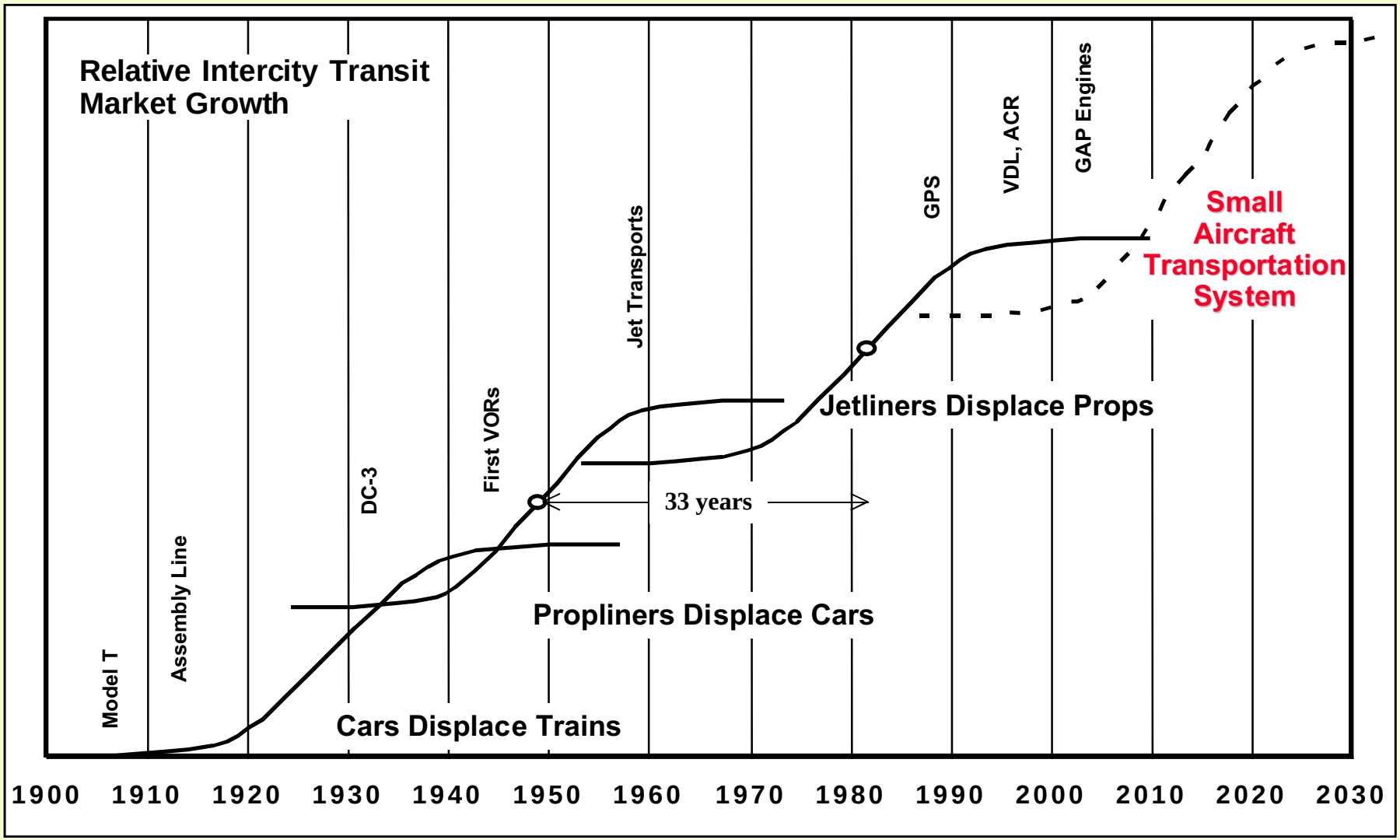
- **"The telephone has too many shortcomings to be seriously considered as a means of communication."**
  – Western Union executive, 1876
- **"The problem with television is that the people must sit and keep their eyes glued on a screen; the average American family hasn't time for it."**
  – NY Times, 1939 (World's Fair)
- **"I think there is a world market for maybe five computers."**
  – IBM Chairman Thomas Watson, 1943
- **"Computers in the future may weigh no more than 1.5 tons."**
  – Popular Mechanics, 1949
- **"There is no reason for individuals to have a computer in their home."**
  - DEC Chairman Ken Olson (DEC), 1977
- **"640,000 bytes of memory ought to be enough for anybody."**
  – Microsoft Chief Software Architect Bill Gates, 1981

The Substitution of Cars for Horses

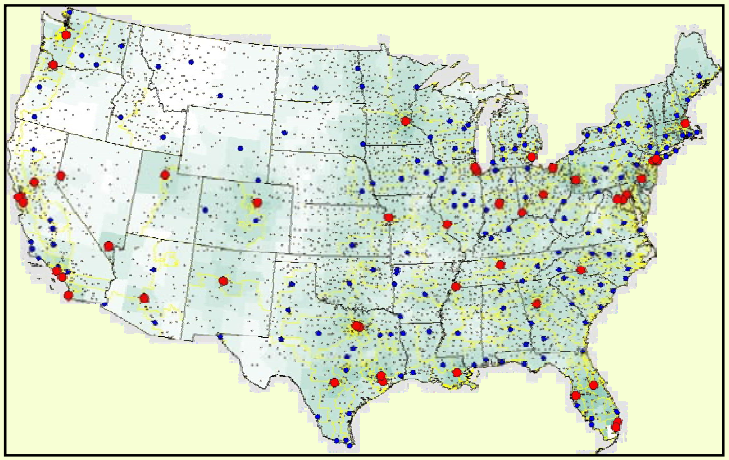
N. Nakicenovic (1986)



(R)evolutions in Higher Speed Travel



SATS Research Project (FY 2001-2005)
Equitable, On-Demand, Distributed Air Mobility



- **93% of population within 30 minutes of SATS-type airport**
- **41% within 30 minutes of any commercial airport**
- **22%within 30 minutes of major/hub airport**

Mobility
Enable people to travel faster and farther, anywhere, anytime

Performance
Less travel time at an affordable price

Accessibility
Safe reliable access to more locations, when & where you need it

Cost
User cost
System cost
Provider cost

Time
Doorstep to destination, with intermodal penalties

Availability
Convenient, on-demand, with mission reliability

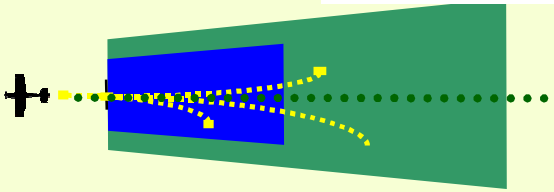
Safety
Proven safer
Perceived safer

SATS Operating Capabilities

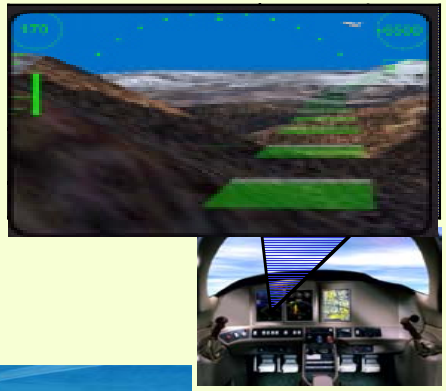
Creating Access to All Runways (ergo: Communities)

Higher Volume Operations in Non-Radar Airspace and at Non-Towered Airports

Lower Landing Minimums at Minimally Equipped Landing Facilities

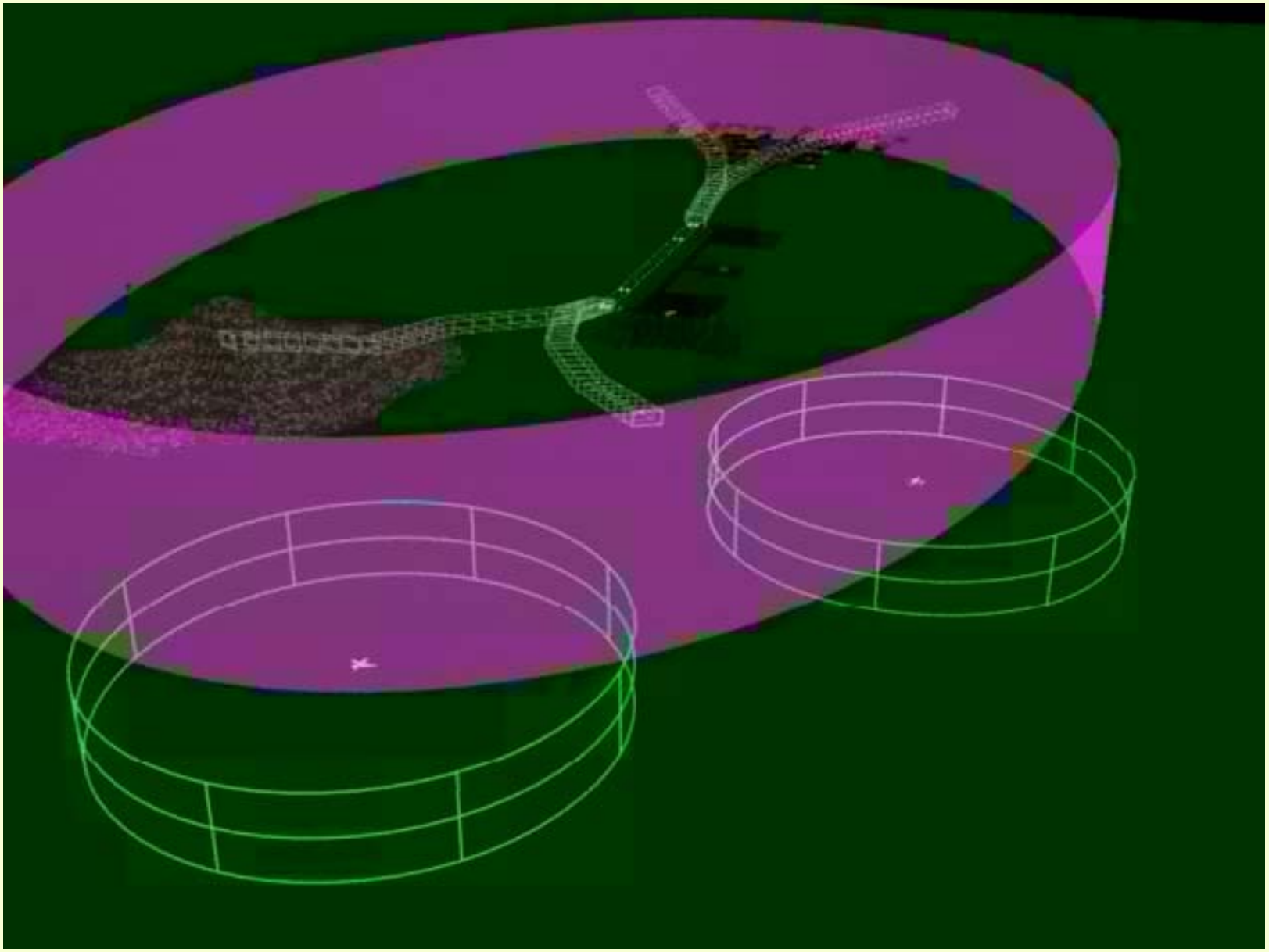


Increase Single-Pilot Crew Safety & Mission Reliability

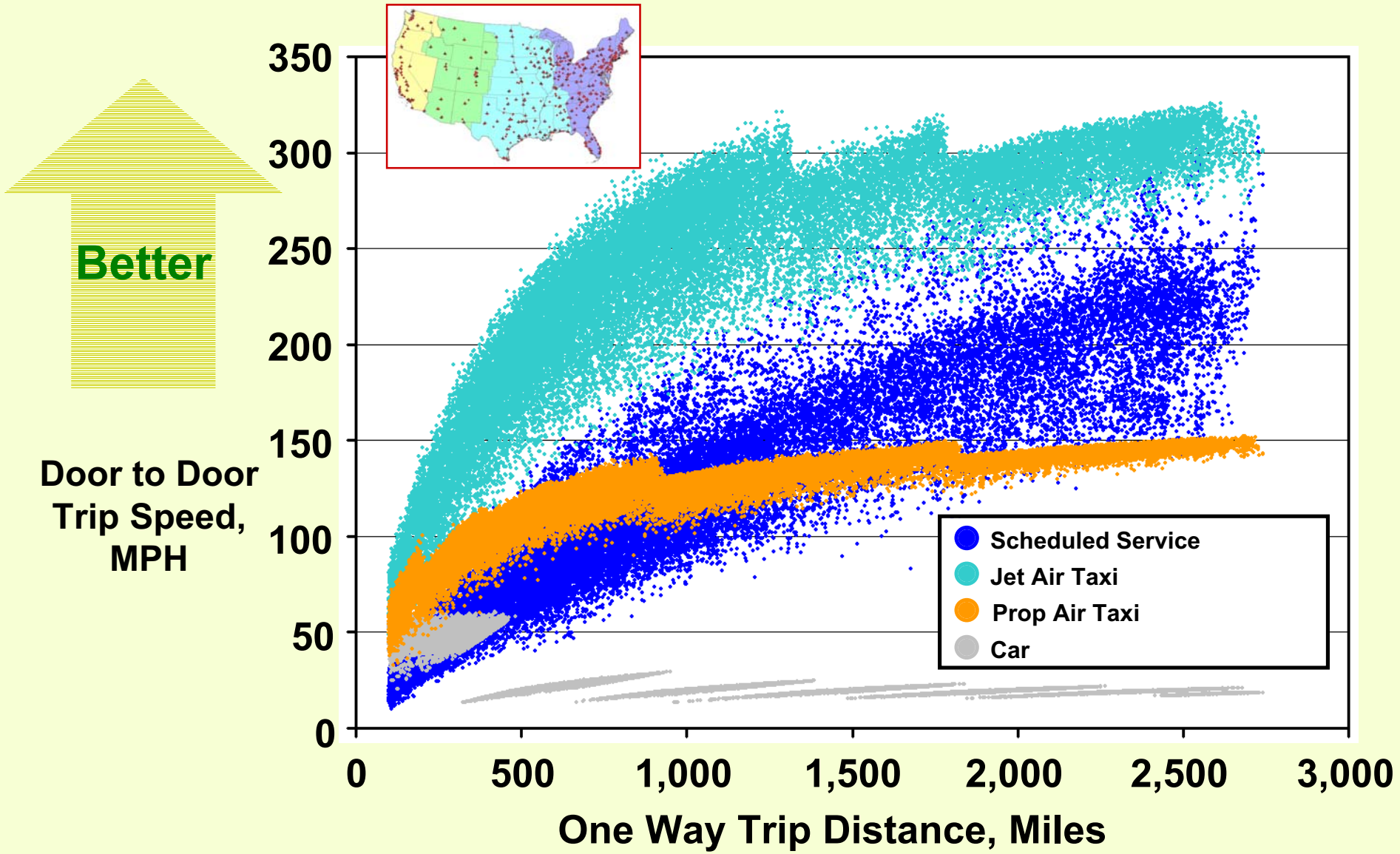


En Route Procedures & Systems for Integrated Fleet Operations

SATS Operating Capabilities Animated



Speed of Travel by Mode Choice

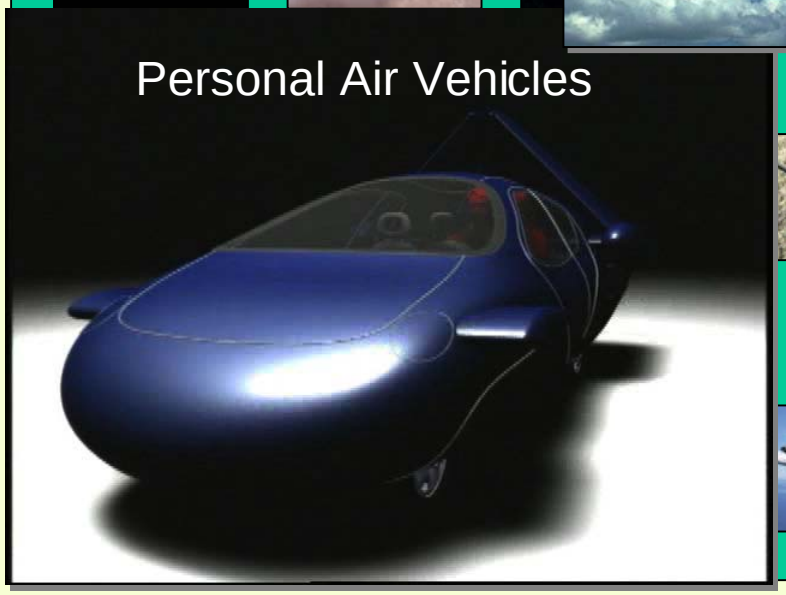


Vehicle Sectors

Trans

Flexible

Sensing/Protecting



PAV GA Biz Jets Regional Long-Haul UAV High-Performance

Can You Imagine NASA Technical Papers Titled:

- **Aero-control design parameters for a 30 mph minimum control speed for a 4,000 pound, six-place multi-engine aircraft**
- **Distributed propulsion systems with real-time optimization for takeoff, climb, cruise, and descent**
- **Aircraft control with no moving parts (no ailerons, elevators or rudders)**
- **Micro- or nano-porous surfaces for laminar, turbulent, and separated flow control**
- **Effect of Propulsive system Thrust-to-Weight Ratio greater than 15 on air vehicle design**
- **Airframe damage tolerance through structural intelligence**
- **Aircraft acoustics design for nighttime neighborhood compatibility**
- **Software reliability (Windows self-repairing, never crashing)**
- **Arpanet-like wireless aircraft systems integration (based on 802.11b and Bluetooth broadband technologies)**
- **Aircraft on-board computers as nodes on a mobile airborne internet**
- **Vehicle operations and control based on hand and eye motions**
- **A display-less cabin system architecture designs based on electrophoretic, OLED, and retinal display technologies**
- **An integrated flight control, display, communication-navigation, attitude heading reference system that you wear**
- **Class-less, object-technology-based self-organizing airspace**
- **Aircraft design concepts optimized for trip lengths of less than 100 miles**
- **Multi-static radar technology-based, on-board aircraft and CBLF conflict detection**

Revolutionaries or Road Kill?

Toyota*

Honda

*In certification flight testing

What's Different This Time?

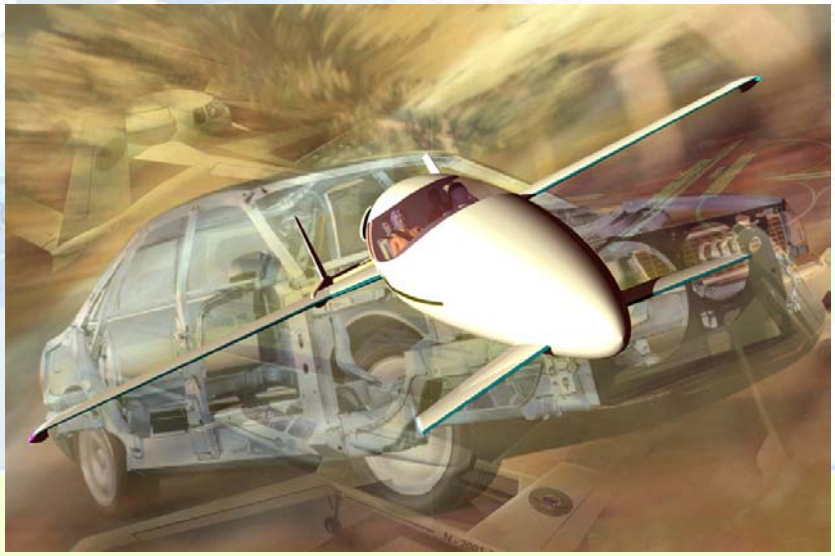
The reasons that these new aircraft represent disruptive innovations:

- **The new aircraft**
- **The new entrepreneurs**
- **The new production system architectures**
- **The new customers**

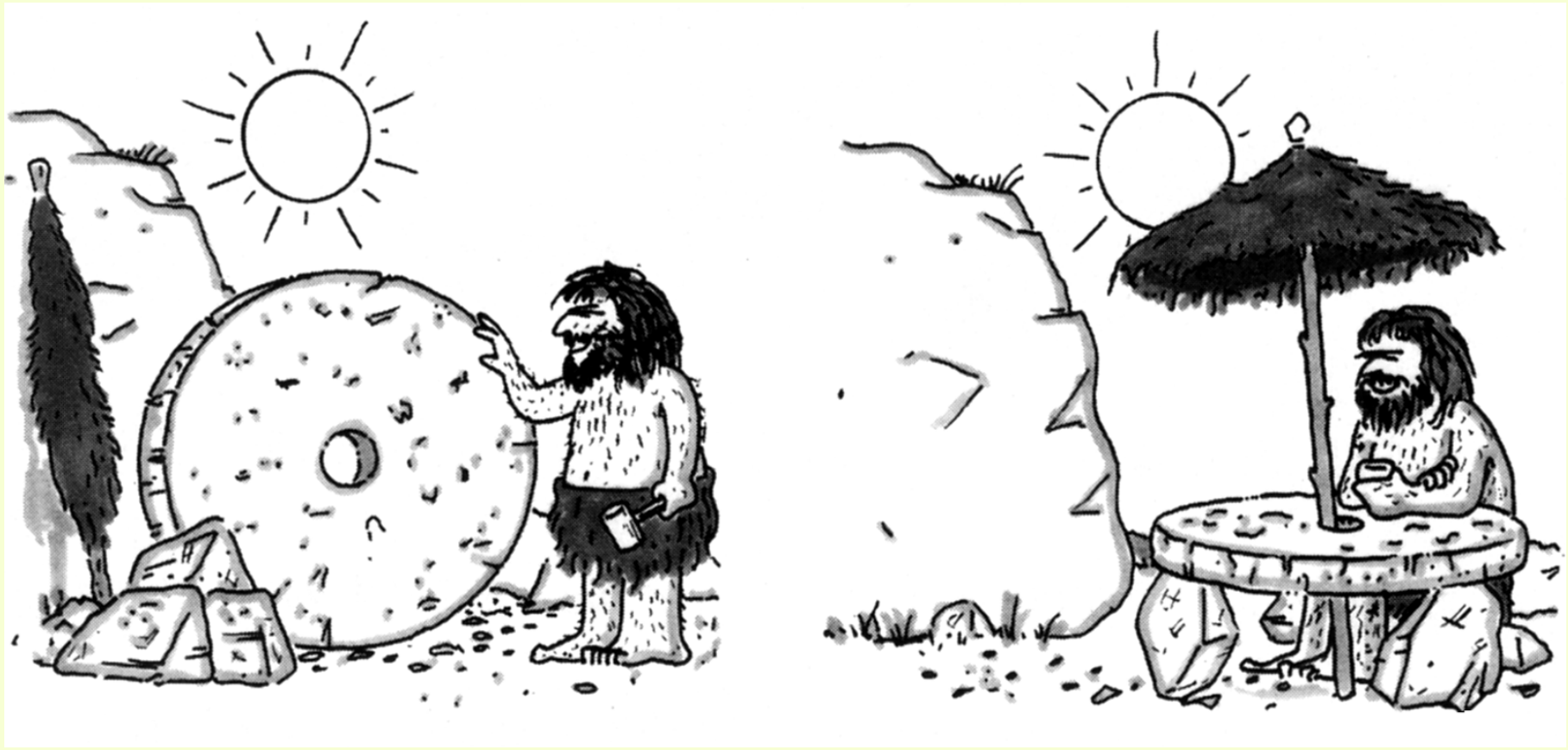
What's Left to be Done?

The reasons that NASA's work is not done:

- **A further revolution in the cost of speed is needed for aircraft designs focused on the shorter (<100 miles) and longer range (>2000 mile) point-to-point mission issues.**
- **A further revolution in airborne and airspace technologies and operating capabilities to any runway end or helipad is needed for reliable accessibility**

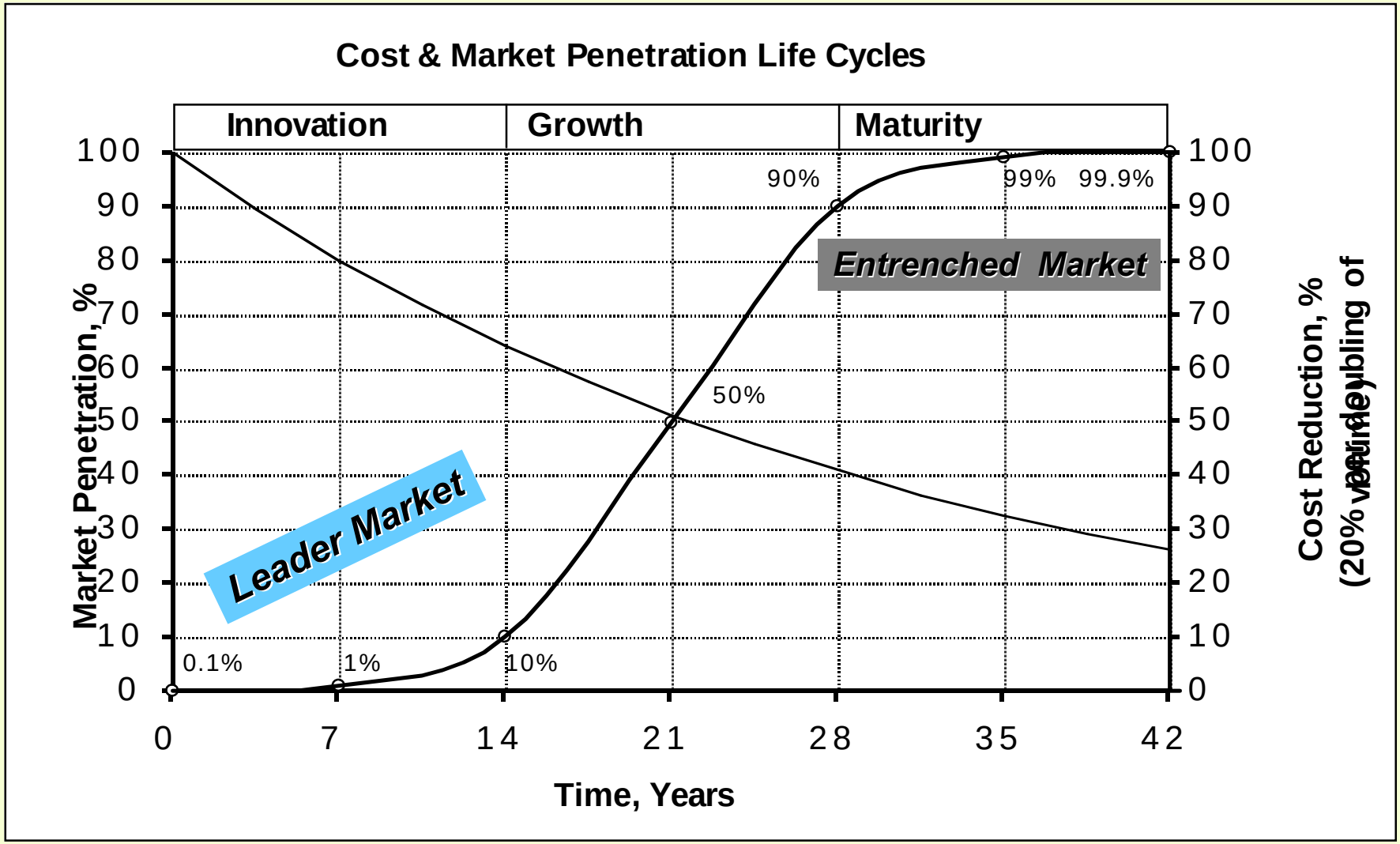


What Is a Disruptive Innovation?

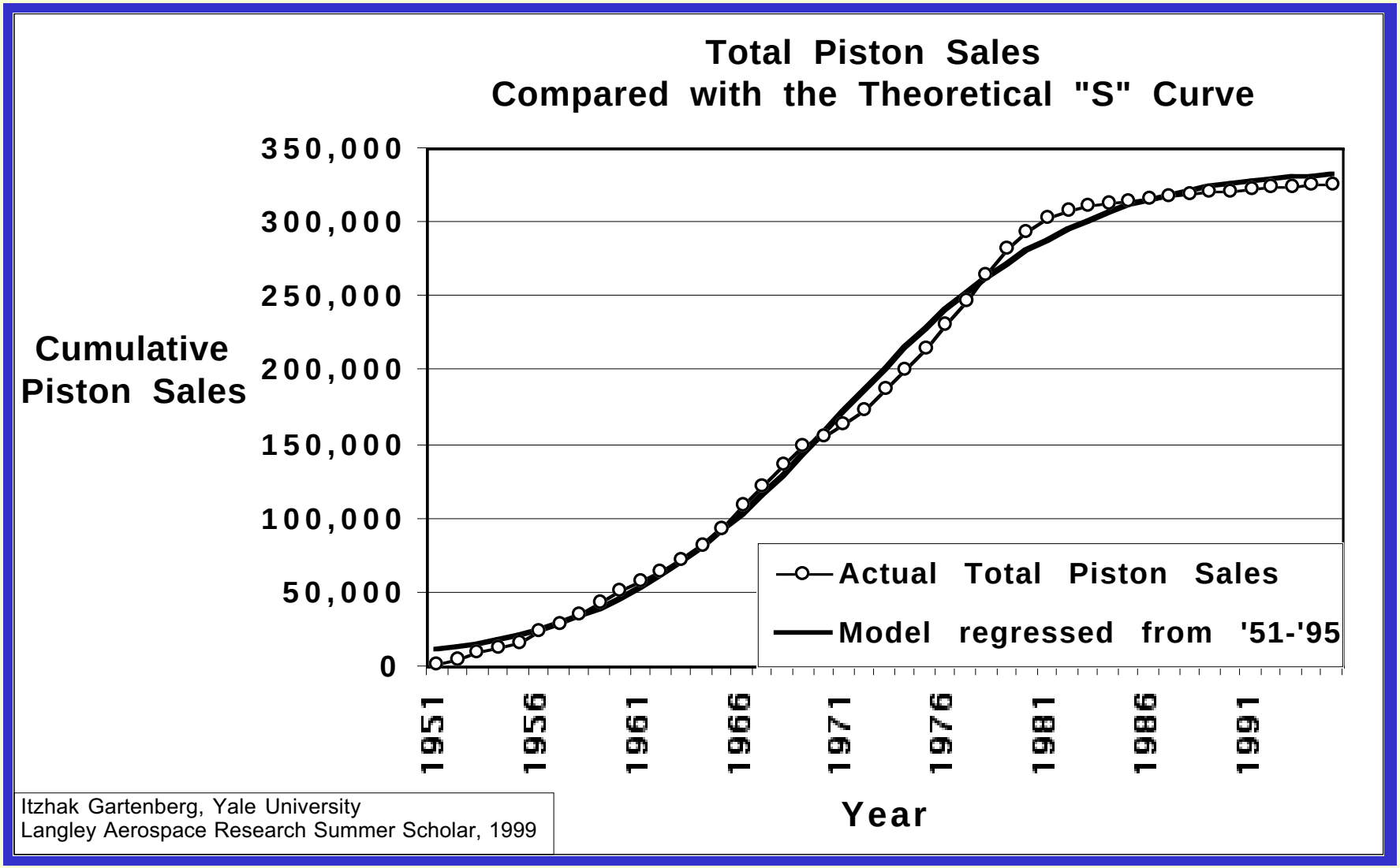


Innovation and Cost Life Cycles

$$N(t) = M / (1 + e^{-(at + b)})$$

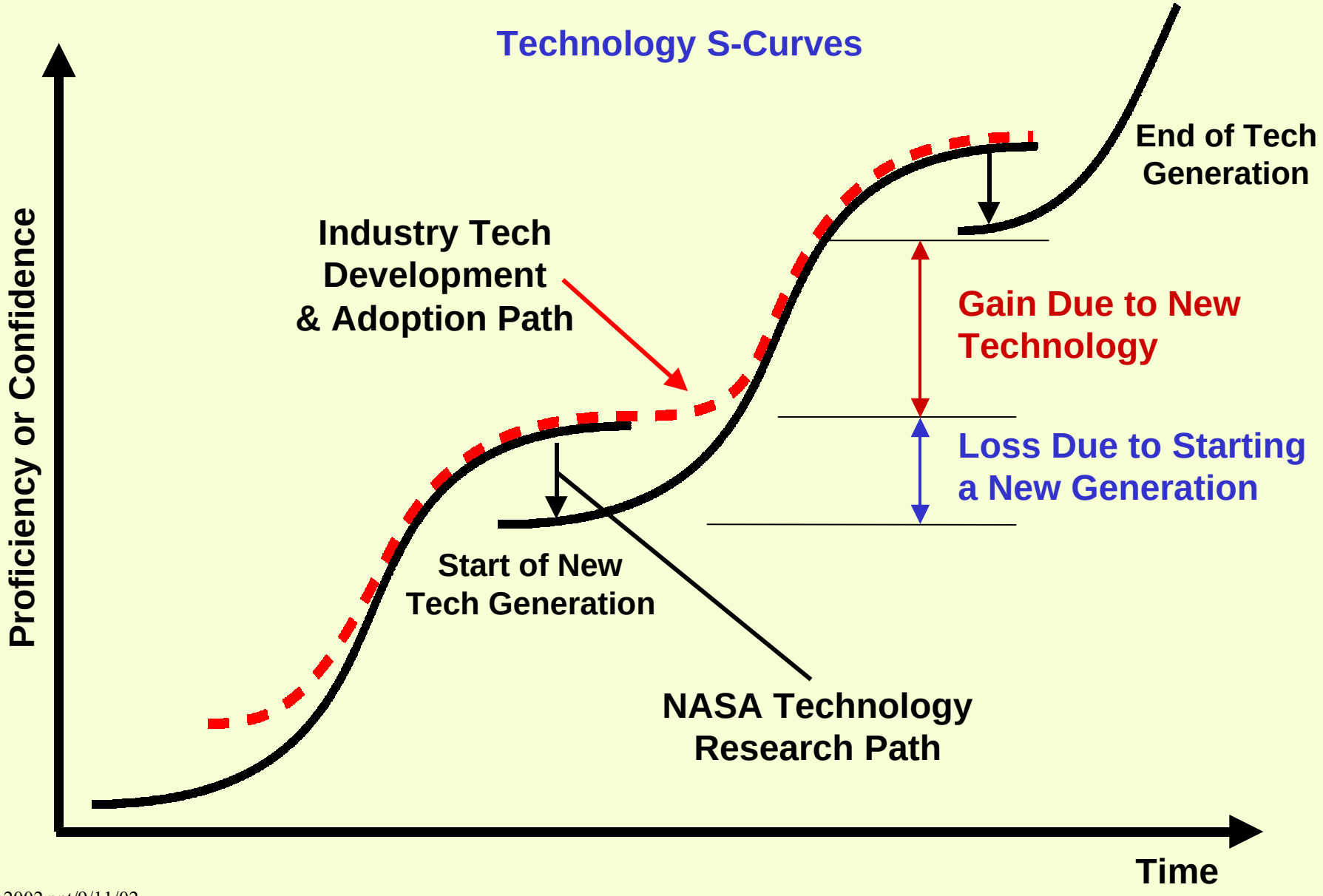


General Aviation Life Cycles



Questions Regarding NASA's Role

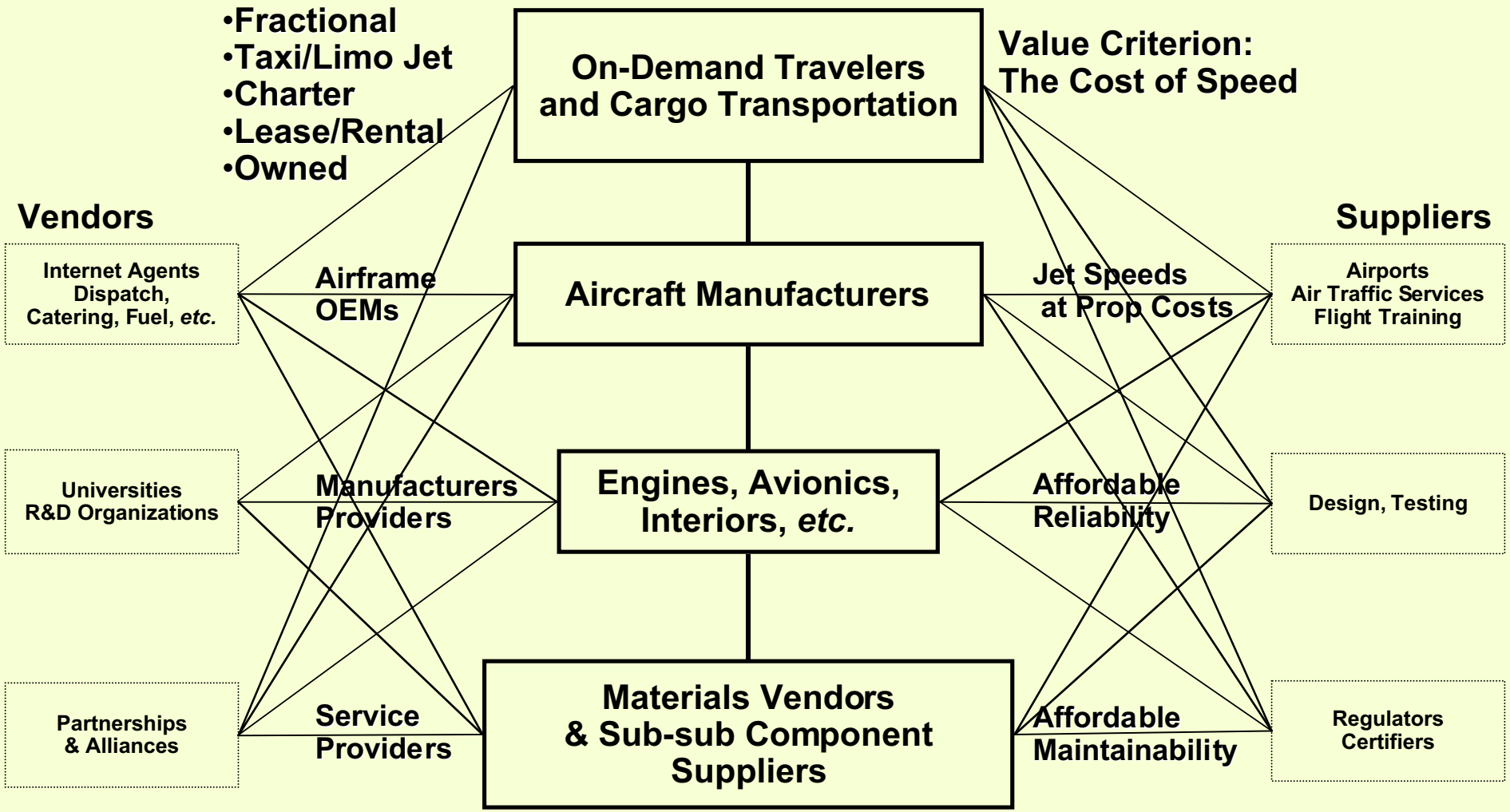
Langley Aero Roadmap Planning Team (2002)



SATS Value Network

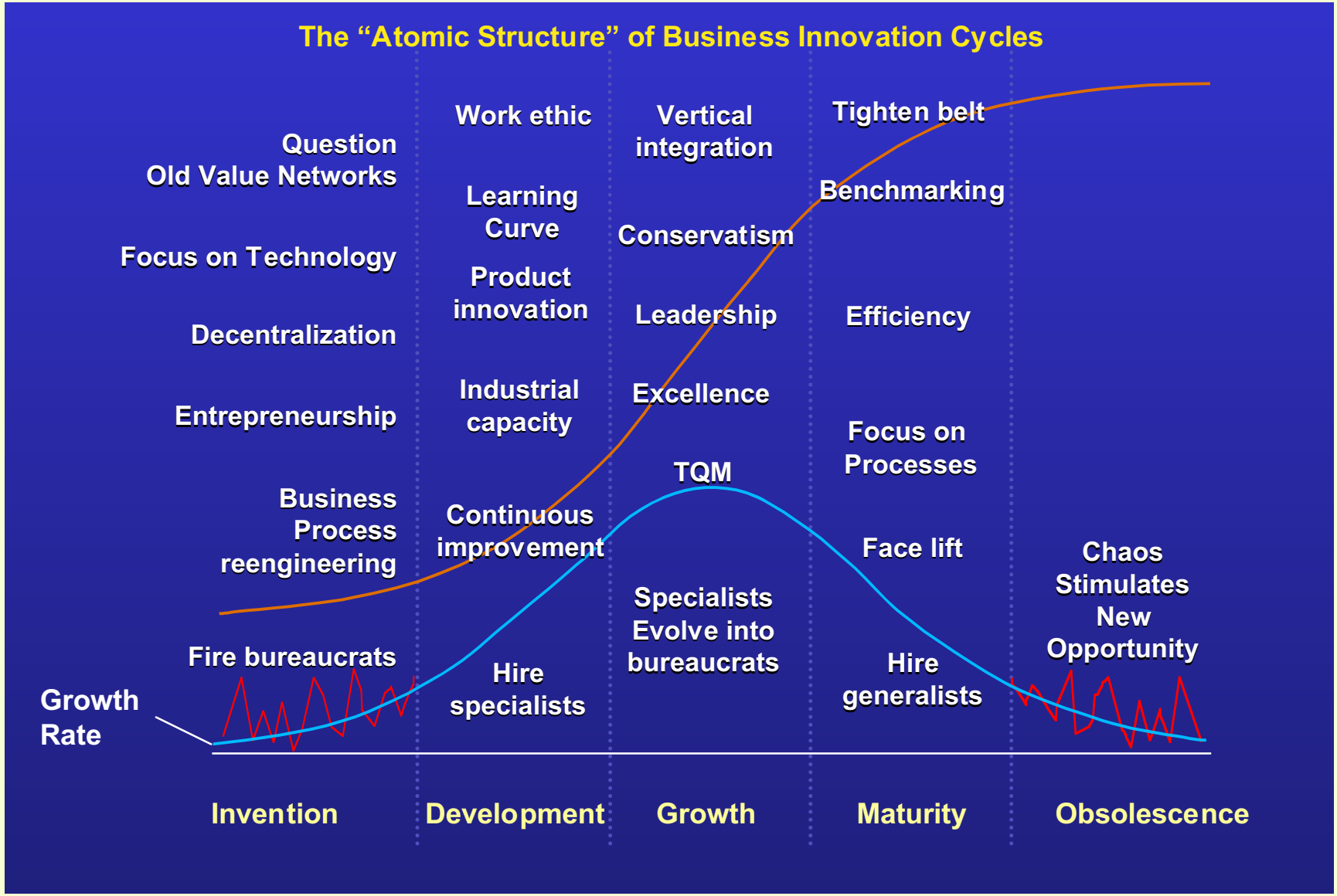
Consumer Value Criteria for Disruptive Innovations

Expected rewards from new consumers of disruptive innovations drive value network performance criteria and relationships.

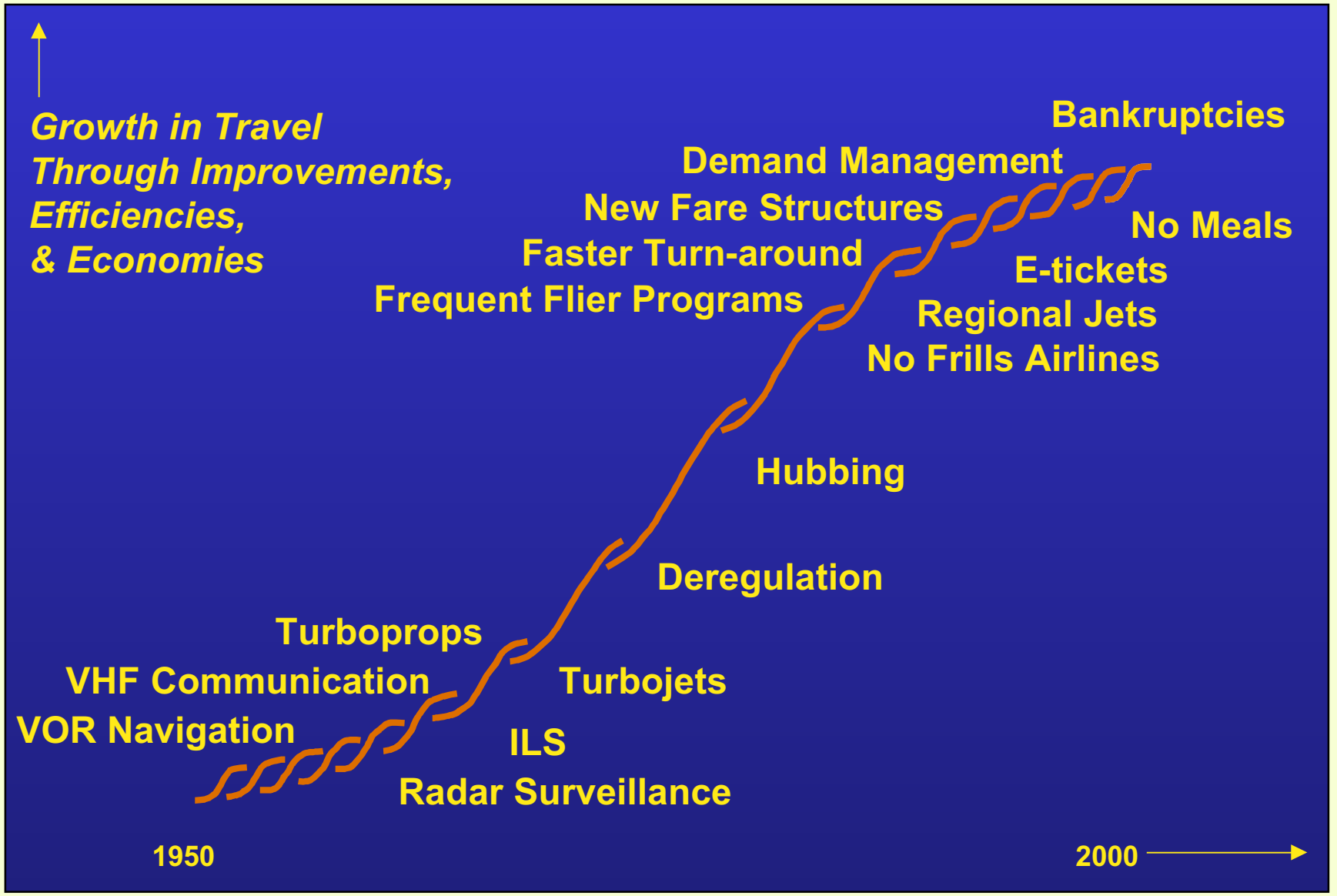


Innovation Life Cycle

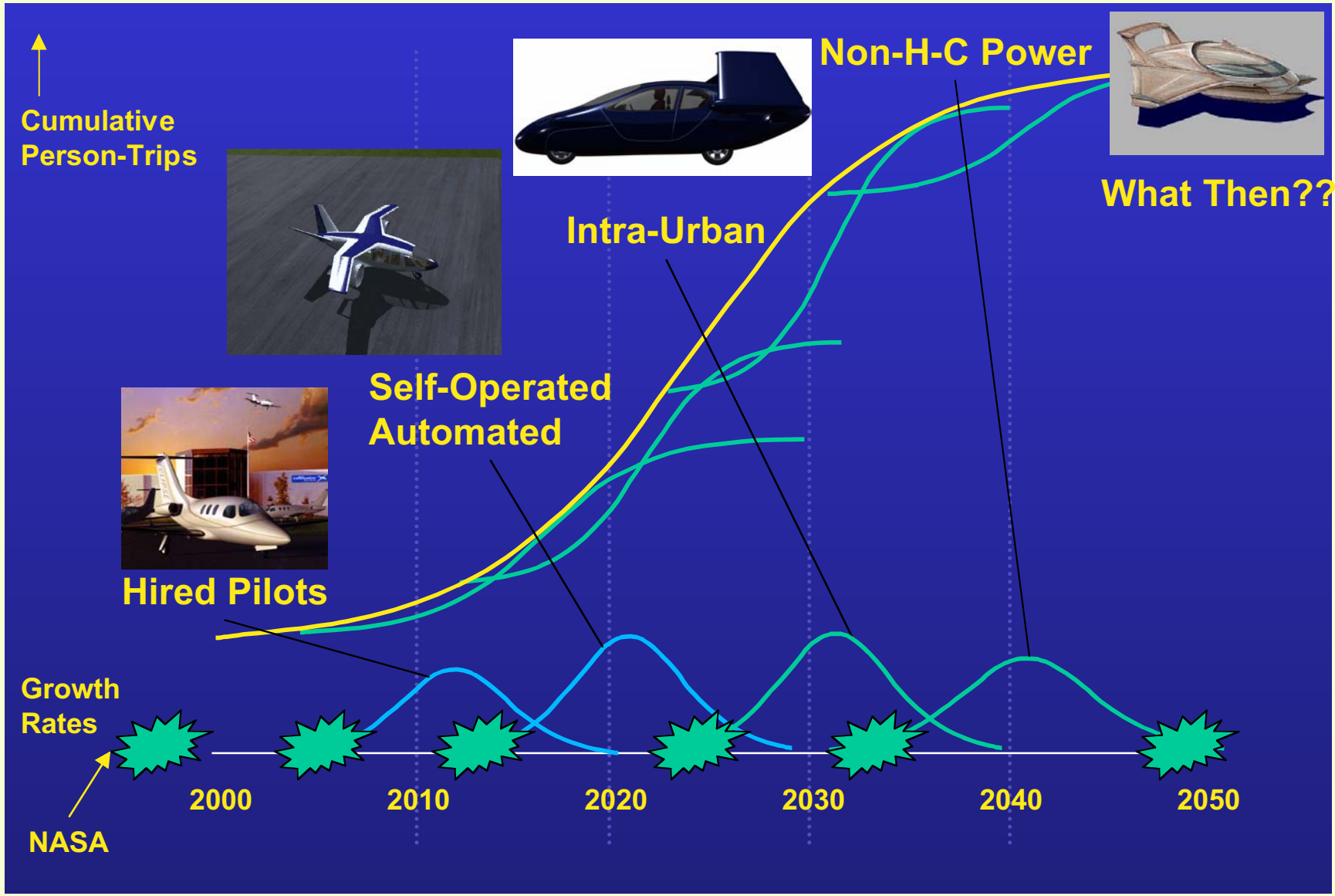
T. Modis (1999)



The Notional Life Cycle of The Innovation Called Airline Travel



A Notional Life Cycle For an Innovation in Personal Air Mobility



NASA - NCAM Partnership

National Consortium for Aviation Mobility

Freedom of Access Throughout America

The Challenges of Creating New Value Networks and Disruptive Innovations

- **Old value networks define guiding philosophies and value criteria, supportive relationships, personal and professional comfort zones, rewards and recognition, and the expected financial returns.**
- **Creating new value networks requires questioning old value criteria.**
- **Transitions from old to new value networks feel like chaos.**
- **Markets diverted or induced by new value networks cannot be predicted (thus representing unattractive targets for entrenched industries).**
- **NASA is uniquely positioned by charter to host the incubation of new value networks for disruptive innovations.**
- **For this strategy to work, the Center must continue to grow supportive organizational and business practices to nurture the new value networks.**

Summary

- **The vision for SATS represents a logical step in a natural progression in the nation's history of disruptive transportation system innovations.**
- **The role for NASA is to host the incubation of new value networks for disruptive technology innovations.**
- **While we cannot know what form the SATS vision will ultimately take, the historical nature of transportation system innovations, along with the enabling technologies from AGATE, GAP, SATS, PAVE, *et.al.* suggest that ubiquitous and equitable personal air mobility may be a logical 21st century evolution.**
- **"As Only NASA Can"**


From Wheels on America
to Wings on America
Equitable
On-Demand
Widely Distributed
Point-to-Any Point
21st Century Air Mobility