ENVIRONMENTALLY CHALLENGED

1. How does consumer influence ...?

- Low travel cost e.g. people packer plane
- Methane/H2 fuel
- Highly taxed, inefficient convenient travel
- Internet & other communications are a substitute if travel becomes more expensive
ENVIRONMENTALLY CHALLENGED

2. Nature of general business . . . ?

• Just in time mfg.
• Low inventory
• Growth of mini-mill reprocessing scrap
• Small firms decline
• Decrease in business travel
• Low cost assembly may return to US
ENVIRONMENTALLY CHALLENGED

3. Role of regulatory authorities . . . ?

- Certification may be in terms of efficiency
- Local CO2 landing fees
- European regulations make Europe the enemy
- Use tax for dedicated environmental improvement research
- Balkanization of regulatory regime
4. How global civilian aero industry operates

- All searching for loopholes
- Two airframers
- Larger market for US subsystems & components than airframes
  - Including entertainment systems
- Two world engine mfg.
- Commercially derived avionics packages
- Largest portion of business is upgrades
- Large premium for ATM improvement
- Major market for sensors technology
5. Military security environment?

- Proliferation of monitoring systems
- Increase in ASATs by CO2 target violators
- RPVs for tactical application
- Microvehicles
ENVIRONMENTALLY CHALLENGED

6. Needs and opportunities for US aero . . .?

- Hydrogen airplane
- People packer airplane
- Impacts on NASA facilities
- R&D on extraction of H2 without CO2 in process
- Restructuring aviation industry
  - Gets highest priority for CO2 emissions?
- Change travel behavior
- Major innovation in flight simulation
- Military applications - greater emphasis on RPV and simulators
- Small aircraft
  - Efficiency
  - Bypass ground transportation CO2 discharges
  - Many small airports
- Systems analysis modeling capability for transportation system
- Stealth aircraft for both military and civil applications
- Low fuel burn technologies, e.g., light weight composite structures, low drag, high-lift, efficient engines (reduced power/idle descent)
- Low carbon fuel technologies, e.g. methane, H2, fuel infrastructure
- Alternate sources of propulsion for alternate vehicles
- Upgrade or replace older engines
- Aviation system improvements
  - ATM
  - Unpiloted civil aircraft
- Space based laser for sanctions
- ASATs for violators
- Short-takeoff and landing
- Micro vehicles
- Monitoring systems
ENVIRONMENTALLY CHALLENGED

6. Technological implications?

• Hydrogen airplane
  – Low weight cryo tankage materials
  – Safety in ground handling, e.g., leak detection and mitigation
  – CO2 efficient slush H2 production and handling
  – Airplane configuration
  – H2 engine development

• Low fuel burn technologies
  – Engineered and smart materials
  – New A/C config for high lift/low drag
  – Efficient engines
  – MEMS

• Improved security for civil aircraft
  – Low observable
  – Blast resistance
  – Airplane integrated detection system

• ATM for fuel efficiency
  – Highly accurate on-board weather prediction and monitoring
  – Sensors for more accurate positioning
  – System integration

• Uninhabited aircraft
  – Secure wideband data links
  – Non human centered automated decision making
  – Sensor technologies
  – System integration technologies

• Mini launch vehicles for micro payloads - civil and military reconnaissance
ENVIRONMENTALLY CHALLENGED
Robust Elements in Our World

• Hydrogen airplane
  – Low weight cryo tankage materials
  – Safety in ground handling, e.g., leak detection and mitigation
  – CO2 efficient slush H2 production and handling
  – Airplane configuration
  – H2 engine development

• Low fuel burn technologies
  – Engineered and smart materials
  – New A/C config for high lift/low drag
  – Efficient engines
  – MEMS

• Improved security for civil aircraft
  – Low observable/countermeasures
  – Bomb/blast resistance
  – Airplane integrated contraband detection system
ENVIRONMENTALLY CHALLENGED

Robust Elements in Our World

• ATM for fuel efficient routing
  – Highly accurate on-board weather information and monitoring
  – Sensors for more accurate positioning
  – System security and integrity

• Uninhabited aircraft - military/cargo/passenger
  – Secure wideband data links
  – Automated decision making
  – Sensor technologies

• Mini launch vehicles for micro payloads, i.e. tens of pounds - civil and military reconnaissance
  – Reduced payload size with constant functionality reduces cost

• Totally quiet airplane
7. Look beyond time horizon and speculate

- Micro aircraft based on MEMS
  - Sensors
  - Munitions
- Mini launch vehicles for micro payloads
- Exoatmospheric travel
ENVIRONMENTALLY CHALLENGED

8. R&D activities that could address technological implications
ENVIRONMENTALLY CHALLENGED

Opportunities and Needs
Technology Implications

1

• Description: Hydrogen powered large commercial aircraft
• Rationale: Visible carbon free airplane
• Problems:
  – Infrastructure, i.e. cost of producing H2
  – Safety - real and perceived
ENVIRONMENTALLY CHALLENGED
Opportunities and Needs
Technology Implications

2

- Description: Carbon based fuel aircraft technologies for minimizing CO2 emissions
- Rationale: May be best solutions for stopgap; refit potential
- Problems: Not a complete solution, competitive with other modes
ENVIRONMENTALLY CHALLENGED
Opportunities and Needs
Technology Implications

3

• Description: Improved security for civil aircraft to combat terrorism
• Rationale: Need to counter other countries’ threats in this scenario
• Problems: Adds weight, complexity increased price
ENVIRONMENTALLY CHALLENGED

Opportunities and Needs

Technology Implications

4

• Description: ATM for fuel efficiency through shorter routes, reduced holding, and meteorological optimization of flight paths

• Rationale: Minimize fuel, minimize CO2
ENVIRONMENTALLY CHALLENGED
Opportunities and Needs
Technology Implications

5

- Description: Uninhabited aircraft, smaller and thus reduced weight and fuel consumption
- Rationale: Reduced weight, fuel consumption, less CO2 output
- Problems: Acceptance by public
ENVIRONMENTALLY CHALLENGED
Opportunities and Needs
Technology Implications

6

• Description: Mini launchers for micro payloads - civil and military reconnaissance
• Rationale: Tensions, places we can’t fly over, “cheaters,” industrial intelligence, int’l science groups
• Problems: Everybody (e.g. terrorists) can have one!
ENVIRONMENTALLY CHALLENGED

Robust Elements Across Worlds

- Low fuel burn technologies
- ATM technologies
- Low cost LEO launch capability (under 3000 lb payloads)
- Totally quiet aircraft
- Uninhabited aircraft
  - Reconnaissance
  - Combat
  - Cargo
- Highly survivable aircraft
- Integrated modeling and simulation vehicle design
ENVIRONMENTALLY CHALLENGED

Breakthrough Points of Intervention

• Any new energy source which does not omit CO2, e.g., fusion to make H2
• Alternate solutions for CO2 problem, e.g.,
  – Bioengineered carbon eaters
  – Airborne CO2 “catalytic converter”
• Silent aircraft and rotorcraft
• Power MEMS
  – Each “powerplant” is 100 watts
  – Power on surface of aircraft
• Materials to reduce structural weight fraction by 2
• “Boomless” supersonic aircraft
• High subsonic VTOL and/or tiltrotor aircraft
• Pilotless civil aircraft
• Low cost tunneling technology
• Low cost exoatmospheric travel
ENVIROMENTALLY CHALLENGED

Agenda

• Robust elements across worlds
• Robust elements in our world
• Breakthrough points of intervention