VEHICLE TECHNOLOGIES SUMMARY & DISCUSSION

James R. Burley II
SATS Planning Lead for Vehicle Technologies
NASA-Langley
j.r.burley@larc.nasa.gov
757-864-2008

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Vehicle Technologies
Outline

- **Summary ~ 45 min**
  - General Comments & Observations
  - Vehicle Technologies
  - Issues & Obstacles
  - Back-up charts (goals, objectives, milestones, etc. “one-pagers” for each technology)
- **Discussion ~ 45 min**
  - Vehicle Technology Leads form “Panel of Experts”
  - Prepared questions to start discussion
  - Opportunity for ‘Infrastructure Technologies’ participants to query ‘Vehicle Technologies’ Panel

Vehicle Technologies
General Comments & Observations

- Common themes/concepts
  - "Operator-centric" goals…ease-of-use, cost, utility ….lots of automotive analogies
  - AGATE-like approach (i.e. partnerships & alliances)
  - Issues are primarily cost/legislative/regulatory in nature, with some technological challenges (ex. liability, certification)
  - No vehicle technology obstacles!
- Differences
  - Fixed-wing vs. fixed-wing and/or rotorcraft(VTOL)
  - Flight Deck Automation - from "commercial-transport-like" to "take me to Atlanta, Ga."

"Non-pilot operators" of the future will be to SATS ….what today's pilots are to AGATE

Airframe Technologies

- Low Cost Manufacturing Technologies
  - Automation
- Material & Component Certification
- Center of Design & Manufacturing Excellence
- Virtual Design & Manufacturing (Tools)
- Ice Protection
- Cabin Noise

Airframe Issues & Obstacles

- Customer Travel reliability requirements vs. cost
- Probability of planned departure/arrival at destination considering aircraft icing
- Cost of ice-protection system
  - Certification
  - Manufacturing
  - Maintenance

Propulsion Technologies

- Materials
  - Ceramics
  - PMCs
  - Metal & MMCs
- Noise
- Bearings, Gears, and Transmissions
- Fuels & Combustors
- Small Turbomachinery Manufacturing & Design
- Controls & Health Monitoring
- Electric Propulsion

Propulsion Issues & Obstacles

- Low-Cost Manufacturing Methods
- Long-life, High Temp. Materials
- Interior & Exterior Noise & Emissions
- Low-cost, “Bullet-proof”, Intuitive Automation Software/hardware
- Liability & Certification

Flight Controls Technologies

- No Aerodynamic Technology Development needed (Fixed-wing Only)
- Man/Machine Interface
- Fly-by-wire digital flight controls
- Decoupled Controls (no direct connection between control “stick” and control surface)
- Software Verification & Validation

Flight Controls Issues & Obstacles

- Risk that focus may be technologies and airplanes instead of operator's ease of use and accessibility to SATS
- The level of simplification required for acceptable operation with low training requires full time, full authority, fly by wire. This will require a substantial paradigm shift.
- The threat of litigation to new technologies that enhance safety in unfamiliar ways is significant and may block implementation.

Avionics Technologies

- Simplified controls for operation
- Intuitive operator interfaces
- Sensors
- Flight management
- Conflict detection and resolution
- Collision avoidance
- Avionics Open Architecture
- Virtual VFR
- Active noise reduction
- Communication (2-way)
- Smart airplane

Avionics Issues & Obstacles

- What does affordable mean? What is the pricing model (individual SATS airplane purchase vs. shuttle service)?
- Certification – low-cost, timely certification of software and hardware
- Data link – international spectrum issues, single data-link platform to perform all functions?

Training Technologies

- Web based training systems
- Embedded training
- Virtual Reality
- Integrated PCATD
- High School “Flyer’s Education”
- Immersion training

Training Issues & Obstacles

- Aircraft configurations/operating systems not consistent
- Technologies (vehicle, CNS/ATM, airport, and/or training) will not be developed in a timely manner.
- Required certification change processes takes too long
- Over dependency on automation
- Insufficient flow of information between technology development teams
- Transition from current operations to SATS environment
- Current regulations do not allow for:
  - The reduction in training time
  - Proficiency based training
  - Use of simulators/flight training devices/ PCATDs to a level required to meet the SATS goals
  - Electronic evaluation of proficiency

Questions & Discussion

Vehicle Technologies
Prepared Questions

- Should rotorcraft/VTOL be considered as part of the SATS vehicle model?

- What is the proper level of automation that SATS should strive to achieve by 2008?

Back-up Charts

Vehicle Technologies - Aerodynamics and Control

Intuitive Control of the SATS Aircraft

Goal - Increase attractiveness of personal air travel by reducing accidents, life-cycle costs through reduction of training requirements and operator workload by developing intuitive flight control systems. Intuitive and automatic flight controls, along with cockpit design, support a goal of one week's training to make aircraft operations as approachable as any business skill. In this way the capacity of the nation's transportation system is expanded.

1999 Baseline - Operation of today's aircraft is nonintuitive and generally requires at least 200 hours and two years of specialized training. Continuing proficiency training requires about six dedicated annual flights. The flight controls in today's state-of-practice aircraft do not prevent stall and spin entry or structural overloading. Current state of the art includes the basic technologies required to meet our goal. Implementation of these technologies is currently blocked by significant cost and regulatory barriers. These technologies are at a TRL of 4 or 5.

Objectives - Develop decoupled control systems, envelope protection, and auto land capability to increase safety and enhance ease of operability. Develop handling qualities and reliability GS&Cs (design guidelines, standards and certification requirements) for flight controls systems.

Approach - Current accident data will be used to determined flight control and workload related accident rates. The results will be used to predict accident rates associated with intuitive flight controls systems, quantifying the potential to save lives. If the accident data studies demonstrate significant safety potential, human factors will be investigated using flight and ground based simulation experiments to establish improved situational awareness, lower workload, and lower training requirements. A POC/research vehicle will be developed for validation of technologies and marketability. A government industry task force will be convened to write appropriate FAA regulations to support implementation of advanced intuitive flight controls systems.

Milestones - The following milestones are required for implementation

Q4/00	Begin SATS program
Q2/01	Accident data investigation
Q2/01	First flight of POC/research vehicle
Q4/02	completion of ground based simulation of human factors
Q2/04	Completion of flight based human factors study
Q3/06	Completion of the regulatory task force work
Q2/07	GS&C completed

Issues/Obstacles - No hard technical or time constraints restrict completion of this goal. There is a risk that the focus may settle on technologies and airplanes instead of focusing on the operator's ease of use and accessibility to the SATS.

- The level of simplification required for acceptable operation with low training requires full time, full authority, fly by wire. This will require a substantial paradigm shift.
- The threat of litigation to new technologies that enhance safety in unfamiliar ways is significant and may block implementation.