Aerospace Technology Working Group

April 27 - 29, 1999 Lancaster, CA

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IVHM Sensor Technology

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Brief History of IVHM Planning

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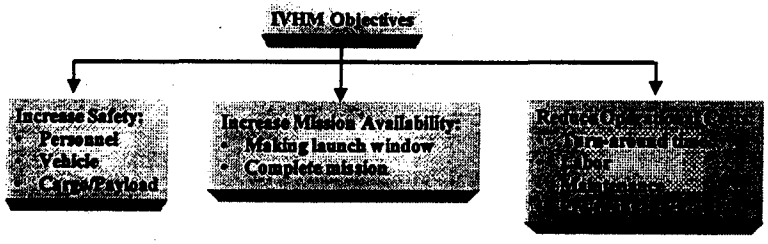
In 1992, Codes R & M requested the SATWG to address the status of IVHM and develop technology plans

Series of workshops held and a summary report on key technology needs and research directions presented

Access-to-Space Program was started, focusing on performance-driven technologies for Single-Stage-to-Orbit

- This activity resulted in the X-33/RLV Program now underway
- Difficulty in integrating IVHM into the X-33 combined with the application of intelligent systems for autonomous spacecraft health monitoring has now spurred interest in supporting IVHM technology developments
- JPL Workshop focused on identifying the potential contribution that advanced sensors/IVHM can make across aerospace systems and how implementation on flight programs can be enhanced

Overview

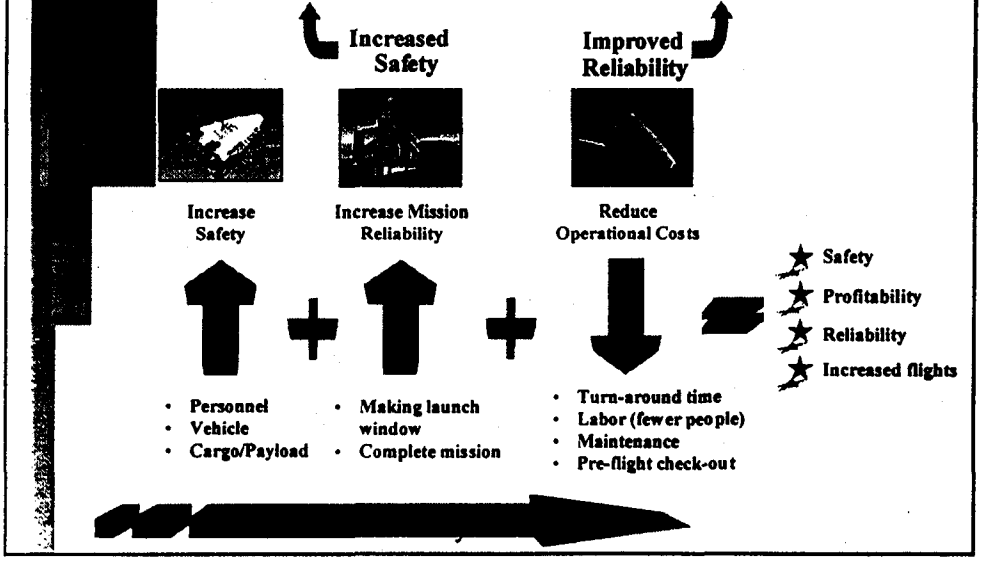


To accomplish these objectives requires an IVHM system approach at the start of the program with:

- **A top-level approach for subsystem testing to understand the physical changes using the IVHM sensors**
- **A bottom-up approach to use IVHM sensors to understand and improve critical components during the development cycle**

Benefits

Reduce Space Transportation Costs



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Sensor Workshop

Nov. 17-19, 1998 Pasadena, CA

Over 115 people from NASA Centers, industry and academia attended

- http://mtc.jpl.nasa.gov/rlv-asstt/home.htm

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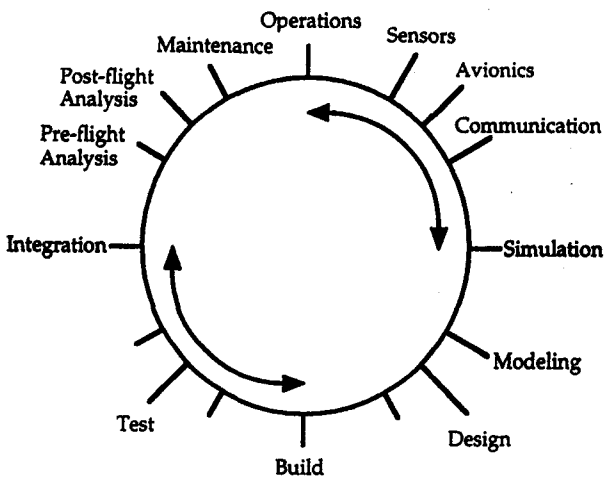
Overall Conclusion

- The approach required for the advancement of sensor systems development for aerospace transportation is both more effective management and technical awareness of the total program
- This implementation includes comprehension of the total concept from the top down and the specific implementation of useful sensors from the bottom up
- This systems approach is cost-effective because it requires understanding of the total life-cycle costs, from the start of the design until repeated operational utilization of space transportation systems

Relation of IVHM to Life-Cycle Costs



Specific Conclusions

- Communication between individual NASA Centers performing IVHM activities and between NASA and industry needs to be improved and better coordinated
- Current maturity and confidence level of IVHM-related technologies needs to be improved
- IVHM will be a necessity for future airplanes and aerospace activities and it cannot be added afterwards, therefore, the timing is critical for the integration of vehicle health management to coincide with the system design process

Specific Recommendations

- Create a NASA-wide team to interface between those Program Managers and Centers performing IVHM activities, facilitating better communication and coordination and acting as an 'information broker'
- Leverage existing Testbeds at Centers to prove IVHM technologies and capabilities and so raise their TRL from 'development' to 'flight ready,' where they may be integrated into flight projects
- Create Cost/Benefit tools and economic models to better demonstrate how IVHM activities can contribute to reducing Life-Cycle Costs and integrate with the Intelligent Synthesis Environment (ISE) technology area's objectives

NASA Team Objectives

erform IVHM Integration between NASA Centers

Provide real opportunity and platform to work together and evolve into NASA's IVHM Team

- Working group evolving into IVHM Technology Program (e.g., Cross-cutting type program)

Support specific program IVHM needs

- Launch vehicles, satellites, aeronautics programs
- Support, advise, and direct individual program IVHM plans

- **Bridge technology gaps and manage development program**
  - Coordinate between program needs and identify common technologies
  - Identify technology gaps and lobby for bridge funding
- **Interface and coordinate with external interfaces**
  - Jointly work with supporting technology programs and leverage applicable resources (i.e., ISE, Instrumentation, etc.)
  - Coordinate with industry, academia, and other government agency technology development plans

Advanced Sensors Task

- Task is to help NASA team coordinate IVHM activities across NASA Centers
- Determine future applicability of sensors (Sensor Report)
- Support of new initiatives

Scope of Sensor Report

investigate the state of the art in IVHM equipment in:

IVHM Sensors, especially for avionics sensors

- Look at sensors and methods used for sensors used for robotic and inhabited spacecraft
- Integrate methods used in industry, with special emphasis on commercial and military aircraft, naval and automotive industries
- Collaborate with structural and propulsion sensors at other NASA centers

- Investigate state of the art for Remote Health Nodes
  - Summarize present state in space and aerospace applications
  - Look at other industries for current ideas and practices
  - Investigate present limits for mass, power, and volume
- Understand present state for Sensor-RHN interconnects
  - Look at government and industry capabilities for interconnect in allied industries
  - Investigate data bus architectures
  - Understand state of the art for wireless interconnects

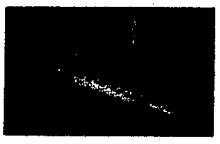
Roadmap

Translate aircraft fast maround paradigm to space vehicles

Expand spacecraft sensors paradigm

Integrate next generation sensors

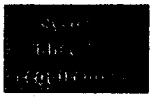
Integrated sensor system for RLV health management



Transfer technology/architectures/methods to current & future vehicles

Customers:
- **Commercial**
- **Military / Civilian**
- **NASA**

Roadmap



Products:

- **Identify current sensor deficiencies**
- **Identify future sensor enhancements**
- **Translate requirements to design**
- ***Develop plans for meeting RLV needs***
- **Feedback of results to U.S. industry**