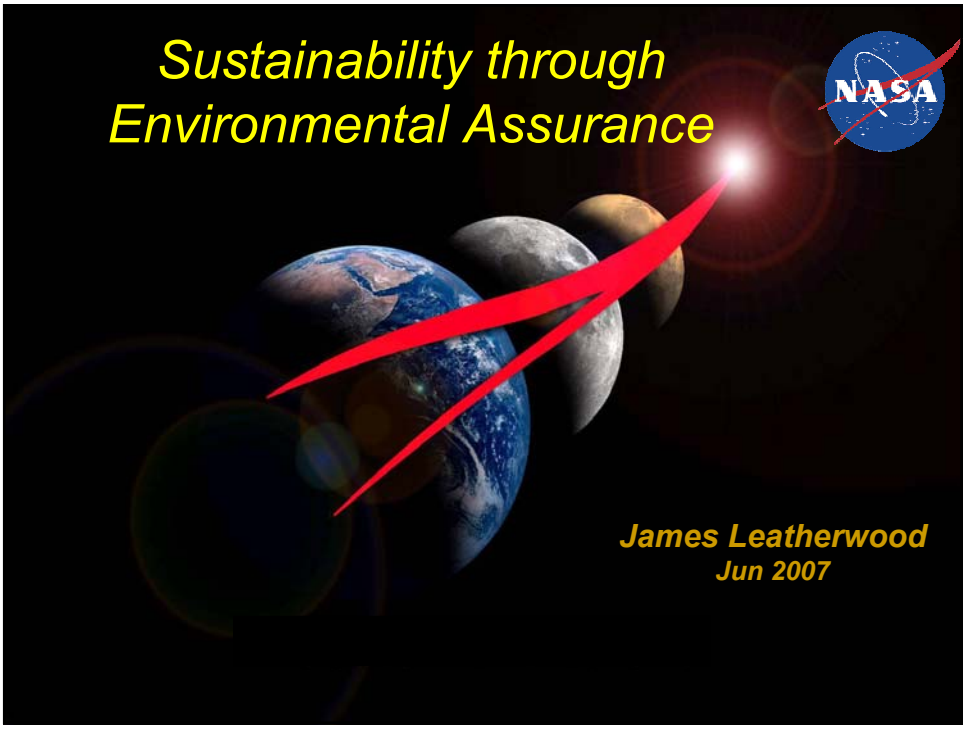
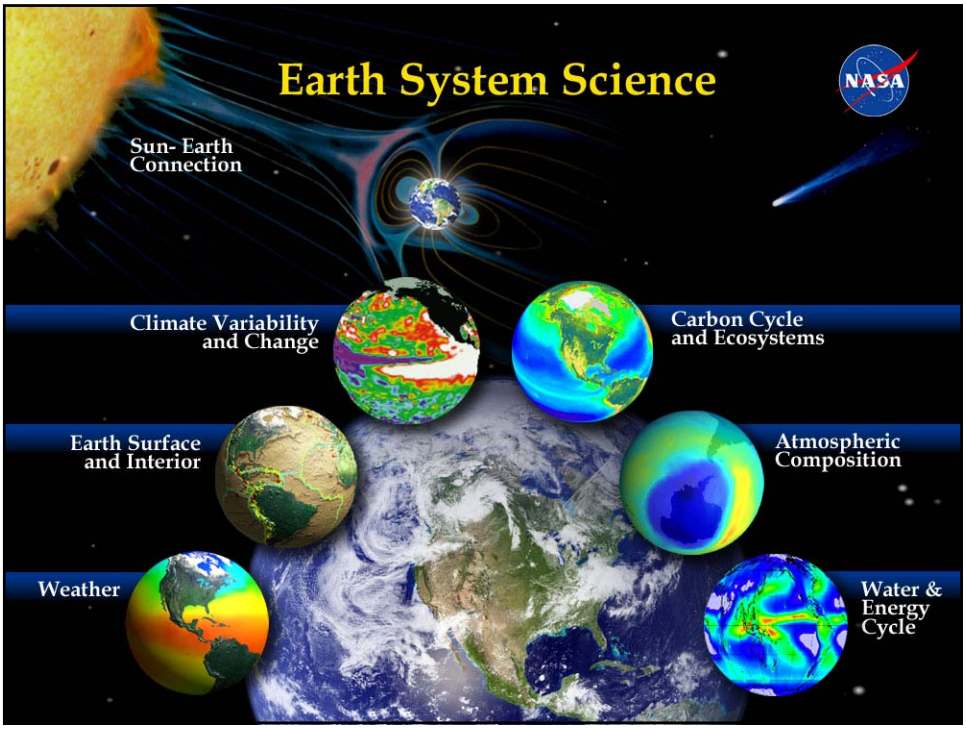
Sustainability through Environmental Assurance



James Leatherwood
Jun 2007

Agency Strategic Goals

1. Fly the Shuttle as safely as possible until its retirement, not later than 2010.
2. Bring a new Crew Exploration Vehicle into service as soon as possible after Shuttle retirement.
3. Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration.
4. Complete the International Space Station in a manner consistent with NASA's International partner commitments and the needs of human exploration.
5. Encourage the pursuit of appropriate partnerships with the emerging commercial space sector.
6. Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations.


Earth System Science
NASA
Sun- Earth Connection
Climate Variability and Change
Carbon Cycle and Ecosystems
Earth Surface and Interior
Atmospheric Composition
Weather
Water & Energy Cycle

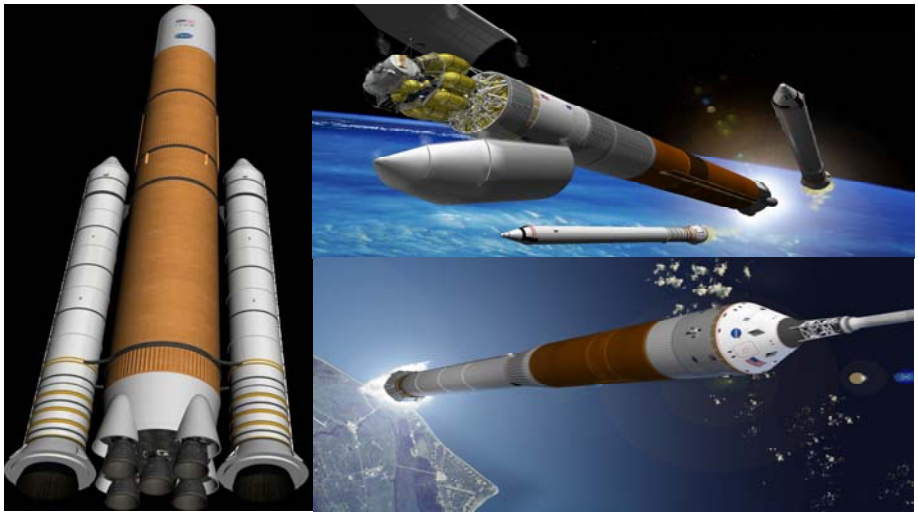

Back to the Moon

Crew Launch Vehicle (CLV) and Crew Exploration Vehicle (CEV)

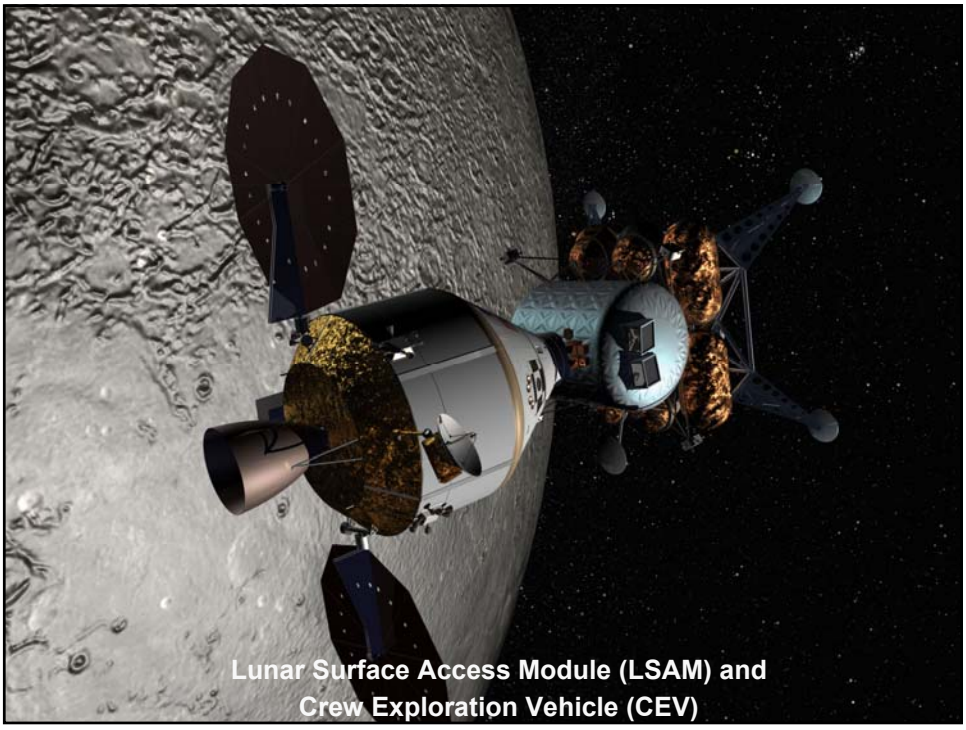
First Launch: 2011 - 2014

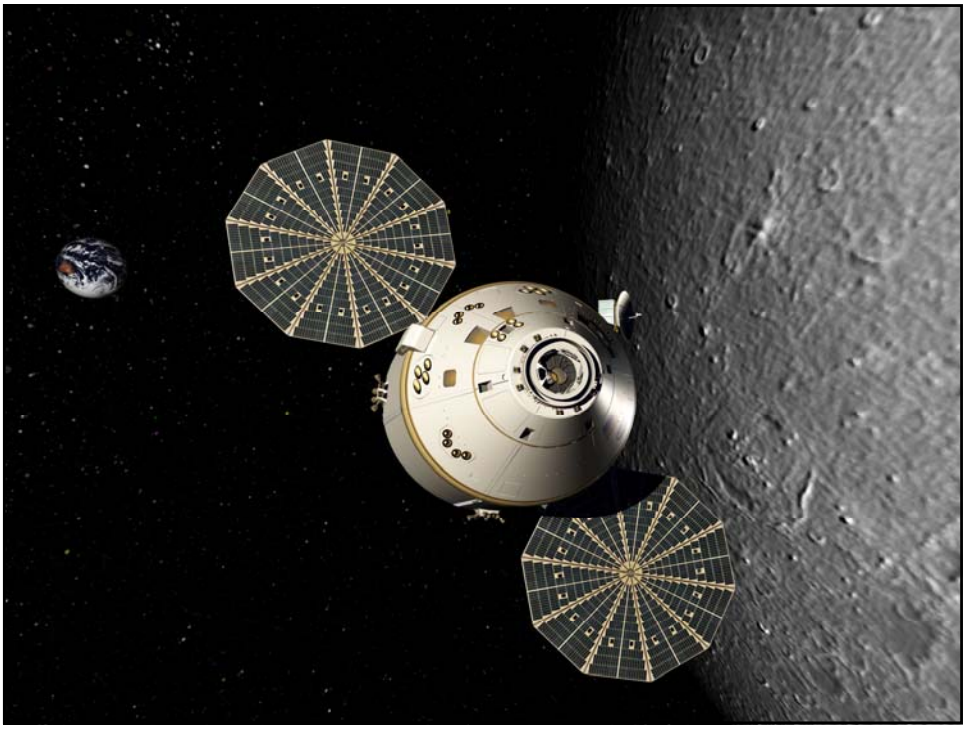
Crew Exploration Vehicle (CEV) Servicing the International Space Station (ISS)

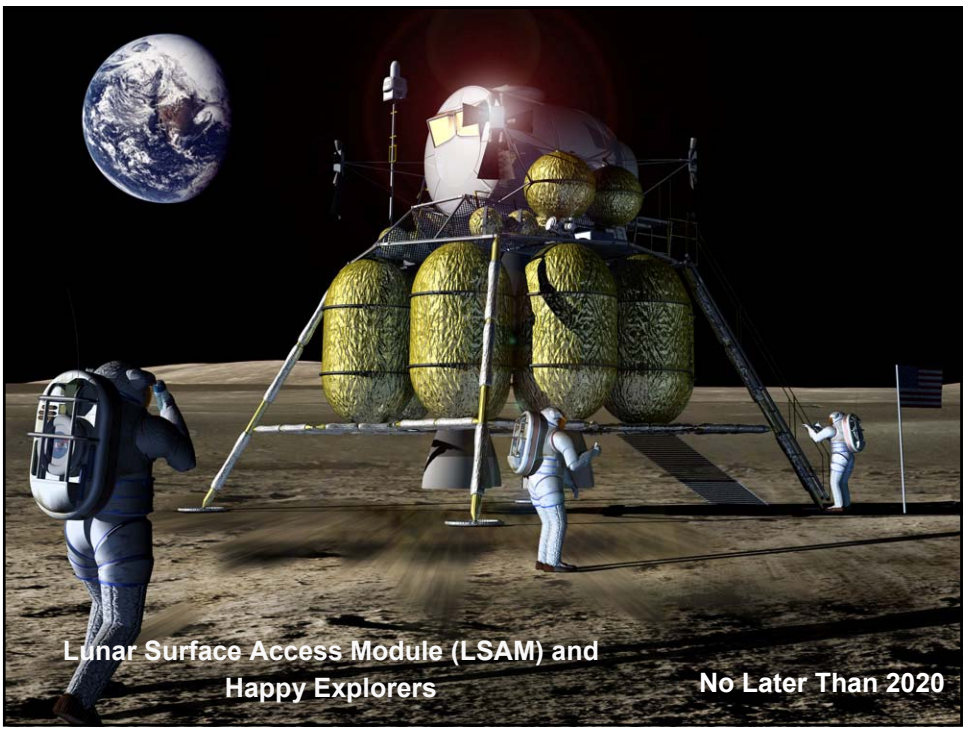
First ISS Mission: 2011 - 2014

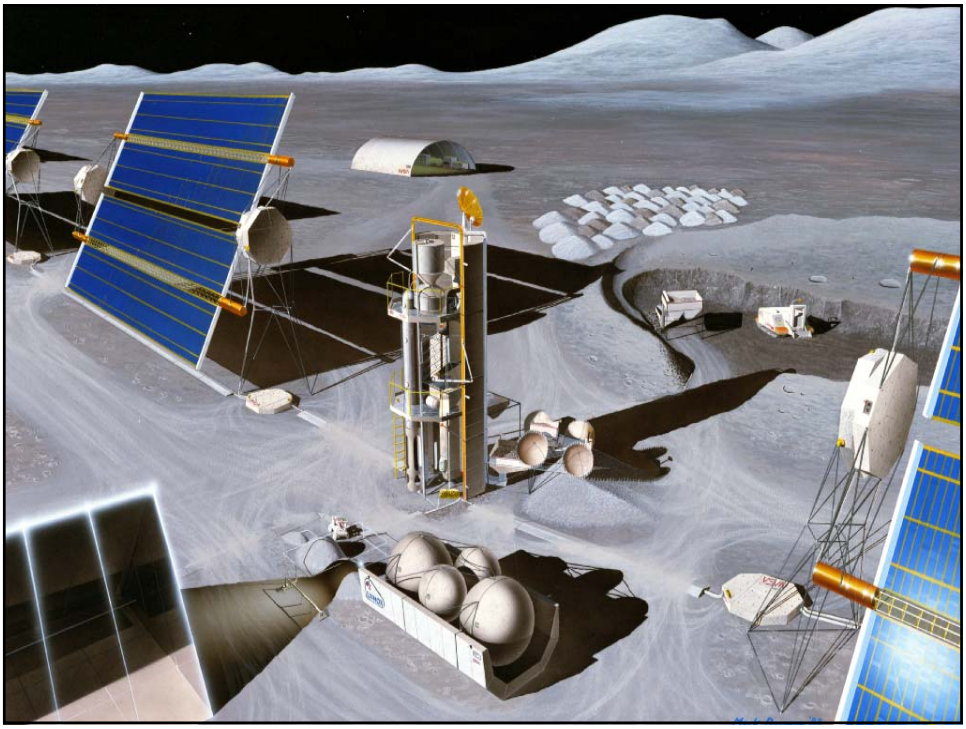


To see far is one thing, going there is another.
- Constantine Brancusi





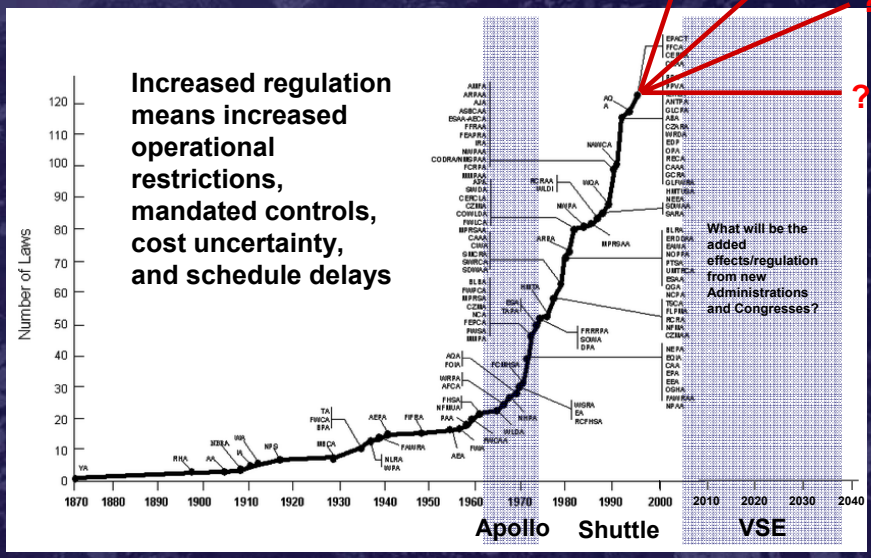

Lunar Surface Access Module (LSAM) and
Happy Explorers
No Later Than 2020



Agency Challenges

- NASA's missions presents intense technical, financial and management challenges
- Operating environment extremely constrained from cost and schedule perspectives
- External requirements exacerbate problem
  - Directive on Waste Electrical and Electronics Equipment (WEEE)
  - Directive on the Restriction of Hazardous Substances (RoHS)
  - Registration, Evaluation and Authorization of Chemicals (REACH)

Trends for Long-Life Systems Increasing Env. Regulation



Source: J. A. Cusumano, New Technology for the Environment, Chemtech, 1992, 22(8), 482–489

Manager Focus

- Performance
- Cost
- Schedule
- Risk

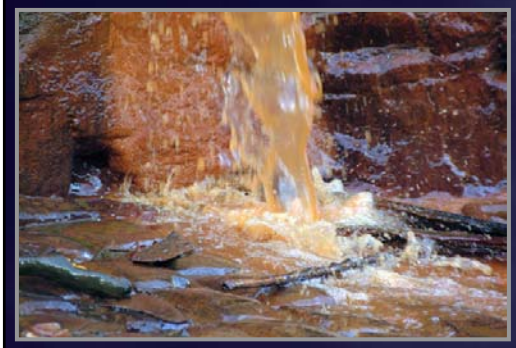
Engineer Aspirations

- Exercise Creativity
- Challenging Work
- Community
- Excitement

Historic Approach to Environmental Management

- Identify, quantify, measure, monitor, review and assess environmental problems.
- Activity is driven by external requirements (e.g., regulations, Executive Orders, public outcry)
- Sometimes in conflict with mission goals
- Regulatory framework is the main driver for change

End of Pipe



System Inputs & Outputs Model

1969

INPUTS

- raw materials
- fuels / energy

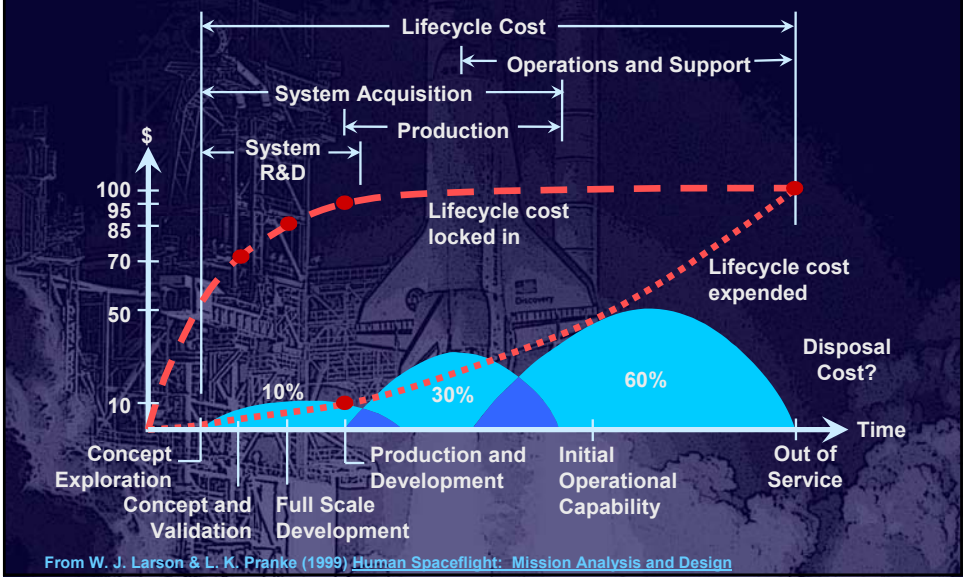
SYSTEM

OUTPUTS

- waste heat
- solid waste
- air emissions
- water emissions
- usable products

end of pipe

Trends for Long-Life Systems Costs Locked In & Cost by Phase

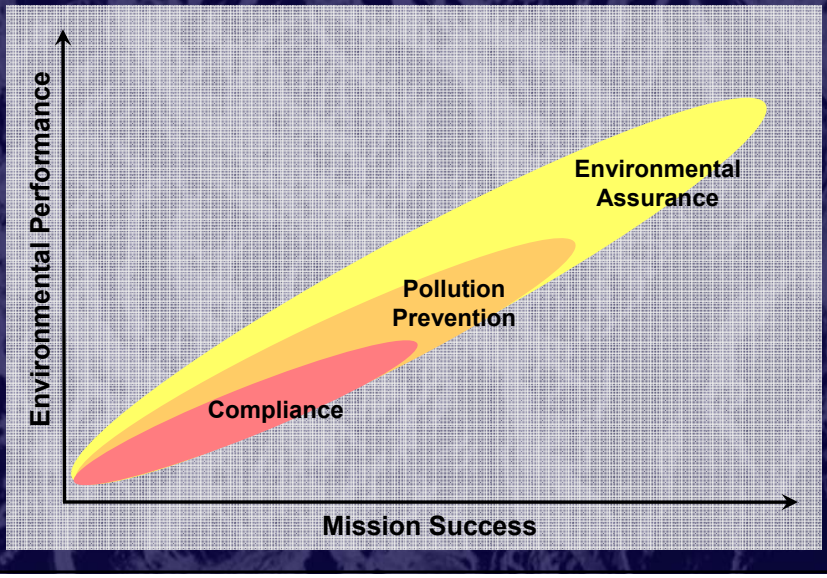


From W. J. Larson & L. K. Pranke (1999) Human Spaceflight: Mission Analysis and Design

Environmental Assurance for NASA Systems

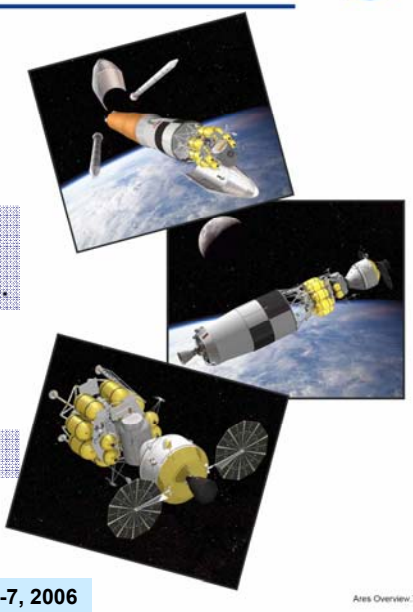
Bridges Integrated Mission Risk Management with Sustainability

Environmental Management Initiatives



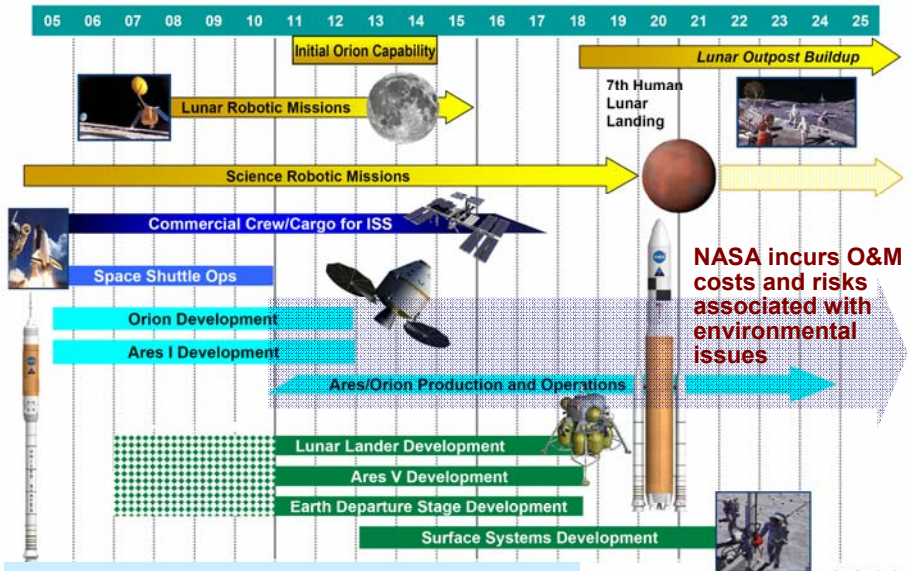
Design Philosophy for Mission Success

- **Keep it simple.**
  - Minimize complexity and interactions.
  - Simplify interfaces.
  - Make it robust.
- **Focus on reliability, maintainability and supportability early to improve safety and reduce operations costs.**
- **Apply validated engineering tools, models, and data to new vehicle configurations.**
- **Apply Lessons Learned**



Includes DDT&E and operations – environmental factors act primarily in the ops phase

Adapted from Ares 1 SRR Presentation, Nov 6-7, 2006



Adapted from Ares 1 SRR Presentation, Nov 6-7, 2006

Better Alignment with Mission

Environmental Assurance Scope

Risks posed by the Program to the environment

- Identified under NEPA through the Environmental Impact Statement (EIS) process prior to Program inception
- The EIS describes programmatic options and addresses environmental considerations associated with each

Risks posed to the Program by environmentally-related drivers

- Real-time risks from a new environmental driver
- Real-time risks from configuration issues/changes that trigger an existing driver

Environmental Assurance Definition

Environmental Assurance is the proactive detection, analysis, mitigation, and communication of environmentally-driven risks to NASA mission-required research, development, fabrication, processing and operations.

Environmental Assurance Goals

1. Identify, analyze, and measure environmentally driven programmatic and institutional risks.
2. Communicate environmentally driven programmatic and institutional risks to appropriate owners
3. Team/partner with risk owners to proactively reduce risk's impact, likelihood, and scope (e.g., may apply to multiple programs and projects)
   - Provide information to regulatory authorities
   - Acquire special waivers from regulating organization
   - Identify and validate appropriate solutions for mitigation of environmentally driven risks

The risk owners (e.g., programs and projects) will have day-to-day responsibility for management of their risks.

Environmental Assurance Risk Drivers

Government Requirements

- EHS-related laws, regulations, executive orders, or policies that set rqmts

Other Environment, Health, and Safety Considerations

- Considerations related to environment, health or safety
- Is often, but not always, related to "government requirements"

Vendor Economics & Issues

- Vendor decisions to change formulations, cease production of a material, or otherwise impact materials and processes
- Is often related to the other drivers

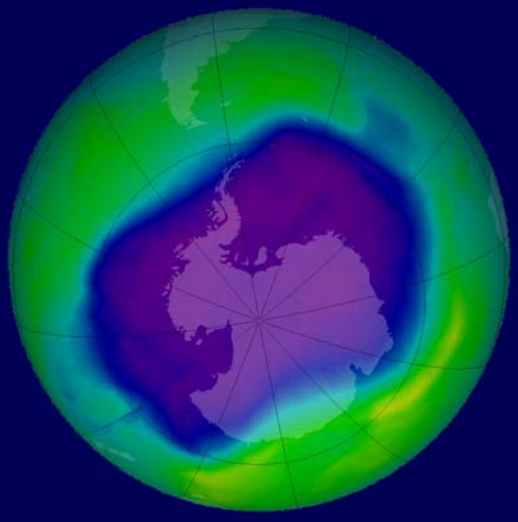
Technology and Market-Based Forces

- Technology advances can reduce manufacturers' incentives to produce technologically obsolete materials
- Global trends in materials selection and procurement can impact materials availability by reducing production viability of certain low-volume items

Natural Disasters

- Manufacturing facilities and infrastructure damage by earthquake, hurricane, fire and other disasters can affect manufacturers' ability or willingness to produce materials

NASA and NOAA Announce Ozone Hole is a Double Record Breaker

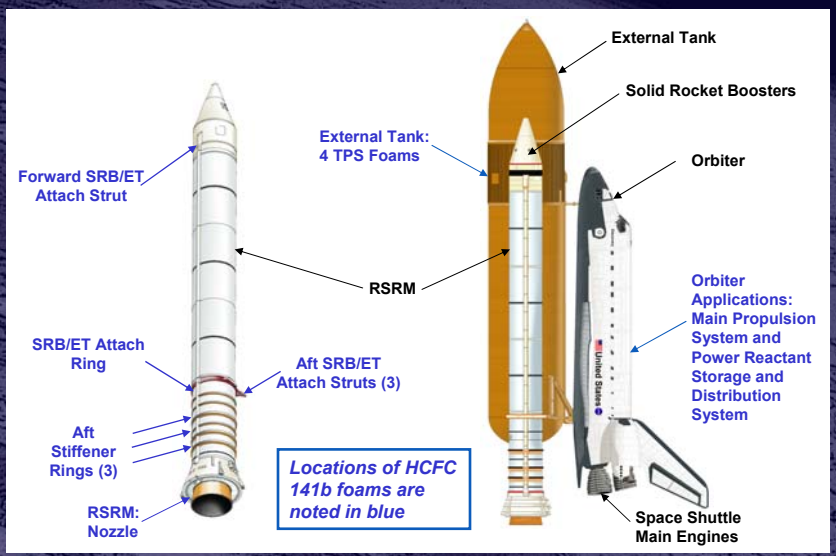


October 19, 2006

From September 21-30, 2006 the average area of the ozone hole was the largest ever observed, at 10.6 million square miles. This image, from Sept. 24, the Antarctic ozone hole was equal to the record single-day largest area of 11.4 million square miles, reached on Sept. 9, 2000. The blue and purple colors are where there is the least ozone, and the greens, yellows, and reds are where there is more ozone.

http://www.nasa.gov/vision/earth/lookingatearth/ozone_record.html

Shuttle ODS Applications



International Influences on Material Selection and Use

Multilateral Environmental Agreements (MEAs)

- Persistent Organic Pollutants (POPs)
- Long-Range Transboundary Air Pollution (LRTAP)

European Union

- Registration, Evaluation, and Authorization of Chemicals (REACH)
- Restriction of Hazardous Substances (RoHS)
- Waste Electrical and Electronic Equipment (WEEE)

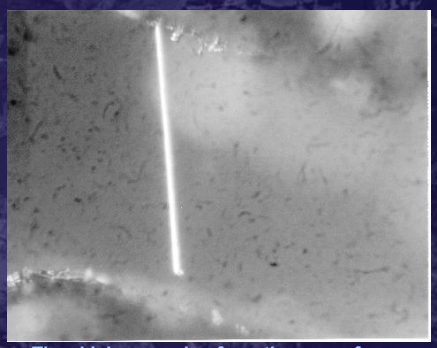
Asia

- Emerging RoHS-like laws in China and Korea

Example of Indirect Impact on Supply Chain

Restriction of Hazardous Substances (RoHS)

- Effective 1 July 2006
- Bans several materials used in new electrical and electronic equipment (EEE)
  - Lead
  - Cadmium
  - Mercury
  - Hexavalent Chromium
  - PBB and PBDE flame retardants



Tin whisker growing from the case of one relay in the direction of an adjacent relay.

Partial List of Materials and Processes of Concern

- Trichloroethane
- Precision Cleaning and Cleanliness Verification Processes Requiring ODSs (HCFC 225 and HCFC 225g)
- TPS and Cryoinsulation Containing ODS (HCFC 141b)
- Chromate Primers
- Cadmium Plating
- Hexavalent Chromium Conversion Coating
- Paint Strippers Containing Methylene Chloride
- Lead Based Solid Film Lubricants
- Paints Containing Perchloroethylene
- High-Level Volitile Organic Compound (VOC) Coatings
- Alkaline Cleaners Containing Hexavalent Chromium
- Hazardous Air Pollutant (HAP) Inks
- Methyl Ethyl Ketone
- Materials and Products Containing Perfluoroalkyl Sulfonates
- Materials Containing Brominated Flame Retardants
- Materials Requiring Perfluorooctanoic Acid (PFOA)

Contacts and Resources

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Environmental Management Division
http://oim.hq.nasa.gov/oia/emd/index.html

Questions?