Technology and Innovation Committee Report

Esther Dyson

February 10, 2011

Turnover

- Eric Haseltine resigned – personal reasons
- Gordon Eichhorst joined – great addition!

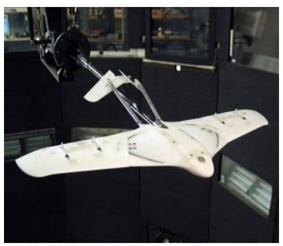
Meetings of T&I Committee 1 of 2

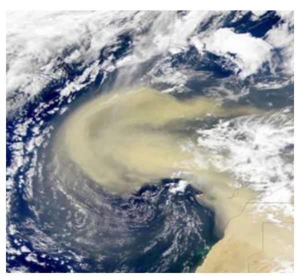
- NASA Langley Research Center, October 20-21, 2010.
  - Members attended Aviation Unleashed conference on October 20 in Hampton, VA.
  - Public session on Oct. 21 at LaRC included tours of research labs; tour of 14 x 22 Subsonic Wind Tunnel; Center overview update; innovation efforts at LaRC; presentations on OCT formulation and the Game Changing Development program.

NASA Langley Core Competencies

Aerosciences

Research for Flight
in All Atmospheres

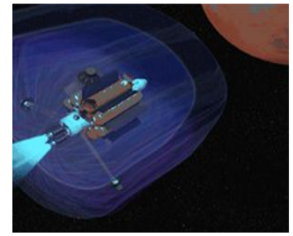




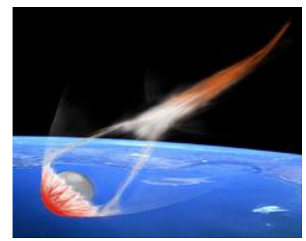
Characterization of all Atmospheres

(Lasers & LIDAR)

Aerospace Systems Analysis



Entry, Descent & Landing



Aerospace Structural & Material Concepts

What we (LaRC) are doing to encourage innovation …

facebook

YouTube

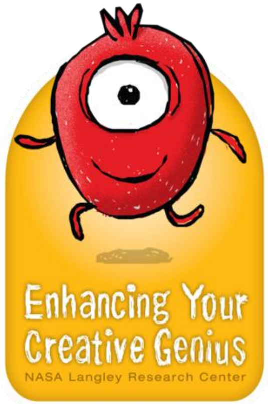
yammer

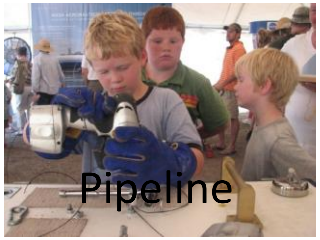
Lecture Series

Revolutionary Technical Challenges

IOTs

Organization Innovation Plans





Colloquiums

TEDxYouthDay

[Individual *"Beyond the State of the Art"* Plans]

TEDxNASA
x = independently organized TED event

Creativity & Innovation Funds

Lunch & Learn

10% White Space

INNOCENTIVE®

Game Changing Development

Level II Program Office: LaRC

Objective: Solicit innovative ideas enabling new capabilities or radically altering current approaches to launch, build, and operate space systems.

- Matures technologies through the mid-TRL regime to enable useful game changing capabilities for scientific discovery, and human and robotic exploration
- Projects are intended to be capability-oriented and to move ideas from discovery to use.
- GCD emulates the outcomes of the DARPA approach at technology development
- Guided by NRC's Findings and Recommendations*

Acquisition Strategy

- Concept Studies will be competed to flesh out idea(s), quantify their challenges and identify approaches to overcome them
- A subject matter expert Project Manager (PM) may recommend the idea for a new project start. If *game changing,* the Chief Technologist may authorize the PM to release a BAA

○ The BAA asks for many ideas to achieve the project goals from the community. The PM and a committee of experts assess and award multiple elements per project.

* NRC report, America's Future in Space, 2009

Awards

- **Concept Studies**: $300K-$500K; ~120/year (~60 in FY11)
- **Small Projects**: 2 - 3 years, ~$3M/year; ~12 new project starts/ year (~6 in FY11)
- **Large Projects**: 2 - 3 years, ~$12M/year; ~12 new project starts/ year (~6 in FY11)

Collaboration

- Teams will include Govt Agencies, academia and industry.

Meetings of T&I Committee 2 of 2

- NASA Kennedy Space Center, January 11-12, 2011.

  Committee:
  - Toured KSC research labs,
  - Received input from NASA Chief Technologists
  - Received briefings on status of NASA Technology Transfer and Commercialization activities, NASA's Technology Roadmaps, and overview of KSC technology activities.
  - Received an update on OCT programs and NASA budget status.
  - Toured Space Operations facilities, including VAB with Space Shuttle Discovery - VERY COOL, and also cold!

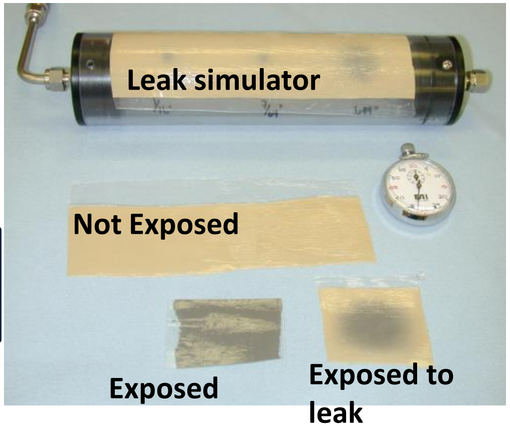
Research and Technology Capability Areas at the John F. Kennedy Space Center

- Storage, Distribution and Conservation of Fluids (Cryogens, Liquids, Gases)
- Materials for Life Cycle Optimization
- Life Sciences & Habitation Systems
- Remediation and Ecosystem Sciences
- In-Situ Resource Utilization and Surface Systems
- Life Cycle Optimization of Products, Projects, and Programs
- Space Launch and Suborbital Technologies
- Tracking, Timing, Communications (TT&C) and Navigation Technologies

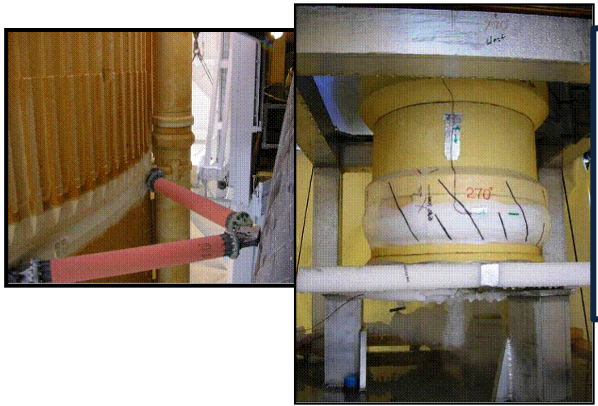
Storage, Distribution and Conservation of Fluids (Cryogens, Liquids, Gases)

- Examples of KSC Work:
  - High Efficiency Storage, Distribution and Recovery Systems; including Transfer Losses and Re-liquefaction of Boil-off
  - Aerogel Insulation Systems for Helium Purge Elimination
  - Thermal-Fluid Analysis of Composite Overwrapped Pressure Vessels (COPV) Loading
  - Energy Efficient Thermal Insulation Systems
  - Helium Life Cycle Cost Reduction and Limited Resource Conservation
  - Breathing Air for Propellant Handler’s Ensemble, Environmental Control & Life Support System (ECLSS), and Habitation
  - Development of Innovative Components and Instrumentation
  - Detection and Isolation of Hazardous Gases and Fluids

Integrated Refrigeration and Storage System



Chemchromatic sensing for detection of hypergols and H2



Aerogel Insulation used for External Tank LO2 Bellows Ice Elimination

Pulse Tube Cryocooler for Oxygen Liquefaction

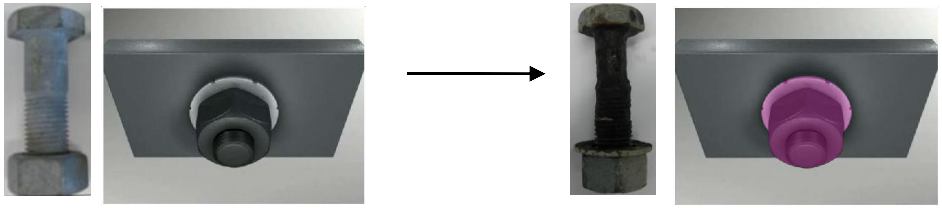
Materials for Life Cycle Optimization

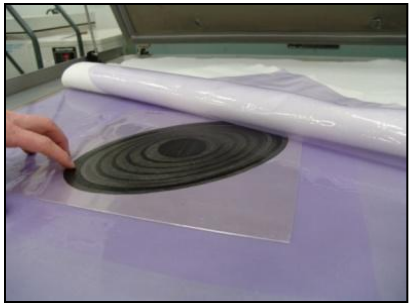
- Examples of KSC Work:
  - Corrosion Detection and Mitigation
  - Non-Destructive Evaluation/Inspection
  - Wire Fault Detection and Self Repair Systems
  - Multilayer Insulation Systems for Superconducting Power Cables
  - Environmentally Friendly, Long Life Materials (Anti Microbial, Low Flammability)
  - Electrostatic Charge Dissipation Technologies
  - Repair of Composites and Advanced Materials

Wire Fault Repair and Detection System

Insulation Systems for High Efficiency Long-Length Flexible Piping

Corrosion Detection and Control





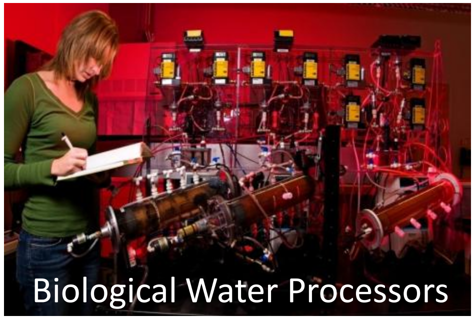
Composite Repair for Large Structures

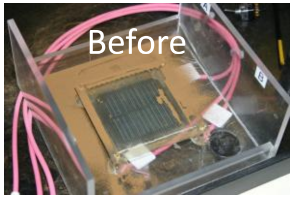
Life Sciences and Habitation Systems

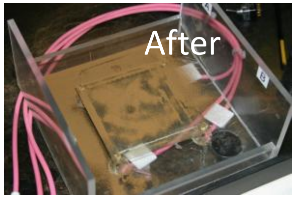
Examples of KSC Work:

- Microbial, Plant, Cellular and Animal Investigations
- Bio-regenerative and Biological Closed Loop Life Support Systems
- Advanced Protective Equipment Testing and Development, Heat Stress Mitigation
- Commercial Space Flight – Evidence-based Crew and Passenger Medical Screening Tools and Crew and Passenger Medical Standards, Hazards Assessments, In-flight Medical Emergency Treatment Protocols, Passenger Spaceflight Training Programs
- Self Healing for Inflatable Structures
- Space Bio-imaging
- Dust Mitigation on Windows/Solar Panels/Thermal Radiators/Batteries and Power Systems
- Dust Tolerant Seals, Mechanisms, and Connections
- Light Emitting Diode (LED) Technologies to Enhance Human Adaptation


Vegetable Production Unit


Biological Water Processors

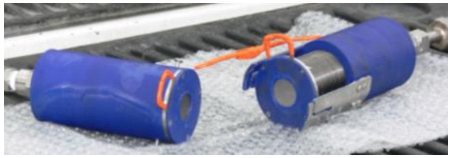




Dust Mitigation Technology on Solar Panel

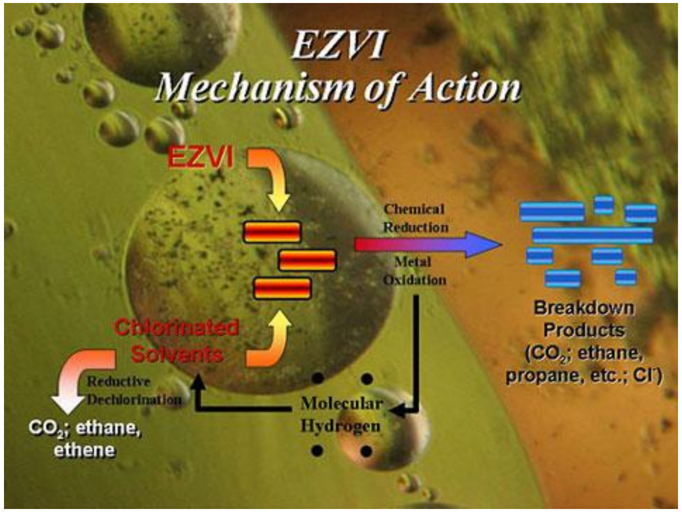

ResQPod increases blood circulation to brain

Dust Tolerant Connector



Groundwater Remediation

- To clean up an Apollo-era mess, Kennedy Space Center and the University of Central Florida partnered to develop a biodegradable environmental cleanup technology.
  - Emulsified Zero-Valent Iron (EZVI).
  - EZVI uses iron particles in an environmentally friendly oil and water base to neutralize toxic chemicals.
- Other partners in this effort include the U.S. DOE, DoD, EPA, GeoSyntec, Inc., and NASA's STTR Program.
- NASA's success in remediating this historic launch site has led to numerous non-exclusive licenses for EZVI.
- EZVI is now restoring contaminated sites to health in numerous states including Arkansas, California, Florida, North Carolina, and Texas.



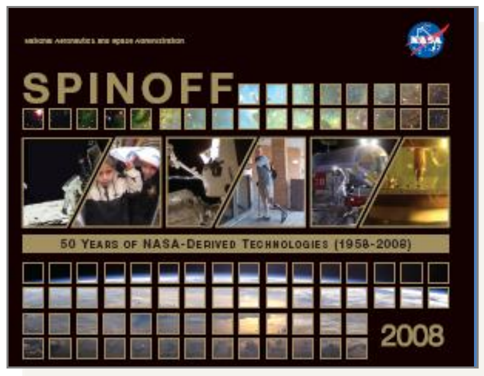
NASA Technology Transfer & Commercialization

- NASA has a long history of transferring technologies for public benefit.
- NASA's direction to do this traces to the Space Act that created NASA in 1958:

  "Provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof."

Applications of NASA-Derived Technology

- Health and Medicine
- Transportation
- Public Safety
- Consumer, Home & Recreation
- Environmental and Agricultural Resources
- Computer Technology
- Industrial Productivity



NASA @ Home & NASA City
http://www.nasa.gov/city

Public Benefits of NASA-Derived Technology

- Economic Growth
  - New Jobs
  - New Markets
  - Increased Efficiency
  - Improved Competitiveness
- Quality of Life
  - Improved Safety
  - New Products
  - Lives Saved or Extended
  - Green Technologies
  - Environmental Cleanup

TecFusion Summits

- 28 TecFusion™ Summits since 2004.
- Large companies have reviewed over 3,700 Phase II technologies.
- 335 SBIR companies have presented over 400 technologies.
- 21 sponsors.
    - 2 have sponsored 3 Summits.
    - 3 sponsored 2 Summits.
    - Some annually and in other cases every year-and-a-half to 2 years.
    - Two are on the schedule for a fourth Summit.
    - 12 Fortune 500 companies.
- 65 technologies ongoing discussions with 9 in continuing partnering efforts.

NASA Technologies Helping Sustainability

- Assistance to Developing Countries
  - Clean Drinking Water
  - Improved Agriculture
  - Telemedicine and wireless networks
  - Improved Environmental Decision Making
- Use of Green Technologies
  - Aeronautics Technologies
  - Green Buildings
  - Encouraging Green Technologies
  - Solar Power Applications
  - Paint Stripping
  - Global Research into Energy and the Environment at NASA (GREEN)
- Environmental Cleanup
  - Groundwater Remediation
  - Land Mine Cleanup
  - Landfill Cleanup
  - Oil Spill Cleanup

- Disaster Warning and Relief
  - Earthquake relief
  - Tsunami Warning
  - Wildfire Response
  - Hurricane Warning

NASA-derived technologies are saving lives and improving the quality of life across the country and around the globe.

NASA-Derived Technologies Contributing to Security

- Improving Operational Systems
  - Health & Performance Monitoring for Aviation Security
  - Safe Composite Over-wrap Pressure Vessels
  - Fire-Protective Fabrics & Smoke Masks
  - Intumescent Materials
  - Neutralizing Land Mines
  - Secure Networks for First Responders and Military
- Threat Detection
  - Detection/Warning of Chem/Bio Attack
  - Hyperspectral Imaging for Counter-Terrorism
  - Anthrax Smoke Detectors
  - Fiber Optic Chemical Agent Sensing
- Inspection Technologies
  - Crack Detection in Nuclear Power Systems
  - Hyperspectral Imaging for Food Safety
  - Inspection of Suspicious Liquid/Solid Substances
- Identification & Investigation
  - Pattern Recognition for Security Applications
  - Video Enhancement Supporting Criminal Investigations

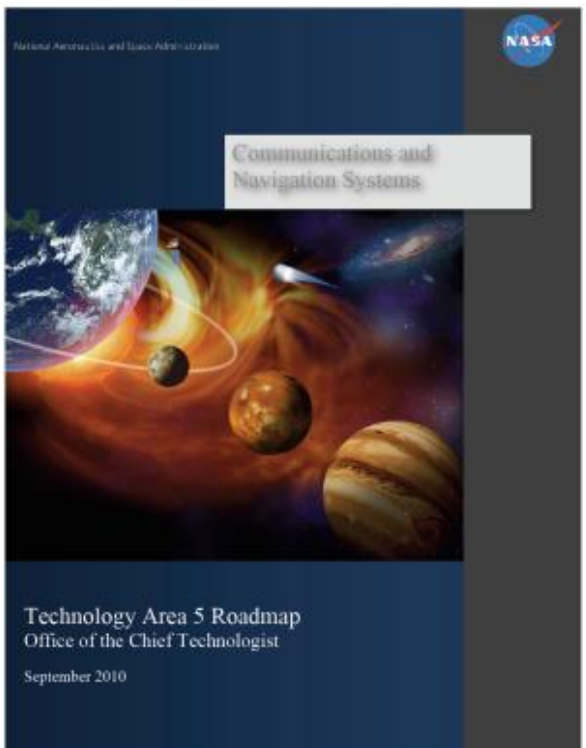
These examples represent how NASA-derived technologies are being put to work and making the world a safer and more secure place.

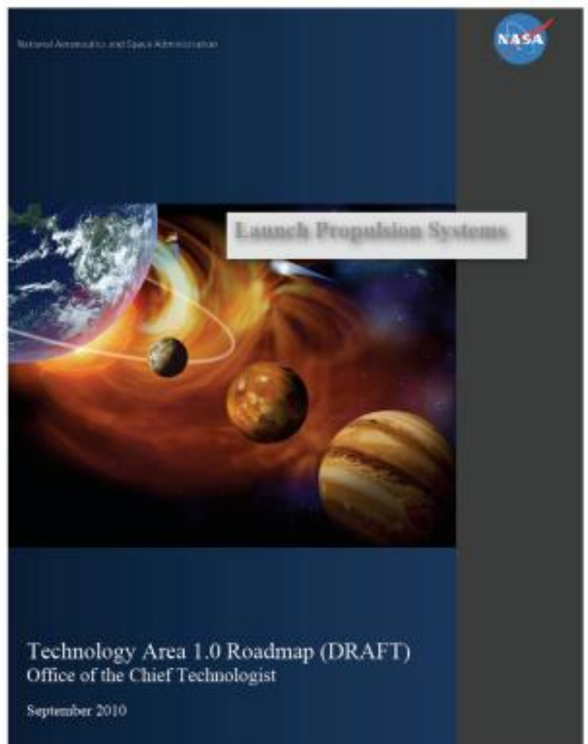
Initial Draft Roadmaps Received, Internal Review Completed, & Publicly Available

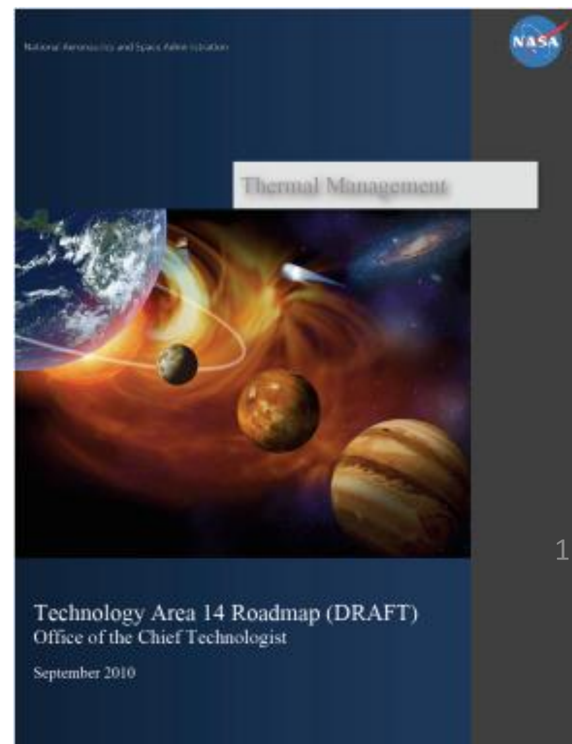
We now have draft 25 page reports in for each of the 14 roadmaps on the OCT website (reviewed by):

- MD POCs and whomever in NASA they ask to help
- Center Chief Technologists and up to 15 others they can ask
- OCT Division Leads and up to 3 others
- OCT SI members, especially the POCs to each roadmap team

http://www.nasa.gov/offices/oct/home/roadmaps/index.html







NASA Technology Areas (TAs)

	A-STAR TAXONOMY
1	LAUNCH PROPULSION SYSTEMS
2	IN-SPACE PROPULSION SYSTEMS
3	SPACE POWER AND ENERGY STORAGE SYSTEMS
4	ROBOTICS, TELE-ROBOTICS, AND AUTONOMOUS SYSTEMS
5	COMMUNICATION AND NAVIGATION SYSTEMS
6	HUMAN HEALTH, LIFE SUPPORT AND HABITATION SYSTEMS
7	HUMAN EXPLORATION DESTINATION SYSTEMS
8	SCIENTIFIC INSTRUMENTS, OBSERVATORIES, AND SENSOR SYSTEMS
9	ENTRY, DESCENT, AND LANDING SYSTEMS
10	NANOTECHNOLOGY
11	MODELING, SIMULATION, INFORMATION TECHNOLOGY AND PROCESSING
12	MATERIALS, STRUCTURAL & MECHANICAL SYSTEMS, AND MANUFACTURING
13	GROUND AND LAUNCH SYSTEMS PROCESSING
14	THERMAL MANAGEMENT SYSTEMS

Technology Area Breakdown Structure

National Aeronautics and Space Administration

TA01 • LAUNCH PROPULSION SYSTEMS

SOLID ROCKET PROPULSION SYSTEMS
- Propellants
- Case Materials
- Nozzle Systems
- Hybrid Rocket Propulsion Systems
- Fundamental Solid Propulsion Technologies

LIQUID ROCKET PROPULSION SYSTEMS
- LH_2/LOX Based
- RP/LOX Based
- CH_4/LOX Based
- Detonation Wave Engines (Closed Cycle)
- Propellants
- Fundamental Liquid Propulsion Technologies

AIR BREATHING PROPULSION SYSTEMS
- TBCC
- RBCC
- Detonation Wave Engines (Open Cycle)
- Turbine Based Jet Engines (Flyback Boosters)
- Ramjet/Scramjet Engines (Accelerators)
- Deeply-cooled Air Cycles
- Air Collection & Enrichment System
- Fundamental Air Breathing Propulsion Technologies

ANCILLARY PROPULSION SYSTEMS
- Auxiliary Control Systems
- Main Propulsion Systems (Excluding Engines)
- Launch Abort Systems
- Thrust Vector Control Systems
- Health Management & Sensors
- Pyro & Separation Systems
- Fundamental Ancillary Propulsion Technologies

UNCONVENTIONAL / OTHER PROPULSION SYSTEMS
- Ground Launch Assist
- Air Launch / Drop Systems
- Space Tether Assist
- Beamed Energy / Energy Addition
- Nuclear
- High Energy Density Materials/Propellants

TA02 • IN-SPACE PROPULSION TECHNOLOGIES

CHEMICAL PROPULSION
- Liquid Storable
- Liquid Cryogenic
- Gels
- Solid
- Hybrid
- Cold Gas/Warm Gas
- Micro-propulsion

NON-CHEMICAL PROPULSION
- Electric Propulsion
- Solar Sail Propulsion
- Thermal Propulsion
- Tether Propulsion

ADVANCED (TRL <3) PROPULSION TECHNOLOGIES
- Beamed Energy Propulsion
- Electric Sail Propulsion
- Fusion Propulsion
- High Energy Density Materials
- Antimatter Propulsion
- Advanced Fission
- Breakthrough Propulsion

SUPPORTING TECHNOLOGIES
- Engine Health Monitoring & Safety
- Propellant Storage & Transfer
- Materials & Manufacturing Technologies
- Heat Rejection
- Power

TA03 • SPACE POWER & ENERGY STORAGE

POWER GENERATION
- Energy Harvesting
- Chemical (Fuel Cells, Heat Engines)
- Solar (Photo-Voltaic & Thermal)
- Radioisotope
- Fission
- Fusion

ENERGY STORAGE
- Batteries
- Flywheels
- Regenerative Fuel Cells

POWER MANAGEMENT & DISTRIBUTION
- FDIR
- Management & Control
- Distribution & Transmission
- Wireless Power Transmission
- Conversion & Regulation

CROSS CUTTING TECHNOLOGY
- Analytical Tools
- Green Energy Impact
- Multi-functional Structures
- Alternative Fuels

TA04 • ROBOTICS, TELE-ROBOTICS & AUTONOMOUS SYSTEMS

SENSING & PERCEPTION
- Stereo Vision
- LIDAR
- Proximity Sensing
- Sensing Non-Geometric Terrain Properties
- Estimating Terrain Mechanical Properties
- Tactile Sensing Arrays
- Gravity Sensors & Celestial Nav.
- Terrain Relative Navigation
- Real-time Self-calibrating of Hand-eye Systems

MOBILITY
- Simultaneous Localiz. & Mapping
- Hazard Detection Algorithms
- Active Illumination
- 3-D Path Planning w/ Uncertainty
- Long-life Extr. Enviro. Mechanisms
- Robotic Jet Backpacks
- Smart Tethers
- Robot Swarms
- Walking in Micro-g

MANIPULATION
- Motion Planning Alg., High DOF
- Sensing & Control
- Robot Arms (light, high strength)
- Dexterous Manipul., Robot Hands
- Sensor Fusion for Grasping
- Grasp Planning Algorithms
- Robotic Drilling Mechanisms
- Multi-arm / Finger Manipulation
- Planning with Uncertainty

HUMAN-SYSTEMS INTEGRATION
- Crew Decision Support Systems
- Immersive Visualization
- Distributed Collaboration
- Multi Agent Coordination
- Haptic Displays
- Displaying Range Data to Humans

AUTONOMY
- Spacecraft Control Systems
- Vehicle Health, Prog/Diag Systems
- Human Life Support Systems
- Planning/Scheduling Resources
- Operations
- Integrated Systems Health Management
- FDIR & Diagnosis
- System Monitoring & Prognosis
- V&V of Complex Adaptive Sys's
- Automated Software Generation
- Software Reliability
- Semi Automatic Systems

AUTON. RENDEZVOUS & DOCKING
- Rendezvous and Capture
- Low impact & Androgenous Docking Systems & Interfaces
- Relative Navigation Sensors
- Robust AR&D GN&C Algorithms & FSW
- Onboard Mission Manager
- AR&D Integration & Standardiz.n

RTA SYSTEMS ENGINEERING
- Human safety
- Refueling Interfaces & Assoc. Tools
- Modular / Serviceable Interfaces
- High Perf., Low Power Onboard Computers
- Environment Tolerance
- Thermal Control
- Robot-to-Suit Interfaces
- Common Human-Robot Interfaces
- Crew Self Sufficiency

TA05 • COMMUNICATION & NAVIGATION

OPTICAL COMM. & NAVIGATION
- Detector Development
- Large Apertures
- Lasers
- Acquisition & Tracking
- Atmospheric Mitigation

RADIO FREQUENCY COMMUNICATIONS
- Spectrum Efficient Technologies
- Power Efficient Technologies
- Propagation
- Flight & Ground Systems
- Earth Launch & Reentry Comm.
- Antennas

INTERNETWORKING
- Disruptive Tolerant Networking
- Adaptive Network Topology
- Information Assurance
- Integrated Network Management

POSITION, NAVIGATION, AND TIMING
- Timekeeping
- Time Distribution
- Onboard Auto Navigation & Maneuver
- Sensors & Vision Processing Systems
- Relative & Proximity Navigation
- Auto Precision Formation Flying
- Auto Approach & Landing

INTEGRATED TECHNOLOGIES
- Radio Systems
- Ultra Wideband
- Cognitive Networks
- Science from the Comm. System
- Hybrid Optical Comm. & Nav. Sensors
- RF/Optical Hybrid Technology

REVOLUTIONARY CONCEPTS
- X-Ray Navigation
- X-Ray Communications
- Neutrino-Based Navigation & Tracking
- Quantum Key Distribution
- Quantum Communications
- SQIF Microwave Amplifier
- Reconfigurable Large Apertures

TA06 • HUMAN HEALTH, LIFE SUPPORT & HABITATION SYSTEMS

ENVIRONMENTAL CONTROL & LIFE SUPPORT SYSTEMS & HABITATION SYS.
- Air Revitalization
- Water Recovery & Management
- Waste Management
- Habitation

EXTRAVEHICULAR ACTIVITY SYSTEMS
- Pressure Garment
- Portable Life Support System
- Power, Avionics and Software

HUMAN HEALTH & PERFORMANCE
- Medical Diagnosis / Prognosis
- Long-Duration Health
- Behavioral Health & Performance
- Human Factors & Performance

ENVIRONMENTAL MONITORING, SAFETY & EMERGENCY RESPONSE
- Sensors: Air, Water, Microbial, etc.
- Fire: Detection, Suppression
- Protective Clothing / Breathing
- Remediation

RADIATION
- Risk Assessment Modeling
- Radiation Mitigation
- Protection Systems
- Space Weather Prediction
- Monitoring Technology

TA07 • HUMAN EXPLORATION DESTINATION SYSTEMS

IN-SITU RESOURCE UTILIZATION
- Destination Reconnaissance, Prospecting, & Mapping
- Resource Acquisition
- Consumables Production
- Manufacturing & Infrastructure Emplacement

SUSTAINABILITY & SUPPORTABILITY
- Logistics Systems
- Maintenance Systems
- Repair Systems

"ADVANCED" HUMAN MOBILITY SYSTEMS
- EVA Mobility
- Surface Mobility
- Off-Surface Mobility

"ADVANCED" HABITAT SYSTEMS
- Integrated Habitat Systems
- Habitat Evolution

MISSION OPERATIONS & SAFETY
- Crew Training
- Environmental Protection
- Remote Mission Operations
- Planetary Safety

CROSS-CUTTING SYSTEMS
- Modeling, Simulations & Destination Characterization
- Construction & Assembly
- Dust Prevention & Mitigation

TA08 • SCIENCE INSTRUMENTS, OBSERVATORIES & SENSOR SYSTEMS

REMOTE SENSING INSTRUMENTS / SENSORS
- Detectors & Focal Planes
- Electronics
- Optical Components
- Microwave / Radio
- Lasers
- Cryogenic / Thermal

OBSERVATORIES
- Mirror Systems
- Structures & Antennas
- Distributed Aperture

IN-SITU INSTRUMENTS / SENSOR
- Particles: Charged & Neutral
- Fields & Waves
- In-Situ

TA09 • ENTRY, DESCENT & LANDING SYSTEMS

AEROASSIST & ATMOSPHERIC ENTRY
- Rigid Thermal Protection Systems
- Flexible Thermal Protection Systems
- Rigid Hypersonic Decelerators
- Deployable Hypersonic Decelerators
- Instrumentation & Health Monitoring
- Entry Modeling & Simulation

DESCENT
- Attached Deployable Decelerators
- Trailing Deployable Decelerators
- Supersonic Retropropulsion
- GN&C Sensors
- Descent Modeling & Simulation

LANDING
- Touchdown Systems
- Egress & Deployment Systems
- Propulsion Systems
- Large Body GN&C
- Small Body Systems
- Landing Modeling & Simulation

VEHICLE SYSTEMS TECHNOLOGY
- Architecture Analyses
- Separation Systems
- System Integration & Analyses
- Atmosphere & Surface Characterization

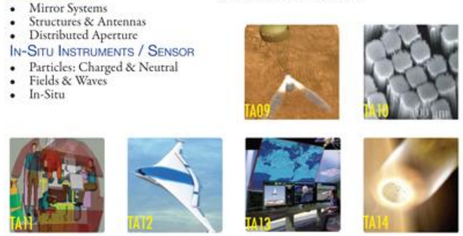
TA10 • NANOTECHNOLOGY

ENGINEERED MATERIALS & STRUCTURES
- Lightweight Structures
- Damage Tolerant Systems
- Coatings
- Adhesives
- Thermal Protection & Control

ENERGY GENERATION & STORAGE
- Energy Storage
- Energy Generation

PROPULSION
- Propellants
- Propulsion Components
- In-Space Propulsion

SENSORS, ELECTRONICS & DEVICES
- Sensors & Actuators
- Nanoelectronics
- Miniature Instruments



TA11 • MODELING, SIMULATION, INFORMATION TECHNOLOGY & PROCESSING

COMPUTING
- Flight Computing
- Ground Computing

MODELING
- Software Modeling & Model-Checking
- Integrated Hardware & Software Modeling
- Human-System Performance Modeling
- Science & Engineering Modeling
- Frameworks, Languages, Tools & Standards

SIMULATION
- Distributed Simulation
- Integrated System Lifecycle Simulation
- Simulation-Based Systems Engineering
- Simulation-Based Training & Decision Support Systems

INFORMATION PROCESSING
- Science, Engineering & Mission Data Lifecycle
- Intelligent Data Understanding
- Semantic Technologies
- Collaborative Science & Engineering
- Advanced Mission Systems

TA12 • MATERIALS, STRUCTURES, MECHANICAL SYSTEMS & MANUFACTURING

MATERIALS
- Lightweight Structure
- Computational Design
- Flexible Material Systems
- Environment
- Special Materials

STRUCTURES
- Lightweight Concepts
- Design & Certification Methods
- Reliability & Sustainment
- Test Tools & Methods
- Innovative, Multifunctional Concepts

MECHANICAL SYSTEMS
- Deployables, Docking and Interfaces
- Mechanism Life Extension Systems
- Electro-mechanical, Mechanical & Micromechanisms
- Design & Analysis Tools and Methods
- Reliability / Life Assessment / Health Monitoring
- Certification Methods

MANUFACTURING
- Manufacturing Processes
- Intelligent Integrated Manufacturing and Cyber Physical Systems
- Electronics & Optics Manufacturing Process
- Sustainable Manufacturing

CROSS-CUTTING
- Nondestructive Evaluation & Sensors
- Model-Based Certification & Sustainment Methods
- Loads and Environments

TA13 • GROUND & LAUNCH SYSTEMS PROCESSING

TECHNOLOGIES TO OPTIMIZE THE OPERATIONAL LIFE-CYCLE
- Storage, Distribution & Conservation of Fluids
- Automated Alignment, Coupling, & Assembly Systems
- Autonomous Command & Control for Ground and Integrated Vehicle/Ground Systems

ENVIRONMENTAL AND GREEN TECHNOLOGIES
- Corrosion Prevention, Detection, & Mitigation
- Environmental Remediation & Site Restoration
- Preservation of Natural Ecosystems
- Alternate Energy Prototypes

TECHNOLOGIES TO INCREASE RELIABILITY AND MISSION AVAILABILITY
- Advanced Launch Technologies
- Environment-Hardened Materials and Structures
- Inspection, Anomaly Detection & Identification
- Fault Isolation and Diagnostics
- Prognostics Technologies
- Repair, Mitigation, and Recovery Technologies
- Communications, Networking, Timing & Telemetry

TECHNOLOGIES TO IMPROVE MISSION SAFETY/MISSION RISK
- Range Tracking, Surveillance & Flight Safety Technologies
- Landing & Recovery Systems & Components
- Weather Prediction and Mitigation
- Robotics / Telerobotics
- Safety Systems

TA14 • THERMAL MANAGEMENT SYSTEMS

CRYOGENIC SYSTEMS
- Passive Thermal Control
- Active Thermal Control
- Integration & Modeling

THERMAL CONTROL SYSTEMS
- Heat Acquisition
- Heat Transfer
- Heat Rejection & Energy Storage

THERMAL PROTECTION SYSTEMS
- Entry / Ascent TPS
- Plume Shielding (Convective & Radiative)
- Sensor Systems & Measurement Technologies

Space Technology Roadmaps **STR • TABS**

TECHNOLOGY AREA BREAKDOWN STRUCTURE

Some PERSONAL observations

- Visited synthetic biology seminar at Ames
- Synbio as an addition to 14 areas?
- The dangers of making tech so “special” it disappears into a directorate…
- The Nanoracks story
- Technology and IMPLEMENTATION

T& I Observations, Findings and Recommendations

- Observation: Both LaRC and KSC have significant and important technology and innovation work underway. The Committee was particularly impressed with the Multifunctional Electrospun fibers, the Electron Beam Free-form Fabrication, the Boron Nitrite Nanotubes and plans for Airborne Wind Capture at LaRC. The Committee was impressed with the Cryogenics laboratory and research, the smart coating research for Corrosion and Detection and Protection, Dust Mitigation Technologies, and the “smart wiring” research and technologies at Kennedy Space Center. Many of these technologies have various immediate or potential commercial applications. The Committee encourages the continuation of this grass-roots innovation and research at all NASA Centers. The Committee believes the adoption of Center Chief Technologists at all of the NASA Field Centers encourages innovation by the NASA Civil Servant workforce.

- Observation: During the Committee’s visit to both LaRC and KSC, there seemed to be issues with technologists being isolated and not sharing or even seeking knowledge beyond their own organization or Center. Additionally, in some cases researchers need to be encouraged to be less risk-averse – especially in the technology development and commercialization arena. More discussion needs to happen throughout the Agency about managed risk and pushing the risk envelope in innovation and technology development – and making the distinction between risk that one can learn from and risk that endangers lives. NASA should consider changes to the reward system to encourage researchers to take informed risks.

T& I Observations, Findings and Recommendations

- Observation: NASA should consider reviewing its approach towards intellectual property protection and administration. A more active approach could assist in reinforcing the Agency's reputation as a technology hub, validate the efforts of leading NASA technologists, safeguard the public investment into NASA technology developments, and provide a more direct link between specific NASA technology and how it benefits humankind.

- Finding: NASA needs to address knowledge management in the area of innovation, research and technology development. Many NASA researchers are not familiar with research and innovation taking place within and outside of their discipline, Center or Agency. An important aspect of in developing cutting-edge technology and innovation is knowledge and ability to share information across a wide spectrum of potentially interested parties. OCT's Strategic Integration and PICS offices are beginning to address this difficult problem. We applaud their initial portfolio capture and management efforts, but believe a more centralized effort that develops processes for a flexible, unified knowledge database on NASA's technologies for users within and outside of the Agency. This database should support an annual technology review for validity that shows growth and decline.

T& I Observations, Findings and Recommendations

- Finding: The Committee also discussed the underutilization of NASA and commercial ELVs and RLVs launch capacities for secondary flight payloads for technology validation and demonstrations. The Committee believes that NASA should encourage missions with additional payload capacity to make it available for research. Secondary payloads are vital for testing and proving many technology capabilities, especially in times of constrained budgets and resources.

NASA ADVISORY COUNCIL
Council Recommendation
Tracking Number: (TBD)

- **Committee Name:**
- Technology and Innovation Committee
- **Committee Chair:**
- Esther Dyson
  Date of Public Deliberation:
- January 11-12, 2011 at KSC

Short Title of the Proposed Recommendation: Use of Secondary Payloads for Technology Demos

Proposed Recommendation:

- The Committee recommends that the NASA Administrator encourage the use of secondary payloads on future NASA and commercial missions as an important capability for testing, validating and demonstrating new technologies and scientific payloads in the coming years.

Major Reasons for Proposing the Recommendation:

- The Committee discussed the underutilization of NASA and commercial ELVs and RLVs launch capacities for secondary flight payloads for technology validation and demonstrations. The Committee believes that NASA should encourage missions with additional payload capacity to make it available for research. Secondary payloads are vital for testing and proving many technology capabilities, especially in times of constrained budgets and resources.

- **Consequences of No Action on the Proposed Recommendation:**
- Missed opportunity to utilize an underused resource for technology demonstrations. Many transformative technologies that could be validated as a secondary payload would remain at a lower TRL level and may not advance for use on later NASA missions.