1. Overview & Purpose

The Federal Aviation Administration's Office of Commercial Space Transportation has established a Center of Excellence in order to identify solutions for existing and anticipated commercial space transportation problems. This COE is a cost sharing partnership of academia, industry, and government that focuses on research areas of primary interest to the FAA and the U.S. commercial space transportation industry as a whole.

To facilitate research planning, a workshop was held at Stanford University on April 6-7, 2011. The goal was to work towards obtaining a set of research priorities for the COE. To accomplish this, approximately 55 representatives of industry, academia, and government (FAA, NASA, DoD) gathered to discuss the issues involved and come to a consensus on the COE's research priorities. The research areas are shown below in Figure 1.

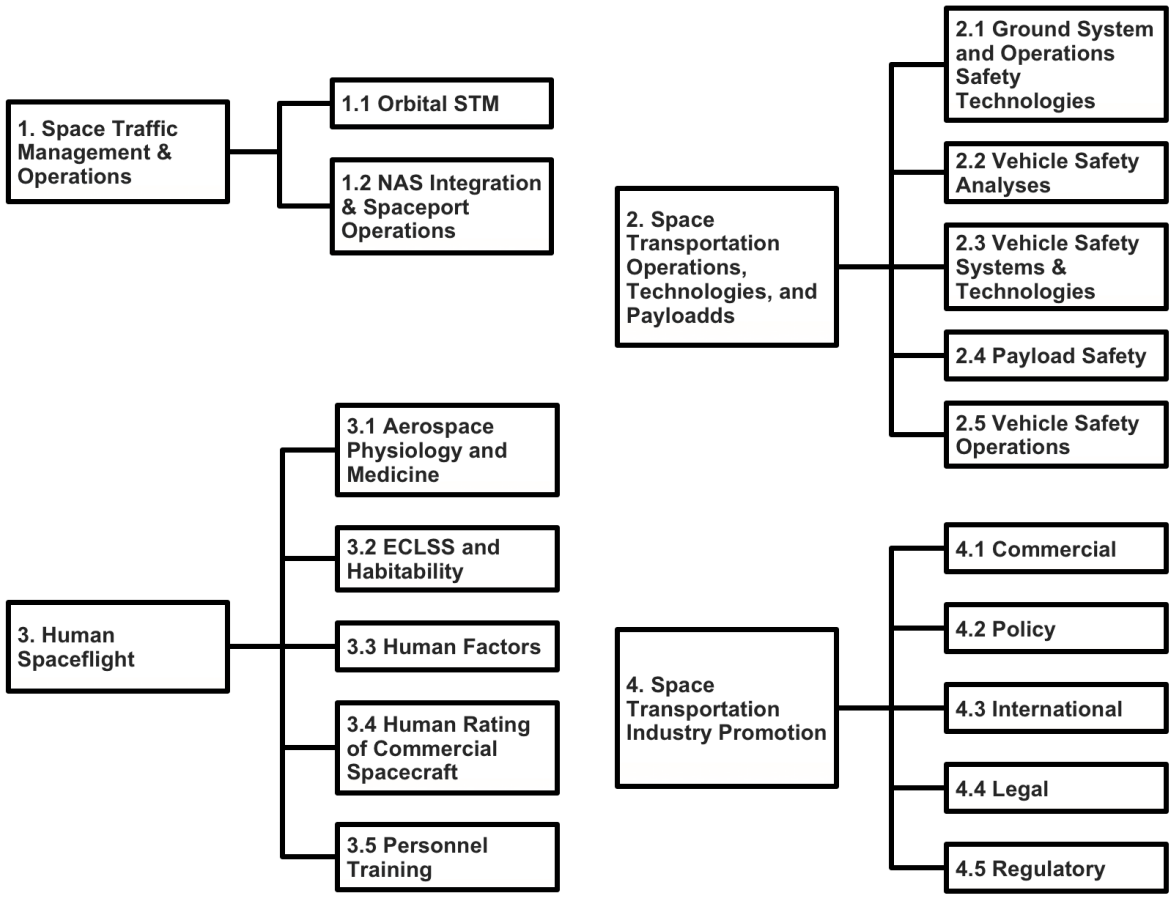

Figure 1: Research Area Breakdown Structure

2. What Happened

The workshop began with a series of overview presentations. These outlined the landscape and identified some notable issues within each of the COE research areas. Theme 1 was covered by Kelvin Coleman of the FAA, theme 2 by Dan Rasky of NASA Ames, theme 3 by Jon Clark of Baylor College of Medicine, and theme 4 by Ken Davidian of the FAA. In addition, Gen. Jay Santee provided an overview of the Department of Defense's perspective. John Logsdon provided a discussion of international issues. The workshop participants then divided into four groups representing each research theme, and were each tasked with:

- Finding a organizational principle or mission statement
- Correcting (if needed) the structure of the theme as defined by the FAA
- Documenting the main research sub-areas
- Identifying important next steps
- If possible, prioritizing research topics

These groups spent 8 hours discussing these issues and then presented their results to the larger group. An agenda is available on the website.

3. Results of Breakout Sessions

The results were presented to the entire group, and their presentation slides are available on the website. The organizing principles and priority research topics are summarized below.

3.1. **Theme 1: Space Traffic Management & Operations**

The orbital Space Traffic Management (STM) task will focus on facilitating commercial utilization of orbital space resources, free from physical interference, by implementing technical and regulatory provisions. The National Airspace System (NAS) integration and spaceport operations task will focus on integrating commercial space vehicle and spaceport operations into the NAS by providing equitable sharing of NAS resources for both air and space traffic.

Important research tasks for this theme include:

- Identify determinants for orbital STM services and their economic, regulatory, and legal aspects
- Develop technical/regulatory provisions to prevent collisions
- Design space transition corridors for safe and efficient separation of aircraft and commercial spacecraft within the NAS
- Develop a framework for safe and efficient spaceport operations

3.2. Theme 2: Space Transportation Operations, Technologies, and Payloads

The mission statement for theme 2 is: “Intent is to perform research to significantly improve reliability/safety/risk posture and availability for stakeholders in full mission cycle vehicle operations and ground operations while ensuring that proper business case closes (and no negative interactions with rest of participants).”

More specifically, the research has three primary goals. These are:

1) Inform FAA licensing/certification decisions
2) Provide the FAA with the right questions to ask
3) Suggest guidelines for best practices to be shared with entire segments of the industry

There was extensive discussion in this group as to what should and should not be placed within this research area. In addition, some sectors of the industry weren’t able to attend the workshop and it was felt that their input would have a significant effect on the final results. Given the broad nature of this topic, many possible research topics were generated with the intent that a much wider group could vote on prioritization.

A sample of some of the research topics:

- Determination of roles & responsibilities in regards to ground operations
- Standard frameworks for safety analysis that can lead to licensing decisions
- Environmental operating limits (wind, weather, radiation, etc.)
- Life cycle prediction of TPS, structures, etc.
- Guidelines for safety equipment
- Extent of payload characteristics that need to be revealed to ensure operational safety
- Abort procedures
- Re-certification
- Safety-reporting systems

3.3. Theme 3: Human Spaceflight

The goal for theme 3 is to optimize the human and spacecraft systems for performance, safety, and access for commercial human spaceflight. The most important result from this group’s discussion is that the FAA and NASA need to work hand in hand. NASA’s unique and extensive experience and data regarding human spaceflight would be monumental in facilitating progress in this area.

A sample of priority research items:

- Develop methods and procedures to collect and analyze biomedical data and a database to track medical outcomes.
- Develop standards for pilot fatigue, G limits, medical acceptance/waiver criteria, training, and ECLSS.
- Develop a risk analysis report on medical incapacitations and situations that might occur in RLV flight crew and space flight participants.

- Provide input for an informed consent briefing for spacecraft and mission specific profiles.
- Compile Human Rating and Spacecraft Lessons Learned Database, with focus on close calls and mishaps and recent work (ie Orion capsule).
- Conduct research to help the FAA support crash worthy structures and personal protective equipment, and optimize the human survival envelope.

3.4. Theme 4: Space Transportation Industry Promotion

Theme 4 has the following purpose and goals statements:
1) The purpose of the Industry Promotion research area support effective policy decision-making and reflect the dual regulatory and promotional missions of the FAA Office of Commercial Space Transportation.
2) Research addressing regulation is designed to maximize regulatory cost-effectiveness; research concerning promotion aims to maximize industry growth.

Priority research was identified:
- CST demand market research
- Retrospective analyses of:
    - Transition from government to private customers
    - Commercial failures
- CST industry assessment and evaluation by industrial organization economists
- Options for a single international space regulatory regime
- Liability limitation: history, issues, and options
- Barrier analysis of existing regulations

4. Next Steps

Now that we have preliminary results from this group of representatives of industry, academia, and government, our subsequent goal is to host a second workshop in the DC area in mid August. This will allow us to gain broader participation and get input from groups that were unable to attend the workshop at Stanford. At the workshop we will get valuable feedback on these results and work towards getting a true consensus from all who are interested in commercial space transportation.

Between now and then, we will support market studies on commercial space transportation that will help guide the discussions on the future of this industry. In addition, we will work to develop a clear structure and approach to prioritizing research topics.