

# Space Shuttle Strategic Planning Status

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*By Gordon L. Norbraten, NASA  
NASA Johnson Space Center, TX*

*By Edward M. Henderson, NASA  
NASA Johnson Space Center, TX*

### **Abstract**

The Space Shuttle Program is aggressively flying the Space Shuttle manifest for assembling the International Space Station and servicing the Hubble Space Telescope. Completing this flight manifest while concurrently transitioning to the Exploration architecture creates formidable challenges; the most notable of which is retaining critical skills within the Shuttle Program workforce. The Program must define a strategy that will allow safe and efficient fly-out of the Shuttle, while smoothly transitioning Shuttle assets (both human and facility) to support early flight demonstrations required in the development of NASA's Crew Exploration Vehicle (Orion) and Crew and Cargo Launch Vehicles (Ares I). The Program must accomplish all of this while maintaining the current level of resources. Therefore, it will be necessary to initiate major changes in operations and contracting. Overcoming these challenges will be essential for NASA to fly the Shuttle safely, accomplish the "Vision for Space Exploration," and ultimately meet the national goal of maintaining a robust space program. This paper will address the Space Shuttle Program's strategy and its current status in meeting these challenges.

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## **I. Summary**

This paper provides a current status of the strategic and tactical planning in place to fly the remaining Space Shuttle flights and ultimately retire the Program. Though the Space Shuttle Program is scheduled to come to an end in 2010, it would be a grave misperception to conclude that the demands placed on the Program have lessened. The Space Shuttle Program will complete the assembly of the International Space Station (ISS), giving it the capability to support a crew of six and significant increases in level of research. Shuttle will also perform repairs to the Hubble Space Telescope (HST), thus extending its ability to continue astronomical discovery for years. Between now and program retirement, a mere three years away, Shuttle will fly more missions than were flown during the entire Apollo Program. Executing the transition and retirement (T & R) of the Space Shuttle Program while remaining operational without compromising flight safety adds a new layer of complexity to an already healthy challenge.

NASA's projected budget is basically flat. Supporting three human space flight programs (Shuttle, Station and Constellation) within it requires some very innovative planning including retiring unneeded Shuttle assets as soon as possible, thus reducing Shuttle costs while freeing up assets needed for Constellation Program (CxP). This activity has already started and will accelerate over the next few years. As a result, some Shuttle contracts to vendors and suppliers have or soon will be terminated. Often these decisions are irreversible without significant cost to recover the capability should it be needed later.

Systems requirements for CxP are in formulation and many design contracts have not yet been selected. So, their needs for Shuttle assets are currently uncertain. This, along with the general requirement for CxP to significantly reduce operating costs, has resulted in the transfer of fewer Shuttle assets to CxP than was originally planned. Therefore, most Shuttle assets will be released and/or archived. This has led to a disconnect between the skill sets required by SSP and those required by CxP; thereby introducing significant risk to the Shuttle Program's ability to retain critical skills as many in the workforce have transitioned to support the new program, Constellation.

## II. Space Shuttle Program Status

The Space Shuttle, International Space Station and Constellation human space flight programs have a considerable role in meeting America's fundamental goal for Space Exploration, namely "to advance U. S. scientific, security, and economic interests". NASA's exploration road map (fig.1) shows the relationship between flying out the Shuttle, assembling and supporting the ISS, returning humans to the Moon, and developing the capability to go to Mars and beyond. The key to meeting these goals is NASA's ability to bridge the gap from the Shuttle Program to Constellation without a significant negative impact to the U.S. Space Leadership role.

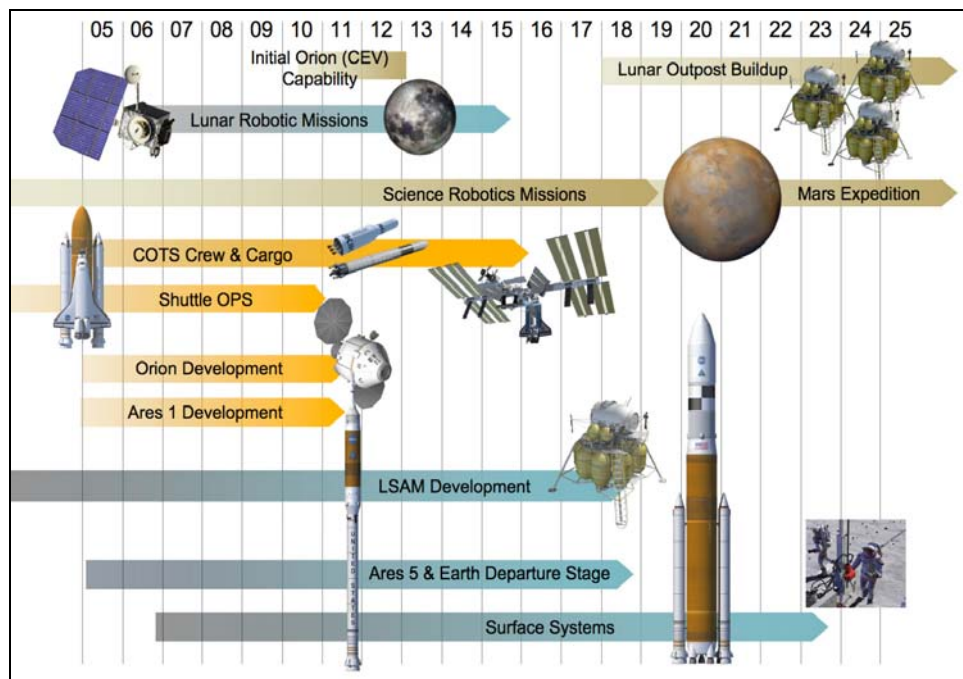


Figure 1. NASA's Exploration Roadmap

Once the Space Shuttle Program's aggressive manifest (fig.2) to assemble the International Space Station and repair the Hubble Space Telescope is complete, the SSP will have fulfilled its primary role in implementing the *Vision for Space Exploration* (VSE) and can then be retired. This will clear the path for building a new generation of spacecraft that will take humans back to the Moon and beyond.

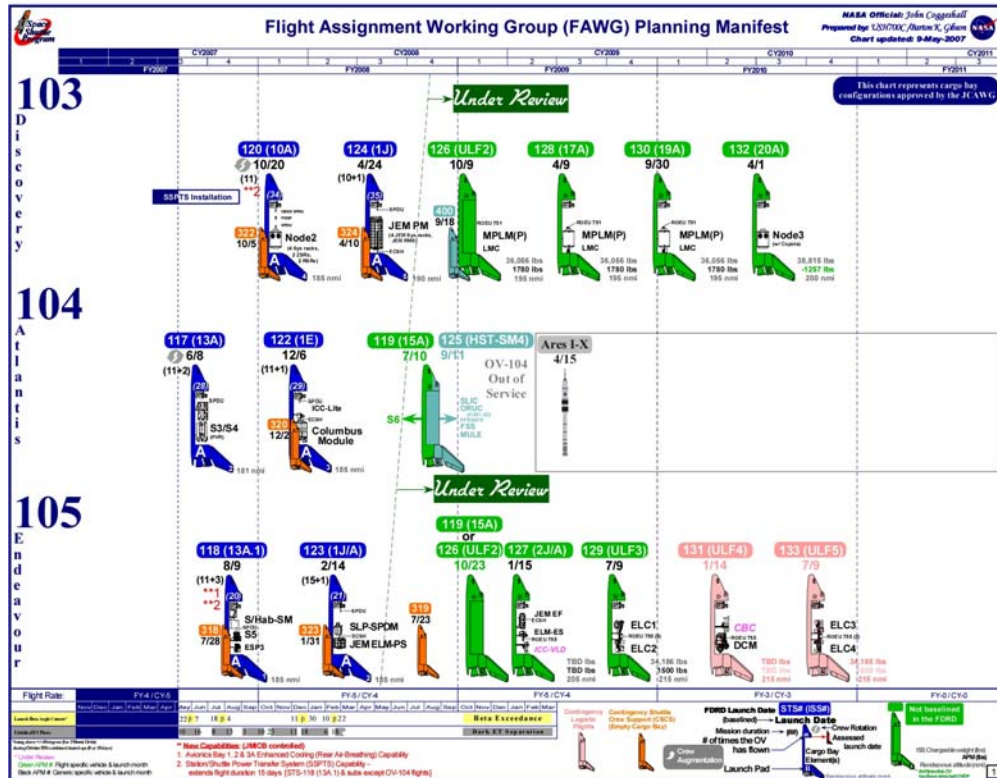


Figure 2. Flight Assignment Working Group (FAWG) Manifest

Note that although the flight manifest extends through 2010, the first Shuttle Orbiter (Atlantis, OV-104) is scheduled to be retired in 2008. It will be preserved as a “donor” vehicle and will be used as a source of spare parts for the remaining flights of Discovery (OV-103) and Endeavour (OV-105).

There is at least one potential threat to NASA’s ability to retire the Space Shuttle Program at the end of 2010. Unplanned launch delays that cause an unforeseen slip in the entire manifest would result in an Agency decision to either continue flights post 2010 to satisfactorily complete ISS assembly or to stand fast to the 2010 deadline and leave the Station unfinished. However, there are currently no contingency plans to fly or support Shuttle flights after 2010 for this or any other unknown threats. Therefore, there will be no U.S. human spaceflight capability after 2010 until the new Constellation vehicles, Ares I and Orion, are available.

A multi-program integrated manifest (fig. 3) shows the remaining Shuttle flights, candidate logistics flights to support the ISS, and the planned Constellation test and crewed flights During “the gap”, the period between SSP operations and CxP operations, ISS crew rotation and logistical support will be provided internationally. COTS may be able to supplement these needs should they be ready in time.

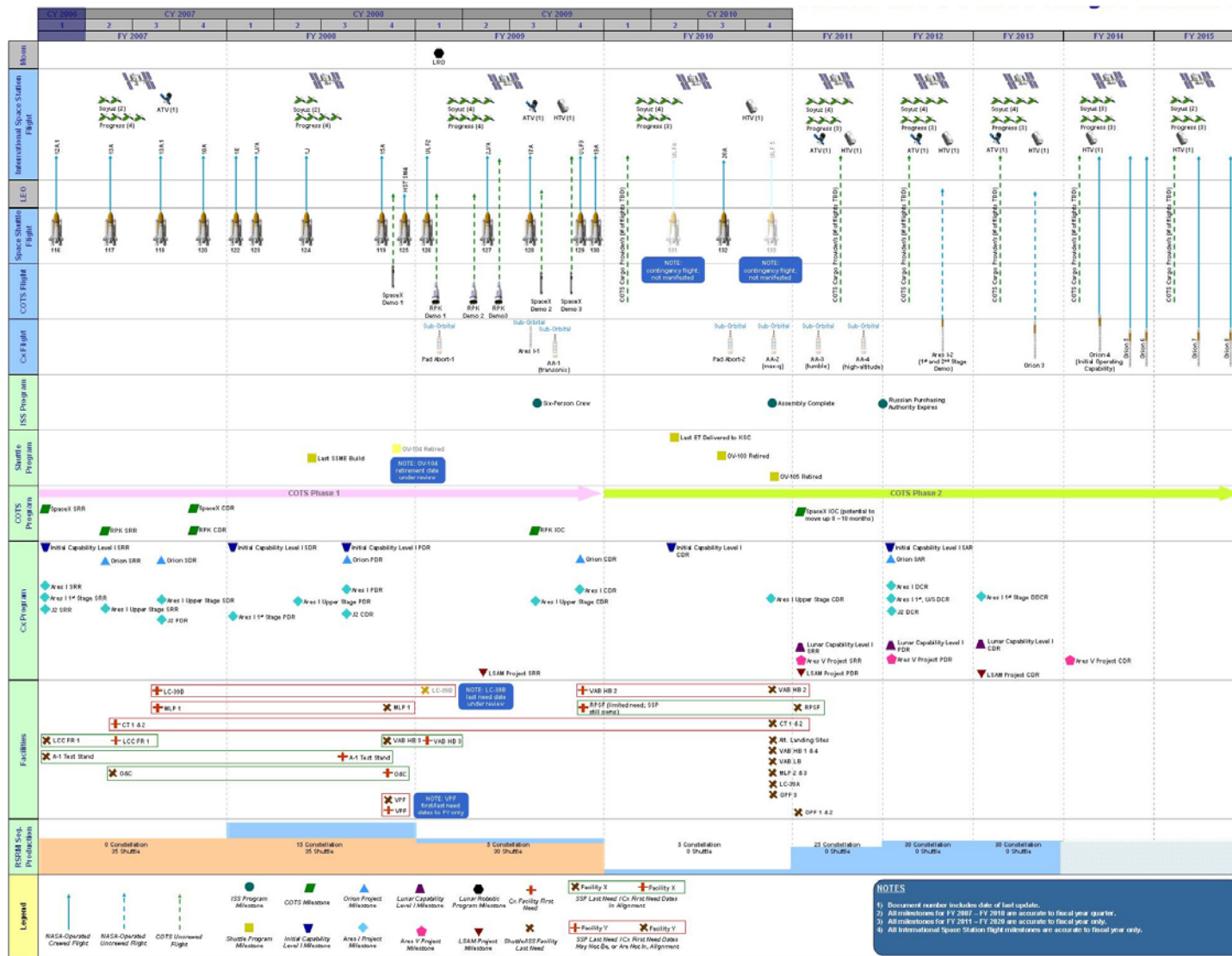


Figure 3. Multi-Program Integrated Milestones (FY 2008 President's Budget)

### **III. Transition and Retirement (T & R)**

As previously noted, the VSE and the current Shuttle manifest indicate that the final flight of the Space Shuttle is approximately three years away. Efforts have been in place at NASA Headquarters and within the Space Shuttle Program over the last two years to assure that the retirement of the program can be effected without undue risk to either the remaining shuttle flights or the viability of future agency programs and projects.

The terms transition and retirement have been used interchangeably, but the following distinctions should be made. "Transition" has been a favored term based on the notion that a significant percentage of the Space Shuttle flight hardware, facilities, capabilities, and personnel will provide the foundation for future agency programs and projects. "Retirement" is a more technically correct term when applied to the Space Shuttle Program as a whole, since the program officially is scheduled to end shortly after the final shuttle flight in 2010.

#### **a. The Transition Management Approach**

Following the announcement of the VSE, the Space Shuttle Program initiated a benchmarking review of similar scale program cancellations in the aerospace and defense industries. Of particular interest were the management approaches to assure the integrity of ongoing operations following the announcement of a fixed retirement date. While many enterprises established separate management structures to direct the operational program and the retirement effort, NASA chose to leave both responsibilities under the direction of the Space Shuttle Program Manager. The principal rationale was that the overriding concern for flight safety and mission success would potentially be compromised by a separate management team making independent decisions about program assets, capabilities, vendors, and staffing.

Currently, the day-to-day T&R responsibility within the Space Shuttle Program is vested in a "Transition Manager", who is one of three deputies to the Space Shuttle Program Manager. A virtual transition leadership team has been established that includes representatives from the Shuttle interests at the four human space flight centers, as well as experts in resource management and procurement strategy. There are three groups that provide direct support to this leadership team. First, a support staff drawn mainly from the Space Shuttle Strategic Planning Office provides a project management framework for transition, including documentation, schedules, risk management systems, and metrics. Second, a group of crosscutting function managers addresses program-wide requirements in areas such as human capital planning, workforce communications, records management, environmental planning, real property disposition, and personal property disposition. Finally, each Space Shuttle Project element and support organization provides an individual dedicated to transition planning and execution.

In addition to the transition management structure within the Program described above, transition managers have been appointed in both the Space

Operations Mission Directorate (SOMD) and the Exploration Systems Mission Directorate (ESMD) at NASA Headquarters.

## **b. Transition Strategic Planning**

The strategic aspect of transition planning involves the long range look at Space Shuttle capabilities, their potential applicability to future agency programs, and the budgetary requirements that arise because of retirement.

The review of long term capability needs is provided by a Strategic Capabilities Assessment (SCA) data base. This data base has partitioned the complete Shuttle Program into approximately 300 distinct capabilities.<sup>ii</sup> For each capability, an assessment of the assets and skills is provided, along with the estimated last need date based on the projected shuttle manifest. While a majority of these capabilities are required until the end of the program, many capabilities associated with flight hardware production are already at or beyond their last need dates. For example, procurement of the raw materials required to produce external tanks has basically ended, and the production lines for major main engine components are scheduled to be shut down by the end of 2007.

An assessment of the Space Shuttle capabilities is currently ongoing in the Constellation Program to determine which of these can directly or indirectly support their objectives. Solid Rocket Booster capabilities obviously provide direct benefit because the Ares I configuration utilizes a single booster rocket as its primary source of lift capability. Other capabilities may provide indirect support, because the useful part of the capability is not the flight hardware itself, but possibly the test facilities, subsystems and components, or the engineering expertise associated with that capability.

The budgeting part of the strategic planning for transition involves utilizing benchmarking, predictive models, and bottoms up analysis to estimate the unique costs that are occasioned by the retirement of the Space Shuttle.

## **c. The Transition Tactical Decision Process**

As each Shuttle capability approaches its last need date, a process has been established to thoroughly review the implications of terminating or transferring that capability before final decisions are made. The review package is referred to as the "smart" document, actually an acronym that stands for Space Shuttle Management Resource Transition Document. Included in the review is information about the capability, the expected disposition, the costs of disposition, the risk to the ongoing operational program, and the costs to recover the capability if the strategic objectives of the agency change at a future date.

A formal board structure exists (*fig.4*) to review these decision packages at all levels. At the program level, the Transition Program Requirements Control Board or TPRCB performs a technical, budget, and risk review before confirming the recommendation to terminate or transfer the capability. This board is chaired by the Shuttle Program Transition Manager. At the agency level, a Transition



Control Board further assesses the impacts of the more important recommendations forwarded by the shuttle program. This board is chaired by the two agency level directors responsible for space operations and exploration systems, with representation from several other critical agency offices.

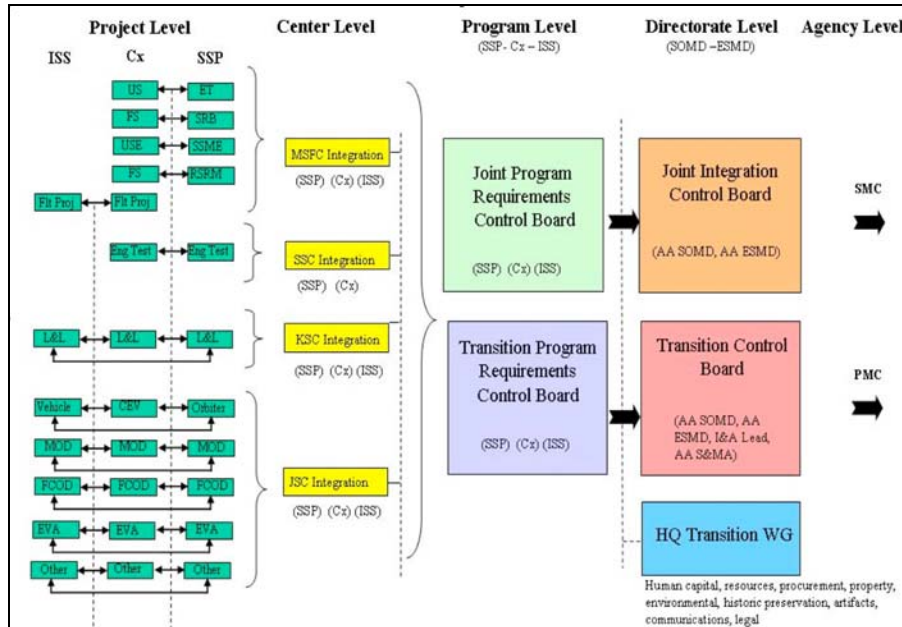


Figure 4. ESMD/SOMD Transition Board Overview

#### d. Transition Activity in 2007

This year, 2007, appears to be a critical year for the planned retirement of the Space Shuttle Program. Some of the key transitions manufacturing decision dates are shown on figure 5. A small but significant set of capability decisions are being made that lead some to declare 2007 “the year of no return” on the decision to complete Shuttle activities by the end of September 2010, meaning that the ability to continue flying the Shuttle beyond 2010 would either be lost or at the best, extremely cost prohibitive. Contracts for the procurement of the raw materials used to produce the External Tanks have already been terminated, and the floor space at the start of the tank production lines is being assessed for the use of future programs. An increasing number of vendors that supply Orbiter subsystems and components have seen their final orders for parts. More significantly, production lines for Space Shuttle Main Engine turbopumps, powerheads, and main combustion chambers will be shut down by the end of the year. Finally, one of two main engine test stands at the Stennis Space Center in Mississippi has already been deeded over to the Constellation Program for testing of the J2X engine.



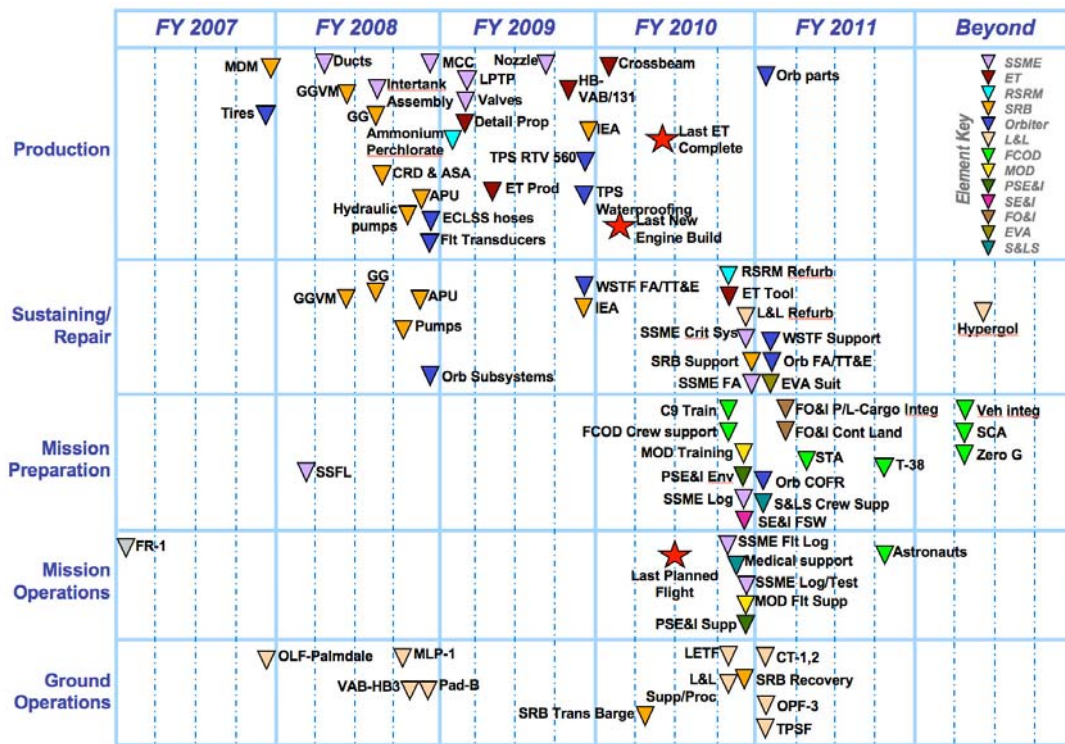


Figure 5. Shuttle Transition Strategic Capabilities Last Need Milestones

### e. Assessing Transition Risk

The announcement of Space Shuttle retirement introduces two general categories of risk. The first addresses the unique risks to the remaining operational program; the second addresses longer term threats to the agency resulting from the rapid termination of a program that involves a significant percentage of NASA's physical assets and workforce.

Risks to the remaining operational program include the retention of critical skills, the viability of the supply chain, and the maintenance of the physical assets required to launch safely and effectively. The critical skill retention issue is most significant, because an incentive has been created for each individual to look at career opportunities outside of the Space Shuttle Program that may have longer term security or better opportunities for advancement. Similarly, suppliers are incentivized to review their business plans, and to possibly opt out of current or future NASA work.

Shuttle retirement also introduces risks and cost threats that do not directly affect ongoing operations. The primary threat is whether the agency can effectively close down the Space Shuttle Program without sizable budgets that would stymie the development of future programs and projects. Another question is whether the existing property management organizations within NASA can handle the upcoming tidal wave of property disposition decisions.

## f. Measuring Transition Effectiveness

The transition and retirement effort, like any other sizable NASA project, has established measures of effectiveness that are reported on a quarterly basis to the agency level Transition Control Board. Among the categories of metrics presented (*fig. 6*) are costs, cost avoidance, human capital allocation among programs and centers, workforce communications and survey results, and property disposition.

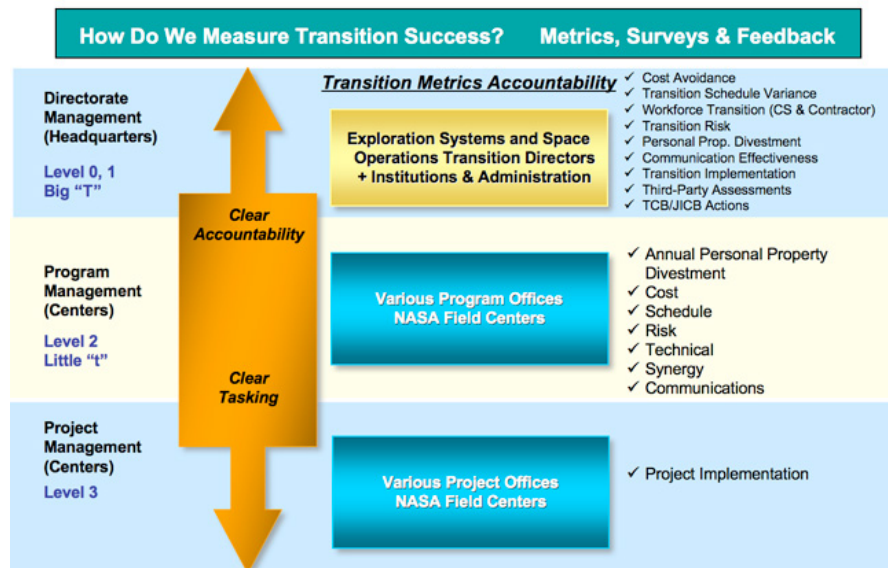


Figure 6. Transition Metrics Overview & Accountability

Within the program and associated projects, other measurements are gathered and analyzed that collectively paint a picture about the overall effectiveness of the transition and retirement effort.

## g. Budgeting for Shuttle Retirement

The retirement of the Space Shuttle Program is expected to be a costly effort that comes at the precise time when the agency is trying to maximize its allocation to future program and project development. Estimates for the cost of retirement have ranged between \$1 and \$3 Billion, with wide variations based on the assumptions and time phasing of the shutdown effort.

To this point, only about \$30 Million has been spent on retirement, primarily to cover the initial planning activities and the costs associated with the several capabilities already being retired or transferred to other programs. It is expected that about 20% of the overall cost will occur while the Shuttle Program continues in operation. The remaining 80% would be spent after the final flight in 2010.

The largest single cost is associated with the disposition of close to one million items of personal property (flight hardware, test equipment, processing equipment and the like) and real property (land and buildings at multiple sites within the NASA and contractor locations). Other costs are associated with post-

shutdown staffing requirements, incentives to current personnel, contract closeout activities, and environmental remediation.

#### **h. The Broader Impact of Shuttle Retirement**

The retirement of the Apollo program following the last lunar mission in 1972 had a significant negative impact on NASA and its associated aerospace contractors. Although the impact of the Space Shuttle retirement should not be as far-reaching, it will take a concerted effort by NASA leadership to assure that the effort is managed to soften the overall impact.

A primary concern to the agency is the length of the “gap”, the time between the final Shuttle launch to the first crewed launch of the Constellation Program. The longer the gap, the more difficult it is to maintain the skills, the staffing, and the infrastructure to ensure safe, effective, and regular access to space.

A second concern is the loss of capabilities that only exist in the Space Shuttle system. While future vehicles will enable destinations that are not accessible to the Space Shuttle, there is a significant loss of capability associated with on-orbit repair and retrieval of satellites, and the ability to return sizable mass to earth.

A final concern centers on the leadership role that the United States plays in space. When President Bush announced the Vision for Space Exploration, he tied it specifically to the need to protect and promote our long term scientific, economic, and national security interests. The Space Shuttle has been used to promote these national interests, while at the same time providing a myriad of opportunities for international cooperation and direct participation in the great adventure of human space flight.

#### IV. Conclusion

The Space Shuttle Program has critical milestones and tasks ahead in order to complete assembly of the Space Station and repair the Hubble Space Telescope. The transition and retirement of the Space Shuttle Program is a formidable activity essential to completing its mission and meeting the nation's Vision for Space Exploration. As always, safe flight and mission success are the fundamental decision drivers. Transition management boards are in place and lines of communication have been established. Space Shuttle contractors, vendors and suppliers are phasing out while work for the Constellation program is picking up (figs. 7&8). After the Shuttle retires, a gap in U. S. human spaceflight capability is certain without some change in national policy or budget increase. In the meantime, decisions are being made now that limit future options. If a gap is a concern, alternatives should be evaluated soon.

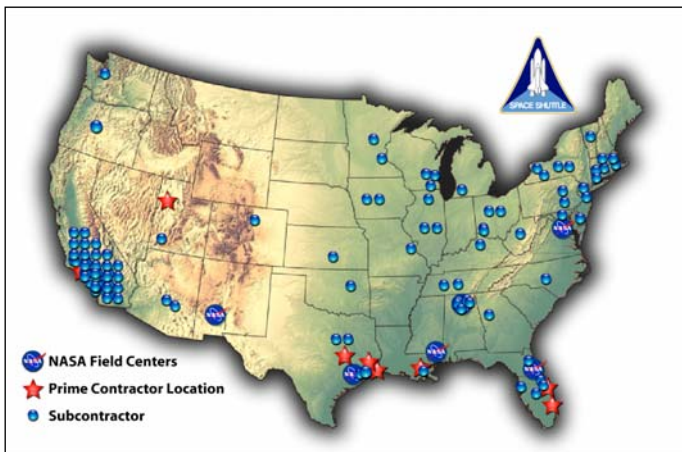


Figure 7. SSP Work Locations

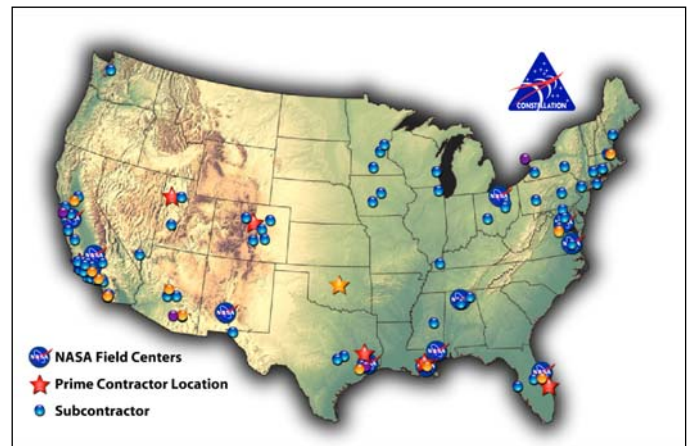


Figure 8. CxP Work Locations

<sup>i</sup> “A Renewed Spirit of Discovery: The President’s Vision for U.S. Space Exploration” (speech), given by President George W. Bush on February 4, 2003.

<sup>ii</sup> For the purposes of the SSP Transition and Retirement effort, Capability is defined as the logical breakdown of program elements’ property, personnel, suppliers, and contracts into functional groupings that provide product(s) or service(s)