VOLUME 2 ISSUE 4 FALL 2008

Rendezvous

Where today meets tomorrow

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TRANSITION & Retirement

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PICTURED ABOVE: Kennedy Space Center as captured by ASTER, one of five Earth-observing instruments launched December 18, 1999, on NASA's Terra Satellite.

From Leadership

Transition is not a job for the Space Shuttle Program alone. As you'll read in this issue, the shuttle program is only one piece of a much larger picture. But there's no question that it's an important piece. The program itself may end in two years, but the actions we take between now and then can help shape the future far beyond 2010.

NASA Headquarters is focusing on where the agency is going; it's our responsibility to implement that direction at the program level. It's our responsibility to determine where we can best share resources; to make sure that we've identified what people skills, facilities, hardware and capabilities need to transfer from shuttle to Constellation; and also to figure out the impact of shuttle operations on Constellation Program requirements.

The Program Manager's Review in September was a great opportunity to formalize the working level discussions between our space shuttle projects and elements and their counterparts in Constellation about how we can collaborate between the two programs. The goal of the meeting was to come out with a list of proposals for collaboration.

It was a great success, with a list of approximately 300 proposals. We have an incredible opportunity for synergy between our programs over the next two years. Shuttle has a unique set of skills and capabilities, and Constellation has plenty of work with which to put them to use. We,Äôve only just begun to plumb the depths of all the kinds of things we can do to help Constellation.

But it doesn't have to stop there. Not only do we have the challenge and opportunity to transfer forward our capabilities and workforce into the future, but we also have the opportunity to rethink how we accomplish the business of space exploration. This is our chance to proactively shape our approach to operations and ensure that we have the right workforce to do the job.

It's an exciting time to be at NASA. Even acknowledging that our shuttle program is coming to an end, we know what comes next. With the efforts and actions we put in place today, we can reshape NASA to be agile, efficient and fully capable of achieving the vision Headquarters and Washington, D.C., have laid out for us.

Dorothy Rasco
Manager, Space Shuttle Business Office
SSP T&R Lead
Johnson Space Center

From the Editor

Fall 2008. What a momentous time this is for NASA, the space program and the extended human spaceflight family. Our mission schedule shifted again with STS-125, the fifth and final Hubble servicing mission, being moved into 2009. Both the Space Coast and the Gulf Coast dealt with the destructive power of Hurricanes Gustav and Ike. The presidential election that will change the face of the nation also could certainly alter the agency's course. All these occurrences and events impact all of us. But behind the scenes, transition work continues unabated.

Our expanded T&R Progress Report reflects the ramp up of activities across the agency now that we're less than two years out from the retirement of the shuttle. For the first time since the Apollo program, we are building a lunar lander, along with other systems for scouting out the moon. You can read about it in our story on Altair.

For this issue, we talked with transition leadership at NASA Headquarters in Washington, D.C. to get the big picture strategic view on the state of transition and its many complexities and challenges. And then, to provide you with a more tactical story, we also talked to the folks responsible for transitioning Michoud Assembly Facility in New Orleans from a single program/single customer facility to a multi-program/multi-customer dynamic.

We looked into what transition looks like from a non-shuttle perspective with specific insights from Linda Ham, transition manager for Constellation, and also talked with several individuals at JSC, KSC and MSFC who are already splitting their time between shuttle and Constellation work.

Lest we forget that we still have 10 important shuttle missions left to complete, we also talked with Mike Burghardt, affectionately known as "Mr. RTF," who has spent his career at Boeing committed to the shuttle program, from build (of Endeavour) to the retirement of the fleet in 2010, and remains steadfastly focused on the shuttle program's final missions.

Finally, we asked our readership to weigh in with their opinions on a series of pertinent and timely questions. We think you'll find their observations interesting and worth further discussion so we encourage you to use the feedback buttons and let us know what you think.

Finally, Rendezvous' presence on the Web continues to grow. The magazine is nowavailable publically at www.nasa.gov/transition/rendezvous. In addition, our internal website, rendezvous.jsc.nasa.gov, is now offering more information than ever, with biweekly news updates, leadership blogs and more. As always, printable files for each issue can be found in our archives.

Enjoy!

The View from the Top

Transition's big picture is a lot bigger than most people realize.

We're closing in on 2009, which means that there's less than two years left for shuttle. Rendezvous sat down with some of NASA's transition leadership at headquarters to get an update on just where we are in the big picture of transition, and to also talk about strategies going forward in the face of unknowns.

Transition is not a simple issue.

Structuring transition, organizing it and planning it are incredibly time-consuming and difficult tasks filled with variables and "what ifs." Defining it has to do with who and where you are within NASA or the space program. So working its many twists and turns makes for very long days and more than a few sleepless nights for the people in charge of it.

Transition is also a pretty touchy issue — particularly to the people out in the centers, civil servants and contractors alike, whose entire careers have been spent on programs with low Earth orbit goals. To these folks, transition has more to do with whether or not they'll have jobs past 2010 than where we're headed in the next 30 to 50 years. So the agency has worked hard to understand transition and address the legitimate concerns of the multi-program workforce.

But in the meantime, to the folks who are tasked with flying out the shuttle manifest safely and successfully, the last shuttle mission in 2010 is an abrupt change in their transition. Their questions about migrating from shuttle to Constellation are real. If I do my job on shuttle, will I miss out on opportunities on Constellation? And the even larger, more immediate question is: Will the Vision for Space Exploration survive the presidential election?

"...transition is all about making sure that the people, the equipment and facilities, and the planing processes are all coordinated to meet their Vision for Space Exploration objectives..."

As defined by the agency, transition does not merely refer to the end of the Space Shuttle Program and the completion of the International Space Station. The agency-wide effort known as Transition is defined in much broader terms as a continuum of efforts divided into three major themes or, as John Olson, transition manager for NASA's Exploration Systems Mission Directorate, calls them, the "Big Three" – workforce, infrastructure and property, and budget to schedule.

In other words, transition is all about making sure that the people, the equipment and facilities, and the planning processes are all coordinated to meet their Vision for Space Exploration objectives efficiently and pretty much at the same time.

"These three things encapsulate everything we do on a daily basis, including the way we manage our resources and assets strategically and the way we lead change," Olson said. "Mike Griffin [NASA Administrator] likes to say, 'This is the first major change in U.S. Civil Space Policy in 35 years,' and Bill Gerstenmaier [Associate Administrator for Space Operations] has said 'We're not going out of business, we're going into a new and exciting line of business for the next 30 to 50 years.' So transition is about getting everything we can from one successful program, learning from that and leveraging all our lessons learned from Apollo, Skylab, shuttle, station and our science missions, and applying them to our broad exploration objectives for the future."

What is transition?

The official NASA transition definition encompasses the careful planning, optimized utilization, and responsive disposition of personnel, processes, resources and real property, focused upon leveraging existing shuttle and ISS assets for exploration programs' safety and mission success.

Moving the workforce into a new mindset

As an agency that means changing the way NASA's been doing things for more than three decades and moving from an operations and sustaining mode to a recurring development-to-operation paradigm.

To Jane Datta, Headquarters human capital transition lead, this is a major issue.

"Once you move from an operational mode where your variables are well known and your processes are proven, you move into a developmental mode where you might be able to migrate some of your processes and skill sets, but not necessarily all of them," she explained.

"Some of the variables will be familiar, but you're dealing with a new environment and set of objectives, which in the end, is much more than going into a new job. It's a new mindset."

In pure agency terms, approximately 2,000 civil servants are currently employed on the shuttle and station programs. In broader space program terms, that also includes another 15,000 or so contractors, who are no less committed to their programs. The trick is keeping these shuttle and station people focused on flying out the shuttle manifest and operating the space station while also asking some of them to contribute to early Constellation development. (See "Program Sharing" in this issue.)

John Olson

Jane Datta

But Datta is also looking past the shuttle's last mission to what happens immediately afterward.

"In the civil service workforce side, you suddenly have a lot of people who become available, many of whom are already working on Constellation part time, but now they're 100 percent available," Datta explained. "So, one of the questions we've wrestled with is this: What exactly is the Constellation work that will absorb this workforce so they'll have productive work to do immediately following the close of the shuttle program?"

At this point no one really knows for sure. But they're working hard to get a better handle on Constellation's needs and the timing of them.

"I think the agency has done a lot of really good things up to this point — from workforce communications to identifying and addressing some of the disconnects that are inevitable, by taking some early actions to make it smoother come 2010," Datta said.

"Anything we can do in workforce planning, here at Headquarters and out in the centers, to identify the workforce skills we need going forward, will help us migrate folks from program to program so we're leveraging what they know and not having too much duplication of skills or capabilities."

The thing Datta and her colleagues need most is to have firm ideas about what the work looks like for Constellation. This, of course, is complicated by the fact that Constellation is still maturing. (See the T&R Progress Report in this issue.)

Having had a fairly stable workforce for decades, Datta said, this is a tall order for the agency. The burden is on the agency to do the right thing.

"The burden is on the agency to do the right thing."

"Doing the right thing means being clear about what the work is and what will be required to get the work done so that people can be well enough informed in advance to make the right choices for themselves," Datta said. "If they know that their skill set needs to be changed or expanded, then they need enough lead time to adjust and decide how to do this. We need to be as clear as we can be about what the future holds."

Joel Kearns, transition manager for the Space Operations Mission Directorate, thinks that the planning processes, particularly in workforce needs and allocation, are beginning to mature. Enough, he said, that we're past the point of determining options and choosing paths – we're refining plans now. But that doesn't mean the hard part is over.

"It's going to be challenging to fly out the 10 complex shuttle missions and complete the Hubble servicing and station assembly within the next two years," he stated. "And in parallel with that, it's going to be challenging to keep everyone on Constellation on schedule, so that the gap between the last space shuttle flight and the first spaceflight of the Constellation Program is kept to a minimum."

Handshake relationships between programs and offices

In effect, Kearns sees two transition challenges ahead. The SOMD transition challenge is concerned with getting the total shuttle job right, and keeping everyone on schedule for retirement and transfer to Constellation. The ESMD transition challenge is making sure that there is a comprehensive plan for Constellation and that everyone is executing his or her part of the plan. He likens the relationship and the flow of work between the directorates during this time of transition to a handshake. Or rather, a lot of handshakes.

"NASA has been called upon to do all the different things the White House and Congress has asked us to do within our annual appropriations," Kearns said. "But we're not just shuttle, station and Constellation. We're also aeronautics and science research, astronomy and Earth sciences — and all that goes on in parallel with our spaceflight programs. There is no such thing as one space program at NASA anymore."

Joel Kearns

Rich Wickman

"There is no such thing as one space program at NASA anymore."

Facilities, property, equipment and artifacts

Rich Wickman, transition lead for NASA's Infrastructure & Administration Office (I&A), is responsible for the disposition of the equipment and facility assets of the shuttle program. I&A, which is a Headquarters mission support office, handles all the enabling functions for programs and projects that have to do with facilities, personal property, aircraft management and environmental management, as well as manage the construction program for the agency.

"Obviously, when we talk in terms of shuttle transition, we're talking about the transfer to or modification of facilities for the Constellation Program, the demolition of unneeded facilities and the construction of new facilities," Wickman explained. "But one of our biggest challenges is disposition of all the personal property used by the shuttle program — roughly 1.2 million line items."

Shuttle property includes anything from an entire orbiter processing facility at Kennedy Space Center, a test stand at Stennis Space Center, flown items such as shuttle tires, and ground support equipment. So Wickman's role is to make sure that the infrastructure of the agency is well positioned with the right assets in place to support the new program going forward.

"It's an integrated picture, but it really is about the future," Wickman said. "There are a lot of facilities and equipment that are obviously needed to support human spaceflight. An important Constellation program goal, however, is to get operating costs as low as possible, so this will mandate different concepts of what some of the infrastructure and facilities will look like."

I&A is also dealing with a gap issue of its own.

"The plans for these individual elements need to match up without holes between the programs."

If something is currently needed by shuttle now that could possibly be utilized by Constellation later, what should be done with it after the shuttle program releases it? Who pays to maintain it between shuttle last use and Constellation first need? In general, NASA releases capabilities it no longer needs, or the next program that needs them must support them once the current program stops using them.

"The plans for these individual elements need to match up without holes between the programs," explained Kearns.

One thing that promises to help in this process is the Exploration Requirements for Institutional Capabilities or ERIC study. Conducted this past summer, the study defines Constellation's facility needs. What facilities does NASA already have that Orion, Ares, Altair, etc., can use, which won't have a use post-shuttle and what new facilities need to be built?

"Coming out of ERIC we'll have a much better handle on what's needed to support exploration going forward, " Wickman said.

There are plans to do the same kind of study or audit on the personal property side of the equation, which is essentially everything else — equipment and tools.

"All the stuff that isn't bolted down," Kearns explained.

Here the challenge gets a bit more complex. The immediate concern is to fully grasp the enormity of the tasks by analyzing the results of the transition property assessment and making appropriate re-use and disposition decisions. While the focus will be on disposing unneeded property, the agency must also be mindful of preserving the Space Shuttle Program's history and the artifacts associated with it.

"Artifacts are significant items, many of which have flown in space, worth preserving for posterity," Wickman said. "These are things that folks both inside and outside NASA will find educationally useful or inspirational. We want to get a better handle on what those items are and who is interested in them, such as museums, schools and communities."

In effect, Wickman is talking about marketing history.

The General Services Administration is working with NASA to advertise the availability of potential artifacts, even before the shuttle program is finished with some of them, so that I&A can best plan where they should go.

Planning on the move

Then there's the third theme in Olson's "Big Three" of transition themes: planning. That includes determining what needs to happen, who does it, when it happens, how much it costs and who pays for it. In other words, everything from schedule to budget.

"A key part of transition from the exploration side is good program planning, stewardship and development," Olson said. "From the institutional perspective, it's good workforce management."

Already transition has driven NASA to look for better insight into the agency's civil servant and contractor workforces and their skill sets. And from a facilities and infrastructure perspective, it's been the catalyst for looking at program requirements and facility needs. This has never taken place with this level of fidelity in the past, and Olson said it's an extremely positive indicator of progress.

"When you have so many more people engaged in this level of transition, it becomes a kind of cultural revolution that is moving the entire institution toward a new paradigm for a future state," he said.

"When people have so many more people engaged in this level of transition, it becomes a kind of cultural revolution..."

But how is it possible to plan so comprehensively when budget objectives, design requirements and workforce needs are moving targets? When mission schedules shift with the weather, and the agency's leadership, which serves at the pleasure of the President, will soon be faced with an entirely new administration?

That's the greatest challenge of all.

Briefing a new boss

Right now, Kearns and Olson, their offices, and a host of others at Headquarters are preparing the information to brief the new administration on the agency's current status vis á vis the transition of the space program as we've known it for the past 30-plus years to realizing the dreams of the Vision for Space Exploration. The emphasis for both will be to ensure stability of the agency while responding to the new administration's needs and direction.

"I think both candidates realize the importance of space exploration," said Olson. "They realize the importance of it to our economy, our national security and to our country as a whole. So I think they're both looking to take positive steps on the path we're already on."

Both candidates, Olson said, have talked about evaluating the space program portfolio to determine if additional dollars are needed.

"We're seeing a higher level of national and global awareness and discourse on human spaceflight and space exploration," he said. "And since we've had bipartisan support from Congress in the past for the Vision for Space Exploration, it's important that we carry the momentum forward."

Olson also made the point that the exhaustive and comprehensive planning around the agency's efforts to shorten or somehow minimize the gap is critical at this point in time, given the current national economy and the workforce impact to certain constituencies.

Then there's the rest of the world to consider.

"There's simply too much at stake to have an extended period of indecisiveness."

The Chinese and the Russians have made their space objectives and intentions clear. India and the European Union are looking to increase their participation in space ventures and expand their presence in space with both human and robotic missions.

"Our next President will undoubtedly recognize the importance of our national pre-eminence in space exploration," Olson said. "There's simply too much at stake to have an extended period of indecisiveness. Too much at stake to have any ambiguity."

Getting it right

While he's hard at it, routinely putting in 12-hour or more days and six-day weeks, what keeps Olson up at night is worrying about "getting it right," an issue that overarches all of the activities, themes and programs discussed in this article. To Olson, and to Kearns and Wickman and Datta and the many others who are leading, managing and working transition everywhere in the agency, "getting it right" is the end-all objective.

Getting it right is clearly communicating to all stakeholders that there are plans in place, that there's a big picture, that there's buy-in on the Hill. It's making sure that decisions take into consideration all the options, and that they're made in a timely manner so that the right people can act on them. It's being honest and transparent with the administration, whichever one it is, that governs the agency's future. It's making sure that the agency gets it right for the 17,000 civil servants and contractors who work on the shuttle program and want to have a future on the Constellation Program.

"We're sprinting a marathon."

"We're sprinting a marathon," Olson said. "But the real litmus test is, can we safely and efficiently shut down shuttle and maintain a viable workforce and a viable space station while we bring Constellation online?"

Transition is this continuum between the programs and these eras in spaceflight.

"We had shuttle first, we'll have station completed in the future. We've got to bring the commercial folks (COTS) online. We need to get back to the moon and set up our outposts," said Olson. "I want to see us go to Mars... Maybe my sons will get to go to Mars."

Editor's note: Dr. John Olson was recently selected to serve as the Acting Director of the Directorate Integration Office in the Exploration Systems Mission Directorate, where he is now responsible for the Lunar and Mars exploration architectures and the International, Commercial, Science, and Government partnerships that support the Global Exploration Strategy. Bob Soltess, who led the ERIC study, is now the Acting Exploration Transition Manager.

Understanding Transition

Getting their collective arms around the space industry's big picture task of transitioning from the Space Shuttle and International Space Station programs to the Constellation Program and other elements of the Vision for Space Exploration was the objective of the AIAA's 3rd Space Exploration Conference & Exhibit held in Denver, Colo. in early 2008. Moderated by Dr. John Olson, transition lead for NASA's Exploration Systems Mission Directorate, a panel presentation titled "Transition: A Look Ahead" featured representatives from NASA's Space Operations Missions Directorate, NASA's Office of Infrastructure and Administration (property and facilities), the Constellation Program, NASA's centers, and the prime contractors for the shuttle, the Orion and the Ares vehicles.

In the discussion, they examined the scope of the transition challenge in significant detail — including multi-program integrated milestones, workforce and facilities needs, and leveraging proven technologies. Their concluding points were, in that big picture nutshell, that transition would continue to be a huge challenge in regards to workforce, infrastructure and facilities, and planning; and key to transition success were integration, coordination and communication.

T&R

Transition activities across the agency

Pictured above: First round testing of the ullage setting motor for the Ares I rocket, completed Sept. 11, 2008 at marshall Space Center.

It's hard to believe that more than four years have passed since the President announced the Vision for Space Exploration — and that the space shuttle program, after three decades of stellar service will be retired in less than two years. While this eventuality is bittersweet to much of the shuttle workforce, the ramp up of activity on the Constellation Program should serve as significant encouragement. This issue's T&R Progress Report is proof positive that we are building the future of our space program.

Transitioning transition
Shuttle earns a FONSI
Assuring safe landings
Testing the plume
Weighing less
Space age materials handling
Looking for H_2O with LRO
Building a build sequence
Ares I takes giant leap
J-2X: Go for fabrication?
Providing push for Ares I
Ares 1-X: headed to KSC
International lunar science fest
Orion goes for a dip
LSS concepts contracts awarded
Simulating high altitudes
Crashing LCROSS

Transitioning transition

Over the summer, the Space Shuttle Program changed the structure and function of the Transition Management Office to better address the immediacy of shuttle retirement and the challenges and opportunities of transition to Constellation. Five years out from retirement of the shuttle when the office was initially formed, the transition organization was structured chiefly to perform the benchmarking and long-term studies needed to help the program (and the agency) get a handle on the enormity, complexity and ramifications of T&R.

With shuttle retirement less than two years away, however, the structure and function of transition needed to be mainstreamed into the program to accomplish its twin goals: flying out the shuttle safely and effective retirement and transition of shuttle assets. Implementing this new structure puts the responsibility for transition and retirement activities into the hands of the project and element managers.

With Dorothy Rasco, manager of the program's business office, at the helm of the day-to-day tactical efforts and Rebekah Reed, manager of the management integration and strategic planning office, responsible for the strategic planning effort, transition's functions now have the visibility needed for pivotal activities that are easily as important to NASA's future as they are to the flyout of the shuttle.

[See also Linda Ham: Managing transition from the other side and From Leadership in this issue.]

The shuttle earns a FONSI

NASA has completed the final Space Shuttle Program Programmatic Environmental Assessment on transition and program property disposition, addressing the potential environmental impacts associated with the transition and retirement of the program. Based on the comments received on the draft environmental assessment released in February 2008, NASA has issued a "Finding of No Significant Impact" – better known as a FONSI – with respect to the disposition of Space Shuttle Program real and personal property.

That means that after looking at all the plans the program has made for disposing of all its personal property – everything from transferring it to Constellation to destroying it – and considering what the environmental impacts that they could have, nothing of significant impact was found.

"Therefore we don't have a major environmental impact to mitigate," said Steve Glover, the environmental cross-cutting lead for the Space Shuttle Program transition and retirement effort. "So we're able to move on forward now with the implementation phase."

Pictured above: A variety of lenses used by the gimbal-mounted LIDAR device are visible through the opening in its ball-shaped housing.

Assuring safe landings

How do you know if your lunar landing site is safe? It's not as easy as calling air traffic control or checking the weather for current local conditions. What if you're trying to land close to certain necessary resources that also happen to be in close proximity to terrain that could be potentially hazardous?

Obviously, precision range and directional velocity are important when navigating to a tricky lunar landing.

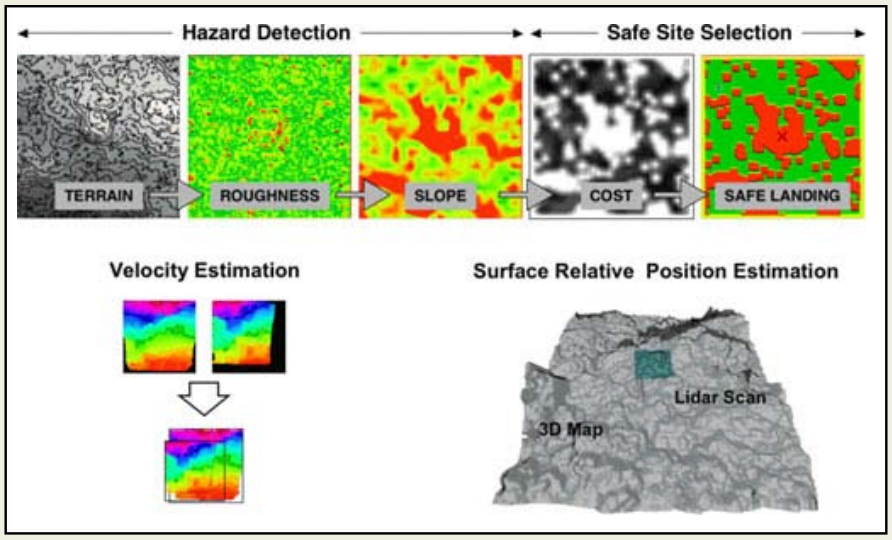
That's why NASA's Langley Research Center in Virginia and Jet Propulsion Laboratories in California are working together to develop two critical sensor technologies that will allow lunar landers to identify and navigate to safe landing sites. The first sensor system is a 3D active imaging device that will measure the topography of a landing area. The second is a sensor that will accurately measure speed of descent to land at the chosen site with precision.

Coupled with terrain analysis algorithms developed at JPL, these sensor technologies were integrated into the Autonomous Landing and Hazard Avoidance Technology – or ALHAT – project that has already undergone two series of flight tests in late spring and late summer at NASA's Dryden Flight Research Center.

The first test in May successfully demonstrated the application of the 3D imaging technology known as "flash" LIDAR. The second set of flight tests, completed in August, helped to evaluate the capabilities of a new LIDAR technology called the Doppler LIDAR velocimeter, which provides precise vehicle velocity vector, attitude and altitude readings.

A total of six test flights were flown in August, in which the velocimeter was flown by a helicopter over two target areas approximately three miles apart on the surface of Rogers Dry Lake in the high desert. Repeated runs were made at varying altitudes from 300 feet to more than 6,200 feet while the gimbal-mounted LIDAR measured relative speed, altitude and attitude of the helicopter.

Preliminary results with the ALHAT Doppler LIDAR show its accuracy and rate of update to be more than 10 times higher than that of conventional Doppler radar-based sensor technology.



Pictured above: Results from LIDAR-based terrain analysis algorithms developed at JPL.

Testing the plume

Finding out how the plume of the jettison motor could affect the safe escape of the crew from the crew module during a launch pad emergency was the business of the 14x22 subsonic wind tunnel at Langley.

Tests were run on a small-scale mock-up of the launch abort vehicle, which will eventually include the Orion crew capsule as well as the launch abort system. To simulate the exhaust plume, high-pressure air was run through the system. Researchers were interested in learning more about the interaction and effects of the system's jettison motor during separation between the abort system and the crew module. The jettison motor is one of three solid propellant motors in the launch abort system.

Pictured above: The small-scale mockup of the launch abort vehicle in the 14x22 subsonic wind tunnel at Langley.

Weighing less in the future

What do race cars, sailboats and space capsules have in common? They need to be tough, but light.

Advanced composite materials are the answer. Not only do they offer the attributes needed, but they can also be formed into highly complex shapes that offer better structural integrity. So in January 2007, a nationwide team of structures experts established by NASA's Engineering and Safety Center took on the challenge of building entirely out of advanced composite materials the internal primary structure of a space capsule similar to the Orion crew module.

The task is daunting. Although advanced composites have been used for several decades in high-end, light-weight sports equipment, as well as race cars and sailboats, designing and building a space capsule that is safe for human space travel, not to mention reliable and cost effective, is a different animal.

However, the potential benefits of composite materials outweigh its design challenges. A composite structure weighs 10 to 15 percent less than an aluminum structure of the same dimensions and design. And in space travel, weight is the great equalizer. Reducing weight by 10 percent could have a significant impact on reducing mission expense

"...in space travel, weight is the great equalizer. Reducing weight by 10 percent could have a significant impact on reducing mission expense."

In fact, composites are already being considered for lunar landers, habitation modules and launch vehicles where weight is a premium. Composites are even being considered for use in the Orion crew module, as an internal structure that serves as a sort of "pressure shell." This underpinning for the module's floor and walls can be made out of a single structure that could be more efficient in sharing the loads between the inner and outer shells during a water landing.

The module components were fabricated and assembled at the Alliant Techsystems facility in Iuka, Miss., and will be shipped to NASA's Langley Research Center for testing and analysis. Testing of the final assembly of the composite crew module is projected to commence in January 2009.

Space age materials handling

Look! Out there in space! It's a shovel. It's a forklift. No, it's a crane!

Fortunately for the crew that has to move stuff around on the surface of the moon, it's all of the above and then some — and it's still evolving.

Known as the Lunar Surface Manipulator System, a prototype system with all those capabilities was fabricated out of off-the-shelf aluminum pipe and winch motors off a four-wheel-drive truck, but could eventually be built out of composite materials to cut its weight by half.

Put through its initial paces during testing at Moses Lake, Wash., last June, it moved payloads between a mockup lunar lander to carrying devices at an average rate of five to seven minutes per lift. In a second demonstration at NASA's Langley Research Center in late July, the system capably moved boxes while being remotely controlled by two operators — one handling the manipulator itself via computer and mouse, and one handling the system's manipulator arm.

Generation 1 of the Lunar Surface Manipulator System proved the architecture and physics behind the system's design. Generation 2, planned for 2010, will feature a number of improvements to add to its versatility, including providing the system with the capability of unloading itself from the space cargo vehicle that will ferry it from Earth to the moon... or Mars.

Pictured above: The small-scale mockup of the launch abort vehicle in the 14x22 subsonic wind tunnel at Langley.

Looking for H_2O with LRO

Water is important to have even on Earth. But on the moon, it could mean the ability to make your own oxygen or even rocket fuel more efficiently than would be possible without it.

That's why searching for signs of hydrogen and the ice deposits it may herald is one of the many missions the Lunar Reconnaissance Orbiter – or LRO – and its battery of scientific instruments and sensors.

This isn't the first time the subject has come up. Clementine, a small probe launched by NASA and the Department of Defense in 1994, directed a radio signal toward lunar polar regions. Antennae back on Earth picked up reflections that could be indications of ice. Additional evidence in 1998 from NASA's Lunar Prospector mission used the presence of hydrogen as another positive indicator. Unfortunately, the findings from both missions could not differentiate between ice or hydrogen in other forms. Nor could they accurately locate deposits within the moon's polar zones.

The LRO, however, will be able to deliver a much more accurate picture. The LRO's camera system will be able to build a detailed image of the polar regions and establish the location of deep craters that never see light – known as permanent shadow regions, or PSRs – that are the most likely areas for ice deposits. The LRO's neutron detector can detect hydrogen or ice in deposits of approximately six miles across and up to a meter below the lunar surface.

The LRO also has an instrument called the Diviner that measures temperature. The Diviner will be able to determine if the PSRs are cold enough to have trapped hydrogen or water molecules for billions of years.

An onboard laser ranging system known as the Lunar Orbiter Altimeter or LOLA, has the ability to map the contours of the polar craters with never-before-achieved accuracy.

Imaging the depth of the craters is the job of the Lyman Alpha Mapping Project, which can effectively "see" in the dark using reflected light from stars and a type of UV light (invisible to the human eye) known as Lyman Alpha.

Joining the neutron detector, LOLA, the mapping project and Diviner aboard the LRO will be an experimental mini radio transmitter to help detect ice deposits through reflected radio signals.

Then there is the Lunar Crater Observation and Sensing System that, when crashed into a polar crater, will create a plume of materials that can analyzed for hydrogen or water content. For more detail on this, see "Crashing LCROSS" in this article.

Building a build sequence

It may look like a state-of-the-digital-arts film production set, but it's not.

The people clad in black spandex festooned with little white balls and carefully executing choreographed maneuvers while computers capture every move are actors, but not in the next animated blockbuster. Instead, they're working for the Human Engineering and Modeling Performance Laboratory at United Space Alliance's Constellation Independent Research & Development facility at Kennedy Space Center.

The objective is elegant and simple: virtual reality to reduce the cost of prototyping...

The actors actually move around in a skeletal mock-up of the Orion pressure vessel to virtually develop techniques for assembling the Orion spacecraft. After recording the actors' movements, programmers add virtual weight to the "loads" the actors are handling inside the vehicle's frame.

The objective is elegant and simple: Use virtual reality to reduce the cost of prototyping by providing ample opportunity to modify designs before they are finalized.

Cutting edge? Certainly. Brand new? Not really. The process has already been proven in planning the placement of the plywood sheets in front of the crawler-transporter's giant tracks when moving a stack along the Crawlerway at KSC.

Ares I takes giant leap to reality

The preliminary design review for the Ares I Rocket was conducted at NASA's Marshall Space Flight Center in Huntsville, Ala., on Sept. 10. Its completion marked the first such milestone in more than 35 years for a United States rocket that will carry astronauts into space.

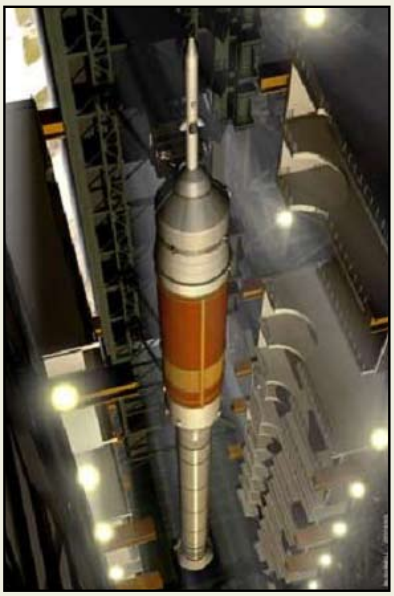
The review, which is one of a series that will occur before the actual flight hardware can be built, examined the current design for the Ares I launch vehicle to determine if it will meet NASA's requirements for the fully integrated vehicle.

Starting in 2015, the Ares I rocket will launch the Orion crew exploration vehicle, its crew of four to six astronauts and small cargo payloads to the International Space Station. The rocket will also be used for missions to explore the moon and beyond in the coming decades.

More than 1,100 reviewers from seven NASA field centers and multiple industry partners took part in the review, which is the final step of the design process. Teams representing each major part of the Ares I rocket – the first stage, upper stage and upper stage engine – all have conducted similar reviews during the past year.

As the review process progresses, more detailed parts of the vehicle design will be assessed to ensure the overall system meets all NASA requirements for safe and reliable flight. The process also identifies technical and management challenges and addresses ways to reduce potential risks as the project goes forward.

With the completion of this review, each element of the Ares I rocket will move to the detailed design phase. The critical design review will allow for a more thorough review of each system element to ensure the vehicle design can achieve requirements of the Ares program.



Pictured above: An artist's rendering of the Ares I rocket in the verticle assembly building.

J-2X: Go for fabrication?

The J-2X team kicked off the first critical design review for a major element of the Constellation Program on Sept. 8 at the Von Braun Center in Huntsville, Ala. The J-2X – a powerful high performance engine currently under development – will power the Ares I upper stage and the Ares V earth departure stage for exploration missions.

The criticle design review demonstrates the maturity of the engine's design and verifies the engine can proceed to full-scalefabrication, assembly and testing.

The critical design review demonstrates the maturity of the engine's design and verifies the engine can proceed to full-scale fabrication, assembly and testing. This design review also allows project managers to determine if the technical approach is on track to meet mission performance requirements including flight and ground systems development and mission operations.

The J-2X critical design review process will culminate with the critical design review board meeting scheduled for November.

Providing extra push for Ares I

The first hot-fire test of the ullage settling motor was conducted in September at Marshall and deemed a success. [Pictured at the top of this article.]

The word "ullage" is taken from the French term "ouillage," which is used in winemaking to describe the space between wine and the top of a storage container. But at NASA it refers to the space at the top of the first stage fuel tank and the need to push the fuel, or settle it, to the bottom of the tank.

The ullage settling motor is a small, solid rocket motor that serves two key roles during the launch of the Ares I rocket. During first stage separation, which occurs 125.8 seconds into flight, the motor will fire for four seconds, producing the forward thrust needed to push the second, or upper, stage away from the first stage. This forward thrust also ensures the rocket's liquid fuel is properly pushed to the bottom of the upper stage fuel tank prior to ignition of the J-2X engine that powers the upper stage.

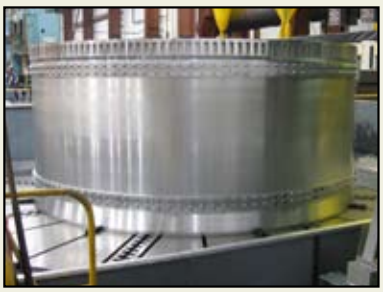
This first series of developmental motor testing consisted of four tests. The second test in the series is planned for February 2009. The full test series is scheduled to run through 2009.

Ares I-X headed to KSC

In preparation for NASA's Ares I-X test flight scheduled for 2009, the first piece of this next-generation rocket is making its way cross-country to NASA's Kennedy Space Center in Florida.

The shipment of Ares I-X hardware will begin with the forward skirt extension, a component of the rocket's first stage. The forward skirt extension houses the main parachutes used to slow the booster down when it returns to Earth after launch. It was manufactured by Major Tool & Machine in Indianapolis.

Upon arrival, the component will undergo quality and fit checks, after which it will move to the Vehicle Assembly Building to be assembled with the other hardware components of the Ares I-X first stage. Additional components will continue to arrive at Kennedy through the next several months.



Pictured above from top to bottom: The Ares I-X forward skirt extension and a packed parachute.

International lunar science fest

NASA hosted a meeting of space agencies from nine countries at the end of July to discuss the next steps in the ongoing scientific exploration of the moon. The meeting laid the groundwork for a new generation of lunar science.

Discussions, led by NASA Headquarters officials, were held at NASA's Lunar Science Institute, located at Ames. Representatives from space agencies in Canada, France, Germany, India, Italy, Japan, the Republic of Korea, the United Kingdom and the United States attended the meeting.

During the meeting, attendees discussed cooperation on an international activity called the International Lunar Network (ILN). The network is designed to gradually place six to eight fixed or mobile science stations on the lunar surface. The stations will form a second-generation robotic science network to replace hardware left by the Apollo program to study the moon's surface and interior.

NASA plans to place its first two ILN landers on the surface of the moon by 2014. The landers are being developed under the Lunar Precursor Robotic Program at Marshall.

Pictured above: A scale model of the Orion crew exploration vehicle is lowered into the pool at NASA's Neutral Buoyancy Lab at JSC.

Orion goes for a dip

Scale models of the Orion crew exploration vehicle recently were tested at NASA's Neutral Buoyancy Laboratory, or NBL, at Johnson Space Center in Houston and at a wave tank at Texas A&M University in College Station.

NASA conducted a series of buoyancy and flotation characteristics tests using the NBL and a one-fourth-scale model of the Orion crew capsule. The model was lowered into the NBL's 6.2-million-gallon pool to float in a series of positions. This testing will allow the engineers and the NBL team to develop their full-scale crew training mock-up for mission training and for creating the crew safety procedures for water-based landings of the Orion crew capsule.

The team also performed a series of tests to validate a new seal design and updated wireless communications. Engineers also evaluated a prototype flotation collar for the spacecraft, which was provided by Kennedy.

A smaller scale model of the Orion crew capsule also was tested at a wave tank at Texas A&M University. The goal of the test was to determine how the spacecraft reacts to strong waves. Engineers simulated gale force winds and large waves to ensure the spacecraft would remain upright.

The next step for the team will be to partner with a team of naval architects from the United States Navy to conduct a series of flotation characteristics and towing tests to help further understand how the Orion crew capsule will act in different sea states and to help generate recovery procedures. The next round of testing will be held in October at the Naval Surface Warfare Center in Carderock, Md., and at the Aberdeen Proving Ground in Aberdeen, Md.

LSS concepts contracts awarded

NASA's Constellation Program has selected 11 companies and one university to independently develop concepts that contribute to how astronauts will live and work on the moon.

Each organization will conduct a 180-day study focused on a topic relevant to lunar surface systems.

Selected organizations and topics are:

Alternative Packaging Options: Oceaneering Space Systems of Houston

Avionics: Honeywell International of Glendale, Ariz.

Energy Storage: ATK Space Systems Group of Brigham City, Utah; Battelle Memorial Institute of Columbus, Ohio; and Hamilton Sundstrand of Canoga Park, Calif.

Minimum Habitation Functions: The Boeing Company of Huntington Beach, Calif.; ILC Dover of Frederica, Del.; and University of Maryland, College Park

Regolith Moving Methods: Astrobotic Technology of Pittsburgh and Honeybee Robotics of New York

Software: The Charles Stark Draper Laboratory of Cambridge, Mass., and United Space Alliance of Houston

The awards total approximately $2 million, with a maximum individual award of $250,000.

The recommendations from the studies will help determine packaging options, identify basic functions for lunar habitats, and conceptualize innovative avionics, computer software, energy storage ideas and equipment and techniques that could help preparation for the lunar outpost site.

A-3 test stand on time

Construction of the new A-3 Test Stand at Stennis Space Center is moving forward and will be completed on time.

Work on the A-3 Test Stand began late last summer; it is the first test stand to be built at Stennis since the 1960s. The new stand is needed to perform simulated high altitude tests on the new J-2X rocket engine to be used in the Constellation Program. Tests on J-2X engine components are already underway; testing on the full J-2X engine is scheduled to begin at Stennis in late 2010 or early 2011.

Simulating high altitudes

Having completed a successful subscale diffuser test series that produced vital data for construction of the A-3 Test Stand, engineers at Stennis are focusing on a chemical steam generator initiative equally critical to the project.

The criticle design review demonstrates the maturity of the engine's design and verifies the engine can proceed to full-scalefabrication, assembly and testing.

The generator is essential for creating the vacuum needed to simulate high altitudes on the new stand. The simulation is necessary for testing the new J-2X engine to ensure it will perform as required in the Constellation Program.

The technology for creating the vacuum needed in the testing is not new; it is already being used at NASA's White Sands Test Facility in New Mexico. However, Stennis engineers will require the chemical steam generator to do more than it ever has in simulating altitudes of up to 100,000 feet. The hardware will be validated before it is used on the A-3 stand to identify any design or operational problems that might exist with the generator.

The initial chemical steam generator test series is expected to continue until mid-December.

Crashing LCROSS

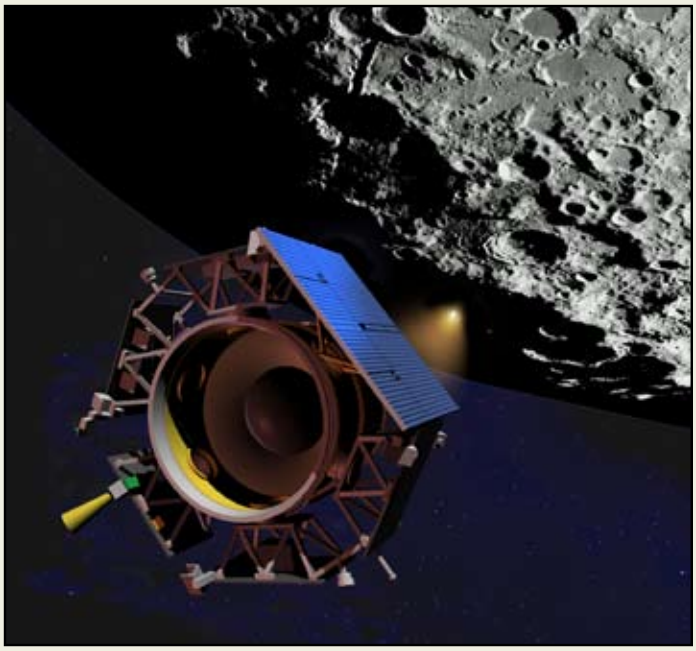
Evidence suggests that near the moon's poles, craters that have not seen sunlight in billions of years may contain water-ice. NASA's Lunar Crater Observing and Sensing Satellite – or LCROSS – mission, planned to launch early in 2009, will investigate one of these craters and search for water on the moon.

Ames is overseeing the development of the LCROSS mission with its spacecraft and integration partner, Northrop Grumman. Ames is managing the mission, conducting mission operations and developing the payload instruments, while Northrop Grumman designed and is building the spacecraft. Ames mission scientists will also spearhead the data analysis.

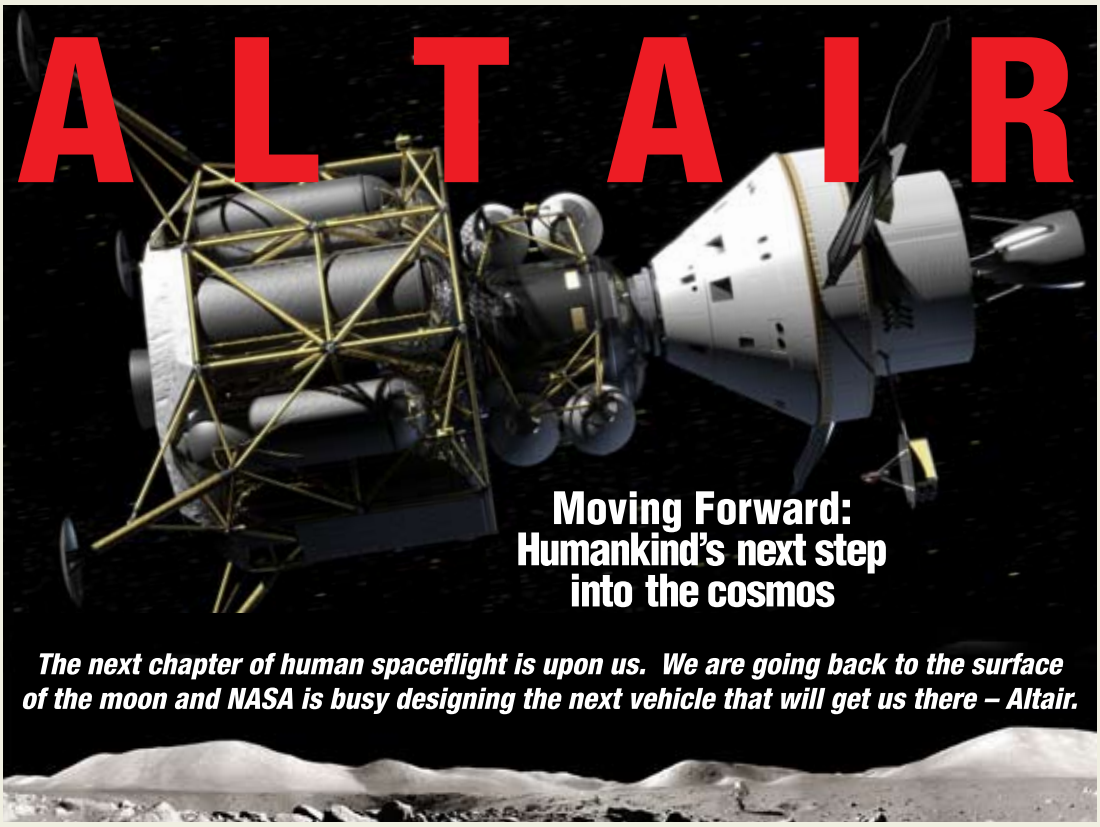
LCROSS is scheduled to launch with the Lunar Reconnaissance Orbiter aboard an Atlas V rocket from Cape Canaveral, Fla., early in 2009. After launch, the LCROSS shepherding spacecraft and the Atlas V's Centaur upper stage rocket will execute a fly-by of the moon and enter into an elongated Earth orbit to position LCROSS for impact on a lunar pole. On final approach, the shepherding spacecraft and Centaur will separate. The Centaur will act as a heavy impactor to create a debris plume that will rise above the lunar surface. Following four minutes behind, the shepherding spacecraft will fly through the debris plume, collecting and relaying data back to Earth before impacting the lunar surface and creating a second debris plume.

The debris plumes are expected to be visible from Earth- and space-based telescopes 10-to-12 inches and larger.

The data gathered from this mission will provide valuable information for the establishment of lunar outposts and sustained human exploration of the solar system —stepping-stones to future exploration.



Pictured above: Artist's rendering of the LCROSS with its shepherding spacecraft (left) and approaching the lunar surface (right).



The new lunar lander, whose name means "the flying one," will launch aboard an Ares V rocket into low Earth orbit, where it will dock with the Orion crew exploration vehicle, enter the orbit of the moon and land the crew on the lunar surface.

About three times the size of the Apollo Lunar Excursion Module (LEM), Altair will be capable of landing four astronauts on the moon, providing them with life support and a base for week-long exploration missions, and returning them to Orion which will bring them home to Earth. Once a lunar base is built, Altair will remain on the surface of the moon for up to six months while the crew lives out of the base. It will also be used as a cargo transporter to deliver supplies and materials to the lunar surface.

"Last time we went to the moon we went with a tent and did a little bit of looking around," said Kendall Brown, Altair propulsion subsystem lead from Marshall Space Flight Center in Huntsville, Ala. "We stayed for short periods of time on the lunar surface, and we only went to a few places that were easy to get to. This time we are trying to learn how to really live in space and live off the land. We want to stay longer and do more."

Building an agency-wide team

A small team of engineers from across the agency is working on the Altair project, which started in early 2007 and is currently in Phase A of its development cycle.

"Obviously Constellation has its hands full with trying to produce both Orion and the Ares I rocket," said Lauri Hansen, Altair project manager at Johnson Space Center in Houston. "We had two choices – we could either wait to start on the lunar aspect when we receive the funding in FY 2011– or get started now and take advantage of the time. And that's what we have done. We formed a very small in-house, agency-wide design team. We handpicked the team leads from across the agency and now everybody is off designing a vehicle. From an engineer's perspective it's a dream job."

The Altair subsystem roles and responsibilities are spread across the team of 120 people who work both full and part time on the project. Brown, who coordinates the studies being done for the descent and ascent propulsion system for Altair, works on the project with engineers from Johnson; Marshall; Glenn Research Center in Cleveland, Ohio; Langley Research Center in Hampton, Va.; and the Jet Propulsion Lab at the California Institute of Technology.

The Altair subsystem roles and responsibilities are spread across the team of 120 people...

"There is so much work going on within Constellation right now that we are having to reach out to multiple centers to get the support we need to get the studies done," Brown said. "We are starting to use a few people that have supported shuttle, particularly at Johnson, and we are beginning to bring in a few from Marshall."

Tim Collins, the subsystems lead for Altair structures and mechanisms at Langley, oversees a team of 20 engineers from five NASA field centers. Collins said there are definite challenges in managing a widespread workforce, but says the benefits to the project are well worth it.

"The agency-wide nature of the project is working extremely well," Collins said. "Each center has stepped up to provide the talent and resources necessary to make this exciting adventure a reality. In today's world it is much easier for team members from across the agency to collaborate virtually through the use of Web-based meetings. The diversity in skills and viewpoints that are derived from this approach is very much worth any inconveniences that result from not being located in the same place."

Rob Button, lead of Altair power subsystems at Glenn, leads a small team of full and part-time engineers who are working on defining the Altair power subsystem from the bottom up. He credits NASA Administrator Mike Griffin with pulling the centers together and creating a positive environment for change.

"I think we can thank Mike Griffin and his '10 healthy centers' mantra for this agency-wide effort."

"I think we can thank Mike Griffin and his '10 healthy centers' mantra for this agency-wide effort," Button said. "I believe that without the impetus from the NASA administrator to make sure that the work is being spread around to all of the centers this agency-wide effort might not be happening. I hope that the next administrator carries it forward, because I think it is a benefit to the agency."

Propelled for the future

The architectural design of Altair requires a propulsion system that uses liquid oxygen and liquid hydrogen, cryogenic propellants that have never been used in the descent stage before.

The ascent stage will either utilize hypergolic propellants, which are what was used in prior missions to the moon or liquid oxygen/liquid methane.

This design challenge, along with the need to land more people and more mass on the lunar surface, means that the propulsion systems have to be as light as possible – while at the same time being able to support long stays on the moon.

"It creates a very, very challenging engineering problem to create these two propulsion systems that will get us to the moon and back safely," Brown said. "We have to make a system that is as reliable as possible, as efficient as we can make it and affordable enough to develop, test and fly – and that's a hard trade space to work in."

Pictured above (left to right): Artist's rendering of the Altair ascent stage, Altair separating from the Orion crew exploration vehicle, and Altair deployed on the lunar surface.

Less is more

The focus for the Altair structures and mechanisms team is to design the Altair landing gear and the various separation systems that exist on the vehicle – for instance, the system that separates the ascent module from Altair when the astronauts return to orbit, from the lunar surface.

Additionally, the team is also designing the primary structural and mechanism components of Altair. These include the pressurized ascent and airlock modules that will be used for crewed missions to the lunar surface and the descent stage structure.

The descent stage supports the massive lunar lander propellant tanks (nearly 25 metric tons when full), as well as the ascent stage and airlock for crewed missions. It will also support approximately 14 metric tons of lunar cargo for un-crewed missions such as habitats, rovers and other equipment and supplies that will support the buildup of a lunar outpost. Because mass is a precious commodity when going to the moon, the goal is to develop the lightest possible systems while maintaining safety and reliability.

"Apollo faced this challenge, and we are doing the same today, only with a vehicle that is significantly larger and more complex," Collins said. "It has been many years since NASA sent humans to the moon, so there are also challenges related to recruiting and training the workforce required to oversee the development of a new generation of vehicles for lunar missions. So far, the Altair team is well on its way to overcoming these challenges."

One thing that Altair and the LEM have in common is that the laws of physics haven't changed.

The laws of physics

One thing that Altair and the LEM have in common is that the laws of physics haven't changed. Like the LEM, Altair, doesn't have to be aerodynamic – it doesn't actually fly in the classic sense of flying because there is no atmosphere on the moon. The atmosphere on Earth, however, still presents a problem.

"It takes us about 150 kilograms on the launch pad to get 1 kilogram on the surface of the moon," Hansen said. "It's really a very math-challenged vehicle and will continue to be that."

Although technology has definitely advanced since the days of Apollo, in the realm of universal travel that doesn't necessarily make things any easier.

"Everyone says, 'Boy, technology has gotten so much better,' " Button said. "But the majority of the vehicle mass is propellant – and it can't really get better because it is limited by physics. The challenge is to figure out how to squeeze performance out of all the other subsystems that make up a small, mass-fraction of the vehicle and increase its capability. I think that is the biggest technical challenge."

Perfect timing: A workforce in demand

NASA's workforce is as multifaceted as its programs and brings with it skill sets and a knowledge base that will remain in high demand as the agency moves through what some see as its biggest challenge to date – the transition from shuttle to Constellation.

"NASA's budget is going up, not down," Hansen said. "The jobs are increasing, not decreasing. I think there is an incredible amount of opportunities, more so honestly than I have ever seen in the aerospace industry. If you look at the major developments that are going on now we are building a smaller, human-rated launch vehicle (Ares I); a massive launch vehicle (Ares V); a lunar lander (Altair) and the Orion spacecraft – and we are still supporting the shuttle and space station. There is no doubt that we are in a transition, but we are not losing all the jobs. I am more concerned that we are going to be tapping out our trained workers. The challenge is being able to translate one skill base to another."

NASA is counting on the agency as a whole to retire the shuttle and move the space program into the next phase of space exploration.

"We still have the top priorities of flying the shuttle safely and supporting the station, as well as working on Ares I and Orion," Brown said. "If we don't have a team made up from all the centers, where we can capitalize on the experience at each one, we are just not going to be able to do the work.

One of the most valuable resources that NASA is tapping into is the wide knowledge base and years of experience that its workforce brings to the space program from all the programs leading up to Constellation.

...the timing of the final stage of the transition from the Space Shuttle Program to Constellation will provide the best-case scenario for opening up new career possibilities...

"We are involving a lot of people (in the Altair project) who worked on the lunar module when we went to the moon before," Brown said. "If we don't capture the knowledge they have now, then pretty soon they won't be available. There is not a more important experience that you can bring to a project than having worked on something, found the problems and solved those problems. You learn more from failures than you ever will from things going right the first time."

Brown says he thinks the timing of the final stages of the transition from the Space Shuttle Program to Constellation will provide the best-case scenario for opening up new career possibilities for the NASA workforce.

"We are going to run into problems," Brown said. "The knowledge and experience of the shuttle community coming in and helping us solve those problems is going to be critical. Work will be winding down on the shuttle at about the same time we will be getting into the more detailed design work on Altair. People working on the last few shuttle missions have to know that the commitment to fly out the shuttle doesn't put them in the back of the line on jobs – the timing is pretty good."

A dream in the making

The challenges of designing the next vehicle that will take humans to the moon are many, but the thrill of being a part of history can be a great inspiration.

"When I step back from the day-to-day task of keeping our team activity going, I am in awe and extremely excited about what we are actually doing," Collins said. "The future is never certain, and it has been so long since NASA focused its efforts on a mission like this, that you sometimes wonder if it is really happening. But it is happening – and what could be more exciting than being part of humankind's next step into the cosmos? If we are ever able to achieve the elusive-but-incredible goal of making travel to the moon, Mars or beyond common endeavors for mankind, our time may be looked upon as the period when we first began to make the investments and develop the designs necessary to make it happen. Realizing that in some small way I might be making a contribution to this legacy is easily the most exciting aspect of my job."

Brown reflects back on his thoughts following the Apollo moon landing and his life-long desire to work in the space program.

"I always hoped," he said. "I always dreamed. I remember after watching the Apollo 11 moon landing when I was 5 years old, riding home in the car and lying in the back window looking up at the stars and the moon and wanting to be a part of space exploration. I was always fascinated with the moon - so I am absolutely thrilled to have the opportunity to help."

Button describes the excitement he felt when he first began working on the design of Altair and how the significance of his role in the bigger picture of space exploration still amazes him.

"I can remember when the project first started, I would catch myself looking up at the moon at night and just gasping – thinking that I can't believe I am working on something that will be going back there. I was awestruck," Button said. " I have been working on it so long now that it has become another part of my job. But occasionally I get pulled back into the excitement when I run into friends from school or family members and they ask 'So what are you doing these days?' and I reply 'Oh, not much, just helping to design the next lunar lander!"

Editor's note: Lauri Hansen recently changed positions and is now the director of Constellation systems engineering and integration; Kathy Laurini is the acting project manager of Altair.

Program Sharing

While one program winds down, another ramps up.

Pictured above: An artist's rendering of the Ares I on the launch pad at Kennedy Space Center (left) and the space shuttle Discovery lifting off on its STS-124 mission to the International Space Station.

Fred Robertson can never be sure of exactly what he'll be working on when he gets to the office.

"It depends on the week," he said. "Some weeks, when there are breaks on the shuttle, I spend 90 to 95 percent of my time on Orion. But the past few weeks, I've been spending 100 percent on shuttle. It all depends on the workloads on both sides. Sometimes it's 50/50."

Robertson has spent the past five years at the NASA Shuttle Logistics Depot near Kennedy Space Center, testing and repairing the electronic boxes that run the shuttle's systems. But recently Lockheed Martin – the prime contractor for the Orion project – hired United Space Alliance – the prime contractor for the shuttle program, and Robertson's employer – to build some of the ground support equipment for the upcoming Orion test flights. Suddenly Robertson was splitting his time between the old and the new – not that he minded.

"When the new program came in, everybody wanted to work on it, obviously," Robertson said. "It's the future."

Charging time to both programs

Robertson's position is not unique. Of the 2,393 civil servants working for the Space Shuttle Program last quarter, just over a third were working exclusively for shuttle. More than 1,000 were also charging time to Constellation. The exact breakdown of contractors working on both programs isn't available, but the Focus and Brainstorming Sessions that Rendezvous conducted earlier this year indicate that it isn't at all uncommon.

In September, the Space Shuttle and Constellation Programs came together to identify ways that the shuttle program could help Constallation.

And it's likely to become more common. In September the Space Shuttle and Constellation Programs came together to identify ways that the shuttle program could help Constellation. One part of that effort was to develop a plan for civil servant and contractor workforce sharing over the next two years to complete joint tasks that were identified at the meeting.

That's in addition to employees who are already splitting their time, like Sam Ortega, ballistics and motor performance lead for the reusable solid rocket booster at Marshall Space Flight Center in Huntsville, Ala. Ortega has been dividing his time between shuttle and Constellation for the past two years. Right now the breakdown is about 70/30, with shuttle getting the majority of the time, but he expects it to reach 40/60 before the shuttle fleet is retired.

"The choice was made a couple of years ago to share resources between Ares and ourselves," Ortega said. "Many of the motor subsystem managers for the last two or three years have been working both Ares and shuttle."

Rating the effectiveness of workforce sharing

So far, the concept is getting good reviews. In an informal survey of 114 civil servant supervisors conducted in July, 80 percent of the respondents rated the effectiveness of workforce sharing between the two programs as average, good or very good.

There are several advantages to this strategy. For one, it's good for both programs. Constellation, for instance, is able to not only take advantage of shuttle experience now, but also give shuttle employees an incentive for sticking around until the program might need them full time.

"Shuttle has a huge knowledge base," Ortega said. "So it behooves us to keep people energized and excited about their work, confident that they're going to have work. Then we can transition them to the Ares program, and when we we're ready to start flying, that knowledge base is still there."

Holding on, but not missing out

Shuttle, on the other hand, gains a way for its employees to hold on until the end without worrying that they'll miss out on all the interesting jobs. And employees get a chance to add some Constellation work to their resumes without abandoning their shuttle loyalties. Ed Mango, deputy director of the launch vehicle processing directorate at Kennedy, said he has more than 50 workers in launch vehicle processing sharing duties with Constellation for that very reason.

"The workforce here sees a bridge into the future."

"The workforce here sees a bridge into the future," Mango said. "Everybody wants to be able to touch the new hardware. They all love shuttle – shuttle is our bread and butter. But they all want to touch the future stuff."

And speaking of the future, the workers might also be able to make their future jobs easier if they have a hand in its development now. Brad Files, chief of the materials and processes branch in the Johnson Space Center engineering department, said the employees in his branch have already been able to apply some lessons learned from shuttle to their work in Constellation.

"When we were only working shuttle and station, everything was problem resolution – something broke and we'd go try to figure out what happened," Files said. "People weren't sure if we could do something for a new program, because we didn't have that experience anymore. But what I've seen is that having that experience has really helped set up the requirements for the new program. We know the problems someone might have later on if they don't set it up right in the first place."

"We know the problems someone might have later on if they don't set it up right in the first place."

Plenty of lessons learned to share

Program sharing isn't without complications. The same managers who rated program sharing as being effective also had plenty of lessons learned to share.

Mostly, they involved the same problems that one experiences working for any program – only times two. Working for another program means a whole other set of requirements and an extra chain of command. And inevitably there are going to be conflicts between Constellation's schedule and shuttle's.

Constellation's requirements aren't always clear, the managers said; shuttle's schedule is unpredictable; and the two programs seem blind to each other.

Theoretically, some of those problems should be easy to solve.

"With Constellation, there's nothing flying," Robertson said. "That's why shuttle takes precedence over everything – we're still flying."

At the same time, ignoring one customer's needs in order to take care of another is no way to keep your customers.

Having to satisfy both customers

"Now we have to satisfy two customers," said Stephan Ryan, another electronics technician specialist with United Space Alliance. "Everyone pretty much agrees that shuttle is supposed to be our No. 1 priority, but the reality is, you have to satisfy both customers. Lockheed Martin gave us this work and wants to see how well we perform."

Mango said managing the push and pull takes quarterly, weekly and even daily meetings at different levels of management to figure out what each project, team and individual's priority is at any given time.

"The challenge is you have to work resources and priorities," he said. "It's a challenge to make sure we have the right priorities to get both jobs done. It works, but sometimes it breaks down."

"It's a challenge to make sure we have the right priorities to get both jobs done."

Hopefully it will break down less often in the future, however. As a result of the meeting in July, the two programs are working on making the partnership as easy for employees to manage as possible. For instance, a tri-program calendar is in the works, so that if Constellation schedules a big design review at the same time that shuttle is planning to hold a flight readiness review, it will be obvious that there's a conflict. It might not always be possible to reschedule one of the meetings, but at least the two will be aware of the double booking.

Still, even if it always works seamlessly, program sharing won't be the magic pill that instantly relieves all fear of transition. Doing a little for the new program can't hurt, but it doesn't stop you from wondering if doing a lot might still be better in the long run.

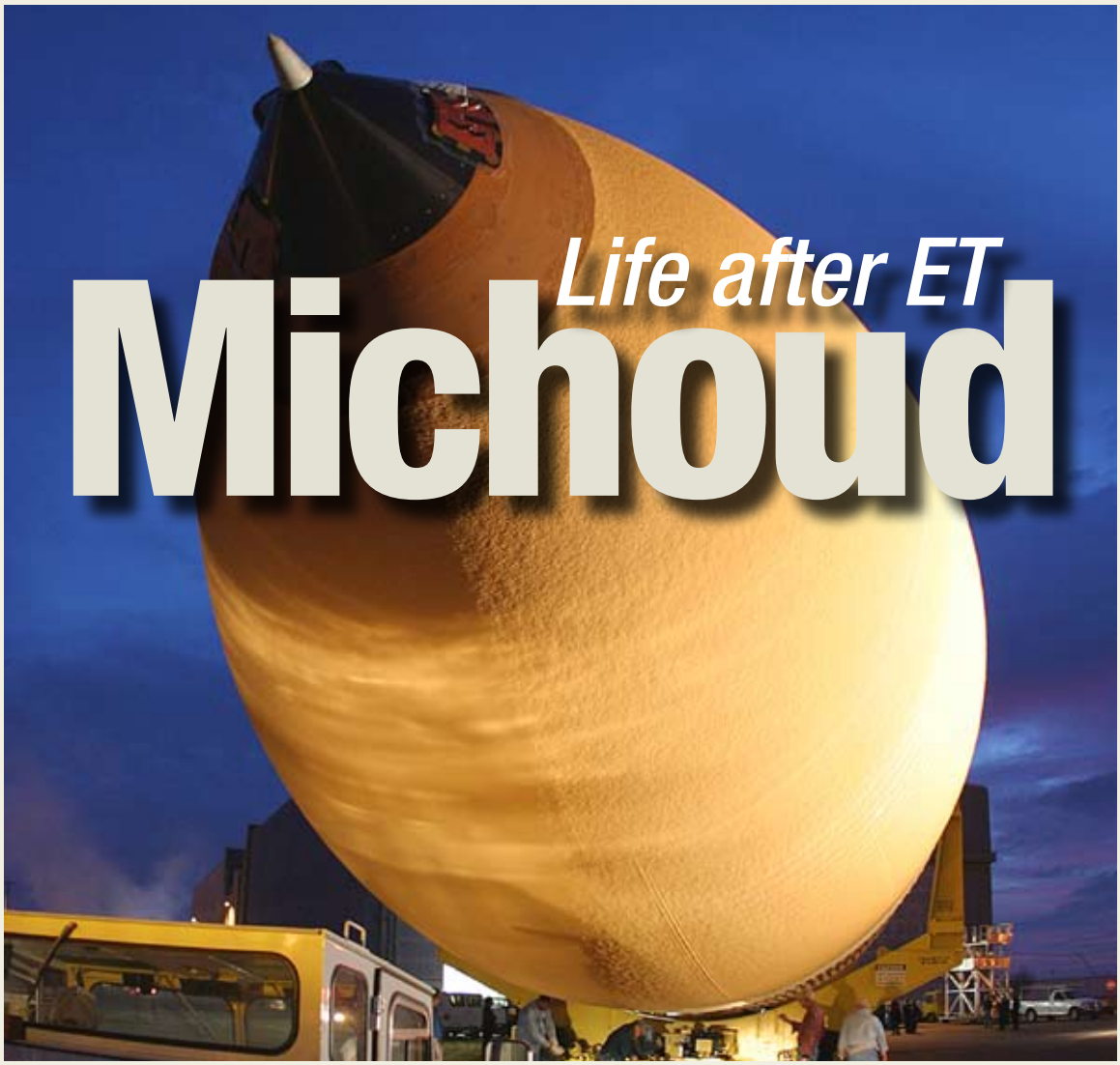
Even with the work Robertson's doing on Constellation, that's a question he asks himself every day: Move on now or wait and transition in 2010? There are only two or three people left in his area who are qualified to do the work on his systems – systems the shuttle will need until the last flight. But he's young enough that he'll still have a lot of career ahead of him after wheel stop in June 2010.

...even if it always works seamlessly, program sharing won't be the magic pill that instantly relieves all fear of tansition.

Working to have the best of both worlds

So far he's answered that question by working to put himself in the right place to have the best of both worlds.

"I think Constellation is going to need people – hopefully like myself, but definitely some of the people I've worked with," Robertson said. "The people don't change. The companies change and the badges change, but it's still the same people. I've worked with people who have been here since Gemini. Hopefully they can capture some of that and pass it on to the new program. Or we can take it to the new program with us."



Michoud

Life after ET

What does the future hold for one of NASA's most impressive facilities? Lots of potential.

The external tank destined to launch the last shuttle flight in the history of the space program is already in production at Michoud Assembly Facility and has been for about a year. This is really not surprising when you consider that an external tank takes 36 to 42 months to manufacture.

Scheduled to leave the facility in the spring of 2010, its departure will bring down the curtain on a 35-year run for the external tank program. But not on the facility that has, in effect, turned out one product for the same prime contractor for decades. Rather, Michoud Assembly Facility has a promising future. So does its committed workforce.

As one program winds down, Michoud is already assuming its Constellation Program role as NASA's assembly facility for the Orion crew vehicle and the Ares I upper stage. In doing so, the facility and its workforce are facing some of the most complex challenges in the space program today.

Logistically, how do you make room for Orion and Ares I upper stage when the entire facility has been dedicated to the external tank for so long? There is new tooling to consider and floor plan puzzles to solve. Workforces from rival companies will need to share space and work side-by-side — Lockheed Martin on the Orion crew vehicle and Boeing on the Ares I upper stage. Programs and people will overlap. And as the ET program winds down, can the necessary skills be retained to work the next generation programs?

These are the issues that NASA's Sheila Cloud, Chip Jones and Pat Whipps, and Lockheed Martin's Mike Javery have been addressing for the last couple of years.

Pictured above: An external tank in a manufacturing bay at Mchoud Assembly Facility.

...communication about what the future holds for the extended Michoud family is key.

Communication is key

Michoud's civil servant/contractor workforce is a tight knit group of dedicated and passionate people. They take care of their own through thick and through thin, so to describe them as a family is quite appropriate. Katrina proved that point and Gustav just reinforced it. Making sure that Michoud's people are informed, prepared and ready for the changes ahead is a priority for both NASA and their prime contractor at Michoud, Lockheed Martin. Therefore, communication about what the future holds for the extended Michoud family is key.

"We've been holding the equivalent of general assemblies at the facility to let our people know what's coming," said Jones, Michoud's chief operating officer. "We inform them about key announcements and events that will impact them, positively or otherwise."

They also talk to people in small groups, do walk-throughs of all the production and administration areas of the facility to answer questions to the best of their ability. When they don't have an answer, they'll run the question up the line to get the level of specificity needed to better understand the issues facing their workforce.

Pictured above: ET-120 is raised from horizontal to vertical in the 400-foot high bay.

"It's a challenge," Jones admits, "because the kind of angst that relates to one's livelihood is always going to be an emotional drain."

The other side of the issue is that they also need to do everything they can to keep the workforce focused on the task at hand and recognize just how important and critical their work really is.

"We're almost in a ship 'n' shoot mode," Jones said. "As goes the external tanks, so goes the shuttle manifest. We're working hard to motivate the workforce to stay plugged in despite the knowledge that their program is coming to an end."

"We're working hard to motivate the workforce to stay plugged in despite the knowledge that their program is coming to an end."

Communicating the status quo in as much detail as is available and as frequently as possible is one way to make sure that their folks can make well-informed decisions regarding their futures. And sometimes the news is not all good. The ET workforce will be subject to reductions as the ET builds wind down. After the Constellation manufacturing tasks ramp up, they expect to get back to the same basic population levels at Michoud.

As NASA's resident ET manager for Michoud, Pat Whipps is tightly tuned into the day-to-day mood of the workforce and how it affects their output.

"I would say that morale is holding steady," Whipps said. "It's obviously not buoyant, but it's not at a place where we believe we can't perform the mission before us. Despite the general knowledge that there will be reductions in force, our folks are focused. They know that everything they do has an immediate effect on the American space program. After all, the ET is clearly visible every time a shuttle gets to the launch pad."

Artist's renderings of the Orion crew exploration vehicle (above) and the Ares V heavy cargo launch vehicle and the Ares I crew launch vehicle (left).

Plenty of pride and passion

For the ET prime and the facility's operator, the changes will be significant. Mike Javery, vice president of operations for Michoud on the Lockheed Martin side, emphasized that his company's first concern was for the workforce.

"Once we realized that the external tank production was ramping down, our immediate focus was to the employees. We started planning activities to the keep our people energized and morale as high as possible because safety of flight is our first priority," Javery said. "One thing we have at Michoud is plenty of pride and passion for our work. We even adopted our own vision statement that says 'We will fly out with pride, passion and integrity, and together we will build our future.'"

In order to do that, the critical skills from the ET program that will be required for the coming Constellation work have to be kept at Michoud. Or at least, have to be kept in the area so they can be accessed when the Orion crew vehicle, the Ares I upper stage and the Ares V get up to speed in the 2010-2012 time frame. Lockheed Martin and NASA devised an employee completion plan for key employees to encourage them to remain onboard to ensure successful fly out for shuttle and assure skills retention for the benefit of Constellation.

"We've worked very hard with NASA to shape our employees' futures," Javery explained. "There was a concern that people might choose to leave the program early. But with the employee completion plan, every time we deliver an external tank, every time a tank is flown and every time a shuttle is returned safely, an employee accrues a certain amount that they can walk away with at the end of their tenure at Michoud."

More than a paycheck

It doesn't end there. According to Javery, financial gain is really not the motivating factor keeping the ET workforce on task and in place.

"Constant communication is key," said Javery, echoing his NASA counterparts. "Town hall meetings, breakfasts, our closed circuit TV system where we provide answers to frequently asked questions, general assemblies, those are critical to letting our people know that we care about them, their families and their lives."

Javery believes that both Lockheed Martin and NASA have done a good job of demonstrating to the Michoud workforce just how important human capital is to them.

"When you think about a program that's gone on as long as the shuttle program, it's more than a paycheck that keeps people here."

"When you think about a program that's gone on as long as the shuttle program, it's more than a paycheck that keeps people here," Javery said. "So you have to help them decide what's best for them in the next two to three years, until the next program needs their skills and the new vehicle actually flies."

But what will it be like to have multiple programs and multiple contractors vying for space at MAF after having ruled the roost, so to speak, on the ET program for more than three decades? Javery is quite clear that it will be a big change, but – if history is anything to go by – a positive one. "Michoud had three or four tenants back in the 1960s," he recalled. "Boeing was here. So were Chrysler and Martin Marietta. Change is good. Competition brings out the best in us. It's all about who can bring the best product forward. If we do our jobs and we're successful, we'll have shaped the future for a lot of employees who will be able to retire on the Constellation programs at Michoud."

Pictured above: Michoud Assembly Facility main building viewed from the air.

Balancing act

From Sheila Cloud's perspective as Michoud's transition manager, transition is all about transforming Michoud from a single program customer facility to a facility that is able to support multiple customers. The challenge there is that the customers are all supported by prime contractors who are fierce competitors.

Futhermore, it will be a balancing act between the allocation of real estate under Michoud's 42-acre roof, accommodating the established certified processes and providing the newest and most efficient processes for the facility's new customers. Cloud said that it will look like a dual system for a short period of time, but it will be a necessary duplication.

"You have to have an objective third party broker, a mission independent contractor as the facility operator," Cloud explained. "The important thing to remember is that Michoud has to support ongoing hardware production at the same time that we're setting up tooling and structures for the Constellation customers — and we have to make sure that nothing we do, no matter how insignificant, disrupts any of our customers."

The concept of operations for the transformed Michoud has taken about a year to develop. It covers the critical processes for ET and has agreement from the new customers, the program and the contractors as to how they will operate within the facility. And it's quite specific.

"It goes all the way down to drawings of equipment or tooling and says, 'on this side of this line, the new facilities operator will maintain this piece of equipment, and on the other side of the line, Lockheed Martin or Boeing will maintain and operate this piece of equipment,'" Cloud said. "What's amazing is that we got concurrence from all the projects, project managers, all the way up to Gerstenmaier and Gilbrech, and then went back and worked all the issues to resolution."

Not your ordinary manufacturing facility

This concept of operations was included in the information that went out with the Request for Proposals for the new facility operations contract.

"We wanted to make sure that this new contractor knows and appreciates that Michoud is not just a manufacturing plant that bends metal and pushes it out the door," Cloud said. "Michoud is a manufacturing facility that supports human-rated flight hardware, which means that processes are certified and the way things are done is much more structured than other industrial manufacturing situations."

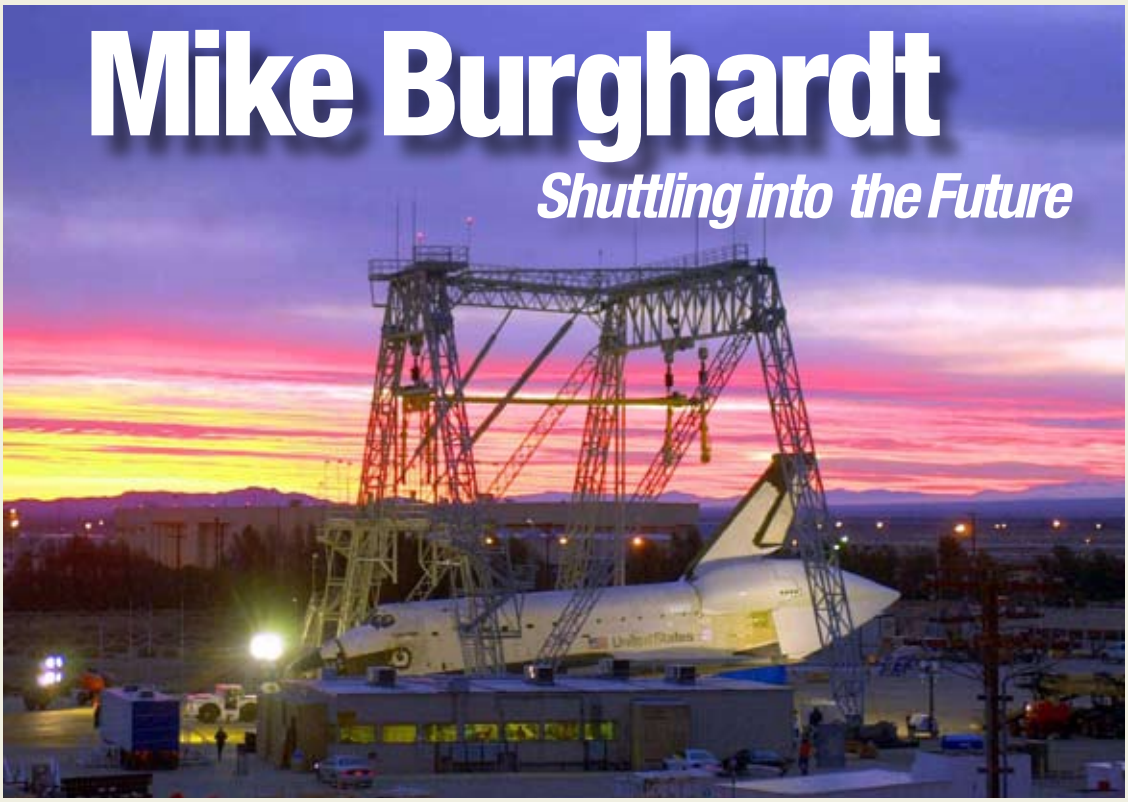
The new facility operations contract will be awarded in December. After it's awarded there will be a 60-day transition period during which Lockheed Martin will hand over Michoud's reins to the new operator.

"Even though the shuttle program is ending, this is really the beginning of the future for Michoud," said Javery. "I see lots of opportunity for us here. Michoud is the largest and only manufacturing facility that can support all of NASA's programs. When you consider the multiple tenants and programs we will have here in the next three to five years, it's a great thing."

Pictured above: No ordinary cargo, ET-126 rolls out to be loaded on the Pegasus barge for its six-day sea trip to Kennedy Space Center.

Mike Burghardt

Shuttling into the Future



A Career in One Program, Looking Forward to the Next.

Pictured above: The Orbiter Lifting Facility in Palmdale, California.

Mike Burghardt remembers Palmdale, Calif., well. He was on his way to a job interview at Rockwell on the B-1 Bomber program when he saw an SR-71 Blackbird take off. And then, just across the runway in a cluster of hangars, he noticed the tail assembly of an orbiter visible in the high bay of the Orbiter Assembly Facility.

Mike Burghardt (seated) and Bo Bejmuk (standing) support the STS-114 Return to Flight mission from the Mission Evaluation Room at Johnson Space Center in late July 2005.

In tln effect, his first two Palmdale impressions sealed his fate and determined the direction of his career in the space program. It didn't come as a surprise to him. Palmdale was aerospace with a capital A. And after growing up watching the achievements of the Apollo program, totally captivated by the notion that a ship could be built that could carry man to the moon, he knew what he wanted to do with his life. In fact, the quote in his 9th grade yearbook attributed to him says he planned on working for NASA. Everybody knew where he was headed. So Rockwell and Palmdale were pretty close to his life-long ambition.

Self-steered into space

To this day, Burghardt considers himself a typical engineering geek. He grew up in suburban Chicago, watched the moon landing on the TV in his parents' basement where the challenge was to get the rabbit ears antenna "just right," and steered his studies toward his dream. His high school class load was heavy in math and sciences. He was into Star Trek, baseball and the German Club. At the University of Illinois in Champagne-Urbana (and later at Embry-Riddle in Daytona, Fla., for work on his master's degree), he majored in aeronautical/astronautical engineering. While at school in Illinois, he lived just off campus in a house with nine roommates — seven of whom were also engineering majors (imagine a mechanically inclined Animal House).

Pictured above: An SR-71A, or Blackbird, viewed from an aerial tanker.

Burghardt's career in space actually started rolling to the launch pad when, as an officer of the student branch of the American Institute of Aeronautics and Astronautics, he played host to a recruiter from Rockwell and wound up with an invitation to visit the B-1 Bomber plant in Palmdale for a job interview. With a little coaxing from an SR-71 and the aft-end of Atlantis, his destiny was determined.

Burghardt went to work on the hydraulic and mechanical systems of the B-1 Bomber program, which was turning out the monster aircraft at a rate of four per month. He was responsible for running check-outs on all the non-flight control-related mechanical systems after the aircraft came out of final assembly.

"I was working the second shift in January 1986 when Challenger happened," he remembered. "I called a friend of mine who worked in orbiter assembly at Rockwell. We were in total disbelief."

The Palmdale orbiter assembly facility had already been partially deactivated at that point since the orbiter build program had wrapped up in 1985 with the completion of Atlantis and initial modification of Columbia. After that, the facility was being used mostly for storage of GSE and tooling from orbiter builds. But after the accident investigation and the Rogers Commission Report, the agency reactivated the Palmdale assembly facility to build Endeavour, using previously built structural spares.

Burghardt was determined to participate in the build effort, contracted to Rockwell in Palmdale. By the time the orbiter assembly facility was completely reactivated, Burghardt had made his move.

Building Endeavour

"I got on to Rockwell's Endeavour build team before the mid-body was situated in its assembly position," Burghardt remembered. That was October 1987 and it would take a total of 44 months to build the last orbiter of the shuttle fleet. Burghardt has vivid memories of that time. To see all the pieces and subsystems come together is something he'll never forget.

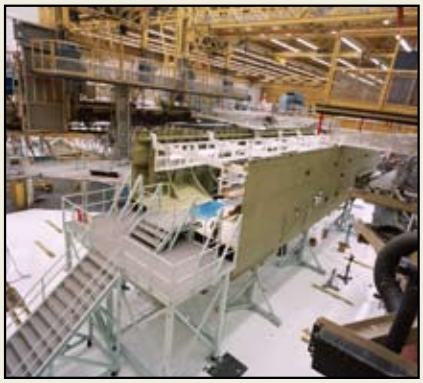
"We didn't have too many people working in Palmdale at the time, so everyone did a lot of extra things that wouldn't normally be part of your job," he said.

For example, he volunteered to go get the orbiter's wings. Literally.

"The wings were constructed on the east coast and were shipped to California via the Panama Canal," Burghardt explained. "I was one of the volunteers who went down to the port at Long Beach and escorted the wings all the way back to Palmdale. It took seven hours. We had to come up the back

Pictured above: Endeavour's mid-body begins to take shape in the Orbiter Assembly Facility.

roads, which were all closed off to regular traffic, to the assembly facility where the wings were mated with the mid-body."



Pictured above: Endeavour's nose is lifted into place during assembly. Burghardt is one of the men visible in this picture.

Another crystal clear memory is looking up at the green surface of the orbiter's belly before the black ceramic thermal tiles had been affixed.

"There was this expanse of belly with a tiny group of tiles bonded to it," he remembered. "Then there were more little groups of tiles here and there. We were watching it grow. And then when we were finally ready for the roll-out, I remember how brilliantly white and clean it looked – the white thermal blankets and the black tiles. It was awesome."

Appreciating all the nuances

Participating in Endeavour's build gave Burghardt a true appreciation for how all the pieces came together and for the engineering nuances of an orbiter.The Orbiter Lifting Facility at Palmdale in action. For example, he doesn't think many people outside the shuttle program are aware of the actual curvature of the wings. To the casual observer, the wings look kind of short and stubby. But to Burghardt, the dehidral shape of Endeavour's wings was nothing short of design elegance.

Pictured above: The Orbiter Lifting Facility at Palmdale in action.

In 1990, Endeavour came off the line at Palmdale and Burghardt went to work on the J1 modification of Columbia.

Palmdale remained his home until 1992 when he transferred to Rockwell's Downey facility in southeast Los Angeles to continue working on the Space Shuttle Program as one of the main propulsion system's component engineers. He worked in Downey for only a year before he was asked to move to Houston to help establish a Rockwell design presence in close proximity with their customer, NASA.

Getting and staying close to the customer

"We knew we needed to work side-by-side with our NASA customer," Burghardt said. "A few of the guys who moved to Houston at that time are still here. Not all of them with the same company or in the same capacity, but they're all still in the program."

So after seven years in the high desert, a year in Los Angeles at Rockwell's bustling Downey facility, Burghardt found himself in Houston, still working on main propulsion system components, which he describes as "all the plumbing that's in the back of the orbiter between the external tanks and the main engines."

"Houston is the heartbeat of the space program, so that's where I wanted to be," said Burghardt. Working at Johnson Space Center allowed Mike and his team to interact with their NASA engineering counterparts, the orbiter project office management, Mission Control personnel and the flight crews. They also supported flights as part of the orbiter project engineering support team from the Mission Evaluation Room.

"Houston is the heartbeat of the space program, so that's where I wanted to be."

"This close proximity to NASA afforded us a quantum leap of insight into the program and where NASA wanted to go," he recalled.

In 1997, after United Space Alliance was formed as the joint venture between Rockwell and Lockheed Martin to handle the Space Flight Operations Contract, Burghardt received an offer to go to work as the fluid propulsion systems manager. In effect, he carried project management responsibilities for the shuttle's fluid systems, including the main propulsion system, the orbiter maneuvering system, the reaction control system, the power reactant storage distribution system, fuel cells, hydraulics and auxiliary power units.

From USA to Boeing and Bo

It was heady work for Burghardt. He managed the work content and made sure that issues progressed toward resolution. He worked with the Rockwell subsystem managers, interfaced with "the Cape," with logistics and with the new design projects, such as long life fuel cells that would have increased the life of a fuel cell from 2,000 hours to 5,000 hours. By 2002, he had become so familiar with the inner workings of the shuttle program that he was asked to return to work as chief team engineer with vehicle operations with the Boeing Space Shuttle Program (formerly Rockwell). Not long afterwards, he became Bo Bejmuk's deputy program director.

"Working with Bo was always an adventure, always interesting," commented Burghardt. "I learned about staying close to our customer from him. He had a deep understanding of what was really important to the customer. At the same time, he never put any limits on what I could do, never undid anything I did and was always encouraging."

Then Columbia happened. In the realm of human spaceflight, everyone's world changed, and everyone stepped up. After helping with the debris recovery efforts, Burghardt became responsible for the Boeing Space Shuttle Program's return to flight activities. Throughout the two and a half years of RTF activities, he worked two full-time jobs. He was Bejmuk's deputy, but he was also "Mister RTF." Month by month, he rode herd on Boeing's return to flight activities mandated by the Columbia Accident Investigation Board, coordinating with the customer, and doing his part to make sure that STS-114 and all subsequent missions would be the safest ever. Gradually, the stoplight charts that monitored RTF progress turned from all red and yellow to green.

In early 2004, almost a year and a half before the shuttle fleet returned to flight, President Bush briefed the nation on his Vision for Space Exploration, spelling out the retirement of the shuttle in 2010. To many in the shuttle program, civil servants and contractors alike, the announcement, while exciting, was also somewhat disheartening — return to flight and retire the program. However, Burghardt felt it was time for a new objective.

Fight patches for STS-107 and STS-114.

Committed to the shuttle, but time to move on

"As much as I consider myself a 'shuttle hugger,' I really believe it's time to move on," Burghardt said. "We need to be doing something more than flying to low Earth orbit."

But as exciting as a moon-Mars objective is, Burghardt remains committed to flying out the shuttle manifest. Today, as Boeing's Associate Program Manager for Vehicle Operations, Burghardt is an example of someone whose job is to stay focused on the task at hand: flying the remaining shuttle missions safely.

> **"As much as I consider myself a 'shutle hugger,' I really believe it's time to move on."**

"I make sure that we resolve any problems that may arise, fully understand any previous failures and their consequences and how they may apply to our hardware or impact our ability to get the next orbiter ready to fly," he explained.

Looking forward, Burghardt is a bit concerned about the erosion of Boeing's considerable human spaceflight knowledge base. "Attrition could be a problem," he allowed. "Holding on to our expertise and keeping it available for the Constellation Program will be a challenge. There are amazingly sharp fresh-outs who are eager to work on Constellation. But as capable as they are, you can't just turn them loose and expect them to be instantly productive. That's where we need to retain expertise — especially our awareness of lessons-learned."

As for his own destiny, Burghardt says that he hopes to continue with the space program, but the landscape has changed.

"We became terribly spoiled with the longevity of the shuttle program," he explained. "Back in the early years of the program, work on the shuttle was geographically packed into a relatively compact area in California. You could hop from company to company and never leave the program."

But now, with the shuttle program winding down and a new program taking shape, the future feels a bit more uncertain to Burghardt.

"Boeing is a big company with lots of different programs," he said. "So I'm fairly sure that I could land on another aerospace program. And since we don't have a lot of family in the Houston area, we could pick up and move if necessary."

But for the next 10 missions, Burghardt and his family will stay put.

"Now is not the time to panic," he said. "We've got missions to fly. Safely."

Bohdan "Bo" Bejmuk: Another True Space Program Legend

Just about everyone who ever worked on the Space Shuttle Program knows Bo. Now retired, he was involved in the space industry for more than 30 years. He was part of the original Rockwell team that designed and built the orbiters, was lead engineer in the vehicle structural dynamics area, led the effort to define the operating environments for the orbiter vehicle prior to first flight and was instrumental in validating the analysis math models that cleared the shuttle for flight.

During his long career in human spaceflight, he was manager of Rockwell's Space Shuttle Systems Integration, was instrumental in the development of the Day of Launch ILOAD Update system to improve launch probability and lead a portion of the Performance Enhancement project to increase the lift capability of the shuttle to support the International Space Station construction. He also helped implement the shuttle/MIR program that allowed NASA to learn about long duration spaceflight. In 1997, he left the shuttle program to serve as chief engineer for the Sea Launch Program, the joint venture between Boeing (Rockwell), the Russian company Energia, the Ukranian companies Yuzhnoye and Yuzhmash, and the Norwegian company Kraerner. In 2001, he became Orbiter Program Director for the Boeing Space Shuttle Program. And in May 2006, Bejmuk was named Boeing's chief engineer for the Constellation Program. Now retired from the company, Bejmuk remains a fixture in the Clear Lake area around Johnson Space Center in Houston.

Managing Transition from the other side

Linda Ham

Blessing or curse, in her work as the Constellation Program transition manager, Linda Ham is living that old saying "may you live in interesting times."

"It's interesting times for us," she said. "We're at such a challenging point, going from one flight program to another."

Technically, the Constellation Program isn't transitioning; it's a new program, so there's nothing for it to transition from. But you'd never guess that from Ham's workload. She goes to transition meetings with the Headquarters transition managers, transition meetings with the shuttle program transition managers and transition meetings with the Johnson Space Center transition managers. Then she goes back to her office and tries to figure out how all of it affects Constellation.

"We're on the receiving end," Ham said. "If we're not paying attention to what we're receiving, then we're not going to have the facilities, personal property, workforce skills, and suppliers that we need to support our program. We'll be holding the bag. We cannot afford to be uninvolved and just let it happen. Otherwise, after shuttle retirement, whatever they kept we have and whatever they didn't think we'd need we wouldn't have."

A large part of Constellation's future

Shuttle's legacy is a large part of Constellation's future. The program isn't going to go out and hire a whole new workforce, build all new buildings and equipment and find a new supplier base. It doesn't have the money to do that and wouldn't want to even if it did. But that doesn't mean it's ready to slip into the hole shuttle will leave, wholesale.

"We don't want to take all of the personal property that shuttle has, because some of it we won't need," Ham said. "Like an orbiter wing. Nuts and bolts. Since we have to pay for transporting it, storing it, logistics and record keeping on all of the hardware that we keep, if we don't need it, we should get rid of it. If we hang on to it, in the end, we'll have to pay to dispose of it if we don't need it. And we don't have any extra money."

Determining the shuttle property and equipment Constellation does want to hold on to is the big task on Ham's to-do list right now. The shuttle program finished the first phase of its Transition Property Assessment in September. The assessment determined what property will be left over when the program ends and their best guess at where it should go from there.

Shuttle came up with 1.2 million line items sorted into categories: to Constellation, to another program, to excess or to the scrap pile. Now it's Constellation's turn to take a look at those initial recommendations and see if they want what their shuttle counterparts thought they would want and whether anything that they expect to need was left off.

That's one of the four major questions that make up Ham's job. She's spent most of her first five months on the job gathering information to help answer another: Which of shuttle's facilities will Constellation need? It's actually even more complicated than trying to pick and choose what of shuttle's equipment might come in useful.

It's been said from the beginning that Constellation should cost less to operate than shuttle. That means that it should need fewer resources such as facilities. However, if Constellation isn't paying for the facility, it might mean that the agency loses that facility's capability all together. So it then becomes an agency-level decision as to whether that capability can be given up.

The future according to ERIC

But for the agency to make that decision, they need to know which facilities Constellation won't need. To answer that the Exploration Systems Mission Directorate started the Exploration Requirements for Institutional Capabilities study not long after Ham came on the job. Each Constellation project started with a blank sheet of paper and made a list of what facilities it will need and when it will need them and how certain it is of that need. Now Headquarters can go down the list, figure out what facilities aren't on it or won't be needed for several years and decide whether the agency can afford to lose the capability that goes with it for now or for good.

Each Constellation project started with a blank sheet of paper and made a list of what facilities it will need and when it will need them and how certain it is of that need.

"It's really a cost/benefits analysis," Ham said. "In some cases, if you don't need it for four or five years, it may be better to let it go and rebuild it. Or we may be better off letting it go and buying it in industry if it's available. On the other hand, there are certain capabilities that we have at NASA that are so unique we should keep them. White Sands has many of those critical capabilities."

The other two major transition questions are workforce and suppliers. The supplier question is hard to address at this point, because contractors pick their own suppliers, and Constellation hasn't even chosen all of their contractors yet.

Common workforce worries

But people have been working on the workforce issue for several years now. Constellation has the same workforce worries as shuttle, but from the opposite side. Both want to be sure the employees with critical skills are still here when they're needed, and for both the main obstacle to that is the gap between the last shuttle mission and the first Constellation flight. Shuttle needs employees to stick around despite the gap, and Constellation needs them to be there on the other side of it.

Both want to be sure the employees with critical skills are still here when they're needed...

"We need them back," Ham said. "From a Constellation standpoint on workforce, what's important to us are the critical skills. And not just at the major spaceflight centers that shuttle uses. We're a 10-center program, so we work with all the workforce issues."

The solution turned out to be joining forces with shuttle.

Cross-program collaboration

"We're working hand-in-hand with shuttle," Ham said. "This is really new. They're doing some tasks for us at Michoud Assembly Facility for skills retention. They're modifying test stands at Stennis Space Center to accommodate both main engine testing and J2X. It's amazing how much we're collaborating."

Ham said she thought a lot had been accomplished in the past five months. And she thinks that the rest of the work can be finished in the two years left.

"Transition will be nearly over at the end of shuttle flyout," Ham said. "They'll still have retirement work to do, but by then we'll know what buildings we're in and what equipment we're using. So five years from now, it should be over and done with, and we'll be well on our way into operations and development for the lunar mission. Which is where we'd like to focus."

Weighing In

Quips & Quotes

For this issue, we polled Rendezvous subscribers and previous participants of Focus and Brainstorm Sessions conducted at centers across the country on certain top-of-mind issues, such as what the future holds for the space program and what challenges are looming on our horizons. We also sat down with a group of interested participants from Johnson Space Center to discuss some of the same issues.

If you'd like to weigh in with your two cents, or you have questions you, you'd like to ask your colleagues, the Rendezvous readership, please feel free to use the feedback buttons. Your responses, if used in subsequent issues of Rendezvous, will be kept anonymous.

- How do you think a new political administration will impact the Vision for Space Exploration?
- Now that 2010 is less than 24 months distant, what are your feelings about the future of human spaceflight?
- What do you think will be NASA's greatest challenge in the coming year?
- After the retirement of the shuttle, what would you like to be doing, and what do you think you will really be doing?
- Have your personal career goals changed since the announcement of the Constellation Program?
- Do you think recent non-American space achievements herald another space race?

How do you think a new political administration will impact the Vision for Space Exploration?

I would hope that additional dollars would be made available, but with the economy as it stands, I don't see that happening.
–MSFC

I think the new administration will need to be introduced/reintroduced to the space industry and how it benefits the country, and reminded in a positive way of the part that space plays in keeping the U.S. a world leader. The new leader will have his own set of values and visions as to where he thinks the country should go and how to get there. I can only hope the new leader takes the time and realizes what has made this country a world leader — space plays a vital part in keeping us on the cutting edge. The willingness to take that bold step or initiative, and the country getting behind the space industry will continue to keep us at the forefront of space exploration and discoveries.
–JSC

What happens in the nation's Capitol could redirect NASA.

Up until recently, they weren't saying much about the space program. No matter who wins, it'll be a mess for a while.
–JSC

With the current massive bailout that is a result of regulation being abolished years ago, I don't see any way that a new administration can increase NASA's funding.
–MSFC

"But after November, everything could change."

I think both candidates are encouraging, but probably the support is there because Florida is a swing state... I'm encouraged that President Bush signed House Resolution 6063 [Soyuz extension]. But after November, everything could change. I just hope the candidates follow through with their commitments.
–JSC

I am hoping that we will get more funding to continue to be No.1 in space exploration. With the economy down now, I don't think the new administration will want to make it worse by cutting another 10,000 jobs from Americans.
–KSC

It's hard to identify positive support for NASA. I feel like the candidates were forced to state opinions.
–JSC

The fact of the matter is that NASA is subject to redirection every four years.
–JSC

It depends on who it is and if the government is solvent. Shuttle will be extended as long as is physically possible at this point.
–KSC

"Hopefully, Congress will continue to be supportive of manned space flight."

I have strong concerns about a new political administration and its impacts on our future. Times are tough right now, and a new administration is going to have a full plate of issues to work. Hopefully, Congress will continue to be supportive of manned space flight.
–JSC

I think the new administration will extend shuttle for another couple of years until commercial vehicles like Falcon by SpaceX can be contracted to take up on the functions of the space shuttle.
–KSC

Both presidential candidates have expressed support for continuing on our present path of shuttle flyout and Constellation development — and I am taking their word for it. I have heard nothing to indicate a radical departure from the current path. The most likely change would be to the current timeline – e.g., that the major Constellation goals of first Orion flight and first lunar flight would be delayed.
–KSC

Now that 2010 is less than 24 months distant, what are your feelings about the future of human spaceflight?

I believe the future of human spaceflight is in serious jeopardy.
–KSC

In 10 years, we'll look back and realize that the shuttle was the best vehicle we ever had.
–JSC

Let's just say that I'm hopeful that we will continue with manned flight.
–MSFC

"Human spaceflight has a long way to go and many great missions to maintain, accomplish new goals and to look forward to the future…"

With 2010 less than 24 months away, now is the time to keep our skills sharp and remain diligent in our missions in space and to keep safety at the forefront of every mission. Human spaceflight has a long way to go and many great missions to maintain, accomplish new goals and to look forward to the future... Each mission has the possibility to provide a building block on which a new life-saving find will have applicability here on earth.
–JSC

We should always have access to space. It's simply not acceptable to have these down times. When we aren't flying, collectively we get this sinking feeling. We want to be putting people in space.
–JSC

I feel that the U.S. will, for the first time in the history of the human spaceflight program, be taking a back seat to the Russians and the Chinese. This is the result of less-than-needed funding by the administration and Congress, poor planning and communication by NASA leadership and a lack of general interest by the U.S. taxpayers for the human spaceflight programs.
–USA

The Earth's moon.

I just don't see Americans getting excited about sending astronauts to Russia to be launched into space.
–JSC

I put my money on the Chinese.
–MSFC

I feel a lot of anxiety. I feel like my life is on hold. I don't want to have another baby because I don't what to have babies and no job. So until we know if there will be jobs, my family is just sitting and waiting.
–KSC

Human spaceflight will carry on just fine, whether it comes from the U.S., Russia, India or China. Ending the shuttle program is a necessary step to achieving greater things.
–JSC

"Ending the shuttle program is a necessary step to achieving greater things."

Human spaceflight should continue for years to come. Space exploration inspires young generations to study engineering and science careers that, in turn, give us a competitive advantage in the world economy.
–KSC

I have a level of uneasiness and uncertainty caused by the gap of no U.S.-manned launch capability. The problem is clear and well documented — the solution, not so much.
–KSC

People are going to look at the gap as NASA mismanagement and that's not fair. None of us think not flying is acceptable.
–JSC

What do you think will be NASA's greatest challenge in the coming year?

Getting the dollars to work shuttle as well as Constellation.
–MSFC

I believe the greatest challenge will be getting funded for the continued development of the Constellation program, while safely continuing the shuttle program.
–KSC

"...getting funded for the continued development of the Constellation program, while safely continuing the shuttle program."

Making sure our workforce stays on.
–JSC

The greatest challenge for the coming year will be to get a solid commitment from the new president and Congress and to deal with the changes in the flight schedules.
–JSC

Maintaining a necessary skill base to safely operate the remaining space shuttle flights.
–JSC

I have a lot of people who are already looking for other work because of their uneasiness about their futures in the space program.
–JSC

Testing Ares and finding out that there are going to be massive cost overruns and time delays.
–MSFC

Attrition rates have dropped the closer we get to the election. After Christmas, I think we'll see more attrition.
–JSC

People need assurance... they're looking for some kind of operations strategy for Constellation to give them some idea of what will be needed down the road.
–JSC

Pictured above: An artist's rendering of an Ares I launch.

To keep skilled employees needed to fly out shuttle and to compete for the next contract.
–KSC

The greatest challenge going forward is to regain the support and capture the attention of the American public. People need to understand the importance of space exploration and the mysteries that are discovered daily.
–JSC

NASA's greatest challenge will be trying to increase their budget to continue flying shuttle and develop a new vehicle to replace it. The budget will not be sufficient to do both unless Congress increases NASA's budget.
–KSC

It will be the same thing it is every year — getting the word out on what NASA can do for our country. I do not think that NASA is doing enough to tell taxpayers how NASA improves their lives. The technological advances that we make when we plan for the moon and Mars, the improvements we have made in the recent past... if people don't know, why would they care?
–JSC

**"Workforce challenges -
a combination of attrition and distraction,
both resulting from job uncertainty."**

Workforce challenges — a combination of attrition and distraction, both resulting from job uncertainty.
–KSC

After the retirement of the shuttle, what would you like to be doing, and what do you think you will really be doing?

I would like to be a part of the Constellation Program.
–KSC

I would like to continue working for the space program. I will probably remain in my current position unless something more interesting becomes available. I currently work for the business office of a NASA contractor... I would like to have a more direct involvement with the development of the new spacecraft.
–SSC

"I would like to have a more direct involvement with the development of the new spacecraft."

Working on a different, well-funded, well-planned and well-managed follow-on program... but I think I'll be laid off as a result of the retirement of the shuttle.
–JSC

Enjoying retirement.
–MSFC

I would love to stay here ultimately, but I will have to look for another job in the area or possibly relocate if nothing is available... which is what I fear. If the space program is not here, it will have a domino effect on every business in the area.
–KSC

I hope to be doing what I am now — working on Orion. We should all be looking forward to new technical challenges and developing new skill sets.
–JSC

I'll continue to work on rockets.
–KSC

I will support NASA-KSC ground processing of Orion and Altair. Our team's experience in ground processing of ISS elements is unique and high value to NASA. NASA will recognize the importance of maintaining continuity and skill retention from SSP to CxP, and shape future operations concepts to keep the ISS ground operations skill base intact to improve the probability of the agency meeting future CxP objectives.
–KSC

Have your personal career goals changed since the announcement of the Constellation Program?

No. I have always wanted to retire with shuttle. It's the best place to work.
–MSFC

In general, no. My career goals continue to involve being a part of the space program.
–KSC

No, my career goals have not changed. It will just require some refocusing or fine tuning of my skills to see where they will best fit in the Constellation Program.
–JSC

No. Only the Wall Street meltdown has changed my goals.
–MSFC

I have pursued obtaining my bachelor's degree. I eventually want to be a teacher, so the announcement that there will be fewer employees has started my backup plan for if I am not picked up [for the Constellation Program].
–KSC

Do you think recent non-American space achievements herald another space race?

Yes.
–USA

No. Just prudence.
–KSC

Hopefully a collaborative effort will come out of it.
–MSFC

"I believe the recent non-American achievements indicate a greater need for the U.S. to push forward with Constellation."

I believe the recent non-American achievements indicate a greater need for the U.S. to push forward with Constellation.
–KSC

Yes. I think non-American space achievements do call for another space race. To remain No. 1 will require a lot of hard work and willingness by Americans to rise to future challenges and go beyond current boundaries... as we have always done before.
–JSC

It would be healthy for us if there were.
–JSC

The public won't know (or care) about a space race until the news covers it.
–JSC

People will wake up when China lands on the moon.
–JSC

Probably not. A manned Mars landing is such a big project (read: expensive) that some have speculated that it will very likely have to be a joint effort with other countries (Russia at least, and maybe others, too). And a recent news story on the radio about China's announcement that they're planning to go to the moon, ended with the comment "They're going to party like it's 1969." I don't really see any competition to get somewhere or do something before someone else does. And it's too bad, because another space race is just what this country needs. It took us only 11 years from the founding of NASA to the first moon landing, when we didn't yet know how to do it and had to build everything from scratch. Why is it going to take us 16 or 18 years to do it again, when we already know how to do it and already have most of the infrastructure in place?
–SSC

If China lands on the moon, then we will have lost the space race. It's hard to imagine. It's hard to see us allowing that to happen.
–JSC

Only on the military side.
–JSC

I think that it's great that we have competition. Maybe it will make Americans want to be No. 1, like we normally do. I think there might be more hope of funding for the space program because of China's achievements.
–KSC

I don't think it will herald another space race. We already have access to space.
–KSC

"We should continue our model of international cooperation..."

America is not currently postured well to compete in a global space race. We should continue our model of international cooperation — indeed expand it to include new partners. Our space policy can become a model of broader global collaboration. Together, we can achieve more by sharing the cost burden and rewards, and still maintain America's reputation as the pre-eminent leader in space exploration.
–KSC