# Horizons

Volume 37, Issue 2 AIAA Houston Section www.aiaa-houston.org September / October 2011

# Congressman Pete Olson
## AIAA Houston Section Dinner Meeting Speaker





# September / October 2011

AIAA HOUSTON
American Institute of Aeronautics and Astronautics

*Horizons is a bimonthly publication of the Houston Section of the American Institute of Aeronautics and Astronautics.*



*www.aiaa-houston.org*

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Horizons and AIAA Houston Web Site
AIAA National Communications Award Winner


2005 2006 2007



*Cover: General Joe Engle, STS-2 Commander, and our dinner meeting guest speaker Congressman Pete Olson. Music by Grammy nominee Lydia Salnikova. Pete remembers Joe as his football coach: "Head up, tail down!" AIAA Associate Fellow Michael Kezirian is also shown. Image credits: Ellen Gillespie & Josh Daniels (right column), Douglas Yazell (left column).*

# Early Warning Flyer for Our Section's Annual Technical Symposium

SEAN CARTER, CHAIR, ELLEN GILLESPIE & DR. SATYA PILLA

American Institute of Aeronautics and Astronautics
HOUSTON SECTION • P.O. Box 57524 • Webster, Texas 77598
Web site: www.aiaa-houston.org

## ATS Houston Section Annual Technical Symposium 2012

### Schedule

08:00 – Registration $15 (all day)
08:15 – Keynote speaker
09:00 – Morning Sessions
12:00 – Luncheon
13:30 – Afternoon Sessions

**Friday, May 18, 2012**
**NASA/JSC Gilruth Center**

### Topics

Space Exploration
Astrodynamics
Automation and Robotics
Communication and Tracking
EVA
GN&C
In-Space Imaging
Space Operations
Life Sciences and Human Factors
Propulsion and Power Systems
SR&QA
Systems Engineering
Space Commercialization
Structural Mechanics
Avionics
International Space Activities

### Symposium Plans

- $15 Registration for everyone.
- Lunch buffet included in the registration cost
- Continental breakfast (including coffee) provided in the Alamo Ballroom during registration
- Advance registration is requested on the AIAA Houston Section web site.
- Submit abstracts for presentation.
- Only abstracts will be published (to streamline organization approval).
- Presentations will be limited to 30 minutes (computer projectors and vu-graph projectors available)
- One Windows laptop PC to be available in each room for presenters. Speakers have the option to use their own laptop.
- PowerPoint presentations to be viewable on our web site. Delivery of presentations expected at the registration desk.
- No Gilruth badging is required – ATS is open to the public. AIAA membership is not required.
- Invited speakers: one morning keynote speaker, one luncheon speaker (TBD)
- Please attend and/or present, including university professors, NASA/JSC personnel, and NASA/JSC contractors.

*Contact the ATS General Chair for more information: Satya Pilla:* vicechair-tech@aiaa-houston.org

### Tentative Deadlines

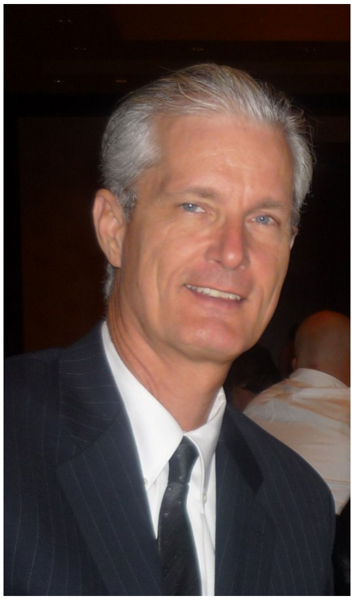
| | |
|---|---|
| *Monday, April 30, 2012* | – Abstracts due to planning committee (contact us sooner if possible) |
| *Monday, May 7, 2012* | – Abstract authors notified of abstract acceptance |
| *Thursday, May 17, 2012* | – Luncheon Reservations (pay at the door on Friday, May 18, 2012) |
| *Friday, May 18, 2012* | – Attendee and Speaker Registration Fee Payments (all day, starting at 8:00 AM) |

## From the Chair

*www.aiaa-houston.org*

*Sean Carter is generously donating the space for his column this month. Once he starts writing his Chair's column, we will have trouble limiting him to one page per issue!*

## From the Editor



*E-mail:*
*editor-in-chief "at" aiaa-houston.org*

# New Technology, New Directions

DOUGLAS YAZELL, EDITOR

NASA human space flight is aiming high with a mission sending astronauts to an asteroid. The team starting NEEMO 15 (NASA Extreme Environment Mission Operations) training soon includes planetary scientist Dr. Steven Squyers, a well-known member of the team from the Mars Exploration Rovers (MER) program (using the famous robot rovers Spirit & Opportunity). That fits well with the flexible path recommended by the Augustine Committee, provided that it is fully funded and uses international partners in the critical path. News reports now talk about NASA's interest in using the European Space Agency's (ESA's) Automated Transfer Vehicle, in a modified form, for the Service Module planned for use with the Orion Crew Exploration Vehicle (CEV), now called the Orion Multi-Purpose Crew Vehicle (MPCV). As for funding, Robert F. Thompson reminded us that the NASA budget was never more than 1% of the national budget except during the early years (Apollo, etc.). As long as NASA funding is based on realistic plans, things should go as well as possible given that we hold national elections on a regular basis. The current NASA budget is probably about 0.5% of the national budget.

NASA recently released a Global Exploration Strategy (GES). This international team of space agencies had two questions in mind, "Why are we returning to the Moon?", and "What are we planning to do when we get there?" This ongoing study now focuses on two paths for the next 25 years, "Asteroid Next" and "Moon Next."

The Department of Defense's (DoD's) Defense Advanced Research Projects Agency (DARPA) led a 100-Year Starship Symposium in Orlando (September 30 - October 2, 2011), related to a study starting in the fall of 2010 and ending on 11/11/11. DARPA will award $500,000 to a winning team to plan things for sending humans to another solar system within the next century without any more government funding.

Until next issue, happy landings!

*Right: Upcoming NASA events for the Global Exploration Strategy. Image credit: NASA, http://www.nasa.gov/exploration/about/isecg/*

| Dates | Location | Description |
|---|---|---|
| Nov. 14-16, 2011 | San Diego, Ca. | Human Space Exploration Community Workshop on the Global Exploration Roadmap |
| May 22-24, 2012 | Washington, D.C. | Global Space Exploration Conference |

*Right: From the Wings Over Houston airshow this year (October 15, 2011), a souvenir from James C. McLane, Jr., a former AIAA Houston Section Chair. Mr. McLane was a WW II P-51D fighter pilot in 1945. In that same Legends & Heroes tent, I visited Celeste Graves (author, A View from the Doghouse, about the WASP) and Captain A.J. High, author of Meant to Fly, and a volunteer at the 1940 Air Terminal Museum. Image credit: Nick King (airplane silhouette).*

# GRAIL Takes a Roundabout Route to Lunar Orbit



Daniel R. Adamo, Astrodynamics Consultant

The Gravity Recovery and Interior Laboratory (GRAIL) mission departed Earth from Cape Canaveral Air Force Station Space Launch Complex 17B on 2011 September 10 at 13:08 UTC, carried by a Delta II Heavy launch vehicle. Liftoff occurred on the third day of a launch season lasting 42 consecutive days.

Twin spacecraft, currently known as GRAIL-A and GRAIL-B, were launched aboard the Delta II Heavy. Each had a mass of 307 kg at launch, 106 kg of which was helium and hydrazine for trajectory changes by a single 22-N main engine and for attitude control by eight 0.9-N thrusters. Beginning 2012 March 8, the spacecraft will conduct their 82-day science mission (spanning 3 lunar sidereal rotations) while flying in the same polar lunar orbit, initially at a circular height of 55 km, with GRAIL-B leading GRAIL-A. Mean separation between the spacecraft will be controlled between 65 km and 225 km, in rough proportion to orbit height. Because the spacecraft are solar-powered, their science mission is constrained to fall between the total lunar eclipse of 2011 December 10 and the partial lunar eclipse of 2012 June 4.

As GRAIL's name implies, the mission's primary objective is to map the Moon's gravity field, improving nearside knowledge by a factor of 100. Because no spacecraft has ever been tracked when hidden from Earth over the Moon's farside, GRAIL is expected to improve knowledge there by a factor of 1000. Neither GRAIL-A nor GRAIL-B will be tracked from Earth while orbiting over most of the Moon's farside, but the two spacecraft will circumvent this problem by tracking each other over radio links between them. This interface will conduct Ka-band ranging, while timing data are exchanged via S-band. An onboard gravity recovery processor assembly produces radiometric data for downlink when the Moon is not blocking transmissions to Earth.

Perhaps even more interesting to astrodynamicists are the routes GRAIL-A and GRAIL-B will take to reach the Moon. These trajectories are the focus of this article. Although their destination is but 400,000 km from Earth, each GRAIL spacecraft will travel about 10 times that distance with respect to Earth before reaching initial lunar orbit. The circuitous routes GRAIL-A and GRAIL-B will take to the Moon require 112.4 days and 113.4 days, respectively. Approaching the Moon over its south pole, each will perform a 38-minute lunar orbit insertion (LOI) burn, GRAIL-A's at 2011 December 31.9 UTC and GRAIL-B's about 25 hours later.

It would have been possible for the Delta II Heavy to deliver both spacecraft to the Moon in 3 or 4 days, but a more leisurely route is desirable for multiple reasons. First, the uninterrupted season of 42 viable launch days would not have been possible with short lunar transits from Earth. Second, extended trans-lunar cruise permits spacecraft systems to be thoroughly checked and calibrated well in advance of LOI. Third, LOI propulsion requirements are appreciably reduced using a weak stability boundary interaction obtained by flying to the edge of interplanetary space near the first Sun-Earth libration point (SEL1).

Located 1.5 million km from Earth in the sunward direction, SEL1 is a quasi-stable "saddle" formed as Earth's relatively minute gravity field gives way to the Sun's. Unstable motion, equivalent to moving on the saddle's convex contour from stirrup to stirrup, is along the Earth-Sun line. Stable motion occurs transverse to this line, equivalent to the saddle's fore and aft concave contour. Motion near SEL1 is therefore chaotic in nature: a small displacement in position or increment in velocity can exert disproportionally large trajectory changes after a sufficient time. Since both GRAIL spacecraft are able to apply small trajectory changes independently from each other whenever necessary, SEL1's instability can be turned into an advantage as illustrated by Figure 1.

(Continued on page 6)


*Above: NASA GRAIL Mission patch. Image credit: NASA (thanks to collectSPACE.com for making this easy to find)*

## Astrodynamics

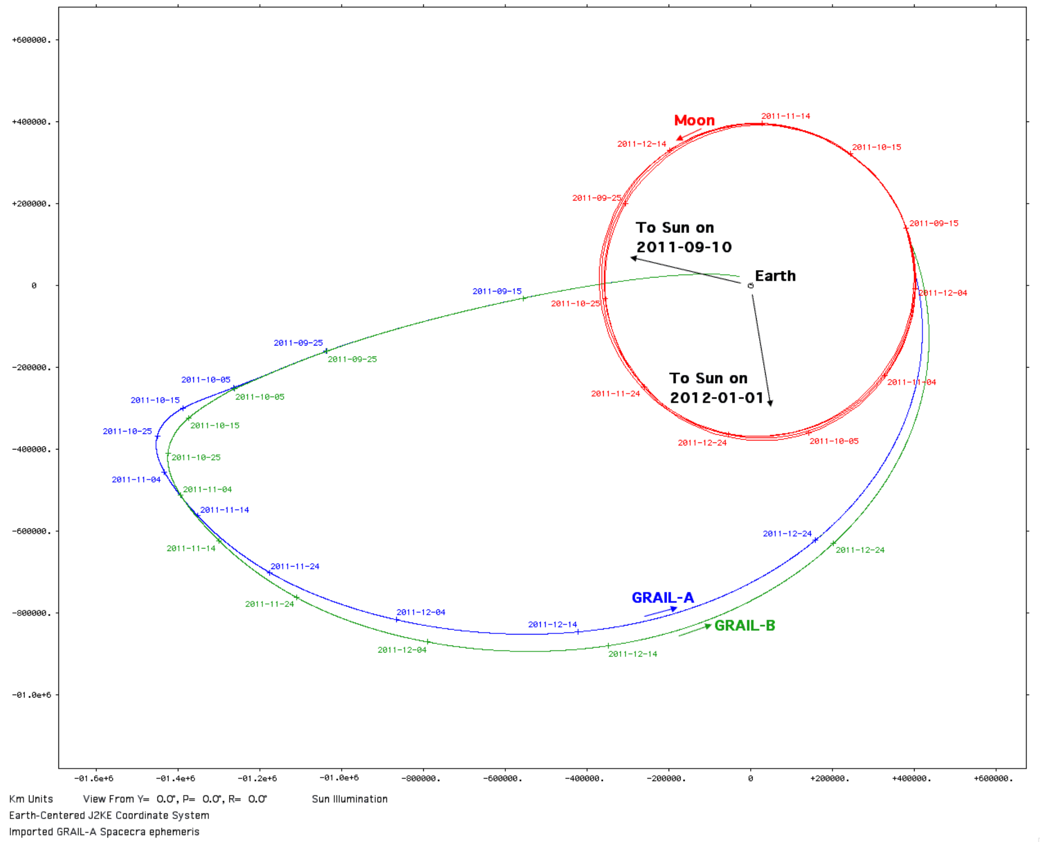



Figure 1. Geocentric GRAIL trajectories plotted in the inertial ecliptic plane. Time tick labels are in year-month-day format.

*Our back cover on page 36 shows an image of the launch vehicle for this NASA GRAIL mission.*

*(Continued from page 5)*

Although both spacecraft leave Earth's vicinity in close proximity at Figure 1's scale, they naturally separate from each other as SEL1 is approached in October of 2011. Because Figure 1 is plotted in an inertial geocentric coordinate system, the sunward direction from Earth rotates counterclockwise by more than 90° during GRAIL's trans-lunar cruise. Two black arrows pointing away from Earth illustrate this rotation in Figure 1.

The Moon makes over 4 complete counterclockwise revolutions about Earth in Figure 1 during trans-lunar cruise. Note that, when the two spacecraft reach their destination, they are travelling in very nearly the same geocentric direction as the Moon. This condition helps minimize LOI propulsion requirements. Furthermore, both lunar rendezvous points fall very nearly 90° counterclockwise in the Moon's orbit with respect to the sunward direction from Earth at that time. This condition equates to the Moon being near first quarter phase as seen from Earth. A lunar rendezvous near first quarter phase is the most direct approach from SEL1 resulting in motion with the Moon in its orbit. According to the U.S. Naval Observatory, the Moon reaches first quarter phase at 2012 January 1.26 UTC, between the two planned LOI burns.

Figure 2 illustrates details of GRAIL trajectories near SEL1. Because this plot is with respect to a geocentric coordinate system rotating at the rate Earth revolves about the Sun, SEL1 corresponds to a fixed point as annotated in Figure 2.

*(Continued on page 7)*

## Astrodynamics

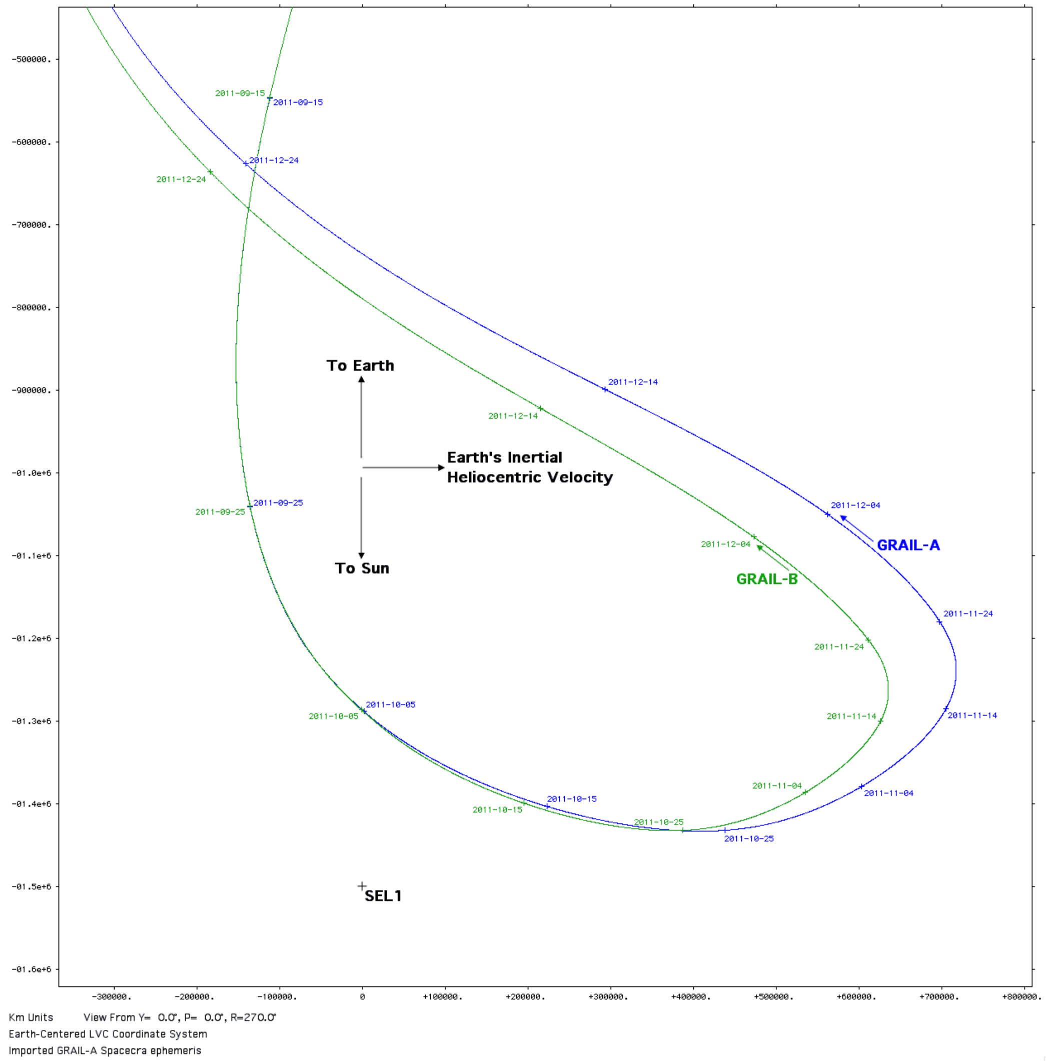



Figure 2. Geocentric GRAIL trajectories in the ecliptic plane plotted near SEL1 using a coordinate system rotating as Earth revolves about the Sun. Time tick labels are in year-month-day format.

*(Continued from page 6)*

Returning to the SEL1 saddle analogy in Figure 2's context, the reversal in GRAIL spacecraft motion initially away from Earth is achieved by not travelling in the sunward direction from Earth farther than SEL1. Cresting the saddle beyond SEL1 along an unstable radial contour would almost certainly result in departing Earth for interplanetary space. Depending on the rate of departure, return to Earth's vicinity could occur in a few months or perhaps not for centuries, if ever. Chaos truly reigns near quasi-stable libration points, particularly when motion is slow.

Another means of gaining insight regarding GRAIL trans-lunar coast is presented in Figure 3, which plots geocentric osculating semi-major axis for each spacecraft as a function of time.

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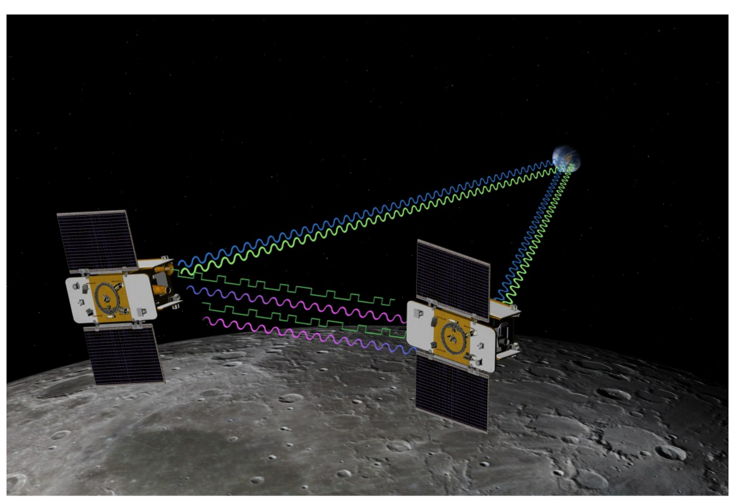
*Below: Artist concept of GRAIL mission. Grail will fly twin spacecraft in tandem orbits around the moon for several months to measure its gravity field in unprecedented detail. Image credit: NASA/ JPL*



# Astrodynamics

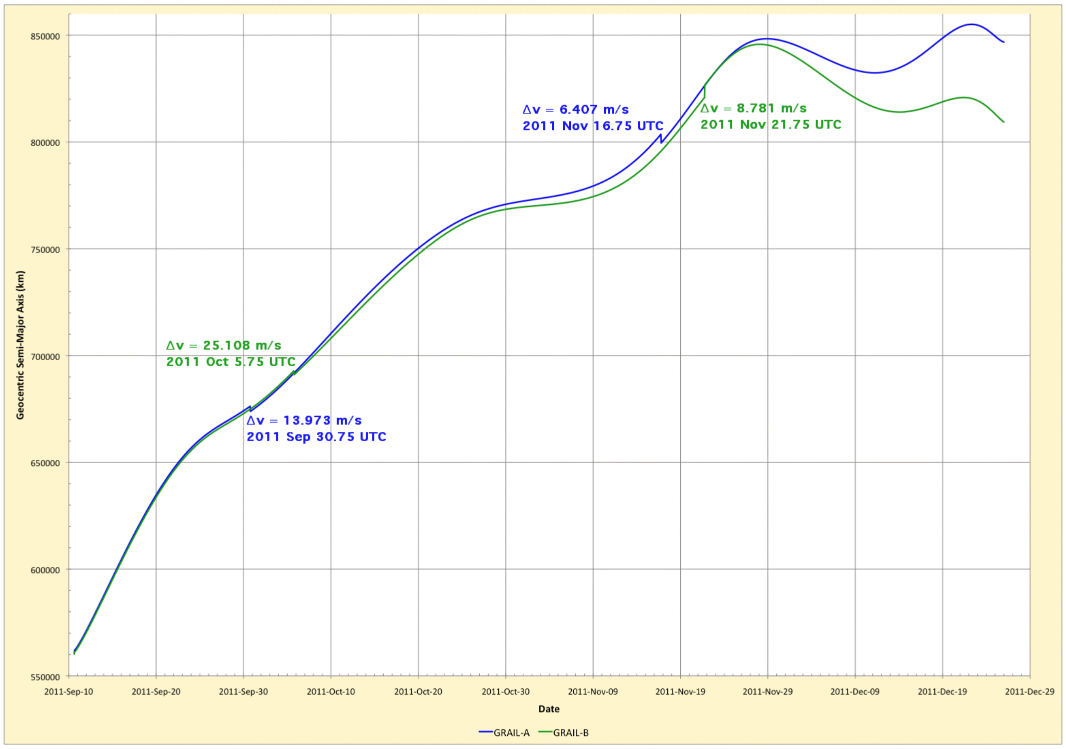



Figure 3. Geocentric osculating semi-major axis versus time plotted for each GRAIL spacecraft during trans-lunar coast.

*(Continued from page 7)*

An unperturbed geocentric conic trajectory would contribute a horizontal line to Figure 3, but solar and lunar gravity perturbations play major roles in GRAIL trajectory dynamics with respect to Earth. Relatively small discontinuous jumps in semi-major axis are attributable to planned spacecraft course corrections. These are annotated with an inferred change in velocity ($\Delta v$) and UTC from GRAIL trajectory targeting posted for public access on 2011 September 23.

Terminal lunar approaches by both GRAIL spacecraft are illustrated in Figure 4, together with initial orbits following LOI. Each LOI burn arc is approximately centered on pericynthion, which falls near ascending node on the lunar equator. The shaded portion of the Moon in Figure 4 is its farside, so the plot is viewed in a direction very nearly toward Earth. Since the Moon is in first quarter phase, the Sun's illumination would be from the left, and the Moon's sunset terminator would run very nearly vertically to bisect the Moon's disc in Figure 4.

Coasted pericynthion heights neglecting LOI are 137 km for GRAIL-A and 156 km for GRAIL-B. Most Apollo lunar approach pericynthion heights were near 100 km, but transit time from Earth was never far from 3 days. This invites comparisons between GRAIL's lunar approach speeds and analogous as-flown reconstructions from Apollo. Such comparisons are facilitated by the conic vis viva energy integral as provided in Equation 1.

*(Continued on page 9)*

$\mu \equiv$ Moon's reduced mass $= 4902.798$ km$^3$/s$^2$

$r \equiv$ lunar speed comparison arbitrary selenocentric distance $= 1837.53$ km (equivalent to a lunar height of 100 km)

$a \equiv$ case-specific selenocentric semi-major axis

$$s \equiv \text{case-specific selenocentric speed at } r = \sqrt{\mu\left(\frac{2}{r} - \frac{1}{a}\right)} \qquad (1)$$

## Astrodynamics

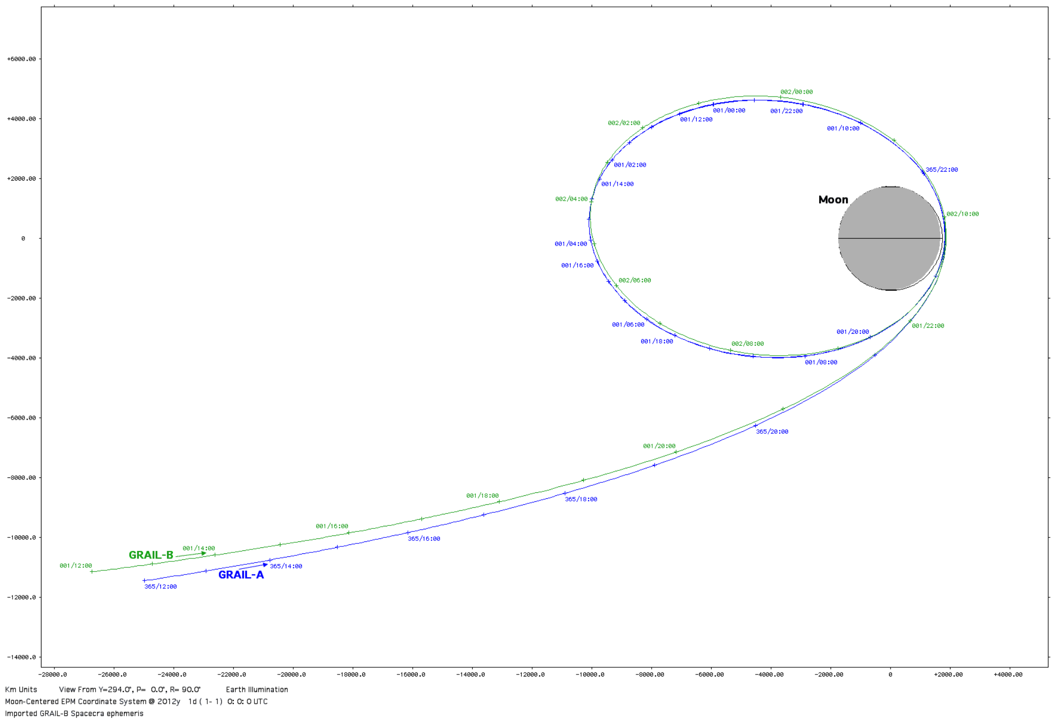



Figure 4. Selenocentric GRAIL lunar terminal approaches and initial orbits with the plot plane near both trajectory planes. The Moon's farside with respect to Earth is shaded. Time tick labels are UTC in 2011 and 2012 day-of-year/hour:minute format.

*(Continued from page 8)*
Three as-flown Apollo cases are compared with the planned GRAIL lunar approaches in Table 1. Because Apollo 13 suffered a trans-lunar abort and never performed LOI, its case-specific *a* is obtained prior to a "pericynthion +2 hours" (PC+2) burn.

A dramatic difference between Apollo and GRAIL cases is evident from their Table 1 *a* values. With Apollo cases, the $a < 0$ condition indicates a lunar flyby leading to escape will occur if a braking impulse is not applied. Assuming conic selenocentric motion, the $a > 0$ condition applicable to GRAIL cases indicates capture into an elliptical orbit has occurred before any LOI impulse. But the large magnitude of GRAIL *a* values, greatly exceeding the 67,000 km radius of the Moon's gravitational sphere of influence, is testimony to their common SEL1 pedigree. Without at least a partial LOI, each GRAIL spacecraft will escape the Moon after a close flyby.

| Case | *a* (km) | *s* (km/s) |
|---|---|---|
| Apollo 10 Pre-LOI | -4180.657 | 2.551279 |
| Apollo 13 Pre-PC+2 | -4473.879 | 2.536171 |
| Apollo 15 Pre-LOI | -4580.352 | 2.531144 |
| GRAIL-A Pre-LOI | +152,177.134 | 2.303058 |
| GRAIL-B Pre-LOI | +184,112.045 | 2.304270 |

Table 1. Selenocentric speed (*s*) comparisons referencing as-flown Apollo and planned GRAIL lunar approach trajectory cases at an arbitrary 100 km height.

Table 1 *s* values confirm the roundabout GRAIL route to the Moon will reduce LOI $\Delta v$ by about 240 m/s with respect to faster transits from Earth suggested by Apollo as-flown trajectories. Considering it would require $\Delta v$ near 670 m/s for each GRAIL spacecraft to achieve a circular lunar orbit at 100 km height from their respective approach trajectories, this savings is significant.

All planned GRAIL trajectory data in this article are obtained from JPL's Horizons ephemeris computation service at http://ssd.jpl.nasa.gov/?horizons. Background information on the GRAIL mission is documented in a launch press kit available for download at http://www.jpl.nasa.gov/news/press_kits/graiLaunch.pdf. The GRAIL mission home page can be accessed at http://solarsystem.nasa.gov/grail/home.cfm, and additional information is available at http://moon.mit.edu/. Lunar phase predictions may be obtained from http://aa.usno.navy.mil/data/docs/MoonPhase.php. Foregoing URLs were each accessed on 2011 September 23.

## Dinner Meeting

# Congressman Pete Olson Reports on the Future of American Space Exploration

**Shen Ge, Edited by Ellen Gillespie, Daniel Nobles**

On Tuesday, September 6th, 2011, the Houston AIAA held its first dinner program of the new AIAA year at the NASA JSC Gilruth Center. It began with the music by Grammy award nominee Lydia Salnikova and had a very patriotic theme. The Clear Lake High School Falcon Junior Reserve Officers' Training Corps marched into the room and ceremoniously posted the flags on the stage while Lydia sang the national anthem *(The Star Spangled Banner)* and *God Bless America*. A short and informal social gathering with a cash bar was held in the minutes prior to the event. There were several notable engineers and dignitaries in the audience, including several astronauts and vice presidents of local Houston aerospace companies. Approximately 70 people attended.

The AIAA evening presentation started with a personal introduction by General Joe Engle, a remarkable man who was both an astronaut and an X-15 test pilot. General Engle shared his experience as Mr. Olson's football coach. Young Olson joined a football team of newly relocated, unplaced kids who wanted to play in the football league. Through hard work and determination the new kids practiced under Coach Engle, initially losing but improving dramatically. Congressman Olson's team beat the established teams and went on to win the League Championship.

While Mr. Olson stated that NASA has performed amazing technical feats against seemingly insurmountable odds in the past, his message focused on NASA suffering due to lack of a focused mission plan, political indecision, and a lack of sufficient government funding.

The Space Shuttle Program has successfully concluded, closing one chapter in manned space flight history. The International Space Station (ISS) continues our manned presence in space, writing the next

*(Continued on page 11)*

*Right: General Joe Engle, STS-2 Commander, and Congressman Pete Olson. Since General Engle was the ranking military officer at this event, a student in the end-of-event JROTC ceremony asked for Engle's, "Permission to strike the colors!" Image credit: Josh Daniels*

*Right: The Clear Lake High School (CLHS) Junior Reserve Officers' Training Corps (JROTC). The official team is seven people, it would seem, though only four appeared in the ceremonies. Thanks to CLHS Principal Dixon and Captain Burroughs, and thanks to those students! Image credit: Shen Ge and the web site (blog) for Lydia Salnikova.*

(Continued from page 10)

chapter on on-orbit research. The commercial space sector will now work to conduct low Earth orbit operations, while NASA provides government oversight and initiates work on the next space frontier using a generic rocket and capsule.

Congressman Olson's vision to accomplish this end is the 2010 NASA Authorization Act and the NASA Appropriations Bill. The NASA Authorization Act and Appropriations Bill are expected to provide isolated NASA funding. The Authorization Act signed on October 10, 2010 by President Obama gave the go-ahead for $58.4 billion to be spent on NASA programs over the next three years.


Congressman Olson supports George W. Bush's Vision for Space Exploration (VSE) which seeks to return a man to the Moon by 2020. Congressman Olson plans to fund VSE using the two methods described above and ended his presentation with the following key points:

1. A long-term Congressional NASA budget commitment is needed with multi-year appropriation.
2. A detailed operations plan on NASA funding expenditures should be created prior to fund allocation.
3. A clearly defined US space exploration goal is required.
4. Cut redundant government programs (such as climate change research) so that NASA is focusing on its own unique goals.
5. Work to develop a new American capability for human space exploration as soon as possible.
6. Non-partisan Congressional leadership for NASA oversight.

## Dinner Meeting

*Left: Grammy nominee Lydia Salnikova performs during our dinner meeting. This is the third time this Tennessee resident traveled to Houston to perform at one of our events! Image credit: Shen Ge and the web site (blog) for Lydia Salnikova.*

*Below: The set list Lydia used after singing the national anthem, The Star Spangled Banner. Image credit: Lydia Salnikova.*

**SEPTEMBER 6, 2011**

1. **America The Beautiful**
2. **Rocket Man**
3. **Fly Me To The Moon**
4. **Beautiful** (original)
5. **Yellow Rose Of Texas**
6. **Satellite**
7. **My Thoughts Of You** (original)
8. **Gravity**
9. ~~**Nadezhda** skip if out of time~~ Change The World G
10. **When You Open Your Eyes** (original)


*Left: Grammy nominee Lydia Salnikova sings the national anthem as the Clear Lake High School Junior Reserve Officers' Training Corps presents the colors. Image credit: Shen Ge and the web site (blog) for Lydia Salnikova.*

## Rocket Launch

# High Altitude

GLENDA REYES, DR. BENJAMIN LONGMIER, EDITIED BY CARLOS SALAMANCA

*Right: The rocket on the launch rail. Image credit: Glenda Reyes*

*Below: Team members: Bottom row left to right, Nicholas Robbins, Glenda Reyes, Michael Jackson, Dr.Le, Steven Benitez, Louis Avila. Top row left to right, Princelee Fernandes, Carlos Salamanca. Image credit: Glenda Reyes*

In 2010, we went to the American Institute of Aeronautics and Astronautics (AIAA) regional student paper conference here in Houston. At the conference, we presented the design and calculations for two rockets we worked on that year; one was the One Mile One Pound and the other was the Transonic Rocket. None of us expected that a year after the conference, AIAA would donate $2000 for our High Altitude rocketry course. The course is the highest level of rocketry in our program. The objective was to design and build a rocket that would reach the altitude of 100,000 feet.

Our team started with 15 students. They were a mixture of students from both the Transonic Rocket and the One Mile One Pound teams. Coming into the class we knew we had to build a rocket, but were almost completely unaware of the difficulties we would face. We started off with some very extensive calculations in a Microsoft Excel spreadsheet. It became our rocket's flight profile. Then in November we went to NASA for an evaluation about continuing with the building of the rocket. The presentation was a success. Our team had the most accurate flight profile. NASA was so impressed they offered to create a 3-D flight profile for

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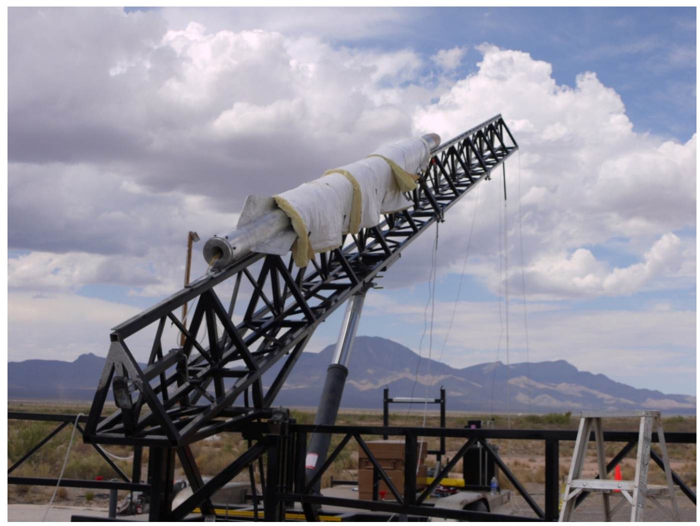

## Rocket Launch

(Continued from page 12)
us. After our flight profile's evaluation, we designed our rocket to fit the specifications of the flight profile. The design was presented to Ad Astra Rocket Company in front of a panel of 3 judges which consisted of Dr. Longmier and his colleagues. Once our design was approved we started ordering parts and sending designs to Longhorn Steel, the shop that machined our parts.

**Airframe**

We started the school year by learning about the history or rocketry. In the lengthy timeline of rocketry research we learned about the monocoque design. This meant that we would use the internal components as the body rather than having the interior components and a body tube over it. It was easier since we had the help of Longhorn Steel. We made a rocket that was about 23 feet long; it had two doors that helped us access all of the various valves, three 4-feet long fins each at 120 degrees away from each other, and a 13-foot long tank. We chose aluminum for our rocket because it was lightweight and strong. Unfortunately the aluminum tube had an oval shape to it and when we wanted to put the phenolic tube it would not fit nor did the nozzle nor the nosecone. Eventually we found a way to fit it all in.

**Propulsion**

The propulsion system faced more obstacles than any other team task. First it was a problem with finding someone that could make our graphite part of the nozzle. Fortunately we found Mr. Sandifer who is our mentor. He was able to help us. Another problem we had was casting the fuel grain. The first time we attempted to cast the fuel grain, we did not have a good seal at the bottom of the fuel phenolic tube, which is where we were going to pour our HTPB, which is what we use to make the fuel grain. What ultimately happened was that as we poured the liquid into the phenolic tube it all came out with only four days before the launch date. Fortunately, our teacher Dr. Le had ordered extra HTPB and we had found a solution for the cap of the phenolic, but we had one more problem; it was going to arrive Monday and we needed it to arrive on time because we were going to leave for New Mexico on Wednesday. Monday came and went but the HTPB had not arrived. Dr. Le was tracking it via Internet and it now said it would not arrive until Tuesday at 2:00 p.m. On Tuesday we waited… waited…and waited until it finally arrived. We met at the school at about 5:30 P.M. and started mixing the HTPB with the hardener until it was ready to be poured. We poured slowly and fortunately it did not leak out. We ended at about 9:30 P.M. on

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*Left: The team after the attempt of the rocket launch with parents, teachers, and Dr.Longmier ,after a long day of work and sadness. Image credit: Glenda Reyes*

# Rocket Launch

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Tuesday and we left for home to pack for the next day.

**Nosecone and Fins**

The fins did not give us any trouble. After we designed them and did some calculations, we were ready for Longhorn Steel to machine them. The nose cone, on the other hand, did give us some problems. We decided to make it out of fiberglass. We had never worked with fiberglass so trying to mold it was very difficult. We decided to make a wooden mold and when we tried putting the fiberglass over it, it hardened too fast. The second time we did not have any trouble doing it since we had gained experience from the first time. However, after it was all done, we thought that was it, but it wasn't. When we arrived at New Mexico we discovered that the nosecone did not fit into the body. We had to sand the inside for almost a day and a half and after all that sanding it finally fit.

**Recovery**

Initially, we wanted to recover the top airframe. Then we thought about recovering the nosecone, but at the end we discovered we did not have to recover the rocket. We decided to cancel the whole recovery plan.

**Blast Off**

It Started with 5 schools, but ended with 2; one of them was us, Booker T. Washington, and the was Fredericksburg High School.

On August 3rd, 2011 we left for New Mexico with our rocket almost complete. Once we got there, we had many problems; the nose cone, fuel grain, and nozzle did not fit into the rocket. We worked on the nose cone the night we arrived in New Mexico and the day after until we got it to fit. With the help of Fredericksburg's team, we got the nozzle and fuel grain to go in.

While we were at the launch site filling our tank with nitrous oxide, the filling valve froze, so we couldn't continue filling. At that point we were more than half way full but still not completely full. After that problem, Brett Williams, the instructor of the Fredericksburg High School team, asked us if we wanted to fly half-filled or abort; we decided we wanted to launch half-filled, but at the same time mission control had asked us to evacuate because a thunderstorm was coming. There was a lot of lightning right before the crew was getting ready to attach the ignition system. At that time Brett and the crew evacuated the tower

(Continued on page 15)

*Right: The team putting the rocket in the launch rail. Image credit: Glenda Reyes*

# Rocket Launch

*(Continued from page 14)*
and our rocket was left on the tower. About 30 minutes passed and Brett and the crew went back to the tower to attach the ignition system. By that time our team had already made the decision to launch without a full tank. We heard, “3, 2, 1” for the countdown from mission control, but unfortunately, the rocket did not go up. Then the man in charge of firing up the rocket discovered he did not turn on the power which was the reason the rocket did not ignite. Immediately, we asked mission control to give us an extra two minutes to try to ignite the rocket again. Again, “3, 2, 1,” and smoke came out of the nozzle and the rocket stayed in the same spot. We had a moment of silence and our faces just dropped. We waited for at least 15 minutes to go back to the launch rail to see what had gone wrong with the rocket. That was when we discovered that our ball valve did not open to allow the nitrous oxide to mix with the fuel grain, and we had a leak.

Even though we did not launch our rocket, we still have it with us, which gives us an opportunity to modify it and try to launch it again next year. We will not give up until we make it to 100,000 ft.

Team members:

1. Project Manager: Nicholas Robbins
2. Glenda Reyes
3. Carlos Salamanca
4. Princelee Fernandes
5. Louis Avila
6. Steven Benitez
7. Michael Jackson

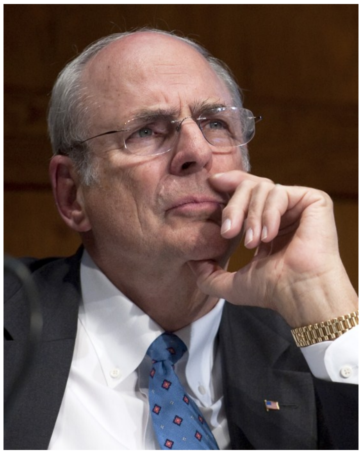

*Above: Steven, Michael, and Nick checking the valves. Image credit: Glenda Reyes*

*Left: The night before the launch Nick the project manager with the help of a teacher putting the fuel grain in the rocket. Image credit: Glenda Reyes*

Public Policy

# The Greatest Obstacle to Human Space Travel

Douglas Yazell, Editor



*Above: Norman Augustine.*
*Image credit: NASA*

*This lecture was part of the Space Frontiers Lecture Series at Rice University. An upcoming lecture is this series is:*

*November 9, 2011:*
*Long Duration Space Flight – Preparing for and Living on the International Space Station*
*Shannon Walker, Ph.D.*
*NASA Astronaut*

*For more information: http://spacefrontiers.rice.edu/fall-2011-schedule/*

Mr. Augustine was a surprisingly popular speaker for this standing-room-only crowd at Rice University on September 14, 2011. The greatest obstacle to human space travel was cited as setting goals substantially greater than the means available to achieve them.

Dr. Kamlesh Lulla of NASA/JSC spoke briefly on behalf of the NASA center. A few remarks by Mr. Augustine will be paraphrased here.

The Soviets did us a favor by waking us up when they launched Sputnik. It is not obvious if it would be good or bad for our country if the Chinese did something similar now, such as sending astronauts safely to an asteroid and back before us. For the moment, we cannot get to our base in Antarctica without a Russian icebreaker.

We are now at a tipping point for human spaceflight. For the last 40 years, we sent people up into space at an altitude the same as the distance from DC to Boston, 400 miles. Talking to young people, they say going back to the Moon was their grandparents' space program. Today's youth wants something new.

Space inspires more passion than most other endeavors.

The cost of human spaceflight is not justified by technology spinoffs. Those gains could be obtained with much less expense. The intangibles of human spaceflight justify the cost. Most people agree that human spaceflight is worthwhile because we are charting a path for the eventual expansion of human civilization into space. This program also inspires our youth and does useful science. It shows what American democracy can accomplish. We also risk experiencing the fate of the dinosaurs: extinction by Earth-asteroid impact.

People often ask if our money should be spent on cancer research or human spaceflight. That question is framed improperly. Human spaceflight is compared to other programs to see which are the most effective. At 7 cents per day, human spaceflight is very effective and gets included every year.

Human spaceflight had a scope and funding mismatch in 2009 and 2010. Initially (with Constellation), NASA leadership believed, with some reason, the required budget would be available. Each year, the actual budget came in about a third less than NASA's plans.

Imagine a program with a high fixed cost (burden rate), say 50%, starting a 10-year, $10B program, then getting cut 30%. The fixed costs of $5B are not reduced, and the results are deadly.

NASA never has enough money for the next program and the existing program. NASA needs a strong technology program so that decision makers 10 years from now will have options.

All human spaceflight programs now focus on Mars. The Augustine Committee (2010) described a flexible path delivering something exciting every few years: asteroid rendezvous, astronauts at a Lagrangian point, astonauts at Phobos and Deimos, the Martian moons, robots on Mars operated by astronauts on Phobos or Deimos. International partners are required on the critical path for political, technical, and monetary reasons, but international programs are the most difficult to manage.

We seek a program worthy of a great nation.

Congress cannot legislate engineering.

No ship can explore the distant horizons while it remains safe in the harbor.

We need nuclear propulsion and nuclear power.

Today's human spaceflight program is not the same one we had before President Obama took office, and before President Obama's decision (in February of 2010) to cancel project Constellation.

We must persuade our politicians that cutting human spaceflight programs will be as unpopular as cutting Medicare. Medicare spills more than our human spaceflight program spends. We must get out and tell the story. People will get interested.

# 1940 Air Terminal Museum at Hobby Airport
# An AIAA Historic Aerospace Site

Museum

DOUGLAS YAZELL, EDITOR

For November and December of 2011, be sure to visit the museum for the Wings & Wheels lunch hour programs (11 AM to 3 PM on Saturdays, November 19, 2011, and December 17, 2011. The theme for that November program is not yet announced as of this writing. The themes for that December program are (1) HoustonSpotters.net, a web site devoted to plane spotting in Houston, and (2) the museum's invaluable volunteers, who make all of the museum events possible.

An e-mail note from the museum promoted the October 2011 Wings & Wheels with the theme of Hangar Day. This included tours of the 1928 Carter Airmail Hangar, which houses the museum's collection of aircraft and artifacts.


A big crowd of maybe 200 people attended an excellent show by The Manhattan Dolls, a Swing-Style Female Vocal Trio, Tuesday, August 23, 2011, from 7 to 9 PM. Quite a few people danced in front of the stage at times during the show, a group of dancers who are friends of one of the museum volunteers. This show by the Dolls was called Sentimental Journey. Such a popular act will no doubt be scheduled for another show soon if possible.

Until next issue, happy landings! *(Image credits: the museum web site, used with permission.)*

*Above: The museum in August of 2010. Image credit: Douglas Yazell*

*A bimonthly column about the museum.*

*1940 Air Terminal Museum*

*8325 Travelair Street*
*Houston, Texas 77061*

*(713) 454-1940 - Phone*

*www.1940airterminal.org*

3AF MP

# Today’s Project Leyel and Marcel Leyat’s Helica Automobiles of the 1920s

Jean-Luc Chanel, Chair of the 3AF Light Aviation and Derived Machines Technical Committee

*3AF MP: l’Association Aeronautique et Astronautique de France, Midi-Pyrenees chapter, www.3af-mp.fr.*

*Our French sister section is 3AF MP. See our web page at www.aiaa-houston.org. Click on technical committees, International Space Activities Committee (ISAC, chaired by Ludmila Dmitriev-Odier). An update to the 3AF MP organization chart is on page 27 of this newsletter.*

The use of aircraft technology in automobiles is an area barely begun by Marcel Leyat, a French aviation and automobile pioneer who worked on it from 1913 to 1925. It did not end well (only about 30 cars sold, according to one report). It deserved a better fate.

Leyat named his car the Helica, since a big (screened-in for protection) propeller on the front of the car was used for locomotion. The French word for propeller is “helice”, rhyming with “hay lease”, and for the French, that is a silent “h.” The Helica consisted of a narrow, lightweight open cockpit for two people positioned in tandem, without chassis (It used a cockpit / cabin.) and powered by a large tractor propeller with its engine, both positioned at the front of the cabin.

These vehicles no longer needed much of the mechanical equipment we require on cars today: no gearbox, no clutch or transmission. The efficiencies of mass, complexity and cost are obvious.

That's not all. Without the "chain" of mechanical devices that usually pass in today’s cars from the engine to the wheels via the chassis, the cabin size was considerably reduced.

The Helicas were nicely designed with aerodynamics in mind. Resistance to the advancement of a car on the road at cruising speed, which is most of the journey, consists of 85% air resistance and 15% rolling resistance. This law of physics is still valid and Leyat was familiar with it between 1910 and 1920, long before the era of aerodynamic research in automobile design, which can be dated from the 1930s.

The idea that the vehicle must be pulled rather than pushed, the idea of dynamic stability and aerodynamics, was the brainchild of Marcel Leyat from the moment he used the tractor propeller for propulsion, 21 years before Citroën’s Traction of 1934.

With a century of automotive progress, the best solution for

*(Continued on page 19)*

*Right: A replica of a 1920s Leyat Helica created by American Jeff Lane, owner of a car museum in the USA. This photograph was taken in Meursault, France, during the 2009 exhibition celebrating the 100th anniversary of Marcel Leyat’s first flight in the airplane he designed and built. Image credit: Jean-Luc Chanel*

(Continued from page 18)
balance and propulsion is now given by the all-wheel drive of the Audi Quattro.

From 1913 to 1925, the Helica, liberated from the problem of distributing power to four wheels, gave the same ride and the same advantages as today's cars (including the Audi Quattro) using all-wheel drive with much less complexity.

**Today's Project Leyel**

Project Leyel is is a project about an experimental land vehicle, a study project in a way. The new vehicle is different from that of Marcel Leyat in the sense that there is no propeller, no engine and no drive system on the front of the cabin, but there are four mini-turbines placed in the sides of the vehicle (two per side, powered by electricity produced by batteries and a single generator).

**Advantages of Project Leyel Compared to the Cars of Today**

Naural and fundamental safety is paramount. When the wheels are freed of the problem of motor control, vehicle motion no longer depends on how well the tires grip the road. The wheels merely carry the vehicle. Project Leyel will take a fresh look at improving handling by reducing slip.

Thus, we have these improvements on all terrains and in all seasons, and we will demonstrate that with a prototype later when it is put together and tested.

Better performance from elimination of mechanical components is also expected. Then it will be possible to obtain a vehicle which is safe, fast and economical.

The elimination of many mechanical components traditionally used in a conventional car, is an improvement (with no compromise) in many ways; less material, smaller size, less weight, less complexity, less cost, less pollution, fewer friction losses, and more reliability. The number of parts constituting a Helica was perhaps 30% of that of a classic 1920s car, and the mass was 50% of that of a 1920s conventional car. Each of those many benefits listed above helped to create the other benefits listed above. This will also be true of Project Leyel.

Safety, in the case of the Helica as well as Project Leyel, includes improved ease of driving, another benefit obtained from the removal of the transmission: the only commands required are those for acceleration and braking; no

(Continued on page 20)

*Left: Three models used by Project Leyel; a full-scale model for a roomy interior design, a half-scale model for the placement of equipment, and a model close to 1 / 5 scale for wind tunnel tests. Image credit: Jean-Luc Chanel.*

## 3AF MP

*(Continued from page 19)*
shifting gears, no operating a clutch.

**The State of Preliminary and Future Studies and Activities**

The Junior Enterprise of the ISAE Ensica, the EPI (Studies, Industrial Projects), based in Toulouse, France, has signed with me in 2009, a confidentiality agreement and a set of study assignments in order of logical design from CatiaV5 definition of the external forms of an enclosed cockpit / cabin, to the Computational Fluid Dynamics (CFD) software FLUENT through, serving as verification of assumptions used in the studies, notably the principle of the invention: an active aerodynamics, improving with the commissioning of four mini-turbines.

I have also approved a suite of tests consisting of a single mini-turbine, which I will soon put into operation for testing of noise, fuel consumption and endurance. After making drawings, I ordered an air intake ring (toroidal) and an exhaust pipe in order to maximize the mini-turbine before executing the tests of its thrust.

Finally, my inventor's patent, filed in August 2008, has reached a phase of international protection. I ordered my intern, Alexander d'Armancourt (who just finished his first year at IPSA Toulouse), to work on preliminary studies which will result in future patents. He did a great job. Philippe Mairet assisted me in selecting the student.

We will soon study an aerodynamic principle: the Chilowski effect, discovered around 1913. It will generate some negative drag, thus additional force to drive the car forward.

As for the cabin / cockpit, we will study a hybrid material made of an assembly of sandwich metal and glued wood, as shown below in the photograph.

**Disadvantages and Corresponding Paths of Improvement for Project Leyel**

Overall, the Leyat and Leyel vehicles perform well at high speed and have poor performance at low speed. Obstacle clearance, steep slopes, and low-speed acceleration are weak. Marcel Leyat could have fixed those things, in part, with a variable pitch propeller (not available in his time), which can act as a gearbox by adjusting the power and traction to the vehicle speed and the terrain. One related path of improvement for Project Leyel is to use at least one drive wheel. This would be disengaged at high speed in favor of the main propulsion, and high speed is where cars spend most of their time. Current plans for Project Leyel include at least one drive wheel at low speed.

Passengers can be troubled by wind and noise. Project Leyel will study the use of a closed cockpit. This study is currently underway.

The rotating masses of the mini-turbines: do they present a risk of explosion in case of impact? Regarding Project Leyel, the integration of mini-turbines as close as possible to the centerline of the vehicle and the thickness of material around the mini-turbines will oppose this effect and will oppose the energy represented by the amount of rotating material of these mini-turbines, energy that we will need to reduce by the use of lighter but equally opposing high-performance materials. Noise reduction would also be acquired.

In the case of explosion of the mini-turbines of Project Leyel, passengers must not be injured. Protection must be provided in the cabin, protection such as the components of the vehicle of Project Leyel (batteries, generators, etc.).

*Right: As for the cabin / cockpit for the automobiles of Project Leyel, we will study a hybrid material made of an assembly of sandwich metal and glued wood. Image credit: Jean-Luc Chanel.*

# 100 Year Starship Symposium (DARPA)

Douglas Yazell, Editor

I attended this 3-day symposium in Orlando, Florida, from Friday September 30 to Sunday, October 2, 2011, with about 1,200 other attendees. It was open to the public and registration was free. Dr. Albert A Jackson IV, one of our section members, made me aware of this opportunity, and he attended the symposium, too. He my write about it later for Horizons, or initiate a Lunch-and-Learn on this subject. I was lucky to spend a lot of my time there with another section member, George Abbey, Jr.

Four of us spent a good bit of time with NPR reporter Dan Grech who drove up from Miami Friday night. We joined him at the hotel bar while he had a late dinner. We had a long talk there with the five of us, and a Japanese physicist (Masataka Nishi) made some back-of-the-envelope calculations that mentioned in the following radio show. Dan contributed his report to Ira Glass and the NPR radio show This American Life. That episode is now online and easy to access for online listening or saving as a podcast. The first 10 minutes or so of that hour's show is about this event. It is a very complimentary summary of the event.

Keith Cowing of NASAWatch.com was there to live-blog the event.

The technical track report by Dr. Jim Benford at the end of the symposium concluded that sending people to the nearest star within the next 100 years is feasible. The financial track was another subject whose output I will not summarize here.

The famous Mr. Stewart Brand (The Whole Earth Catalog, The Long Now Foundation) chaired a track on philosophical and religious considerations.

Dr. Harry Kloor chaired a track called Communication of the Vision. His biography in the program says, "Dr. Kloor earned the unique status of being the first - and to date - the only person in the world to simultaneously earn two Ph.D.s; one in physics and the other in chemistry." At an event-closing session with all attendees, Dr. Kloor expressed his appreciation for a technical presentation by C. Maccone of the Internaional Academy of Astronautics and the Tau Zero Foundation, "Sun Focus Comes First, Interstellar Comes Second."

This event was a half-day Friday, all day and night Saturday, and a half-day Sunday. Two panel discussions with science fiction writers were very popular. The last event Saturday night was a storytelling event called Callahan's Crosstime Saloon, based on books by Spider Robinson. The writers on these two panels were Stephen Baxter, Dr. Gregory Benford, Dr. Geoffrey A. Landis, Robert J. Sawyer, Allen Steele, Elizabeth Bear, Joe Haldeman, G. David Nordley, Charlie Stross, and Vernor Vinge.

One of the keynote speakers was Ariel Waldman of Spacehack. She is an open science strategist and an interaction designer.

Dr. Jill Tarter, Director of the Center for SETI Research (The Search for Extra-Terrestrial Intelligence) chaired a track on destinations. Dr. Margaret Turbull made a presentation called, "Targets in the Search for Habitable Worlds: What's Out There?" She is (according to newworlds.colorado.edu) the New Worlds Observer Science Team Lead for the Global Science Institute. She spoke about a proposed spacecraft mission searching for Earth-like planets by flying a telescope and a starshade in formation, with the separation cited once as 80,000 kilometers. The discovery of an Earth-like planet orbiting another star and capable of supporting life would increase public support for missions sending people to that destination.

For me, the symposium was worthwhile and inspiring, and I will continue to network with those attendees for many years to come.

## 100 Year Starship

*Image credit: DARPA*

*See the Calendar on page 28 for two upcoming lunch-and-learns related to this subject.*

*Links:*

*http://www.100yss.org/index.html*

*https://www.fbo.gov/index?id=3e5c070bee30761011872793bbe62845*

## APR
## E-Publication

*Aerospace Projects Review (APR) is presented by Scott Lowther, whose unique electronic publication is described as a "journal devoted to the untold tales of aero-spacecraft design." More information, including subscription prices, may be found at the following address:*

*Scott Lowther*
*11305 W 10400 N*
*Thatcher, UT 84337*
*scottlowther "at" ix.netcom.com*
*http://www.up-ship.com*

# Shuttle-Derived Personnel Launch Vehicle

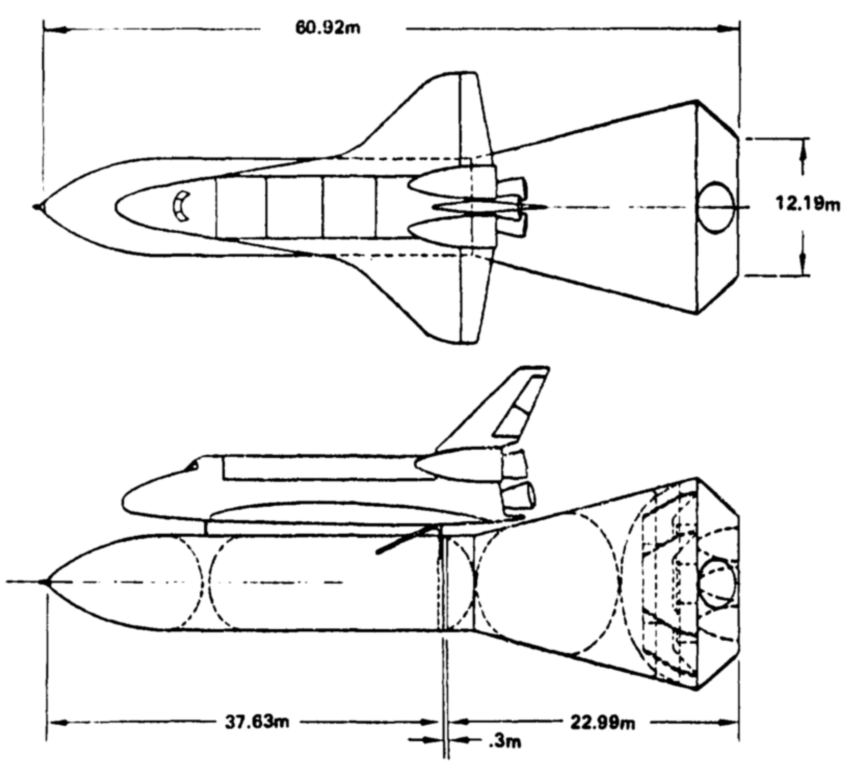
Scott Lowther, Aerospace Projects Review (APR)

While Boeing designed the Space Freighter for transportation of cargo to low Earth orbit for the Solar Power Satellite project, transport of people was to be by another means. While the Freighter could of course carry passengers, it was not designed to bring down large payloads. Passenger transportation, unlike cargo transportation, requires that the launch vehicle be able to bring down as much as it takes up. So Boeing, rather than designing an entirely new launch vehicle, proposed in 1977 a modification of the Space Shuttle launch system.

The Shuttle orbiter would be largely unchanged. The cargo bay would carry a special passenger module, much like a truncated jetliner fuselage; fifty passengers could be carried in four-abreast seating. The solid rocket boosters would be dispensed with and replaced with a single conical liquid propellant booster. The purpose behind replacing the solid rocket boosters was to reduce the cost of launch; to that end, the booster was simplified as much as possible. Instead of conventional turbopump-fed rocket engines, it was a pressure-fed design fueled by liquid propane burning liquid oxygen. The tanks were thick (up to one inch) welded aluminum in order to withstand the internal pressure. A consequence of that was that the structure of the booster would be very strong and resistant to damage, and presumably easy to refurbish between flights. To aid in splashdown, the booster was given an auxiliary propulsion system of ten pressure-fed N2O2/UDMH rocket engines for terminal deceleration before splashdown.

The external tank was given a few modifications. Obviously it needed modifications to alter the attachments from the side-mounted RSRMs to the aft-mounted propane booster. But since the vehicle was staged serially (the SSMEs on the orbiter would not be started until burnout of the boost-

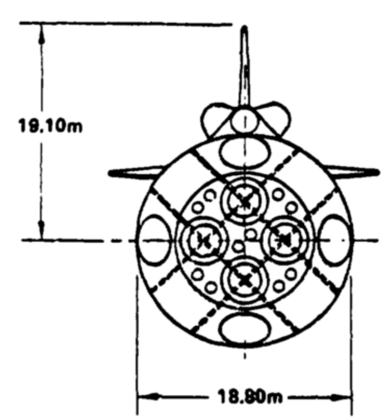
*(Continued on page 23)*




| | |
|---|---|
| GLOW | $2.612 \times 10^6$ KG |
| BLOW | $1.779 \times 10^6$ KG |
| $W_{P1}$ | $1.560 \times 10^6$ KG |
| ULOW | $.659 \times 10^6$ KG |
| $W_{P2}$ | $.547 \times 10^6$ KG |
| PAYLOAD | $.074 \times 10^6$ KG |
| T/W AT LIFTOFF | 1.238 |

MAIN PROPULSION

| STAGE | $\epsilon$ | NUMBER/TYPE | THRUST/ENGINE (VACUUM) $10^6$ N | THRUST/ENGINE (VACUUM) $10^6$ lbf | $I_{sp}$ SEC |
|---|---|---|---|---|---|
| 1 | 40 | 4-$C_3H_8$ | 6.623 | 1.916 | 340.0 |
| 2 | 77.5 | 3 SSME | 2.091 | .470 | 455.2 |



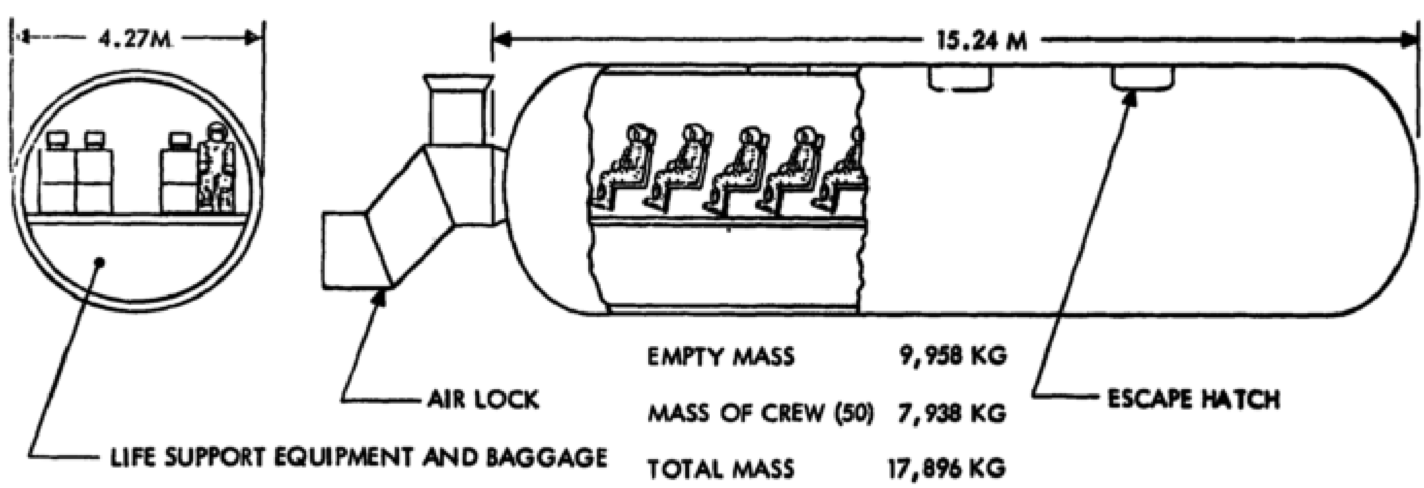
(Continued from page 22)
er), the external tank did not need the same propellant loading; it was estimated that 166 metric tons of propellant could be saved. The tanks was therefore reduce slightly in length, saving a bit of weight.

The target orbit for the personnel-carrying shuttle was 477 km altitude circular at 31° inclination, with a net payload of 73,550 kilograms. The program was expected to acquire 26 boosters, ten new orbiters and 3,584 external tanks. Average cost per flight was expected to be $12,619,000, in 1977 dollars.

## APR E-Publication

*In our last issue of Horizons, the subject of this bimonthly APR article by Scott Lowther was the Boeing Space Freighter. See www.aiaa-houston.org.*

# Aerospace Projects Review



## Current Events

*AIAA Daily Launch*

**NASA Contract Gives Spaceport America "Shot In The Arm."**

The Las Cruces (NM) Sun-News (10/16, Alba) reports, "NASA's recently announced plan to buy flights from two companies that will launch from Spaceport America gives the $209 million project a shot in the arm, as the facility preps for a ceremonial dedication of its largest building on Monday and the overall project inches closer to completion, supporters said last week." According to the article, state Sen. Mary Kay Papen said NASA's contracts with Virgin America and UP Aerospace give the spaceport more "credibility."

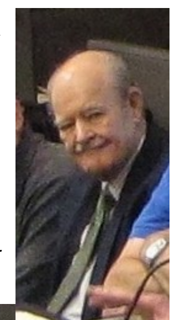
The AP (10/15) reported New Mexico Gov. Susana Martinez "will join British billionaire Sir Richard Branson to mark the start of his company, Virgin Galactic, being at Spaceport America." Also at the event this week will be "Congressman Steve Pearce, NASA representatives and spaceport executive director Christine Anderson."

**JAXA Releases Largest Asteroid Database.**

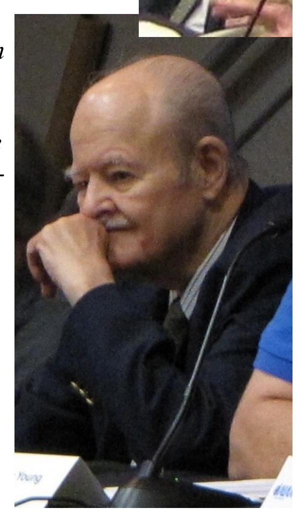
Japan's Yomiuri Shimbun (10/18) reports JAXA "has made available to the public the world's largest database of asteroids in the solar system." The database was developed using information from the Akari spacecraft.

*Obituaries*

### MARTY JENNESS 1935–2011



*Right: Martin David Jenness, 1935 - 2011. Mr. Jenness was part of the original NASA Space Task Group, joining up in 1960. For Apollo 8, he was the technical assistant to the chief of Mission Planning & Analysis Division (MPAD). His primary responsibility was developing the reference mission, especially the trans-lunar orbit portion. He was in the staff support room during that phase of the flight. Seeing the trajectory telemetry from the Moon match his calculations was his "definition of elation." Image credits: Douglas Yazell, from the AIAA Houston Section "40th Anniversary of Apollo 8" lunch-and-learn of December 19, 2008. AIAA Houston Section (editor-in-chief "at" aiaa-houston.org) has a NASA DVD of that event (video and audio) and a supplemental CD. Text credit for the above: Jenness biography from that event. Editor's note: Marty's career included the military: the U.S. Navy.*



*After an extended illness, Marty Jenness passed away on Friday August 19, 2011. He is survived by his wife Phyllis, his son David, his daughter Karen DeJong and her husband Eric, and a grandson Preston DeJong.*

*Marty joined the NASA Mission Analysis Branch of the Mission Planning organization in early 1962. The organization was later to become the Mission Planning and Analysis Division (MPAD) under the able leadership of John Mayer and Carl Huss. In the early months in Houston, MPAD worked out of the temporary office facilities in the Houston Petroleum Center on the Gulf Freeway. During the early development of the Johnson Space Center (JSC) facility in Clear Lake, MPAD moved to the new facility.*

*Marty was initially assigned to the Lunar Trajectory Section of the Mission Analysis Branch and began his career as a lunar trajectory specialist. His primary expertise was in spacecraft guidance, navigation & control (GN&C); he specialized in spacecraft "attitude and pointing" and attitude control.*

*Marty's significant contributions to the development of integrated lunar mission planning and analysis capability were instrumental in meeting NASA's goal of landing astronauts on the Moon. In the early 1960's, capability was developed from the bottom up. There were no text books to guide the way.*

*During his long NASA career Marty supported most major programs, including the Earth Resources Program, Apollo-Soyuz, the Space Shuttle Program, and Space Station. He supported payload and experiment mission planning and integration for all of these programs.*

*Marty retired from MPAD around 1989. During his career he gained the respect and friendship of colleagues across the agency. He will be greatly missed. Text credit: Hal Beck.*

### JON AXFORD 1944–2011

*Right: Jon Charles Axford, 1944 - 2011. Jon was an important member of the Apollo team. He was a procedures developer for Apollo abort operations in the old Flight Crew Support Division. Jon came to NASA as a co-op in 1963 and worked as NASA a civil servant until he retired in 1999. He also worked procedures for Skylab and space shuttle flight software. Image credits: John Mofitt.*

# Mike Moses Moves to Virgin Galactic

Staying Informed

PRESS RELEASE FROM VIRGIN GALACTIC

October 11, 2011

Virgin Galactic Appoints Former NASA Executive as Vice President of Operations Virgin Galactic is pleased to announce the appointment of former NASA executive Michael P. Moses as the Vice President of Operations. Just days prior to the dedication of the company's operational headquarters at Spaceport America in New Mexico, Virgin has named the highly respected human space flight leader to oversee the planning and execution of all operations at the site of the company's commercial suborbital spaceflight program.

Following a distinguished career in NASA's recently-retired Space Shuttle Program, Moses brings to Virgin Galactic a proven record of safe, successful and secure human spaceflight missions, spaceport operations, and human spaceflight program leadership. He served at the NASA Kennedy Space Center in Florida as the Launch Integration Manager from 2008 until the landing of the final Shuttle mission in July 2011. He was responsible for supervising all Space Shuttle processing activities from landing through launch, and for reviewing major milestones including final readiness for flight.

He also served as chair of the Mission Management Team and provided ultimate launch decision authority for the final 12 missions of the Space Shuttle Program, directly overseeing the safe and successful flights of 75 astronauts.

Moses will develop and lead the team responsible for Virgin Galactic spaceship operations and logistics, flight crew operations, customer training, and spaceport ground operations, with overall operational safety and risk management as the primary focus.

"Bringing Mike in to lead the team represents a significant investment in our commitment to operational safety and success as we prepare to launch commercial operations," said Virgin Galactic President and CEO, George Whitesides. "His experience and track record in all facets of spaceflight operations are truly unique. His forward-thinking perspective to bring the hard-won lessons of human spaceflight into our operations will benefit us tremendously."

Prior to his most recent NASA role, Moses served as a Flight Director at the NASA Johnson Space Center where he led teams of Flight Controllers in the planning, training and execution of all aspects of Space Shuttle missions. Before being selected as a Flight Director in 2005, Moses had over 10 years experience as a Flight Controller in the Shuttle Propulsion and Electrical Systems Groups.

Left: *Mike Moses. Image credit: Virgin Galactic*

Moses said, "I am extremely excited to be joining Virgin Galactic at this time, helping to forge the foundations that will enable routine commercial suborbital spaceflights. Virgin Galactic will expand the legacy of human spaceflight beyond traditional government programs into the world's first privately funded commercial spaceline."

Moses holds a bachelors degree in Physics from Purdue University, a masters degree in space sciences from Florida Institute of Technology and a masters degree in aerospace engineering from Purdue University. He is a two-time recipient of the NASA Outstanding Leadership Medal as well as other NASA commendations and awards.

*Virgin Galactic press release.*
*Tara Hyland, MCC, ASA, Virgin Galactic Accredited Space Agent (ASA), Director, Leisure Marketing - US at CWT Vacations, Houston, Texas USA*

*Below: A letter to the editor.*

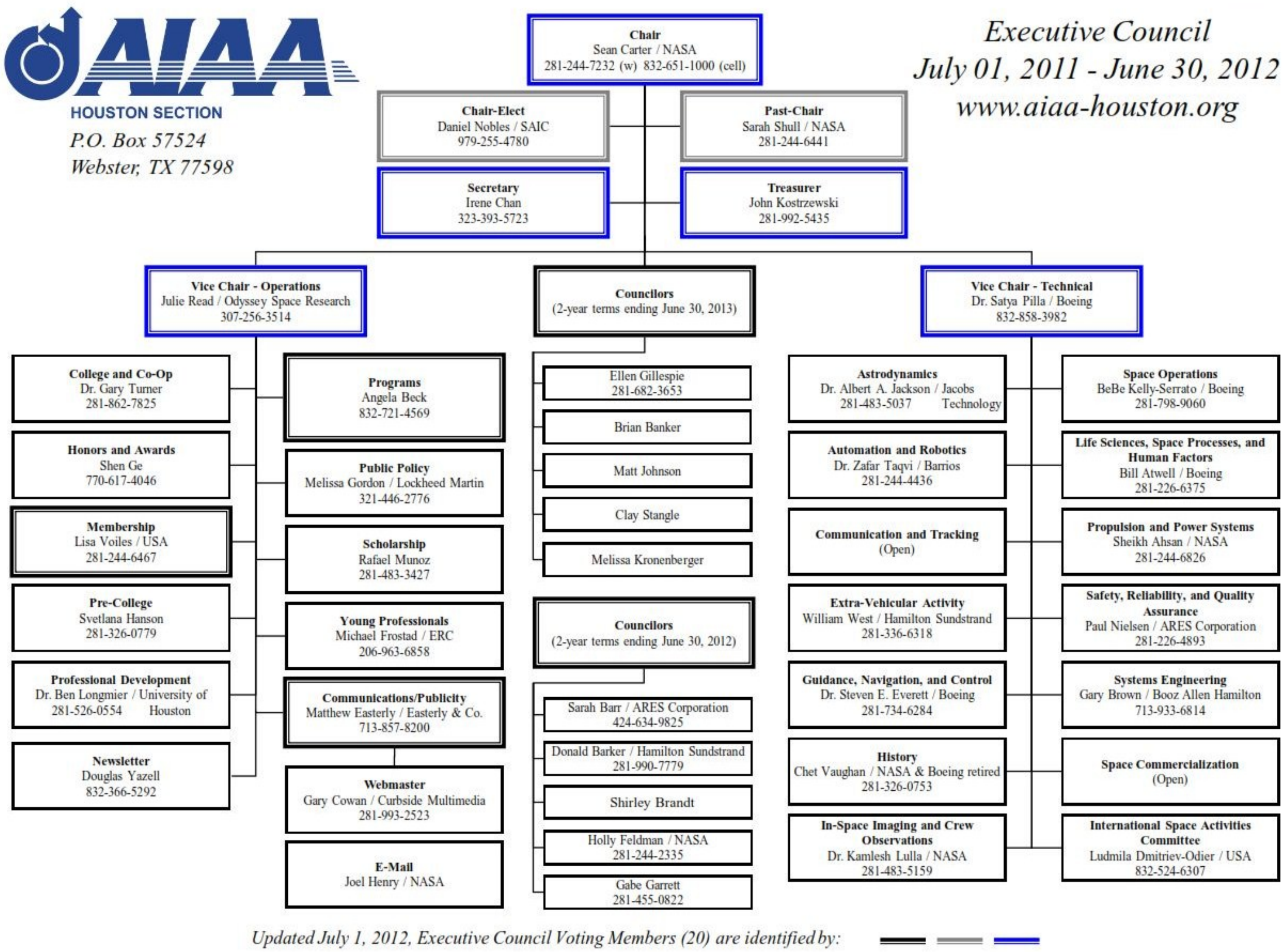
## Dome of an Idea

*James C. McLane III suggests putting a space shuttle orbiter in the Astrodome, along with the Saturn V rocket from Rocket Park at NASA/JSC. His letter appeared in the Houston Chronicle of October 8, 2011. Here is a link to that letter:* http://www.chron.com/opinion/letters/article/NASA-and-other-space-concerns-2208398.php

*Editor: James later said it is probably feasible to display the entire space shuttle stack (solid rocket boosters, external tank, and a real orbiter) depicting a realistic ascent at an angle in the Astrodome.*

*See page 29 for news about the new NASA Space Launch System (SLS).*

## Section News




*The American Institute of Aeronautics and Astronautics*

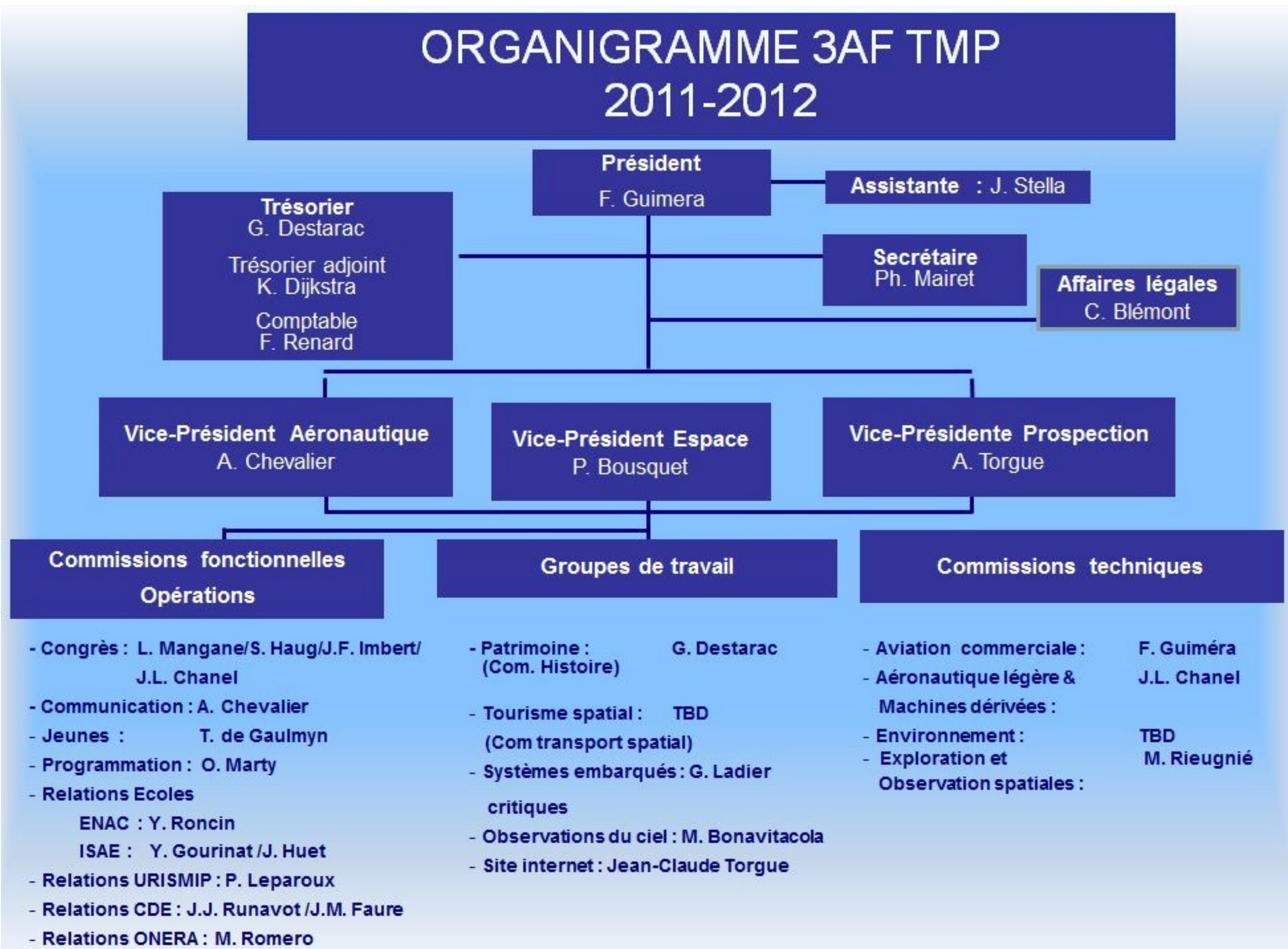

*Above: Image credit: public domain.*

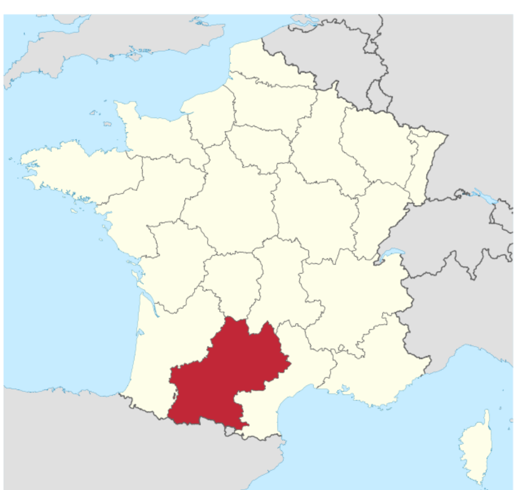
*Above is our ever-changing org chart, a snapshot taken from www.aiaa-houston.org on Monday, October 8, 2011. Tradition states that the Communications Chair has four boxes under it: Publicity, Webmaster, E-Mail, and Newsletter Editor. By combining Communications & Publicity, we accurately showed that Matthew Easterly was serving in both roles. But by not having a separate Publicity box saying "Open", we passed up an opportunity to advertise that opening. Matthew Easterly and Joel Henray (E-Mail Chair) are reluctantly leaving those roles, so please help them and us in finding new volunteers.*

*Our Young Professionals Chair Michael Frostad did a great job leading the Yuri's Night Houston team for the past few years. He would like to have someone else take over that role for that annual event. It takes place in April of each year.*

*Both the Communications & Tracking and the Space Commercialization technical committee are open / inactive. Volunteer now and interact with mirror committees on the national level! Ted Kenny has replaced Chester Vaughan as Chair of the History technical committee. Chet did a great job there for years! Bill Atwell is also stepping down after years or decades in that role as Chair of our Life Sciences, Space Processes, and Human Factors technical committee. Please help Bill and our section to find his replacement. Do you want to create a new technical committee? Contact us!*

## 3AF MP



*Left: The Midi-Pyrenees region of France. The Hexagon is a name sometimes used for France. Everyone knows the other places shown, no doubt. Corsica is an island and is part of France, south of the mainland, and Italy's Sardinia is south of Corsica. The UK and Spain are easy to find. To the east, we find Belgium, Luxembourg, Germany, Switzerland, and Italy, in that order. Image credit: public domain.*

*3AF MP:*
*l'Association Aeronautique et Astronautique de France, Midi-Pyrenees chapter, www.3af-mp.fr.*

*Our French sister section is 3AF MP. See our web page at www.aiaa-houston.org. Click on technical committees, International Space Activities Committee (ISAC, chaired by Ludmila Dmitriev-Odier). As time permits, we will put the above org chart on that ISAC web page.*

# Calendar

**AIAA Houston Section events & other events related to aeronautics & astronautics.**
**This bimonthly issue of Horizons will be online by Monday, October 31, 2011.**
**All items are subject to change without notice.**

**AIAA Houston Section council meetings**
Time: 5:30 - 6:30 PM usually
Day: First Monday of most months except for holidays.
July, August and December are often exceptions.
Location: NASA/JSC Gilruth Center is often used. The room varies.
More information: e-mail chair "at" aiaa-houston.org or secretary "at" aiaa-houston.org

**AIAA Houston Section Council Meeting**
Monday, November 7, 2011

**Lunch-and-Learn, AIAA Houston Section GN&C technical committee**
Date: Tuesday, November 8, 2011
Chair: Dr. Steven E. Everett, e-mail gnc "at" aiaa-houston.org
Speaker: Michael L. Raftery, ISS Deputy Program Manager, Boeing
Subject: Use of ISS for Exploration
Location: Gilruth Center (Lone Star room), www.aiaa-houston.org

**Lunch-and-Learn, AIAA Houston Section Astrodynamics technical committee**
Date: Monday, November 14, 2011
Chair: Dr. Albert A. Jackson, IV, e-mail astro "at" aiaa-houston.org
Speaker: Richard Obousy, Ph.D., MPhys, FBIS, President, Icarus Intertsellar, Inc.
Subject: Project Icarus: A 21st Century Interstellar Starship Study
Location: Gilruth Center, (Brazos room), www.aiaa-houston.org

**Tentative**: AIAA Houston Section Nov. 2011 dinner meeting, www.aiaa-houston.org

**AIAA Houston Section Council Meeting**
Monday, December 5, 2011

**Tentative**: Early December 2011, H. "Sonny" White of NASA/JSC, his presentation from the 100 Year Starship Symposium, AIAA Houston Section astrodynamics technical committee lunch-and-learn at NASA/JSC Gilruth Center

**AIAA Houston Section Council Meeting**
Monday, January 9, 2011

**AIAA Houston Section Annual Technical Symposium (ATS 2011, see page 3)**
Friday, May 18, 2011

**AIAA National & International Conferences**

**12 Nov 2011**
2011 Pacific Northwest AIAA Technical Symposium
Seattle, Washington: SEATAC International Airport Conference Center

**28 Nov - 1 Dec 2011**
29th AIAA International Communications Satellite Systems Conference (ICSSC-2011)
Nara, Japan, Hotel Nikko Nara

**9 - 12 Jan 2012**
50th AIAA Aerospace Sciences Meeting including the New Horizons Forum and Aerospace Exposition
Nashville, Tennessee, Gaylord Opryland Resort & Convention Center

## Cranium Cruncher

STEVE EVERETT

**Challenge**

A problem of determining the ages of the members of Tommy's family was posed last month. The answer to the question, "How old is mother?" is 29 years and 2 months. Additionally, it can be shown that Tommy's father is 35 years old, and Tommy himself is 5 years and 10 months. Congratulations to Ronny Newman (NASA) and Wes Dafler (Boeing) for their correct solutions.

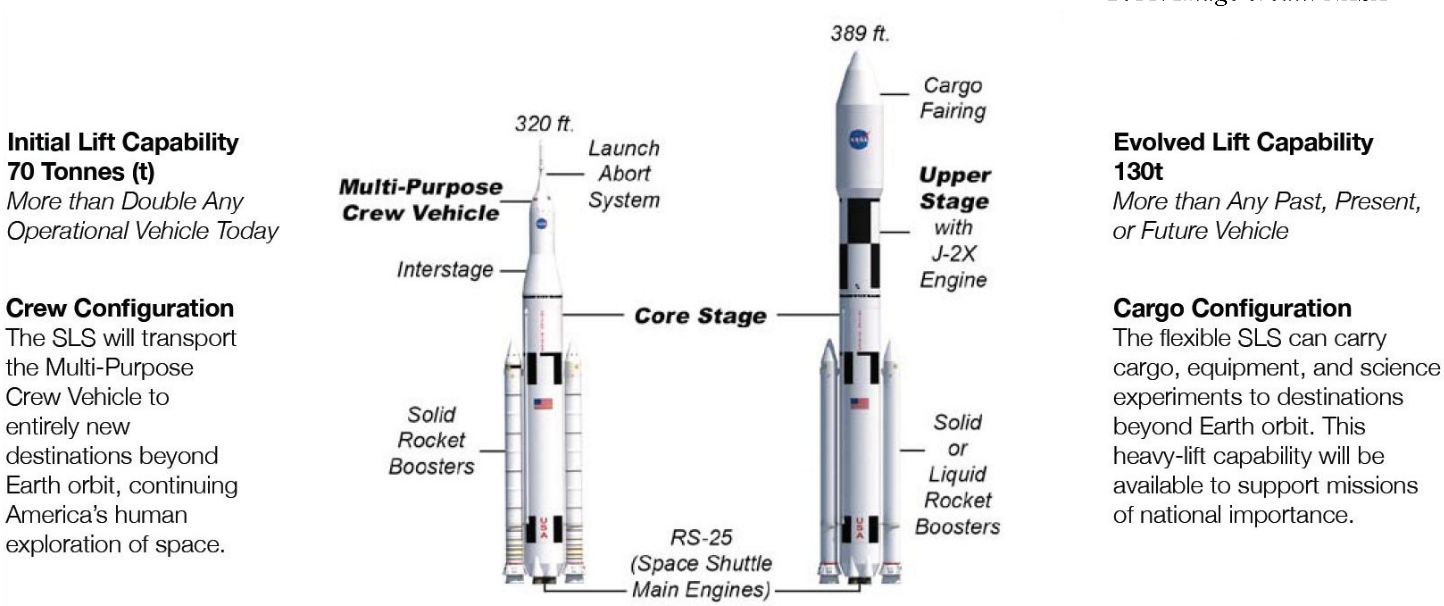
The puzzle this month is one concerning time. When the Clarke Colony on Mars was established, its residents decided to standardize their Mars solar day at 24.6 Earth-hours. (Differences from the true length of the Mars solar day would be adjusted with the use of leap days, minutes, and seconds as required.) Accordingly, they decided also to slightly decrease the speed of their clocks to account for the slightly longer Martian solar day so that their day could also be broken up into precisely 24 Mars-hours. In other words, an Earth clock, whose hour hand would make two revolutions every 24-Earth-hour solar day and whose minute hand would make 1 revolution every 1-Earth-hour, was modified so that its hour hand would make two revolutions every 24-Mars-hour solar day and whose minute hand would make 1 revolution every 1-Mars-hour.

It so happened that at a particular instant, both Earth and Mars clocks read 12:00, so that hands on both clocks were perfectly aligned with each other and pointing directly at the numeral 12. When is the next instant (expressed in Earth time and in Mars time), if ever, that the hour and minute hands on the Earth clock are aligned with each other at the same time that the hour and minute hands on the Mars clock are aligned with each other (not necessarily toward the same numeral on each clock)?

*Bonus question*: Mars gravity is 38% of that on Earth. Assuming no internal changes (gear ratios, for example), what is the percentage change required for the length of the pendulum required to operate an Earth clock on Mars at the desired rate?

E-mail solutions to steven.e.everett "at" boeing.com

*Below: NASA Space Launch System (SLS), the new rocket, announced September 14, 2011. Image credit: NASA*



*In our May 2011 issue we started our series EAA/AIAA profiles in general and experimental aviation with Lance Borden, who is rebuilding his Inland Sport airplane, an aircraft manufactured by his grandfather's 1929 - 1932 company. The second in this series was a profile of Paul F. Dye. The third profile will probably appear in our next issue. This series was suggested by Richard Sessions of EAA Chapter 12.*

*EAA is the Experimental Aircraft Association. The Houston Chapter is #12, one of the earliest created among the hundreds of chapters.*

*www.eaa12.org.*

# EAA and EAA Chapter 12 Information

**Chapter Mission**

The Experimental Aircraft Association's Chapter 12, located at Ellington Field in Houston, is an organization that promotes all forms of recreational aviation. The organization includes interest in homebuilt, experimental, antique and classic, warbirds, aerobatic aircraft, ultra lights, helicopters and commercially manufactured aircraft and the associated technologies.

This organization brings people together with an interest in recreational aviation, facilitating social interaction and information sharing between aviation enthusiasts. Many of the services that EAA offers provide valuable support resources for those that wish develop and improve various skills related to aircraft construction and restoration, piloting, aviation safety, and aviation education. Every individual and organization with an interest in aviation and aviation technology is encouraged to participate (EAA membership is not required, but encouraged). Meetings are generally from 6:30 PM to 9 PM at Ellington Field in Houston Texas. We welcome everyone. Come as you are and bring a guest; we are an all aviation friendly organization!

Ideas for a meeting? Contact Richard at rtsessions "at" earthlink.net, Chapter web site: www.eaa12.org
Experimental Aircraft Association web site: www.eaa.org

**Scheduled/Preliminary Chapter 12 Event/Meeting Ideas and Recurring Events:**
Monthly Meeting: Chapter 302, 2nd Saturday, 10 AM, Lone Star Builder's Center, Lone Star Executive, Conroe TX
1st Saturday of each month – La Grange TX BBQ Fly-In, Fayette Regional (3T5)
1st Saturday – Waco/Macgregor TX (KPWG), Far East Side of Field, Chap 59, Pancake Breakfast with all the goodies 8-10 AM, Dale Breedlove, jdbvmt "at" netscape.com
2nd Saturday – Lufkin TX Fajita Fly-In (LFK)
2nd Saturday – New Braunfels TX Pancake Fly-In
3rd Saturday – Wings & Wheels, 1941 Air Terminal Museum, Hobby Airport, Houston TX
3rd Saturday – Jasper TX BBQ Lunch Fly-In (JAS)
3rd Saturday – Tyler TX Breakfast Fly-In, 8-11, Pounds Field (TYR)
4th Saturday – Denton TX Tex-Mex Fly-In
4th Saturday – Leesville LA Lunch Fly-In (L39)
4th Saturday – Shreveport LA Lunch Fly-In (DTN)
Last Saturday – Denton Fly-In 11AM-2 PM (KDTO)

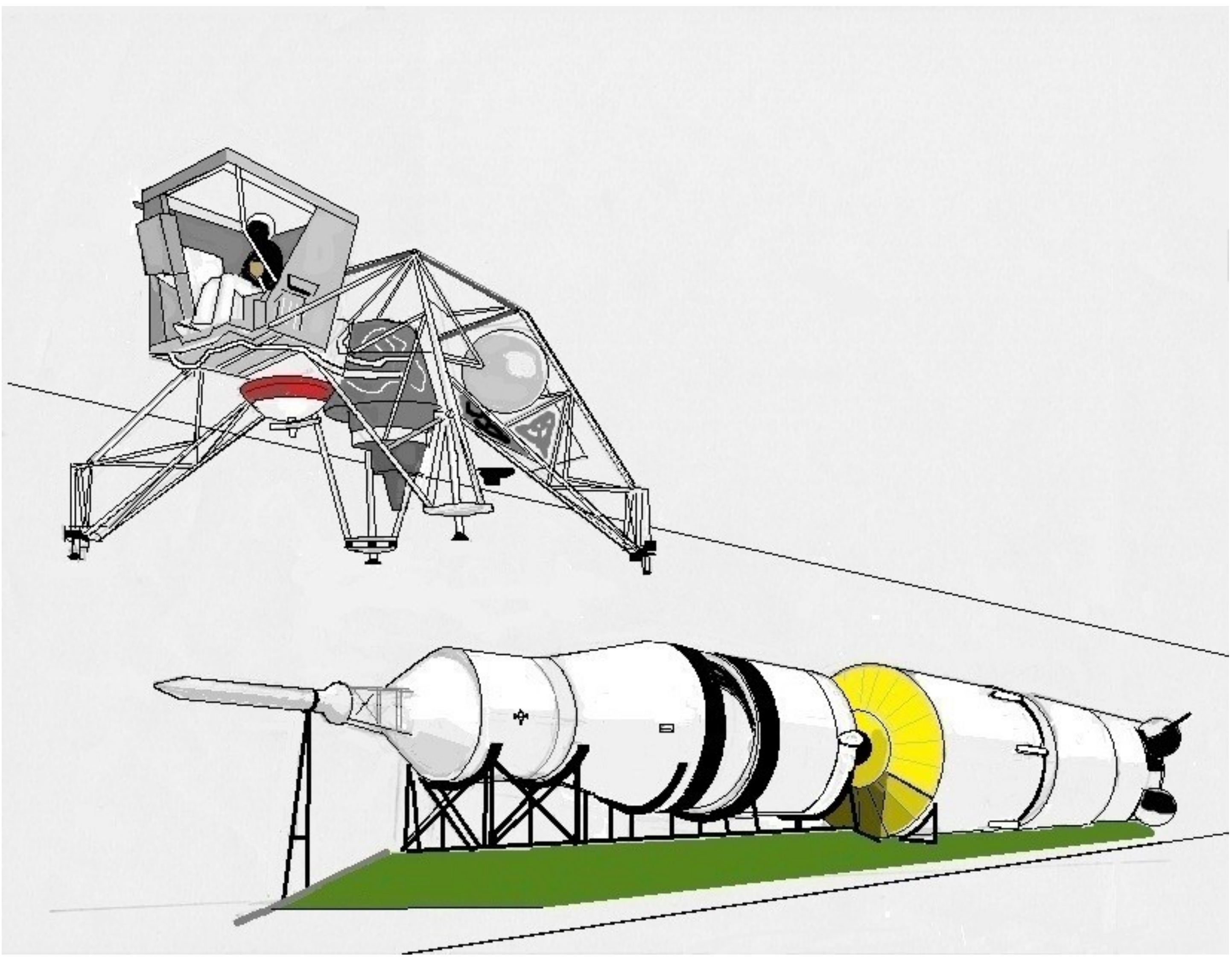
*Right: A large version of a Burt Rutan Long-EZ, owned by Dennis Butler, part of the EAA exhibit at the 2011 Wings Over Houston airshow. Image credit: Douglas Yazell.*

# Works of Art

**Don Kulba, Contributor**

## Art by Don Kulba

*Below: Lunar Landing Training Vehicle (LLTV) in Rocket Park. Illustration by contributor Don Kulba. Moving the LLTV from NASA/JSC Building 2 (Teague Auditorium) to Rocket Park (in the building with the Apollo program's Saturn V rocket) was suggested by a reader.*



# Conference Papers Presented or Co-Authored by AIAA Houston Section Members (including papers from Texas A&M University)

COMPILED BY THE EDITOR FROM AIAA AGENDAS, SEARCHING FOR "HOUSTON", SUBJECT TO CHANGE

*To add your recent presentations to this list, e-mail the editor using editor-in-chief "at" aiaa-houston.org.*

## AAS/AIAA Astrodynamics Specialist Conference
## Girdwood, Alaska, July 31 - August 4, 2011

**Multi-Maneuver Clohessy-Wiltshire Targeting**
*David P. Dannemiller, NASA-Johnson Space Center, AAS 11-650*

## AIAA SPACE 2011 Conference and Exposition, Long Beach, California, Sep. 27-29, 2011:

**Shuttle Risk Progression: Use of the Shuttle Probabilistic Risk Assessment (PRA) to Show Reliability Growth**
*Teri Hamlin NASA Johnson Space Center, Houston, TX; Joseph Kahn SAIC, Houston, TX; Eric Thigpen SAIC, Houston, TX; Yohon Lo BTI, Huntsville, AL , AIAA-2011-7353*

**TAMU: Blueprint for a New Space Mission Operations System Paradigm**
*Leila Meshkat Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA; Granvil Pennington NASA Johnson Space Center, Houston, TX; James Ruszkowski NASA Johnson Space Center, Houston, TX; Jean Haensly NASA Johnson Space Center, Houston, TX; Charles Hogle NASA Johnson Space Center, Houston, TX , AIAA-2011-7338*

**Center for Lunar Exploration Operations (CLEO)**
*Timothy Giblin United Space Alliance, Houston, TX , AIAA-2011-7337*

**Making Human Spaceflight Practical and Affordable: Spacecraft Designs and their Degree of Operability**
*Alan Crocker NASA Johnson Space Center, Houston, TX , AIAA-2011-7336*

**Assessment of the Use of Nanofluids in Spacecraft Active Thermal Control Systems**
*Eugene Ungar NASA Johnson Space Center, Houston, TX; Lisa Erickson NASA Johnson Space Center, Houston, TX , AIAA-2011-7328*

**The Thermal Hogan - A Means of Surviving the Lunar Night**
*Eugene Ungar NASA Johnson Space Center, Houston, TX; Neelay Fruitwala NASA Johnson Space Center, Houston, TX , AIAA-2011-7327*

**Space Shuttle Orbiter Thermal Protection System Lessons Learned**
*Cooper Snapp NASA Johnson Space Center, Houston, TX; Alvaro Rodriguez NASA Johnson Space Center, Houston, TX , AIAA-2011-7308*

**The Legacy of Space Shuttle Flight Software**
*Christopher Hickey NASA Johnson Space Center, Houston, TX; Andrew Klausman United Space Alliance, Houston, TX; Brad Loveall NASA Johnson Space Center, Houston, TX; James Orr NASA Johnson Space Center, Houston, TX , AIAA-2011-7307*

**Shuttle Avionics, Radio Frequency Analysis, and Electromagnetic Compatibility and Lightning Protection**
*Michael Kern The George Washington University, Washington, DC, UNITED STATES; Shian Hwu NASA Johnson Space Center, Houston, TX; Quin Kroll NASA Johnson Space Center, Houston, TX; Catherine Sham NASA Johnson Space Center, Houston, TX; Ray Nuss NASA Johnson Space Center, Houston, TX; Kaylene Kindt NASA Johnson Space Center, Houston, TX; Diana Schuler NASA Johnson Space Center, Houston, TX; Denise Romero NASA Johnson Space Center, Houston, TX; Robert Scully NASA Johnson Space Center, Houston, TX , AIAA-2011-7305*

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**Overview of the NASA Entry, Descent and Landing Systems Analysis Studies for Large Robotic-class Missions**
*Thomas Zang NASA Langley Research Center, Hampton, VA; Alicia Dwyer-Cianciolo NASA Langley Research Center, Hampton, VA; Mark Ivanov Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA; Ronald Sostaric NASA Johnson Space Center, Houston, TX; David Kinney NASA Ames Research Center, Moffett Field, CA , AIAA-2011-7294*

**SRMS History, Evolution and Lessons Learned**
*Glenn Jorgensen NASA Johnson Space Center, Houston, TX; Elizabeth Bains NASA Johnson Space Center, Houston, TX , AIAA-2011-7277*

**EVA: Don't Leave Earth Without It**
*Scott Cupples NASA Johnson Space Center, Houston, TX; Stephen Smith NASA Johnson Space Center, Houston, TX , AIAA-2011-7276*

**Selected Lessons Learned in Space Shuttle Orbiter Propulsion and Power Subsystems**
*Francisco Hernandez NASA Johnson Space Center, Houston, TX; Martinez Hugo NASA Johnson Space Center, Houston, TX; Abigail Ryan NASA Johnson Space Center, Houston, TX; Shayne Westover NASA Johnson Space Center, Houston, TX; Frank Davies NASA Johnson Space Center, Houston, TX , AIAA-2011-7275*

**Progressive Architecture - Evolving a Launch Vehicle Configuration to Achieve an Affordable and Sustainable Program**
*Jeffrey Osterlund United Space Alliance, Houston, TX , AIAA-2011-7271*

**NASA Mission Operations Directorate Preparations for the COTS Visiting Vehicles**
*Sarah Shull NASA Johnson Space Center, Houston, TX; Kenneth Peek NASA Johnson Space Center, Houston, TX **, AIAA**-2011-7264*

**Long-Duration Human Habitation Beyond Low-Earth Orbit: Why is the Near Future Critical?**
*Harley Thronson NASA Goddard Space Flight Center, Greenbelt, MD; Daniel Lester University of Texas, Austin, Austin, TX; John Dorsey NASA Langley Research Center, Hampton, VA; Ted Talay John Frassanito and Associates, Houston, TX , AIAA-2011-7256*

**NASA Technology Area 07: Human Exploration Destination Systems Roadmap**
*Kriss Kennedy NASA Johnson Space Center, Houston, TX; Leslie Alexander NASA Marshall Space Flight Center, Huntsville, AL; Rob Landis NASA Ames Research Center, Moffett Field, CA; Carole Mclemore NASA Marshall Space Flight Center, Huntsville, AL; Diane Linne NASA Glenn Research Center, Cleveland, OH; Edgardo Santiago-Maldonado NASA Kennedy Space Center, Cape Canaveral, FL; David Brown NASA Johnson Space Center, Houston, TX , AIAA-2011-7255*

**VASIMR®: Deep Space Transportation for the 21st Century**
*Edgar Bering University of Houston, Houston, TX; Benjamin Longmier Ad Astra Rocket Company, Webster, TX; Chris Olsen Ad Astra Rocket Company, Webster, TX; Leonard Cassady Ad Astra Rocket Company, Webster, TX; Jared Squire Ad Astra Rocket Company, Webster, TX; Franklin Chang Díaz Ad Astra Rocket Company, Webster, TX , AIAA-2011-7247*

**Space Shuttle Abort Evolution**
*Edward Henderson NASA Johnson Space Center, Houston, TX; Tri Nguyen NASA Johnson Space Center, Houston, TX , AIAA-2011-7245*

**Space Shuttle GN&C Development History and Evolution**
*Doug Zimpfer Draper Laboratory, Houston, TX; Philip Hattis Draper Laboratory, Cambridge, MA; John Ruppert NASA Johnson Space Center, Houston, TX; Don Gavert Self, Huntington Beach, CA , AIAA-2011-7244*

**Space Shuttle Ascent Flight Design Process: Evolution and Lessons Learned**
*Bret Picka United Space Alliance, Houston, TX; Christopher Glenn NASA Johnson Space Center, Houston, TX , AIAA-2011-7243*

**Mission Operations Directorate - Success Legacy of the Space Shuttle Program (Overview of the evolution and success stories from MOD during the Space Shuttle program)**
*Jim Azbell NASA Johnson Space Center, Houston, TX , AIAA-2011-7242*

**Total Ionizing Dose from Ground Level Enhanced Solar Proton Events for Several Electronics Shielding Configurations**

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*William Atwell The Boeing Company, Houston, TX; Steven Koontz NASA Johnson Space Center, Houston, TX; Brandon Reddell NASA Johnson Space Center, Houston, TX; Paul Boeder The Boeing Company, Houston, TX , AIAA-2011-7209*

**The Habitat Demonstration Unit: A Modular Instrumentation System for a Deep Space Habitat**
*Kristina Rojdev NASA Johnson Space Center, Houston, TX; Kriss Kennedy NASA Johnson Space Center, Houston, TX; Hester Yim NASA Johnson Space Center, Houston, TX; Robert Williams NASA Johnson Space Center, Houston, TX; Raymond Wagner Jacobs, Houston, TX; Scott Hafermalz NASA Johnson Space Center, Houston, TX , AIAA-2011-7203*

**Space Shuttle Day-of-Launch Trajectory Design Operations**
*Brian Harrington United Space Alliance, Houston, TX , AIAA-2011-7197*

**The Evolution of Utilizing Manual Throttling to Avoid Excessively Low LH2 NPSP at the SSME Inlet**
*Rick Henfling NASA Johnson Space Center, Houston, TX , AIAA-2011-7196*

**Docking Offset Between the Space Shuttle and the International Space Station and Resulting Impacts to the Transfer of Attitude Reference and Control**
*Kara Pohlkamp NASA Johnson Space Center, Houston, TX; William Helms NASA Johnson Space Center, Houston, TX , AIAA-2011-7195*

**Significant Incidents and Close Calls in Human Spaceflight: Context for Understanding Space Shuttle Lessons Learned**
*Robert Bobola SAIC, Houston, TX; Dennis Pate SAIC, Houston, TX , AIAA-2011-7194*

**NASA/MOD Operations Impacts from Shuttle Program**
*Gregory Mattes NASA Johnson Space Center, Houston, TX; Michael Fitzpatrick NASA Johnson Space Center, Houston, TX; Michael Grabois NASA Johnson Space Center, Houston, TX; Holly Griffith NASA Johnson Space Center, Houston, TX , AIAA-2011-7193*

**NASA Flight Planning Branch Space Shuttle Lessons Learned**
*Jennifer Clevenger NASA Johnson Space Center, Houston, TX; Fisher Reynolds United Space Alliance, Houston, TX; Gregory Whitney NASA Johnson Space Center, Houston, TX; Mark Blanton NASA Johnson Space Center, Houston, TX; Douglas Bristol NASA Johnson Space Center, Houston, TX , AIAA-2011-7192*

**Evolution of Space Shuttle Range Safety Ascent Flight Envelope Design**
*Joan Brewer United Space Alliance, Houston, TX , AIAA-2011-7191*

**The Right Stuff: A Look Back at Three Decades of Flight Controller Training for Space Shuttle Mission Operations**
*Gary Dittemore NASA Johnson Space Center, Houston, TX; Christie Bertels NASA Johnson Space Center, Houston, TX , AIAA-2011-7190*

**Designing the STS-134 Re-Rendezvous: A Preparation for Future Crewed Rendezvous Missions**
*Timothy Stuit United Space Alliance, Houston, TX , AIAA-2011-7189*

**Using the Resources of the Moon to Create a Space Faring System**
*Paul Spudis Lunar and Planetary Institute, Houston, TX; Anthony Lavoie NASA Marshall Space Flight Center, Huntsville, AL , AIAA-2011-7185*

**ISS Operations Cost Reductions through Automation of Real-Time Planning Tasks**
*Timothy Hall NASA Johnson Space Center, Houston, TX; William Clancey NASA Ames Research Center, Moffett Field, CA; Tyson Tucker United Space Alliance, Houston, TX; Deborah Kadlec Barrios Technology, Houston, TX; Marc Spicer NASA Johnson Space Center, Houston, TX; Aaron McDonald NASA Johnson Space Center, Houston, TX; Ahmed Khan United Space Alliance, Houston, TX; Jason Toschlog United Space Alliance, Houston, TX , AIAA-2011-7180*

**Kedalion: NASA's Adaptable and Agile HW/SW Integration and Test Lab**
*Mark Mangieri NASA Johnson Space Center, Houston, TX , AIAA-2011-7176*

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**Electronic Procedures for Medical Operations in Space**
*Mary Hudson Self, Houston, TX; Arthur Molin Self, Houston, TX , AIAA-2011-7175*

**Space Vehicle Powerdown Philosophies Derived from the Space Shuttle Program**
*Mark Willsey NASA Johnson Space Center, Houston, TX; Brad Bailey NASA Johnson Space Center, Houston, TX , AIAA-2011-7174*

**Space Shuttle Orbiter Structures & Mechanisms**
*Adam Gilmore NASA Johnson Space Center, Houston, TX; Brent Evernden NASA Johnson Space Center, Houston, TX; Lynda Estes NASA Johnson Space Center, Houston, TX; Jeff Logan NASA Ames Research Center, Moffett Field, CA; Jim Eilers NASA Ames Research Center, Moffett Field, CA; Kelly Carney NASA Glenn Research Center, Cleveland, OH; Will Decker NASA Johnson Space Center, Houston, TX; Robert Davis NASA Johnson Space Center, Houston, TX; Jeffrey Hagen NASA Johnson Space Center, Houston, TX; Jim Broughton NASA Kennedy Space Center, Cape Canaveral, FL; Carlisle Campbell NASA Johnson Space Center, Houston, TX , AIAA-2011-7158*

**Adding a Second Ku-Band Antenna to the International Space Station**
*Charles Dusold The Boeing Company, Houston, TX; Sundeep Kwatra NASA Johnson Space Center, Houston, TX; Corey Thacker The Boeing Company, Houston, TX , AIAA-2011-7152*

**ISS Interface Mechanisms and their Heritage**
*John Cook The Boeing Company, Houston, TX , AIAA-2011-7150*

**Best Practices for Ensuring Successful Agreements Processing**
*Barry Copeland NASA Johnson Space Center, Houston, TX; Collin Hieger Jacobs, Houston, TX , AIAA-2011-7144*

**Microrovers for Assisting Humans on the Moon and Elsewhere: Microrover Catalog, Requirements, and General Design Conclusions**
*Bruce Betts Planetary Society, Pasadena, CA; Mason Peck Cornell University, Ithaca, NY; Douglas Stetson Space Science and Exploration Consulting Group, Pasadena, CA; Joseph Shoer Cornell University, Ithaca, NY; Tomas Svitek Stellar Exploration, Inc., San Luis Obispo, CA; James Bell Arizona State University, Tempe, AZ; Tom Jones Self, Houston, TX; Forest Purnell Planetary Society, Pasadena, CA , AIAA-2011-7143*

**Shuttle Program Loads Integration: Going from Concept to Operations and Staying Successful**
*Karen Bernstein NASA Johnson Space Center, Houston, TX; George James NASA Johnson Space Center, Houston, TX; Alden Mackey NASA Johnson Space Center, Houston, TX; Tom Modlin NASA Johnson Space Center, Houston, TX; Mike Murphy NASA Johnson Space Center, Houston, TX; Clarence Modlin , Dickinson, TX, UNITED STATES; Neill Murphy NASA/MSFC, Huntsville, AL, UNITED STATES; Steve Brolliar NASA Johnson Space Center, Houston, TX , AIAA-2011-7123*

**Legacy of the Space Shuttle from an Aerodynamic and Aerothermodynamic Perspective**
*Fred Martin NASA Johnson Space Center, Houston, TX , AIAA-2011-7122*

**ISRU - From Concept to Reality: NASA Accomplishments and Future Plans**
*William Larson NASA Kennedy Space Center, Cape Canaveral, FL; Gerald Sanders NASA Johnson Space Center, Houston, TX; Mark Hyatt NASA Glenn Research Center, Cleveland, OH , AIAA-2011-7114*

**Lunar/NEO Commercial Initiatives**
*Robert Kelso NASA Johnson Space Center, Houston, TX , AIAA-2011-7111*

**Integration Process for the Habitat Demonstration Unit Deep Space Habitat**
*Tracy Gill NASA Kennedy Space Center, Cape Canaveral, FL; Jerad Merbitz NASA Kennedy Space Center, Cape Canaveral, FL; Kriss Kennedy NASA Johnson Space Center, Houston, TX; Terry Tri NASA Johnson Space Center, Houston, TX; Larry Toups NASA Johnson Space Center, Houston, TX; Alan Howe Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA; David Smitherman NASA Marshall Space Flight Center, Huntsville, AL , AIAA-2011-7108*

**Design Considerations for a Commercial Crew Transportation System**
*Keith Reiley The Boeing Company, Houston, TX; Michael Burghardt The Boeing Company, Houston, TX; Jay Ingham Bigelow Aerospace, Las Vegas, NV; Michael Lembeck DCI Services and Consulting, League City, TX , AIAA-2011-7101*

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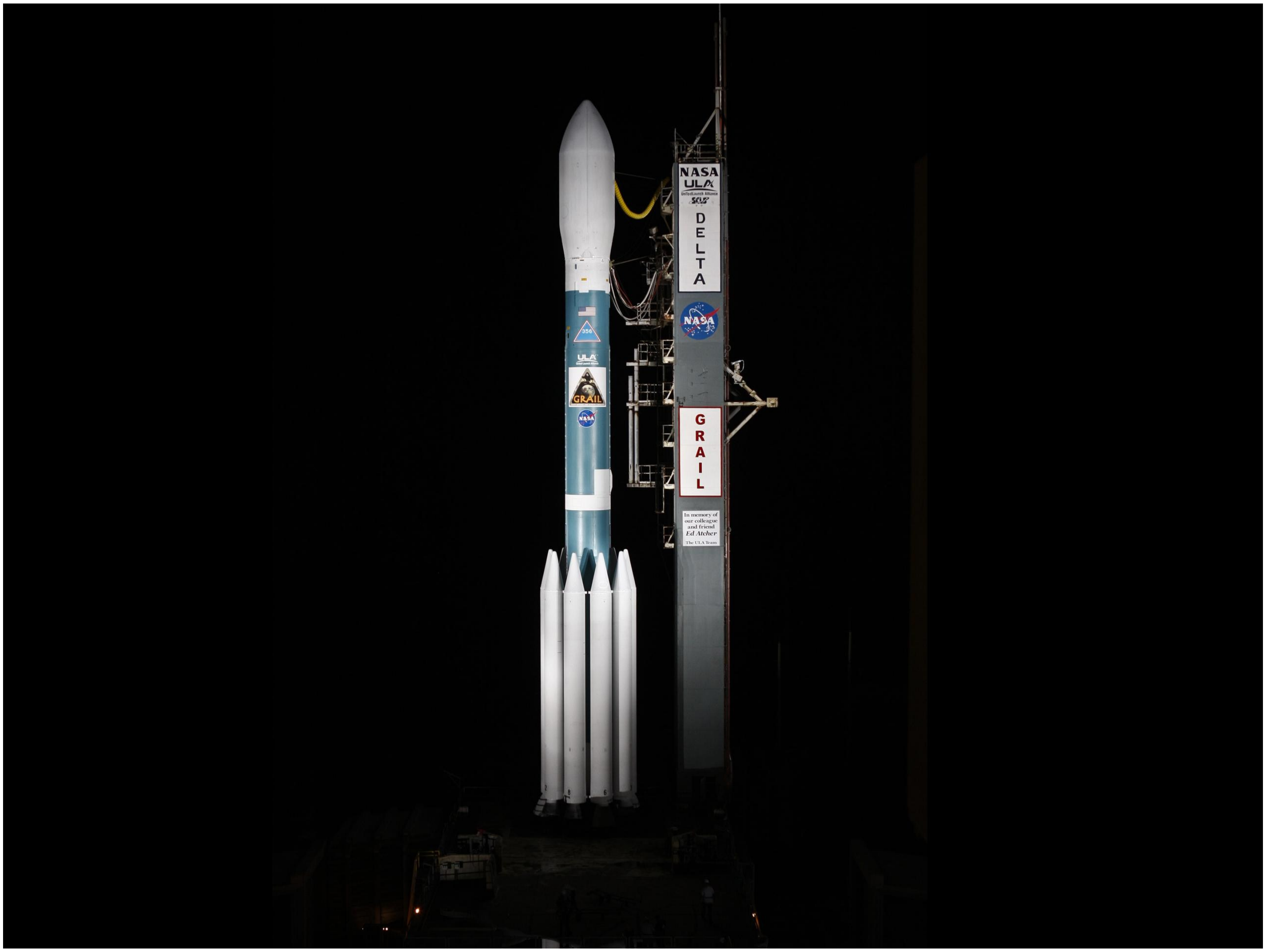


***Above: GRAIL on the Pad***

*NASA's GRAIL twin spacecraft await launch atop a United Launch Alliance Delta II rocket at Cape Canaveral Air Force Station, Fla.. Image credit: NASA/JPL-Caltech/United Launch Alliance, Thom Baur*

## AIAA Mission & Vision Statement

*The shaping, dynamic force in aerospace - THE forum for innovation, excellence and global leadership. AIAA advances the state of aerospace science, engineering, and technological leadership. Core missions include communications and advocacy, products and programs, membership value, and market and workforce development.*

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