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AIAA HOUSTON
American Institute of Aeronautics and Astronautics

NOTICE

This will be the last paper copy automatically mailed to members. For all future issues an email will be sent out announcing when the new newsletter has been posted to the AIAA-Houston web site. If you have no Internet access, or for some reason you need a paper copy, please send an email to: editor@aiaa-houston.org.

Contents:

Thoughts on a Future Lunar Strategy

DR. WENDELL W. MENDELL

By now JSC employees should be very familiar with the Vision for Space Exploration enunciated by the President in January, 2004, at NASA Headquarters. Much of the JSC workforce is concerned about the future of the Space Shuttle and the International Space Station. However, more and more folks are working on projects related to proposed lunar exploration and development.

Although the President seemed quite specific in the list of tasks, debates rage in NASA over the precise meaning of phrases such as "going to the Moon to go to Mars." Some believe the lunar landings must be kept to a minimum in order to maintain a focus on Mars exploration. Others opine that the lunar activities are a critical step towards human exploration into the solar system.

During the short-lived Space Exploration Initiative (SEI) similar debates arose. I delivered a paper at the 1991 International Astronautical Congress in Montreal entitled, "Lunar Base as a Precursor to Human Exploration of Mars." I presented four fundamental programmatic risks that must be addressed before NASA could, with confidence, commit to a human mission to Mars. I argued that the nature of the mission risks required development of new capabilities and technologies in a lunar setting. Beginning in 2001, I delivered a paper on each of three risks, expanding the level of detail with co-authors who are recognized experts on each risk topic. I was planning the fourth paper when the President rendered the discussion moot (in my mind). For the 2004 Congress in Vancouver, I instead presented a paper outlining a lunar strategy consistent with the Space Vision, which would address the risks I had previously identified and which would truly use the Moon to go to Mars.

Although the President seemed quite specific in the list of tasks, debates rage in NASA over the precise meaning of phrases such as "going to the Moon to go to Mars."

Several years ago NASA produced a Mars Design Reference Mission (MDRM). The MDRM is not the way that NASA plans to mount a human mission to Mars, but it does represent a reference scenario against which new ideas can be compared. It is deliberately a technologically conservative scenario, i.e., it does not require new technologies (e.g., nuclear propulsion) or a new class of launch vehicles (e.g., Shuttle C or Magnum). Mission design choices are made to minimize cost, e.g., to minimize mass launched to LEO for each mission.

Chemical propulsion dictates a Hohmann-class transfer to Mars to minimize propellant. The so-called conjunction-class mission is used to allow a single system design for all launch opportunities. However, the trajectories require that Earth and Mars be aligned in a certain way that occurs only once every 26 months. In addition, once the crew arrives at Mars, they must wait approximately 500 days before they can return to Earth. Taking into account the months spent coasting between Earth and Mars on both legs of the trip, the MDRM is called a 1000-day class mission. In other words, from the time the crew leaves Earth orbit to go to Mars, approximately 3 years will pass before they return. And they cannot return any sooner.

Over the past 20 years, many mission scenarios have been published for expeditions to the Moon or to Mars. The ones based on chemical propulsion usually assume hydrogen and oxygen for propellants because that combination has the highest specific impulse, i.e., is most efficient. From these studies has emerged a rule of thumb that if one wants to land one ton on the Moon and later return it to Earth, one needs to launch seven tons to LEO, most of which is oxygen for propellant. The analogous rule of thumb for Mars is a ratio of about 40 to 1. In other words, expeditions to Mars require a factor of five or more in mass lofted to LEO than do lunar expeditions. All of that mass must

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Important notes:

- Not a member? See the end page.

Chair's Corner

STEVE KING, CHAIR ELECT, AIAA HOUSTON

Happy New Year! We enter 2005, a year of progress and opportunity, with an addition to our AIAA family. Our chair, Sophia Bright, gave birth to a healthy baby boy on Jan. 3rd - congratulations. That's the reason behind me writing this column for the next couple of newsletters.

For those of us working in the field of human space flight, these are definitely interesting times. Returning the Space Shuttle to flight has made significant progress and is within our grasp. We eagerly await the continued assembly of the International Space Station. We find NASA's budget to be fully funded this year allowing Project Constellation and its Crew Exploration Vehicle to move forward. Newcomers such as t/Space, Bigelow Aerospace, and Andrews Space are adding spice to the mix. What an exciting time to be involved!

Besides our day jobs, there are many opportunities for you to be involved through AIAA in helping promote our profession, inspire the next generation of explorers, or serve your community:

- Various Engineers Week activities (Feb. 20th - 26th)
- Getting involved with our Integrated Communications working group (newsletter, website, list servers, and publicity)
- Helping conduct a National Space Operations Workshop and Annual Technical Symposium
- Taking on a leadership role in the Section during the coming term

If any of these opportunities inspire you, please contact me at chair@aiaa-houston.org. We have a lot to offer in 2005. Hope to see you at an upcoming event!

From the Editor

JON S. BERNDT

It's January 2005—the beginning of what will be a big year in space exploration. The Space Shuttle returns to flight, Cassini, Huygens, the Mars Exploration Rovers, and other craft continue to explore destinations in our solar system. The Vision for Space Exploration will begin in earnest. In fact, the draft RFP (Request for Proposals) for the CEV (Crew Exploration Vehicle) was just released on January 21st. In various space circles there has been much discussion over what the craft might look like and which vehicle will loft it.

Another question discussed is the CEV program schedule. According to current information, there may be a flyoff between prototypes for competing designs in 2008 followed by a down-select, with the first manned mission not occurring until 2014. This date is four years after the planned time for mothballing the space shuttle fleet. Question: How long should it really take to develop and fly a CEV? Is ten years too long?

History can give us some benchmarks to compare against. For instance, from the NASA publication "Apollo: A Retrospective Analysis":

"Almost with the announcement of the lunar landing commitment in 1961 NASA technicians began a crash program to develop a reasonable configuration for the trip to lunar orbit and back. What they came up with was a three-person command module capable of sustaining human life for two weeks or more in either Earth orbit or in a lunar trajectory; a service module holding oxygen, fuel, maneuvering rockets, fuel cells, and other expendable and life support equipment that could be jettisoned upon reentry to Earth; a retrorocket package attached to the service module for slowing to prepare for reentry; and finally a launch escape system that was discarded upon achieving orbit."

The first manned flight was supposed to be AS-204 (Apollo 1), scheduled for early 1967. That's a span of about six years. The flight of Apollo 8 to lunar orbit was in December of 1968—two years later. Now, does it make sense to think that with advanced tools and the knowledge gained since then it should take any longer than that? That's for the "capsule" alone, however.

Which launcher will loft the CEV? There are the obvious possibilities of a "man-rated" heavy Atlas or Delta, but other possibilities have been raised as well, including one that uses the Space Shuttle SRB.

Maybe the question about schedule is not really about the technical challenges. Maybe a more important question is: what can be learned from a recent $30 million dollar private project involving a small team of highly motivated individuals working on a tight schedule with a hard deadline—working on a "mission".

— JSB

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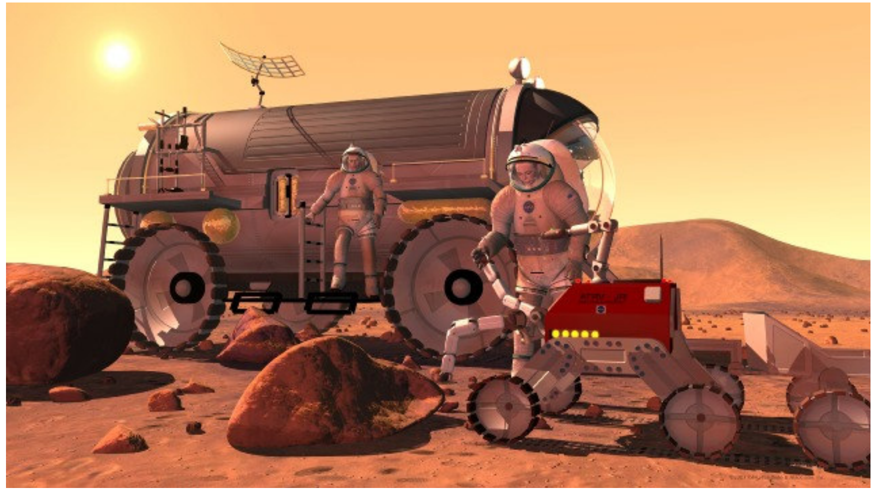
be assembled into a transfer vehicle and fueled in orbit. Many launches of our most capable vehicles are required within a short period of time to mount one expedition. Assembly and checkout must be complete at the time of the launch window because the next opportunity is 26 months later.

The scale of the transfer vehicle with a crew of 6 is not unlike that of the ISS. Imagine the challenge of assembling such a structure without cancelled or slipped launches of the components. The fuel must be added as late as possible to minimize boil-off of the cryogenic propellant.

Current mission operations philosophy depends heavily on regular live communication with the crew on orbit. The time delay for a radio signal from the Earth to Mars varies between 5 and 20 minutes, depending on exactly where the planets are in their orbits. When Mars passes behind the Sun (as seen from Earth), communication is impossible unless some sort of relay satellite system is placed on orbit around the Sun. In any case, interactive conversation is awkward.

The first major risk is the uncertainty in assuring the health and performance of the crew. Physiological, medical, and psychological factors are all important; the latter may be the least understood. JSC maintains a Bioastronautics Roadmap that formally lists and evaluates the current state of knowledge on specific risk areas within this category.

The second risk category is the lack of experience with mission operations of the scale and scope of a human expedition to Mars. Current experience based on ISS and Space Shuttle has some relevance but does not extend to the mission scenarios envisioned for a crew delivered to the surface of Mars. The Apollo experience is also valuable, but it has largely been lost except for old documentation and memoirs.



NASA concept art: pressurized Martian rover.

The next major risk category is reliability and maintainability of the hardware and software systems. The technological capabilities and the operational experience base required for such a mission do not now exist nor has any self-consistent program plan been proposed to acquire them. In particular, the lack of an abort-to-Earth capability implies that critical mission systems must perform reliably for 3 years or must be maintainable and repairable by the crew.

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Horizons

Horizons is a bi-monthly publication of the Houston section of the American Institute of Aeronautics and Astronautics.

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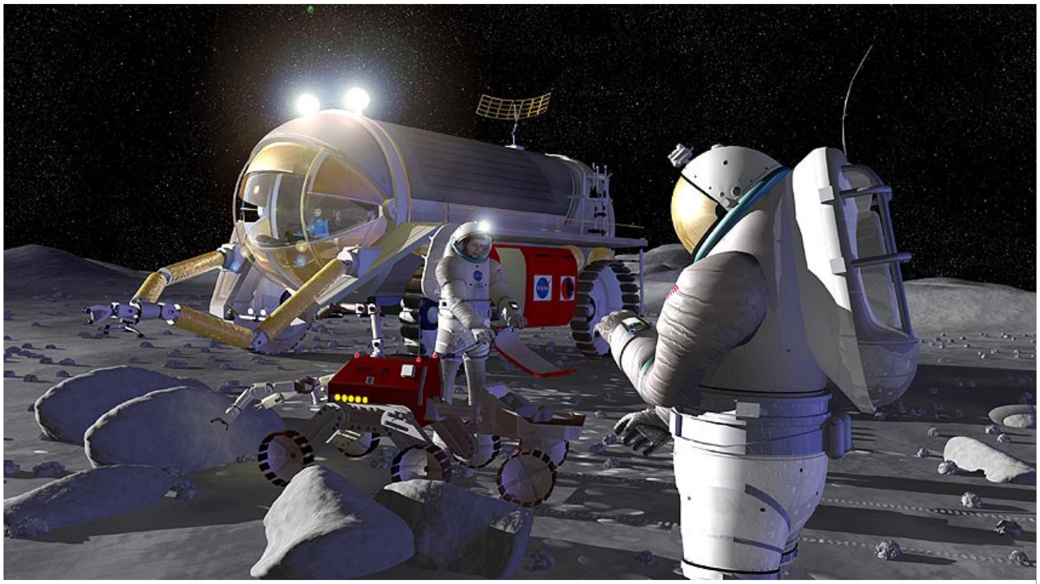

NASA concept art: pressurized lunar rover.

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The fourth risk category is political viability, an issue currently being debated. Large-scale publicly funded programs are subject to continuous critical scrutiny by technically unsophisticated observers who want simple answers to simple (and often simplistic) questions. Tangible accomplishments are demanded over time frames determined by political time constants (two to four years in the U.S.). Historically, NASA has been reasonably successful at maintaining funding of decade-long missions that are understood by all to have a finite duration. The Congress is not yet comfortable with space programs that are open-ended, such as human exploration of the solar system.

"The Moon is the place to learn the art of planetary surface engineering and operations."

A lunar program of human missions can provide a venue for mitigating all these risk categories. Our current experience base easily encompasses Apollo-style landing missions with surface stay times of days. One could design an intelligent program evolution that would grow beyond Apollo scales to MDRM scales and thereby appropriately train and test operations teams, systems concepts, industry design teams, and government management teams in preparation for the interplanetary expeditions.

The counterargument is based on a belief that the risks can be retired or mitigated without an expensive interlude on the Moon. In particular, the lunar environment differs from the Martian environment sufficiently that testing hardware on the Moon designed for Mars makes little sense. The major science questions for the two planets also differ.

These counterarguments are cogent as far as they go but neglect a very important reality. No matter what programmatic direction is taken, we will not have enough time or money to do the amount of testing we would like. Therefore, the lives of the Mars crew and the fate of the program will depend ultimately on judgment and experience of engineering and management teams working on the mission. The mission will be safer (i.e., less risky) if those teams acquire experience working together on problems of a similar kind and of a similar complexity.
Complex systems (e.g., a planetary surface habitat or a life support system) will exhibit behaviors and failure modes unlike those predicted by subsystem testing and system integration analysis. Spacecraft engineers know this well. Unanticipated anomalies on the Moon can be corrected more easily than if they were encountered the first time on the surface of Mars. The Moon is the place to learn the art of planetary surface engineering and operations.

I argue that the principal goal of the lunar program will be risk mitigation at all levels but particularly with respect to human performance, mission operations, and system reliability. All three of these risk categories are driven by the extreme duration of the Mars voyage, the lack of abort-to-Earth options, and the absence of logistical support. Therefore, the ultimate objective of the lunar program is the execution of a mission scenario that demonstrates the ability of design teams, operations teams, management teams, and technology levels to deal robustly with those issues. Such a scenario is a physical facility on the lunar surface at which a crew of at least six lives and works for at least a year out of sight of the Earth, i.e., on the lunar farside.

Consequently, I believe the lunar strategy for the Space Vision cannot be the equivalent of pilot training by "touch and go." Lunar facilities and extended stays are required. This leads to other issues associated with the implementation of Mars program that I discuss in my most recent Congress paper.

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About the author: Dr. Wendell W. Mendell is the Manager of the Office for Human Exploration Science at Johnson Space Center.

2004 Division for Planetary Sciences Meeting

LARRY JAY FRIESEN

A Meeting Summary Report

November 8th through 12th of last year, I had the opportunity to attend the annual Meeting of the Division for Planetary Sciences (DPS) of the American Astronomical Society in Louisville, Kentucky.

I will only be able to report a fraction of what took place. You may imagine, however, that the meeting was quite exciting, with fresh results being reported from Cassini at Saturn, the rovers and orbiters at Mars, news of extrasolar planets, and numerous other topics in the field of planetary science. The order of topics I shall mention below is more or less in the order of my notes, with some attempt to put related subjects together. I have tried to select those topics and discoveries I thought would be of most interest to the readers of this newsletter.

Cassini at Saturn

The rings of Saturn are made of a lot of ice, with some rocky materials thrown in. Iron-bearing minerals, that is the rocky materials, are concentrated toward the inner portion of Saturn's rings. The further out in the ring system you go, the greater the proportion of ice, the less of rock. The Cassini gap in the rings has a very sharp edge. For "sharp", think of going from ring to no ring on a length scale of the order of the size of a single ring particle, or on the order of the spacing between nearest-neighbor ring particles. The minimum particle size in the B ring is on the order of 1 millimeter.

Infrared (IR) observations have found very subtle differences from one place to another on the surface of Titan, Saturn's largest moon. IR is used because visible light cannot penetrate the haze in Titan's atmosphere. Albedo (reflectivity) in the infrared is not strongly correlated with composition. Methane makes up about 2% of Titan's atmosphere (most of the rest is nitrogen). Ethane, acetylene, and carbon dioxide have also been found in Titan's atmosphere.

Cassini has found no firm evidence yet for liquids on Titan's surface, although there has been much speculation that liquid methane, ethane, and/or other hydrocarbons could be present. Synthetic aperture radar shows a few candidates for small lakes, but these make up only a tiny portion of the surface so far observed by radar (only a small part of Titan's surface has so far been accessible to Cassini's radar). The dark regions observed in IR have too much albedo variation to be a flat-lying liquid. Titan's surface temperature averages around 85 K, with some colder and warmer spots. Titan has few impact craters, which implies a very young surface. Titan also has little relief, on the order of 150 meters in areas so far seen by radar, and some areas are very flat indeed.

Clouds have been seen around Titan's south pole. It is not yet understood why these have been seen since 2002, but apparently not before. Within the last year or so, clouds have also been seen in more temperate latitudes. It also seems as if giant storms sometimes occur on Titan. Wind speeds ranging from 0 to 34 meters per second have been measured so far. The tropopause for this atmosphere is about 40 km above the surface.

The distant moon Phoebe is probably a captured Kuiper belt object. Its composition includes water, carbon dioxide, iron-bearing silicates, and organics. The water includes both water ice and water chemically bound to minerals. Phoebe is very dark, with IR reflectance only on the order of 3 to 4%.

Two new satellites of Saturn have been discovered between the orbits of Mimas and Enceladus. Altogether, Cassini has spotted 6 new Saturnian moons.

Kuiper Belt Objects

Among the largest Kuiper belt objects is Varuna, at roughly 900 km in diameter. It has quite low albedo in the IR, about 0.1, and is very red. It rotates once every 6.34 hours, so rapidly that its shape is rotationally distorted. The ratio of its equatorial to polar diameter is around 1.5. It seems to have an asteroid-like regolith.

Most Kuiper belt objects tend to be red, but the reason for this is not known. The average albedo of Kuiper belt objects has been found to be higher than previously assumed. This implies that most of these objects are smaller than we thought, and thus the total Kuiper belt mass is less than previously estimated.

The planet Uranus has been observed to have some cloud features that last for hours, others that last days, and one that has lasted at least 18 years (it was observed by Voyager).

One session was devoted to discussing advanced propulsion systems under research or development which could be applied to planetary exploration missions. Among systems being looked at are high-energy storable propellants and techniques for long-term cryogenic storage. Ideas for aerobraking include a ring-shaped towed ballute. By deploying the bal-

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lute in a towed configuration, behind the spacecraft, it would naturally tend to stabilize the system attitude.

On Tuesday, David Morrison delivered the Sagan Memorial Lecture. His topic was improving impact in public outreach, a skill at which Carl Sagan himself excelled. Morrison pointed out that Sagan worked on his skills; they didn't simply come naturally. Ways in which we can leverage our outreach to the public, and reach more people, include using the media and the internet. Among the most important people for us to reach, for this reason are journalists, especially science journalists.

A major impediment to communication is the use of jargon (for us aerospace types, that includes acronyms). In most cases, we can express scientific and technical ideas in words the general public understands, and we should do so whenever possible. We should try out approaches to presenting ideas on our neighbors and in elevators. We need to learn how to do sound bites; that is, to get to the point quickly. Television news especially is time limited, and much of what we say may be edited out. So we need to be sure that we quickly get to the core of whatever our topic is. Images are an especially effective way to communicate, and images of planetary surfaces are captivating to the public. There are numerous Web sites where people can find planetary images, and Dr. Morrison mentioned that there is an on-line planetary photojournal.

Radar study of Mercury's physical librations indicates that the planet has a molten core, a fact not previously known.

Binaries among both asteroids and Kuiper belt objects were discussed. Different binary types occur in different populations of objects. Asteroid Hermes turns out to be a binary. It was first discovered in 1937, was lost shortly after the discovery, and was recently recovered. The primary of the pair is around 630 meters in diameter; the secondary around 560 meters. The orbital period is 13.9 days, and the system is doubly synchronous. That is, the primary and secondary are each tidally locked to the other, so that both rotation periods precisely match the orbital period. The semi-major axis of this orbit is 1.2 km or about 3.8 times the radius of the primary.
At least a few percent of main belt asteroids are binary, as are a few percent of Kuiper belt objects. And so far one Trojan asteroid, 617 Patroclus, has been found to be a binary.

Tuesday evening, November 9, was Science Policy Night. Many planetary scientists expressed concern about President Bush's Moon to Mars Initiative. Some have embraced it, and all understand that this is the environment they now have to work in. But some have expressed concern that unless some additional money is put into the NASA budget to support the Initiative, work on that may come at the expense of some unmanned science missions they have been planning for.

The most recent volcanism on Mars appears to have taken place 12 to 100 million years

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Staying Informed

This column points out useful web sites, documents, policy papers, periodicals, etc.

Crew Exploration Vehicle Draft Request For Proposals
prod.nais.nasa.gov/cgi-bin/eps/sol.cgi?acqid=113638#Amend%20Draft%2001

U.S. Space Transportation Policy Fact Sheet
www.ostp.gov/html/SpaceTransFactSheetJan2005.pdf

Exploration Systems Interim Strategy
exploration.nasa.gov/documents/explor_strategy_lo.pdf

Encyclopedia Astronautica
www.astronautix.com

"Rocket Man", Wired Magazine
www.wired.com/wired/archive/13.01/branson.html

NASA Spinoff Publication
www.sti.nasa.gov/tto/

NASA Institute for Advanced Concepts
www.niac.usra.edu/

In accordance with U.S. Space Exploration Policy, dated January 14, 2004, the United States is embarking on a robust space exploration program to advance U.S. scientific, security, and economic interests. A central component of this program is to extend human presence across the solar system, starting with a human return to the Moon by the year 2020, in preparation for human exploration of Mars and other destinations.

- U.S. Space Transportation Policy Fact Sheet

New Members

ELIZABETH BLOME, MEMBERSHIP CHAIRPERSON

We are pleased to introduce the following new members to AIAA. If you see one of these folks at the next section event, please give them a hearty welcome:

- Glen Adams, LM
- James Batts, Raytheon
- Suman Chakravoty, TAMU
- Alan Crocker
- Kevin Dries
- Rafael Gatica, Boeing
- David Greeson, Titan
- Frederic Jottras
- Christina Lee, Spacehab
- Arno Wainikainen, EASI
- Sean Waninger
- David Debrestian, Boeing
- Xinlin Gao, TAMU
- Michael Ross, USA
- Chaine Selig
- Catalina Stern, UNAM
- Emily Unbehaun
- Shanna-shaye Forbes, UT
- Bilel Hadri, UH
- Christophe Picard, UH
- Jessica Williams, UT
- Huitao Yang, TAMU
- Mogi Patangan, UT

Help AIAA Help You - Update Your Membership Records

ELIZABETH BLOME, MEMBERSHIP CHAIRPERSON

It is often said that the aerospace industry is the only place where you can have the same job for five years and work for five different companies. That is especially true given the industry wide consolidation that has happened in the last few years. As companies have changed so have the building signs and the business cards. Additionally, our environment provides most people with the ability to move from one company to another as we try to expand our occupational horizons.

With all of these potential changes have you verified if your AIAA member record is up to date? Knowing where our members are working is vital to the Houston Section in obtaining corporate support for local AIAA activities (such as our monthly dinner meeting, workshops, etc.). Please take a few minutes and visit the AIAA website to update your member information or call customer service at 1-800-NEW-AIAA (639-2422). Feel free to also contact me at 281-244-7121.

The AIAA-Houston section is currently missing information for the following members. If you know where they are, please let them know their contact information is not up to date for AIAA. Or, if you prefer, email me, Elizabeth.c.blome@nasa.gov with any contact information you have. Thank you in advance for your assistance is this matter! Missing In Action:

- John Balcerowski
- Jeffrey Marshall
- Rajagopal Pachalla
- Nicholas Tyler
- Craig Bridges
- Justin Doyle
- Henry Hoang
- Thai Hoa Phan
- Pavankumar Mutnuri
- Anh Le
- Eric Lanoix

Membership Upgrades

You are eligible for Senior Member status if you have over eight years of professional practice in the arts, sciences, or technology of aeronautics or astronautics. You may be nominated for Associate Fellow status if you have over 12 years of professional practice in the arts, sciences, or technology of aeronautics or astronautics and are currently a Senior Member. You may be nominated for Fellow if you have personally made notable and valuable contributions in the field of aeronautics or astronautics and are currently an Associate Fellow. You may be nominated for Honorary Fellow if you are a person of eminence in aeronautics or astronautics, recognized by a long and highly contributive career in the arts, sciences, or technology of these fields, and are a current Fellow.

AIAA does not charge a fee to upgrade your membership. Your dues only increase when you are elected to Fellow grade.

Senior Member applications are accepted and processed each month. Associate Fellow nomination forms are due by 15 April of each year, and references are then due by 15 May. Fellow and Honorary Fellow nomination forms are due by 15 June of each year, and reference forms are then due 15 July.

To receive AIAA membership upgrade information, simply call AIAA Customer Service at 800/639-AIAA. Outside the United States, call 703/264-7500. The Customer Service representatives will be glad to forward membership upgrade information to you.

Crew Exploration Vehicle RFP Released

The Crew Exploration Vehicle (CEV) Request For Proposals (RFP) was published on January 21. Some excerpts drawn from the RFP "Statement of Objectives" are presented here:

A key challenge for NASA is to develop new capabilities in a manner that is pragmatic – so that new capabilities can be developed and used to advance exploration in the near term – while also being flexible, in order to incorporate new technologies and respond with agility to scientific discoveries. To meet this challenge, NASA will develop exploration capabilities in stages, or "spirals." Each spiral will usher in a set of major new capabilities in support of the Vision for Space Exploration. Spirals will be structured based on specific requirements, well-defined goals and endpoints, then-current technologies, management risks, an executables budget, and knowledge gained from prior in-space activities. NASA's acquisition strategy encourages the use of open-systems architectures that facilitate upgrades and augmentation while enabling interoperability between systems. Capabilities to be provided by the first three spirals are:

Spiral 1: Earth Orbit Capability. Spiral 1 establishes the capability to test and checkout crew transportation system elements in Low Earth Orbit in preparation for future human exploration missions to the Moon. As new exploration elements necessary for future spirals are developed, they will be tested with the Spiral 1 CEV in the space environment to prepare for future exploration. The objective of crewed access to low earth orbit will be met by 2014.

Spiral 2: Extended Lunar Exploration. Spiral 2 establishes the capability to conduct human exploration missions on the surface of the Moon for extended durations. In this context, extended duration is defined as the capability to support the crew on the surface of the Moon for a minimum of four days. This objective will be met in the 2015-2020 timeframe.

Spiral 3: Long Duration Lunar Exploration. Spiral 3 establishes the capability to conduct routine human long duration missions on the surface of the Moon to test out technologies and operational techniques for expanding the human presence to Mars and beyond. Missions in Spiral 3 will extend in duration from those obtain in Spiral 2 up to several months to serve as an operational analog of future short stay Mars missions. This objective will be met after 2020.

An anchoring capability of the Constellation Program is a CEV that will carry human crews from Earth into space and back again. Coupled with transfer stages, landing vehicles, and surface exploration systems, the CEV will serve as an essential component of the architecture that supports human voyages to the Moon and beyond. Given an acquisition strategy utilizing spiral development, a system-of-systems implementation, and reliance on technology for sustainability and affordability, the following project objectives have been established:

1. Ensure that the CEV is designed from the outset as a key element of the Constellation "System of Systems"
2. Optimize crew safety within the limitations of meeting system performance requirements
3. Design and execute a meaningful risk mitigation program that culminates in a PDR and demonstration flight by the end of calendar year 2008
4. Deliver a quality design that ensures simplicity and addresses all aspects of human spacecraft development, certification and operations
5. Execute a human flight in 2014 utilizing a CEV meeting Spiral 2 CEV requirements with an objective of meeting Spiral 3 CEV requirements
6. Perform to an established cost, schedule and technical baseline
7. Maximize the use of existing technology in the design of the CEV
8. Base the vehicle design on an Open Systems Architecture
9. Simplify the interface design between the CEV and other Constellation elements to optimize integration
10. Certify by test to the maximum extent possible
11. Develop technology portfolios and define requirements for advanced development projects for technology insertion
12. Implement innovative designs for the CEV spacecraft and ground systems to achieve efficient and effective operations.

This solicitation for the CEV component of the space transportation system utilizes a phased approach. Phase 1 of the acquisition calls for a maximum of two contractors to:

· Conduct a flight demonstration program to validate industry's capability to perform on cost, on schedule and on performance. Additionally, the demonstration will be part of the overall CEV risk mitigation strategy.
· Evaluate NASA's ESMD and HSRT programs for potential CEV program integration as part of a concerted effort to improve system effectiveness and affordability.

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Some Analogous Vehicles for Comparison

Apollo-Skylab CM/SM

Weight: 31,000 lbs. (wet)
Crew Size: 3 (nominal)
Hab. Volume: 218 ft^3

Soyuz TM

Weight: 16,000 lbs. (wet)
Crew Size: 3
Hab. Volume: 318 ft^3

CEV

Weight: < 44,100 lbs. (launch)
Crew Size: up to 4
Hab. Volume: 500 ft^3 (4 crew)

Sources:
NASA Skylab Saturn 1B Flight Manual
www.astronautix.com
CEV RFP

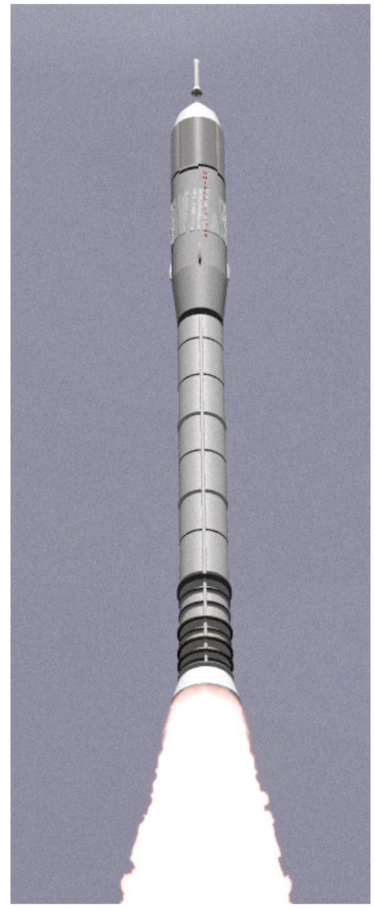
· Conduct a series of trade analyses on critical performance drivers for the purposes of identifying threshold and objectives for Phase 2 of the CEV contract. Affordability, sustainability, and extensibility to future spirals will be the focus of the analyses.
· Participate in a NASA led System Requirements Review (SRR) and Preliminary Design Review (PDR) for the human-rated CEV.
· Provide an iterative analysis of cost, risk and performance based on realistic timelines and estimates of cost.
· Provide a risk management plan which will mitigate program uncertainties by establishing priorities, options, adequate margins of safety, and "off-ramps."

CEV Phase 1 ends with a planned down select to a single prime contractor in late 2008. Phase 2 of the CEV acquisition calls for a single Contractor to complete the development, test, and deployment of a human-rated CEV. After completion of phase 2 the contractor shall provide, as Government options, sustaining engineering services and production capability to support additional flights and additional CEV spacecraft. The Government reserves the right to perform a down select at any time and to not select either contractor after 2008.

The CEV Initial Performance Parameters (IPP) are not meant to curtail innovation or alternate architectural concepts during Phase I activities. To that end, a set of focused trades will be conducted against these IPP's to include:

1. Launch weight mass trades (both increases and decreases)
2. Ability to Abort anytime during all mission phases
3. Inclusion of the LSAM functionality within the CEV system
4. CEV direct return vs. Earth Capture
5. Mission Duration (both manned and unmanned mission phases)
6. Crew size (from 3 to 6) and crew habitable volume changes
7. Splitting CEV functionality into modules (e.g., earth surface to LEO, LEO to Lunar orbit, Lunar orbit to Earth return)
8. Human Rating Requirements cost drivers
9. CEV system support of spiral 3

Through this competition, industry partners will be selected to work with NASA in conducting cost/performance analysis for alternatives to the point-of-departure architecture and CEV requirements. At the same time, industry will mature their designs for the CEV while working their risk reduction demonstrations. The goal is to finalize the Spiral 1 requirements in 2006, complete the flight demonstration program and PDR in 2008, move onto final design and fabrication in support of the first crewed flight in 2014, and then continue on to the moon, Mars, and beyond. ▲



One concept for a CEV Launcher features a Space Shuttle SRB as the first stage. This idea is described in an article by Jeff Foust (The Space Review): www.thespacereview.com/article/226/1

(*rendition above by Jon Berndt*)

CEV Technical Requirements (IPP)

1) Launch mass less than 20 metric tons (about 44,100 lbs.)
2) Provide capability to conduct missions with 1, 2, 3, and 4 crewmembers with minimum habitable volume of 3.54 cubic meters (125 ft^3) per crew member
3) Provides abort capability through all flight phases
4) Be 2 fault tolerant to hardware component failures within safety critical systems except where design to minimum risk is approved by NASA
5) Integrate with the Launch System to achieve low earth orbit
6) Integrate with the Earth Departure Stage to achieve lunar orbit
7) Integrate with the Lunar Surface Access Module to achieve lunar surface mission objectives
8) Integrate with Ground Systems for launch processing and mission control
9) Integrate with In Space Support Systems to support overall Constellation command, control, communication, and information requirements
10) Be capable of orbital maneuvers and rendezvous/docking with other Constellation systems.
11) Be capable of return from lunar orbit to the earth surface
12) Be capable of supporting human life from launch on the earth surface through mission complete on earth surface during a maximum mission duration of (TBD) days
13) Be capable of unmanned operations for test flight purposes during Spiral 1 efforts and during crew member lunar mission activities

(Continued from page 6)
ago.

Fascinating multispectral imaging results were shown from the Spirit and Opportunity Mars rovers. The little spheres called "blueberries" are iron-bearing, perhaps hematite.

Further evidence of the past (and possible current) presence of water on Mars has been found in the form of salts. Salts seem to be ubiquitous on Mars, and water is required to form them. Among the salts found are lots of sulfates and some chlorides. Some bromides also seem to be present.

It may be possible to form stable sulfuric acid on Mars. If so, this could depress the freezing point of water to as low as -74 degrees C. This could aid the formation of some flow features which have been seen.

Representatives from ESA presented results from their Mars Express orbiter, including some things they've learned from high resolution stereo images. Olympus Mons is a very long-lived center of volcanic activity. Some activity may go back as far as 2 billion years ago, while they estimate the most recent activity in the caldera was between 100 and 200 million years ago. Some eruptions on the flank of the volcano are younger still: perhaps only 2 million years.

The Europeans have found evidence for glacial activity on the western scarp of Olympus Mons, apparently in the form of what are called rock glaciers. The youngest glacial flows are very, very young, perhaps 4 million years (this is quite young compared with most features on Mars, even though we may not think of 4 million years as "young" on Earth). Some episodes of glacial activity in this region may go back hundreds of millions of years.

In contrast, the Mars Express investigators don't find evidence for recent volcanic activity in the southern highlands. Volcanic activity on Mars seems to have been episodic rather than continuous.

An unexpected observation is that ages of many features on the Martian surface (estimated from crater counting) seem to be coming out in the range of 1.5 to 1.6 billion years, including an episode of standing water in one chasma.

The perennial Southern Ice Cap (the part that remains frozen all summer) has been found to be dominated by water ice. What had been seen before was CO_2 ice. It turns out this is a thin veneer over the water ice, where thin means a few tens meters. This cap is a major sink for water on the planet. The Northern Perennial Ice Cap is all water ice. 25,000 years ago, northern summer on Mars was warmer than southern summer. That is the opposite of the situation today. Today's climate on Mars favors the transport of volatiles (water and carbon dioxide) north.

The large volcanoes on Mars act as water pumps to help form clouds. This can contribute to the presence of the glacial ice on the western part of Olympus.

Hubble Space Telescope (HST) has produced maps of the asteroid Ceres at a resolution of 30 km per pixel using 3 filters (which means maps in 3 colors). Ceres' rotational pole position has been located to within less than 5 degrees. Ceres shows no obvious topological relief higher than 60 km. Its equatorial diameter is 975 km; its polar diameter is 909 km. Ceres appears to be a fully relaxed object, which means its overall shape is determined by its own gravity and by its rotation, with no contribution due to the mechanical strength of the materials that make it up. It may be the only asteroid which has attained this status. Its density is 2,077 kg per cubic meter - just over twice that of water. There are some suspicions that it is not homogeneous: that is, the density may not be the same throughout its volume.

Recent discoveries of more extrasolar planets were announced. One with a mass at least 2.8 times the mass of Jupiter was discovered with a highly eccentric orbit of 54 days around star HD 37605.

Another has been discovered in orbit around r^1 Cancri, also known as 55 Cancri. This makes the fourth known planet in the 55 Cancri system. The previously known planets have periods of 14.7 days, 44 days, and 4507 days. The orbital period of the newly discovered one is 2.8 days. Its mass is at least 14.2 Earth masses; the most likely mass is 17 to 18 Earth masses - very similar to the mass of Neptune. This is a very important step, since observers are now not only able to find planets the size of Jupiter or larger; in some cases they can now detect planets as light as Neptune.

A mass has been calculated for a planet orbiting Epsilon Eridani. The inclination of this planet's orbit to the sky has been determined by careful astrometry to be between 20 and 30 degrees. Mass of the planet is 1.7 (+ or - 0.3) times the mass of Jupiter. Because the orbital inclination is known, this is an actual mass, not a lower bound.

In the Vega system, small dust grains are leaving the system. This dust was probably generated by a recent collision between two sizeable objects, such as two planetesimals or two large asteroids.

▲

Dr. Friesen has a PhD in Space Physics and Astronomy and is currently teaching part-time at UHCL.

Cranium Cruncher

BILL MILLER

This month's puzzle:

Our hero Eddie Viscosity is taking a ride on the Bolivar Pass ferry. He notices that at the same instant his ferryboat leaves the Galveston dock, another ferryboat leaves the Bolivar Peninsula docks and heads out across the ship channel. Each boat travels at a constant speed, but one is faster than the other. Eddie's boat passes the other at a point 720 yards from the nearest shore. Both boats remain at their docks for ten minutes after arrival, then start back. On the return trip, they meet 400 yards from the other shore. Despite his disappointment with the ladder problem, Eddie feels that given this information, he should be able to calculate the width of the ship channel. Can you?

For purposes of the puzzle, the boats move at right angles to parallel shorelines. There is no current in the ship channel. Frequent Bolivar Ferry riders will recognize that the ten minute wait in the docks is also an idealization!

Send solutions to wbmiller3@houston.rr.com. The answer, along with credits, references, and names of the solvers, will be provided next time.

Last issue's puzzle:

I first heard of the "crossed ladder problem" over twenty years ago. Its interest lies in the fact that at first glance the puzzle appears to be a simple trig problem. However, as you dive in, it soon appears that not enough information is given. In the interest of space I'll refer interested parties to an excellent write-up on the problem at

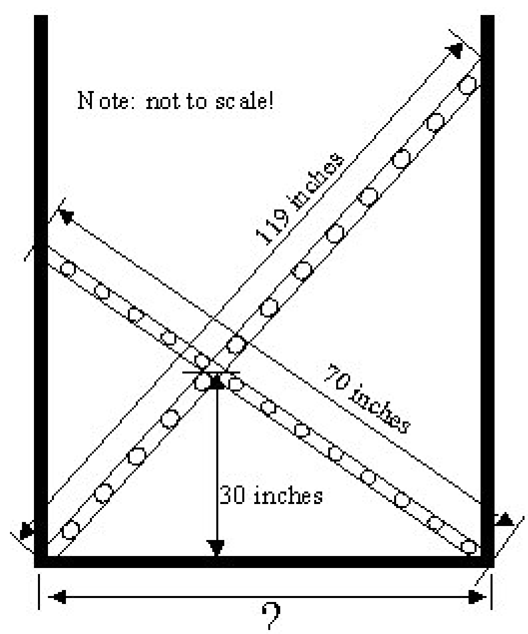
http://mathworld.wolfram.com/CrossedLaddersProblem.html

but suffice it to say that the problem reduces to solving a quartic equation. I have also seen someone get very close with a graphical solution!

For the dimensions given last time, the width of the alley is 56 inches. Correct solutions were received from:

Carl D. Scott, Ph.D.
Andy Holkan
Ed Smythe
Frank Baiamonte

...and honorable mention to Douglas Yazell, who got the answer, but disqualified himself because we had discussed the problem several years ago. All of the winners will receive AIAA Houston section posters.



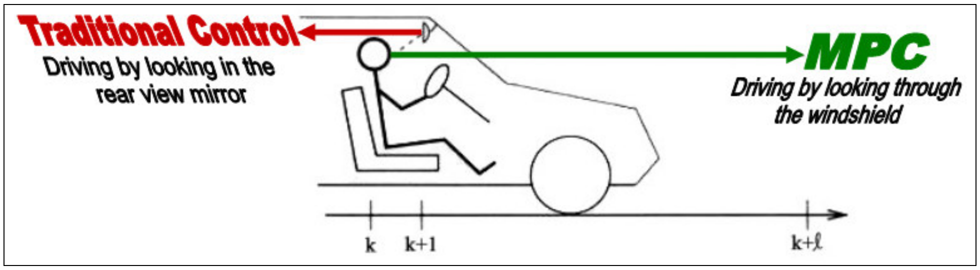
A Lunch and Learn Summary Report

Model Predictive Control

ANDREW PETRO

The Propulsion and Power Systems Technical Committee hosted a Lunch and Learn seminar on December 2, 2004. About 30 people listened to a description of Model Predictive Control by Abran Alaniz.

Model Predictive Control (MPC) is a mission level control design methodology that is suitable for linear and nonlinear constrained systems. As described by Abran, traditional control methods are analogous to driving while only looking through a rear-view mirror. In other words, the control system can only respond to measurements of what has occurred in the past. MPC is analogous to driving by looking through the windshield and the control system can respond to predicted behaviors.



Due to MPC's computational requirements, early applications were limited to low-bandwidth systems such as those found in industrial and chemical processes. With the significant increase in computational power over the last decade, application to high-bandwidth systems is now feasible, including applications in the aerospace field.

Abran's talk reviewed the history of MPC and introduced the mathematical background for generating an MPC controller for linear and non-linear plants. He used an inverted pendulum on a cart as a simple example and then presented a more complex example with the demonstration of a real-time application of MPC in a three-degree-of freedom helicopter model. This helicopter model was part of Abran's thesis work as a Draper Fellow during 2002-2004.

Abran Alaniz received BS and MS degrees in Aeronautics and Astronautics from MIT in 2002 and 2004 respectively. Since August 2004 he has been a member of technical staff for the Charles Stark Draper Laboratory Draper in Houston.

AIAA Policy Review

Aeronautics

a five-year plan for revitalizing the NASA aeronautics program

Issue:

The loss of U.S. leadership in aeronautical technologies has major detrimental impacts on national issues such as the economy, aviation safety and security, industrial competitiveness and military superiority. A number of high-quality national studies and reports have documented the current crisis in U.S. aviation and have called for a revitalization of NASA's aeronautics research program.

In the FY 2004 NASA appropriation legislation, Congress provided funding for the National Institute of Aerospace (NIA) to contract with industry and academia to develop an aggressive five-year research and investment plan for aeronautics R&T, including air traffic management. The report will be delivered to Congress in March of 2005.

Recommendation:

AIAA recognizes that the U.S. must take significant steps to retain, and in some areas, regain, our technological superiority in aviation and aeronautics. We support the Industry/Academia development of a five-year augmentation plan for the NASA aeronautics program and request Congress and the White House to implement the report recommendations.

AIAA Policy Resources

AIAA takes you to the center of public policy developments now shaping the future of aerospace. Check here for the latest policy news and information. Plus AIAA events and initiatives that keep America's leaders informed about our industry's positions on the issues - and the public aware of the continuing benefits that aerospace brings to the country and the world.

Want to participate? The tools to help you get started are here:

http://www2.aiaa.org/content.cfm?pageid=7

Activities and Announcements of the Section

On December 14th twenty six AIAA members were given a tour of the Mission Control Center (MCC) at Johnson Space Center. Numerous facilities were visited on the tour including the Apollo Era Control Center and all three current flight control rooms (FCRs). All manned spaceflight missions have been controlled from the Mission Control Center in Houston since the second Gemini mission in 1965.

The first stop on the tour was the Apollo Era Control Center. This room is preserved as a National Historic Landmark as the room used by NASA flight controllers to accomplish the first moon landing. Tour participants were able to see and touch consoles staffed by NASA legends such as Gene Kranz and Chris Craft.

The rest of the tour was spent admiring the current flight control rooms. These rooms were built in 1996. They are referred to as follows: White FCR (Shuttle Realtime Operations and Simulations), Blue FCR (ISS Realtime Operations, staffed 24 hours a day, 7 days a week since November of 2000) and the Red FCR (used for ISS Simulations). Since both the White and Blue FCRs were filled with flight controllers doing what they do best, tour participants were only able to observe these control centers from the observation level. I think all who attended will agree that seeing the MCC in action is quite an impressive sight!

Region IV Seeks to Fill Deputy Director Positions

Our AIAA Region has vacant Deputy Director (DD) positions in the areas of Young Professionals, Career Enhancement, and Public Policy. DDs help coordinate activities and communications, related to their area of interest, between the Sections within their Region. They also assist in evaluating the annual report submittals. If this opportunity interests you, please contact Merri Sanchez (Region IV Director) at merri.j.sanchez@nasa.gov or 281-244-8461.

Outreach and Education

The Spirit of Apollo Scholarship, Educator Associate Winner

DOUGLAS SCHWAAB and JOY CONRAD KING

The Spirit of Apollo Scholarship is sponsored by the AIAA Houston Section to advance the arts, sciences and technology of aero and astronautics. The Section scholarship program will start accepting applications in February for the 2005-2006 academic year. Application deadline will be 1 April 2005. The scholarship is for students in Texas colleges, that have completed one academic year with at least a 3.0 GPA and studying in any field of engineering, math or science. Additional information and eligibility details can be found on the section webpage (www.aiaa-houston.org). Please encourage qualified students you know to apply!

The AIAA Houston section was honored to learn that one of its own members, Dolores (Lollie) Garay, recently won the AIAA Educator Associate Achievement Award. This award is given out every year by the AIAA Foundation to deserving K-12 educators around the country. This year there were seven chosen including one from Canada. The winners receive an all expense trip for two to Washington D.C. to take part in the Aerospace Spotlight Awards Gala and tour the nation's capital. Lollie is taking part in AIAA's Educator Associate program which includes a free membership for teachers.

Ms. Garay is the Science Projects Coordinator/Lead Science Teacher at Redd School in north Houston. She holds a Master of Science in Teaching from Rice University, Department of Physics& Astronomy. She has been a teacher for 32 years and is currently teaching grades 3-8. She is also involved in many programs including a year-round Family Science Programs, a summer camp, and the LABRA TS After-School Enrichment Program. She has also organized a Science Advisory Committee at her school to coordinate science curriculum and special events and regularly provides in-service workshops for the school staff.

Besides winning the AIAA award, Lollie has also been awarded several distinctions including the Presidential Award for Excellence in Math & Science Teaching in 2003 and was Elementary Science Teacher of the Year in 1999.

The Houston section is proud to have a winner in the area and congratulates all the teachers out there exciting students about math and science and preparing them for the future.

CALENDAR

January
10-13 43rd Aerospace Sciences Meeting (Reno, NV)
10 Executive Committee Meeting – January 10th
13 Social at Molly's Pub
19 Ballunar Society Tour
20 Naz. Bedrossian, Draper, "Network Centric Computing", Systems Engineering TC
22 Mars Rover Competition
Begin soliciting and assembling Associate Fellow and Fellow nomination packages
29 Future City Design Competition

February
4 YP – Aeros Game!
7 Executive Committee Meeting
10 "*State of the Center*" address, Lt. Gen. Jefferson Howell, JSC Director, Gilruth Ballroom
16 Dinner Meeting, Gilruth Ballroom
Bill Chana - Triphibian Aircraft: water, snow, land
17 Lunch and Learn: Graphical Object Simulation Tools & Techniques by Draper/Mark Jackson
18-20 Mars Settlement Design Competition
23 Professional Development Lunch-n-Learn, 11:30-12:30, JSC Bldg 16
20-26 Support E-Week Activities
22 Social
Continue soliciting and assembling Associate Fellow and Fellow nomination packages

March
1 Appoint Nomination Committee
4-6 Mars Settlement Design Competition
7 Executive Committee Meeting
15 Nomination Slate submitted and formation of Teller Committee
16 Tour, Ellington AFB
17-19 Science and Engineering Fair of Houston
18 Social
31 FIRST Robotics Competition Lone Star Regional at Reliant Arena (through April 2)
Educational Outreach Activities
Nominee List must be sent to section members by the end of March
Lunch and Learns

April
2 Houston Rocket Club, Student Section Bonding
4 Executive Committee Meeting
14 Social
15 Election Ballots sent out
15 Associate Fellow Nominations due
Dinner Meeting – TBD
23 Air show – Lonestar Museum
28 JSC Chili Cookoff

May
2 Executive Committee Meeting
4-6 Host Space Ops Workshop, Space Ops / ATS Gilruth
6 Annual Technical Symposium at Gilruth
13 Social
Facility Tour (TBD)
15 Ballots should be tallied by May 15th
Compile and submit awards for banquet
Finish nomination packages for Fellows
Lunch-n-Learns

Odds and Ends

humor, photographs, etc.

The 41 people whose names are hidden in the puzzle below all share … what?

K E R W I N A N R E C E S O N H Y L S
O G P O U A N F O T T I M H C S S E P
C O N R A D S O O T O H S R E D N A L
N R G D L R W T S S Y O U N G P M M E
P D R E L O I G A B G A E E F F A H C
W O I N E F G A S N I L L O C H T R T
H N S I H F E R O W E G E S G L T T D
I A S W C A R R I H C S S N O E I Z P
T E O R T T T I D U K E I V V V N T O
E B M I I S B O R M A N E A I E G I G
L O U S M A E T P A N L N D H H L E U
T N I R D L A T I U L S C O T T Y W E
T R A K I E W H C S H M B R A N D E L

Columbia lifts off for STS-52 in 1992.

Free Flight and Space Simulators

FlightGear: www.flightgear.org
Space Shuttle: www.orbitersim.com
Lunar Lander: http://www.eaglelander3d.com

Custer Channel Wing

Exercise: Design a simple (without even flaps), 450 HP, five passenger plane, capable of slow flying at 20 mph, 160mph cruise, 200 foot takeoff and landing run, with extreme load carrying ability.

Sometime in the 1920s, Willard Custer took shelter in a barn during a hurricane. Much to his surprise and fascination, the roof of the barn suddenly lifted off, and soared through the air. He wondered why an airplane had to gather speed on a runway, while a barn roof, a poor airfoil by any reckoning, could fly from a standing start. He soon came to the realization that it was the speed of the air over the surface, not the speed of the surface through the air that created lift. Bernoulli's principle applied in both cases. He settled on the idea of pulling the air through channels that were, in fact, the lower half of a venturi. He was reversing the normal method of powered flight. Instead of using the engines to move the airfoil through the air, he used the engine to move the air through the airfoil. His channel had the effect of going several hundred miles per hour, due to the induced air flow, while standing still. The airflow over the surface of the channel created conventional lift, and a lot of it. It was at this point that Custer settled on," It's the speed of the air, not the airspeed", which became his mantra of, "aerophysics".

http://www.custerchannelwing.com/index.html
http://techreports.larc.nasa.gov/ltrs/PDF/2002/aiaa/NASA-aiaa-2002-3275.pdf

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www.aiaa.org

Select the AIAA membership option.