Diabologic: You Can't Take the Sky from Me

by Frank Dolinar

It's been thirty-seven years since humans first landed on the moon (July 20, 1969) as part of NASA's Project Apollo. The next stage of the U.S. manned space program will be sending people to the moon again, as part of a new project called Constellation, with Ares launch vehicles and Orion crew modules.

The Ares launch vehicle will resemble the Saturn V rocket from Project Apollo -- a vertical lift, multi-stage-to-orbit rocket. Indeed, as NASA moves away from the Shuttle as its primary lift vehicle, Project Constellation's fundamental design is an updated version of Project Apollo. When it becomes operational, there will be at least two launch configurations depending on the mission: one for transporting humans to orbit and another for delivering cargo.

The first testing of the six-seat Orion capsules is scheduled to begin in 2014 by launching of four astronauts to rendezvous with the International Space Station (ISS). Lunar missions will begin no later than 2020, and current plans indicate that they will depart from the ISS.

This time, travel to the moon won't be for just a few astronauts for a few days of exploration and observation. No, this time, it looks like we're going to the moon to stay. The goal is to begin building permanent habitats and research facilities, and to provide a jumping off point for further manned exploration of the solar system.

Perhaps, increased traffic to the ISS will encourage (demand?) expansion of its volume, extension of the solar arrays, better and more frequent cargo missions, more (and more redundant) safety systems, and even improved amenities. While I don't expect to see the ISS resemble anything like those in Star Trek or even the classic rotating donut from Disney's Tomorrowland episodes, there will eventually be more and more extensive orbiting habitats, accompanied by a lot more traffic.

The vision of the Earth-Moon transport from the legendary Stanley Kubrick film ***2001: A Space Odyssey*** may finally come to fruition -- about a quarter of a century late.

[For more information on Project Constellation, see the NASA website at:
http://www.nasa.gov/mission_pages/constellation/main/index.html]

While here in the U.S. we are waiting to go back to the moon, the European Space Agency's SMART-1 probe landed on the moon at the beginning of September 2006. Well, "landed" may be a bit of a misrepresentation. SMART-1 was purposely crashed onto the moon.

There was nothing wrong with this spacecraft, except that it was running out of fuel, which means its ability to maneuver was coming to an end. The spacecraft was, in fact, wrapping up a successful 3-year mission to the moon. There were several tasks on this mission:

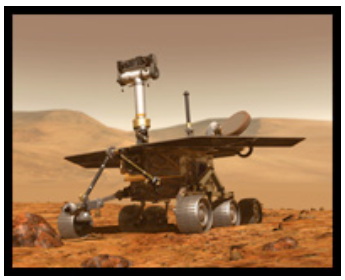
1) test a European-built ion engine, which successfully and precisely propelled the craft in a complex spiral from the Earth to the moon;
2) once in lunar orbit, take thousands of high-resolution pictures to provide a new lunar map; and
3) make mineral maps of the moon's terrain.

A surprise from all the new photographs was the discovery of a mountaintop near the lunar north pole that is constantly in sunlight -- prime real estate for a solar-powered moon base.

The final crash onto the moon, purposefully done at a shallow angle of impact, was to get a bit more information about the moon's geology.

[For more information on the Smart-1 mission, see the European Space Agency's website at:
http://www.esa.int/SPECIALS/SMART-1/SEMX148LURE_0.html]

Thirty years ago (July 20, 1976), Viking 1 made a powered landing on Mars, after an eleven-month flight. The images and data from that first probe to another planet became famous. Viking was expected to function for about three months. NASA's engineers build well, however, and Viking gathered and returned data for six years. Today, the Mars Rovers, Spirit and Opportunity, continue their mission to gather data on the Martian geology almost three years after their landings in January of 2004, with no end in sight. Opportunity just passed its 1,000 day mark.



[For more information on the Mars Rover mission, see the Jet Propulsion Laboratory's website at:
http://marsrovers.jpl.nasa.gov/home/index.html]

According to a UPI article published on July 11, 2006, a joint project of NASA and DARPA (the Defense Advanced Research Projects Agency) is developing and testing 'droid' satellites -- a concept derived from the training droid in the first Star Wars film. These satellites are relatively inexpensive and easy to make.

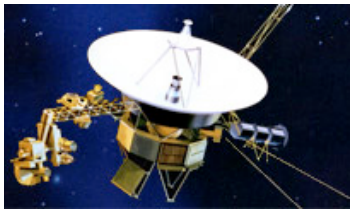
The current test versions of these satellites are 9-pound spheres the size of bowling balls, with computers, sensors, and thrusters that allow for independent individual movement or for coordinated maneuvering of groups of such satellites. At least three of these devices are currently undergoing testing at the International Space Station.

According to David Miller, the director of MIT's Space Systems Lab, such satellites could be used for building large, space-based telescopes and for closely monitoring Earth.

I think they might also be used to help clean up the thousands of bits of debris left in low-earth-orbit (LEO) by past launches. I believe that such trash collection is something we'll have to do eventually. Why not get to it sooner rather than later?

[I first found this in a posting on Slashdot at: http://science.slashdot.org/science/06/07/11/2123218.shtml ;
When I went back to find additional references, I found a website with an artist's drawing of such a droid satellite and a second with a photo of what appears to be the actual device:
http://www.droidbuilders.net/2006/07/12/droid-satellites-tested-at-iss/
http://www.spacedaily.com/reports/NASA_To_Use_Space_Age_Droid_Satellites_999.html]

Over the years, NASA has sent numerous probes to the outer solar system, the most famous of these being Voyager 1 and 2. The images they sent back of Jupiter, Saturn, Uranus, and Neptune sent JPL's astronomers, physicists, and planetary geologists back to their drawing boards. We haven't heard much about these probes for a while, but that doesn't mean that they're out of commission or out of touch.



On August 16, 2006, Voyager 1 (in the fashion of "The Little Engine That Could") reached a distance of 100 astronomical units (AU) from the sun. An AU is the distance from the Sun to the Earth, about 93 million miles (150 million kilometers). Voyager is now about 9.3 billion miles from the sun, at the outer edge of the solar system in an area called the heliosheath -- the outer layer of a 'bubble' surrounding the sun and the zone where the sun's influence wanes. No one actually knows how big this bubble actually is or whether it is symmetric.

Voyager has traveled far and is now moving at about a million miles per day. It's still looking for the tenuous 'edge' of the solar system. Estimates are that it could cross into interstellar space sometime within the next ten years.

[For more information on the Voyager 1 mission, as well as some nice graphic images and links additional related material, see the JPL website at: http://voyager.jpl.nasa.gov/]

While the Voyager probe just keeps on truckin', the Pioneer 10 and 11 spacecraft, launched in 1972 and 1973 (respectively) are, in contrast, doing something odd -- very odd. Some unidentified phenomenon is causing these spacecraft to speed up.

The acceleration is less than a nanometer per second per second. This is an incredibly small acceleration, but it has been applied to these spacecraft constantly for thirty-four years. Pioneer 10 has moved about 400,000 kilometers beyond where it was expected to be.

No one knows what's causing the anomaly. Physicists are baffled and have begun grasping at straws by linking this mystery to other unexplained phenomena. The best suggestion, so far, is for a mission to test gravitational effects in the outer reaches of the solar system. So far it's only a suggestion.

[For more information on the Pioneer 10 mission, see the NASA website at:
http://spaceprojects.arc.nasa.gov/Space_Projects/pioneer/PNhome.html]

The shuttle Discovery made its recent trip covered with new foam tiles. Upon its landing at the end of July, it was immediately examined in detail to determine whether the new tiles had made any difference in the number and severity of dings from debris. There was, in fact, a 33% reduction in dings on the orbiter's underside and a 50% reduction in hits greater than one inch deep.

While this is good news for our aging Shuttle fleet, there may be even better news on the way. The September 14, 2006 issue of "NASA Tech Briefs" has three different articles on Composites and Ceramics:

- Silicon-Carbide matrix composite materials are expected to improve thermo-mechanical properties of engine components with lighter weight materials that can withstand higher temperatures than the current state of the art metallic alloys and oxide-matrix composites.
- Ceramic fabrics impregnated with partially cured polymers and ceramic particles are being developed for use in patching ceramic-matrix composites on the leading edges of the Shuttle.
- A new form of low conductivity ceramic materials (made of "doped pyrochlore oxides") are being considered as alternative materials for high temperature thermal barrier coatings -- probably useful on shuttle leading edges and as a layer of heat shielding on any landing craft coming to Earth from orbit.

[For more information on this mision, see the NASA webiste at:
http://www.nasa.gov/mission_pages/shuttle/shuttlemissions/sts121/index.html
For additional information on manned spaceflight, see the recently consolidated website of the International Space Station & the Space Shuttle at:
http://spaceflight.nasa.gov/home/index.html]

[The website of NASA Tech Briefs is: http://www.nasatech.com]

A year ago I mentioned the beginnings of the efforts of Virgin Galactic, the joint venture of Burt Rutan's Scaled Composites and Sir Richard Branson's Virgin Group. Based on recent updates to the website (http://www.virgingalactic.com), including a short film, Virgin Galactic has been very busy.

The site has a new logo, a new catchphrase ("See the world in a whole new light."), and there's even a short film. It all says interesting about plans and progress. I think there is little doubt they'll make good on their publicly announcement to provide commercial sub-orbital flights by the end of the decade. I assume this means by the end of 2010, which is only four years away.

It's very clear that Branson has seen the financial possibilities in commercial space flight. Also, given his adventuresome personal history, he understands that there will be risks involved and still believes it's worth his time, money, creativity (of which he has more than a little), and energy.

[For more information on Virgin Galactic and the future of commercial spaceflight, see the website (and don't forget to watch the movie) at:
http://www.virgingalactic.com]

The X-Prize hasn't exactly gone away, however. This year, there's a new challenge. On August 8, 2006, there was an announcement about a strange and ambitious competition: The Space Elevator Games. The competition -- a successor to the X-Prize -- is billed as a NASA Centennial Challenge.

This year's competition is jointly sponsored by the X-Prize Foundation and the Spaceward Foundation. The $400K games will be held at the Las Cruces (New Mexico) International Airport on October 20-21, 2006, with 22 teams from around the world competing in two categories: Climber / Power Beaming; and Tether.

The categories may not sound very exciting, but the goal is to demonstrate technologies that will permit the actual construction of an elevator from the Earth's surface to a satellite in geosynchronous orbit at a height of about 23,200 miles, thereby replacing rockets. The sponsors are, in short, looking for a stairway to heaven.

It's a concept straight out of science fiction, made famous by Arthur C. Clarke in his 1978 novel *The Fountains of Paradise*. The original idea came from a Russian scientist, Yuri Artsutanov in 1960. The materials with characteristics necessary to build the elevator were far beyond the technologies of the time.

Basically, a Space Elevator starts by parking a large rock (i.e. an asteroid of sufficient mass imported just for that purpose) in geosynchronous orbit and dropping a cable from that rock to the Earth's surface, somewhere on, or very close to, the Equator. But we're not talking about a typical elevator cable. It's own weight would probably be enough to pull the asteroid right out of the sky, with disastrous consequences. We need something vastly lighter and stronger than your everyday "elevator cable".

Today, 46 years after Artsutanov's idea and 28 years after Clarke's book, we finally have a material light enough and strong enough to use for the cable. A fabric woven of carbon nanotubes would be significantly stronger and lighter than spider silk. Stronger than the nearest competitor, Kevlar, so there's no longer any question about the composition of the elevator cable. Calculations suggest that a paper-thin, meter-wide sheet of fabric composed of nanotubes could be strong enough to support both the climbing device and an additional sixteen tons of cargo.

The trip up the cable won't be dramatic or quick. Assuming the technology is developed to move up the cable at a brisk 250 miles per hour, we're not talking about getting to Low-Earth Orbit. At that speed, it would take about 4 days to get to the "top floor". To carry humans or other live animals, the elevator would have to be well shielded for its trip through the Van Allen Radiation Belts. For taking that first step into space, the Space Elevator (called a "skyhook" in science-fiction parlance) will be a dramatically better "mousetrap". The expectation is that it will have plenty of traffic.

A working Space Elevator can not come too soon for NASA. Decades of launches have neither reduced launch costs nor the ratio of launch mass to what is delivered to orbit. The elevator completely will sidestep the requirements of costly and dangerous rockets and allow NASA to create satellites and probes that are not currently possible.

The prize money may not be claimed this year, or for several years. Regardless, you can be sure that every competitor's entry will perform at a level well beyond last year's best.

[For a lot more information about the concepts and the competition, see the Space Elevator 2010 site at: http://www.elevator2010.org/site/competition.html]
[To get an idea of how much fun moving an asteroid might be, read Robert Heinlein's short story *Misfit*.]

Finally, consider Pluto, the erstwhile ninth planet of our solar system.

As planetary physicists considered the possibilities and the options during last summer, Pluto's status as a planet was an on-again, off-again thing, with the count of "planets" rising for a few days to 12 before falling back to 8, with Pluto no longer in the family. Indeed, Pluto and the asteroid Ceres (the largest asteroid in the belt) have been placed in the category of "dwarf planet". Hmmm. I'm not sure what to make of that, and I appear to be in good company.

Here's a quote from NASA's website (http://www.nasa.gov/mission_pages/newhorizons/main/index.html) discussing the recently launched New Horizons probe, headed for Pluto and points farther out:

> "Poor New Horizons. When it launched in January 2006 it was with all the prestige of the first spacecraft to study Pluto, the last unvisited planet in the solar system. That changed seven months later, when astronomers decided that Pluto was not a planet. For the time being, New Horizons is at least the first mission to a dwarf planet -- the new class of objects into which scientists dumped Pluto. But that doesn't mean it will be the first spacecraft to visit a dwarf planet. Under the new definition (it's still unclear), Ceres may be upgraded from asteroid to dwarf planet, and if NASA's Dawn mission launches as planned next summer, it will arrive at Ceres in February 2015, five months before New Horizons gets to Pluto."

[For more information on the New Horizons mission, see the NASA website at:
http://www.nasa.gov/mission_pages/newhorizons/main]

If there's one thing we've realized in the time since our distant ancestors first gazed up at the stars and planets, it's that, instead of being perfect and immutable, objects in space are constantly changing, sometimes violently so – as are our perceptions of them.

