Bits of This and That
by Charley Kohlhase
retold by Barbara Amago

On November 14, 2002, about fifteen minutes before the JPL Story program was to start, the library staff was finishing setting up the chairs, testing the sound system, and getting the laptop and projector ready. Storyteller Charley Kohlhase, a frequent library user, and well known to library staff, arrived promptly, projecting an air of brisk energy. As the audience began to file in, many of them greeted Charley warmly. At 4:00 Teresa Bailey, the story coordinator, asked the audience to please take their seats and began her introductory remarks.

"Charley is a former science and mission design manager," Teresa began, "He led mission design teams and project systems engineering activities for numerous deep-space missions during the 1960s through 1990s, including Mission Design Manager for the Voyager Grand Tour mission. In addition, he has always been heavily involved in creating public engagement materials that blend art, science, and education. Charley retired in 1998, but is currently supporting several NASA/JPL activities as an "on-call JPL employee." These include the Mars Program Systems Engineering Team, the Mars Technology Program review board, the Kepler project as an external technical advisor, one final Cassini edutainment project, and several other space mission review boards and technical assignments.

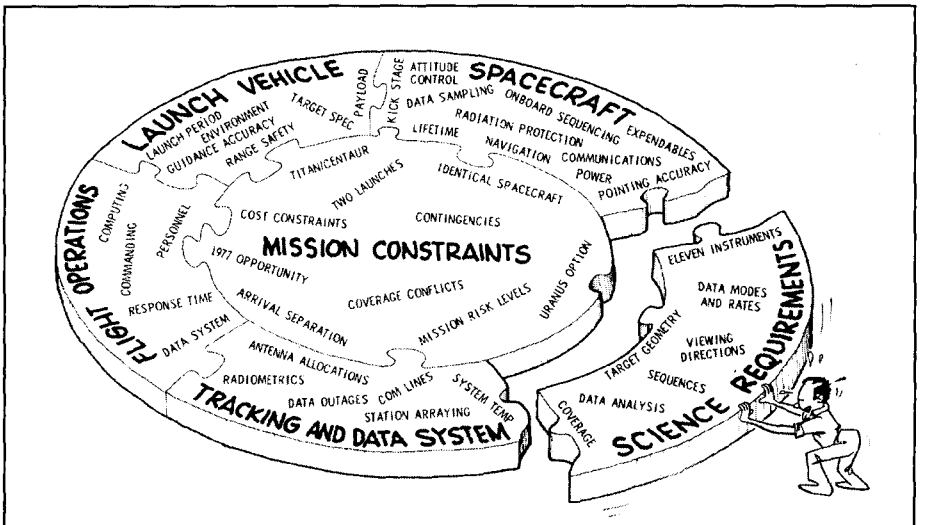
When Charley took the mike he explained the format of his story and why he decided to base it on a Powerpoint presentation. "I'm a sort of 'essence person'," he said, "and also very visual, so I decided to show nice imagery rather than just ramble on about the past."

He then began his story, which focused on six broad topics: building missions, public engagement, virtual reality, art and science, changes at JPL, and Earth's greatest challenge.

Building Missions

Charley was a mission builder for a great part of his career at JPL. There are really only a few elements to a mission – and Charley's first slide showed five of them: science, navigation, spacecraft, Earth base, and launch vehicle. "It should be easy," said Charley with a smile, "just fly a few sensors to some remote world and then send the info back to Earth." He then added a few remarks and proceeded to his next illustration which showed the basic mission elements as interlocking pieces of a puzzle.

There are basically two approaches to building missions, top-down and bottoms-up. In the "old days," the approach was always top-down, taking exactly what the scientific community wanted and making it happen. Today, the approach is, by necessity, more cost-conscious, which leads to bottoms up. You look to see what's "on the shelf," negotiate changes with the investigators, and then build the



OVERALL MISSION DESIGN

mission.

Because he is often asked to explain how gravity assist works, Charley developed an illustration which he shared with the audience. A kid is throwing a ball (analog for the spacecraft) at the front of a train (analog for Jupiter, or whatever planet is doing the assisting), while the "sun" sits in front of the train station watching the action. The ball is moving at 30 miles per hour (mph) toward the train, and the train is traveling at 50 mph. Relative to the conductor inside the train, the ball, as it bounces off the front of train, is perceived to be traveling at 80 mph, but relative to the sun, which is sitting still, the ball is moving at an amazing 130 mph for a directly head-on throw. Even if the ball is thrown from an angle 45 degrees off head on, the ball still rebounds at about 123 mph relative to the station platform.

Public Engagement

Since Charley has retired (he still consults at the Lab part-time), he's had more time to spend on public outreach for space exploration. He explained that the Lab now calls these activities "public engagement," but that the concept remains the same – to share our enthusiasm and pride in our achievements with the general public and to engage them in our endeavor – the exploration of space.

In the late 60's and early 70's there began to be more demand for graphical representations of space missions. Charley got interested and began working with the JPL Graphics department to develop better ways to represent three-dimensional objects. Later on, he heard of someone very special working at the University of Utah named Jim Blinn, with whom he began to work to produce improved computer animations and graphics. He described a bump-mapping technique developed by Blinn that they were able to use successfully as a way to trick the human eye and the lighting laws to create realistic 3D images that didn't require so much computer memory. In this manner, a great deal of memory was spared by not having to "model" all of the 3D variations in each vertex of the otherwise vast network of polygons comprising a minutely detailed surface, such as that of a carpet or an orange. Bump-mapping works great for small undulations in a surface, but not for large changes where the geometry must be modeled.

Charley shared some examples of some Voyager flyby computer animations that he and Jim Blinn developed during the 1970's. The contrast between the "wireframe" images used in the early 70's and the shaded 3D images from later in the decade were remarkable. He also shared some examples of other projects he worked on at the Lab, including an edutainment project that he's working on currently, as time permits. It is called "2004 – A Light Knight's Odyssey," whose sound track is done, but not the costly animation. The computer-character voice parts have been read by such famous actors as James Earl Jones, John Travolta, Samuel Jackson, Ann Archer, Michael York, Sarah Michelle Geller, Robert Picardo, and other notables.

He then related the story of how 620,000 signatures contributed by people from 81 different countries got to fly aboard Cassini. The signatures were submitted on postcards and the Planetary Society scanned them all in. Charley convinced them that it would be higher-tech to put them all on a DVD. Ten copies were made of the DVD, one on the spacecraft, 8 in museums around the world, and one copy is missing. Charley suggested that it might be in one of the retirement boxes of a former project official.

Virtual Reality

Charley's next slide illustrated how 3D programs work. "Primitives" are developed on a computer and assembled in more complex shapes to create everything from boxes to cities. Displays can range from "wire frame" to fully shaded and colored. By removing the "hidden lines," wire frame images are easier to visualize, but of course the addition of solid surfaces and shading look the best. Flat texture maps are added and shapes are smoothed. Then the image is bump-mapped and other features, such as shadows and transparency, are added. Last, any special effects and/or animation is included.

The next illustrations Charley shared were some space scenes he developed, and which at one point he contributed to an art competition at the Lab. The works that were selected by a team of judges were to be hung on the 9th floor of 180 for a period of time. One of Charley's space scenes entitled "Valles Marineris, 2075" was selected, but was later deemed as inappropriate to hang in such a prominent place because of his depiction of an attractive long-legged woman in a short skirt set in a futuristic space landscape. Naturally, Charley was bothered by what he viewed as art censorship and removed his piece from the exhibition. "I showed the female spaceship officer in a position of power, not of anything less," he said. He offered this incident as an example of excessive political correctness. "Political correctness continues to reach new highs," Charley said, "And there will be more about this later."

He then described how the different images were created, using a combination of photographic and computer graphics techniques. An image of a man flying a spacecraft through an imaginary world was actually made from a photograph of Charley sitting in a chair in his own driveway, but later "composited" into the cockpit of a 3D hovercraft.

Charley had several examples that illustrated how different images are constructed, and he commented about how many hours it took to complete them. The time necessary to construct an image and its ultimate quality and impact to the viewer may bear little relation – an image of two space-suited figures tending a plant under a clear field dome on the surface of Mars took about 25 hours to create, whereas a very complex-looking image of a craft speeding through space was constructed in less than an hour. You can see several of his images in the October 2002 issue of Caltech's *Engineering and Science Magazine*.

Art and Science

The thing that really excites Charley now is blending art and science. He then shared several examples from nature and art. Two works he finds particularly interesting are Marcel Duchamp's 1912 painting "Nude Descending a Staircase #2" and Olivier Deschamps' sculpture "Espoir-Desespoir." Duchamp's work caused quite a stir when it was exhibited in New York – the cubist, futuristic style had never been used before to depict the human body. The other example, Deschamps' sculpture of a mother and child, uses the relaxing and restoration of a memory metal (nickel-titanium) in the mother's stomach to move the sculpture up and down with changes in the ambient temperature. This causes the mother's arms, holding the child, to move downward at night as the metal cools and relaxes under the pull of gravity ... and move upward as the sun rises and the metal's temperature returns to the levels it experienced during manufacture.

Another fascinating subject is evolution as art. Contemporary artists and scientists are designing virtual evolution simulations that have great potential for creating new art, as well as new life forms. In two examples from Karl Sims'

work one can see how the artist used computer simulations to model growth. Another artist currently working in this field is Dr. Eric Heller, a physicist at Harvard, who models the motion of electrons over bumpy surfaces to produce art works that sell.

Charley has had the opportunity to know and work with many very creative people during his career, and he shared his observations about what defines creative people. They are often smart, playfully energetic, and move easily between reality and fantasy. They are aware of the great beauty of the natural world and are both passionate and objective. They may be rebellious, but disciplined, and often involved in more than one field. There is often an element of eros but tempered by restraint, as well as a blend of masculinity and femininity.

Changes at JPL since 1959

Charley enumerated many changes that have taken place at JPL during his tenure at the Lab. Some good, some bad, and some neutral in his opinion. On the positive side, he listed that JPL employees are no longer second-class to the Caltech faculty and that we have more computer power. There are more projects, although they tend to be smaller. On the negative side, he opined that a more process-oriented approach might restrict individual initiative. There was more administrative paperwork and an excessive preoccupation with political correctness. The relative influence of politics over engineering is increasing in his opinion, and he is also concerned about the increased need for security.

Other changes that he's seen over the years are more neutral, such as the more formal accountability and more meetings. He expressed concern about the increasing association with military backgrounds for O'Keefe and several of his staff at NASA, and hopes that this trend will be short-lived, with a return to the days of space visionaries at the helm. He ruefully recalled what a privilege it was, on a space-available basis, for a junior engineer to catch the Lab-provided 14-minute helicopter ride to LAX, if there were seats left after a senior JPLer had scheduled the flight. "You took off over Brookside golf course, passing over the unending blanket of swimming pools in southern California, and 14 minutes later, you landed on the tarmac right next to your plane. It was great!" he exclaimed. "But it went the way of other cost-savings measures."

Earth's Greatest Challenge

Charley closed his presentation with an impassioned argument for safeguarding the Earth's resources and natural environment. He quoted E. O. Wilson's May 1995 statement, "As a biologist, I feel like an art curator watching the Louvre burn down." He finds the huge impact that humans are making on habitats, fishery stocks, topsoil, water, forests, and all types of wildlife increasingly alarming. The principal causes are over-population, over-usage of natural resources, and the

mantra of continued, unchecked economic growth. He asked the audience a rhetorical question, "So, is the Earth just going to be ruined beyond recovery, or are we going to do something about it?"

To wrap up his story, Charley offered a list of what he calls his "Memes for Living." (He defined "memes" as ideas, units of thought that can propagate from brain to brain, a concept Charley attributed to Richard Dawkins in his book, *The Selfish Gene*.)

- *Get an education, and use this knowledge well.*
- *Rise early and seize each day (Carpe Diem).*
- *Care about some pursuit with passion.*
- *Spend quality time with those you love.*
- *Use logic to fight the omnipresent irrational.*
- *Be ethical to the highest degree.*
- *Treat your body with respect.*
- *Defend the environment to your last breath.*
- *Meld mind and heart for greatest creativity.*
- *Follow your dreams, and become all you can be.*

The audience clearly agreed with Charley's assessment as they warmly applauded at the conclusion of his story.