Chapter 6
EDUCATION AND THE ARTS

Mars artist Michael Carrol (left) exchanges thoughts with astrophysicist and science fiction author Greg Benford.

Air Force Captain Lynnanne George brought a group of Cadets from the Academy

MAR 98-024

SECONDARY MARS EDUCATION: FASTER, BETTER, CHEAPER

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A combination of timely factors has made public education about Mars possible on a far greater scale than ever before. The (1) Information Superhighway via the Internet and the swift movement of private information allows fingertip data at the push of a computer key. Together with a broad range of (2) up-to-the-minute relays of continued findings by university and NASA scientists, and the (3) availability of online educational lessons and easily purchased CD-ROM disks slide sets and a full range of other related materials all allow daily instruction of space-related technology education almost at a moment's notice. Space education can assist considerably to help young people understand the next stage in human evolution when humans build the first colony on the Martian landscape.

"The woods are lovely, dark, and deep, But I have promises to keep,
And miles to go before I sleep, And miles to go before I sleep."

Robert Frost

The traditional classroom of the 20th century with its pin-up posters, wall maps and written tests, is gone forever. Current and ongoing advances in more realistic subject matter and methods of bringing about learning offer remarkable opportunities for education to take place faster, better, and cheaper for both student and school district. These advances tend to make textbooks, paper and pencil desk exercises, and chalkboards laborious and cost ineffective barriers in the view of enlightened young people who hunger for information about the next civilization in space. Young people know their future is in space and they want to know why they aren't being told more about it (Figure 1).

DILEMMAS OF THE INFORMATION SUPERHIGHWAY

Traditional urban classrooms are being replaced at a rapid rate in the face of computers operating at internet speeds which can disseminate the projects and findings of scientists and engineers while they are taking place. Students and teachers have access to a truly enormous fund of online, frequently updated information from which they can extract data for individual study, student deskwork and classroom use. In some areas of the nation, on the other hand, the pace of change to computer-driven knowledge is slow. We do not all travel the Information Superhighway at the same speed.

People who work in the space community, especially in large cities, seldom can appreciate the dilemmas faced by young people in small towns, especially throughout farmlands in the Midwest and plains regions. Operating capital for small school districts is limited, students are spread out across large geographic areas, community libraries are small and distanced, and student access to and use of major computer systems are highly difficult at best.

Figure 1 The future emphasis for everyone is education. Sketch by the author.

Some rural school districts are not yet on the Internet. For people in these communities, knowledge about where to get teaching materials about space topics is difficult to acquire. Daily computer work is severely limited and students often have no opportunity to take data from the Internet home with them. One 10th grader in rural Missouri, for example, said she was allowed to print out only one page a week from the school's computer—under supervision. Another student said he was allowed to use the school computer only when teachers, administrators and clerical staff weren't using it; another said his mother had to drive him 20 miles to the nearest library to use a computer. Some students have difficulty gaining access to a decent computer and/or a printer of good quality. Images from the Internet could be worthless if printed out on an inferior printer.

Although situations such as these are changing, the rate of change is slow and uncertain. Still, the Internet is the only chance young people have to keep abreast of what is happening in the world of science and technology that is fast overtaking the American culture. As adults and educators, we must broaden that chance to give young people more opportunity not only to use computers but to learn how to create right on the keyboard (Figure 2).

European students (Figure 3), like American students, are faced with similar problems as I learned teaching five seasons at the European Space School for Sixth Form students headquartered at Brunel University in Uxbridge, England. European industry and politics are very supportive of technology education and allow space-related curriculum to become part of the national education structure. Curricula in "Earth and space sciences" are mandated across the United Kingdom and in countries on the mainland so that pure space topics can be taught at will.

Serving as Principal Lecturer at the British Space School from 1989 through 1994, I delivered illustrated lectures about Hypersonics And Spaceplanes, Hubble Space Telescope, Shuttle Orbiter Technologies, the Voyager missions, and also taught two extended courses: Remote Sensing, and Comparing Earth And Mars.

Figure 2 The pace of the knowledge explosion. Sketch by the author.

Figure 3 European Sixth Form students study a course in Earth/Mars comparative planetology in Space School at Brunel University. Photo by the author.

National space schools for high school-age students are now operating in Australia, Brazil, Britain, Canada, France, India, Mexico, Pakistan, Poland, and the former Soviet Union. The schools are strongly supported by industry, education and government and are meeting on regular schedules throughout the year. A number of these countries have asked me for teaching materials and copies of my published articles over the past decade; some have asked me to teach in their schools.

INTERDISCIPLINARY AND NON-TRADITIONAL APPROACHES TO MARS SPACE EDUCATION

Space technology education is not difficult; it's just different. Simply stated, space education is the teaching of the fund of knowledge that allows humans to live and work in the space environment (Reference 1). Certainly Mars is a different world but it still is a sphere and it has geological processes and geography counterparts similar to Earth, although the similarity ends there. Everything on Mars is much bigger.

Teaching about Mars and other space topics requires the acceptance of two non-traditional approaches to the education process (Reference 2). The first is a *Technology Preparation System* (Figure 4) driven by three basic objectives:

- Preparation of a knowledgeable labor force
- Continual acquisition of new knowledge and new technology
- Constant exploration, exploitation, and commercialization of the space frontier.

Figure 4 The technology preparation system is the basic tenet of all space education. Sketch by the author.

The second non-traditional approach is the use of *Advanced Educational Systems* which includes everything from 35mm single lens reflex cameras to computers, camcorders, digital cameras, basic digital data communication, and teaching the technologies of Mars mission. In Advanced Educational Systems:

- Subject matter and materials are not part of today's usual curriculum
- Teachers are required to be more versatile and creative
- Students are led to think and reason as opposed to listening to lectures and filling out

“worksheets”

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The systems are computer-related and require more than simple computer literacy, familiarity and word processing.

Figure 5 illustrates three stages in the study and human perception of Mars. The upper level represents an armchair and telescope method; studying only what we can see and understand from ground level. The middle level shows what we first learned and can study based on flyby spacecraft imagery such as the Mariner 4 and 6 missions. The lower stage awaits a human landing of geologists and other scientists, after the Viking and Pathfinder missions, and the final truths that can only be discovered by human contact.

Figure 5 Advanced Educational Systems provide greater understanding of remote objects in space education. Sketch by the author.

It is imperative that today's scientists and space community leaders capture the attention of young people at the very time when these students are trying to make career decisions. We must expose high schoolers to as many career options as possible so they can make intelligent choices at this critical time in their lives. These intelligent and curious minds are continually searching for a job field or a professional career line that not only offers security and high job interest, but which also allows them to exercise their creative talents.

Young people today in their 11th year of schooling will graduate in the year 2000 and face all the problems and challenges of a new, intense and much faster-paced millennium. By now they should have a clear view of the kinds of life careers they want to pursue, but for the most part, many have absolutely no idea of their intended job fields even though they are only two years away from entering university. The skills they need to survive in the highly competitive job marketplace to meet the awesome challenges of the next millennium include:
abstracting, retrieving, assembling, searching, categorizing, systematizing, comparing, thinking, compiling, transmitting, reasoning and visualizing.

Learning goals should include multidisciplinary approaches to problem-solving, understanding relationships, adopting a global viewpoint, seeing technologies as tools, experiencing rapid cultural change, goal-oriented reasoning, and the ability to think deeply. Arthur Clarke's global village already is a reality and tomorrow's adults will live in it on a much more face-to-face basis than today's adults. But how ready are today's students to learn about new technologies?

A TALE OF TWO COURSES

In 1987 I taught two six-week classes of 47 low-achieving students (only 34 students finished the course) in a suburban high school with a student population of 1800 (Reference 3). Students enrolled in this special two-and-one-half hour summer session were of two specific backgrounds: (1) those who had failed a subject in the regular school year, and (2) those who were interested in simply earning additional high school credit but who had not failed a regular course during the year. Students were tested weekly and also were graded weekly on desk map work. Space technology made up more than 50% of the course.

Students were characterized by poor reading ability, low reading comprehension, poor map-making skills, poor study habits, low organizational skills, and generally low academic achievement. As one might suspect, they had poor self images, low motivation, some behavior problems, low expectations for themselves, and subscribed to a counter-culture value system.

The course, “Technology And Current Events”, had a global perspective, strong use of audio visuals, and interdisciplinary subject matter for which they had no background whatever. Topics in the course included the Thames River Flood Barrier, British/French Channel Hovercraft, Channel Tunnel, Landsat and GOES satellites and imagery, French TGV Train, Netherlands Polders, Concorde Jet Aircraft, MIR Space Station, Hubble Space Telescope, and maps from space of the Sinai Peninsula, Europe, Netherlands, Mainland China, Earth’s Northern Hemisphere, Chernobyl and Africa’s Great Rift Valley.

Final letter grades for the course were A=1, B=9, C=5, D=12, F=7; T=34. Low achieving students can achieve given the right circumstances. Motivating factors in this intense, highly technical course included:

- Studying real-world subject matter
- Studying space technology topics

- Rise in self esteem
- Earning grades they never could earn during regular school
- Students needed a passing grade.

Two years later I was teaching a class of 15 gifted 8th graders for the St. Louis Gifted Resource Council, called “The Space Frontier” which was a walk-in, four hours a day direct contact for six weeks. We studied everything from the Shuttle Orbiter to the European Meteosat weather satellite and the Soviet space program. We also reviewed the political situation of “the space race” in relation to the Cold War. Toward the end of the course, the students built model rockets which they painted and launched on the football field.

One of the students suggested we conduct an experiment to find out how long breathable air would last in a plastic bubble in a swimming pool, and at the same time we could monitor the pH content in the bubble over a period of time. The experiment had some practical application for the Moon and Mars. The students rigged a large plastic sheet with rope and bricks tie-downs, hauled in compressed air tanks, filled the plastic bubble with air, and took turns diving under it to get into the bubble. The experiment was an excellent exercise in design and follow-through, as well as leadership, and a remarkable success considering the students were allowed to spend only one hour a day in preparation, and they received minimal help from me.

These are two examples from opposite ends of the learning bell curve, both highly successful and both rather amazing in their execution. But both were very carefully designed and orchestrated, with motivation coming from within the students themselves. The power of space education is undeniable, and we should put it to work on the study of Mars.

THE MISSOURI SCHOLARS ACADEMY FOR GIFTED STUDENTS

I first taught in the Missouri Scholars Academy at its founding session in 1985 and again in 1986. The in-residence, state legislature-funded Missouri Scholars Academy for rising, gifted 10th graders offered me a third unique opportunity this past summer to put space education concepts into daily practice once more. There were two classes of 18 select students each in *Basic Remote Sensing* (a major course meeting three hours daily) and *Introduction To Mars* (a minor course meeting one hour daily). In addition, the experience presented an opportunity to design a “bare bones” Mars course which now is being expanded and fine-tuned, and could easily become a much larger kind of course. See the MSA scene pictured in Figure 6.

Most of the materials for the course were derived directly off the Internet or obtained from select individuals and agencies working in the space community. A collection of data about Mars with student exercises made up a packet of about 100 pages given to each student. The course was structured to begin with basic facts about Mars as a planet, lead into the planet’s major features such as volcanoes, impact cratering, channeling, atmospherics, landscapes, and finish with the application of this knowledge by starting on the design for a science station on the Martian surface. The main emphasis throughout was on geography, geology, atmospherics and comparative planetology. Four presentation methods were used throughout the course.

Audio Visuals/Models

Color slide sets, some made up as far back as my attendance at Viking press conferences and tours of the Viking launch site in 1975, as well as more recent sets obtained from the Lunar and Planetary Institute in Houston, were the backbone of the course. Lively class discussions and short lectures were accomplished using slides as conversation and question-answer starters. Several VCR tapes such as “Made For Mars: Pathfinder”, “On Robot Wings” and “The Planet Mars” helped fill in the gaps as did posters, original oil paintings and large pictures. The Mars Global Surveyor and Pathfinder missions were examined in detail and imagery called up on specific computer websites. A working model of the Sojourner rover was demonstrated and the students were encouraged to operate it themselves, as in Figure 7.

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Figure 6 Missouri Scholars Academy students work in the computer lab to access Mars website data. Photo by the author.

Figure 7 A Missouri Scholars Academy student puts the Mars Sojourner model through its paces. Photo by the author.

Specific Imagery

Imagery of major features such as volcanoes of the Tharsis region (Olympus Mons, Ascraeus Mons, Pavonis Mons and others), Mariner Valley, Argyre Planitia, the Martian poles, etc., gave students an overview of the geography and geology of the planet. Some paper prints of imagery in color from the Viking missions, which students could keep, were distributed to the class for individual study and comment. Other imagery was obtained off the Internet. Occasionally an especially appropriate piece of imagery from the Remote Sensing class was given to students in the Mars class because otherwise they would have no opportunity ever to see the pictures.

Computer Laboratory Research

Using the PDS Planetary Image Atlas online program (more about this later) as a primary access to surface features, students were led to choose specific sites on Mars and to create their own pictures which they could study at the Academy and then take home with them. Students were able to print out as many as several dozen or more pictures off the Internet, allowing them to thoroughly research one or more specific landscapes and features.

Class Discussion/Student Desk Exercises

Mixed with short lectures and studies of surface features, lively discussions were held during which students were helped to analyze imagery, compare geological evidence, and arrive at reasonable conclusions about how certain surface features were formed. Repeated cratering (first, second and third event cratering were distinguished), mass wasting/slumping of canyon walls (see Figures 8 and 9 of the Candor Chasma section of Mariner Valley), evidences of past water flow through extinct riverbeds, outflow channels, and the creation of Olympus Mons and other volcanoes were determined by class discussion and reasoning.

Although only 25 hours length, the course was highly successful for students who had no other access to this kind of structured study of Mars. On the last day of class, I asked students to render an opinion of the course. Students were highly enthusiastic about the course; and a frequent comment was that the course was not long enough. The site they finally chose for the science station was in the terra fossae region in the northern latitudes because of the nearness to water and an outflow channel.

A STUDENT TECHNOLOGY ACCEPTANCE PHENOMENON

Teaching these and other courses over the years, an observable phenomenon has emerged among average students that I term "The Technology Acceptance Curve" (see Figure 10) and which invariably shows up in courses with high technology content.

During the first several weeks of a course there is a gradual climb to a plateau as students experience the excitement of technology education. But then comes a sudden drop in interest, test scores and individual work assignments in the face of subject matter for which students have absolutely no background. A slow climb back up to a new plateau of comprehension occurs as students begin to apply new principles and come to understand the science and technology of space topics.

This phenomenon does not seem to show up in gifted students who already have exploring backgrounds, and are able to self-sustain their interest and efforts for long periods of time out of self curiosity and higher order study skills. Gifted students are considerably self-motivated and goal oriented, and can focus on priority subjects for long periods of time.

Figures 8, 9 A Missouri Scholars Academy student desk exercise in Mars geology features the slumping event in Mariner Valley. Students used a NASA raw data image to study that had been scanned so it could be Xeroxed. Sketch and computer work by the author.

Figure 10 The Technology Acceptance Curve appears during class instruction of non-gifted students. Chart by the author.

SURFING THE SPACE INFORMATION SUPERHIGHWAY

NASA revised its homepage in 1998 so that accessing the basic web site permits the user to reach all other NASA facilities. With the entire NASA organization contributing to the Internet, information about any NASA topic is instantly available to students and teachers alike. This strategy is ideal for preparing lessons, student preparation of special reports, and even larger scale research projects. From Mars and asteroids to the X-33, International Space Station, Shuttle Orbiter and the greenhouse effect, for example, space theme subjects are absolutely endless. In addition, each site offers a number of links from the NASA homepage to private industry.

Pictures, posters, color slides and booklets about space science topics are available via the Internet in amazingly large quantity. Some current examples are:

a)

for the **NASA homepage:** *http://www.nasa.gov/*

b)

for the **NASA Mars Global Surveyor homepage** and the opportunity to download a series of MGS mission profile slides: *http://mars.jpl.nasa.gov/mgs/home.html*

c)

for the **Mars Pathfinder and Sojourner** sites: *http://mpf.www.jpl.nasa.gov*

d)

Future Mars robotic missions to the year 2004 can be browsed at: *http:/marsnt3.jpl.nasa.gov/education/table-contents.html*. This site will also gain access to the **NASA Jet Propulsion Laboratory's Mars Exploration Education Program: The Road To Mars**

e)

for the **NASA Planetary Photojournal Image Access homepage** and access to pictures and text about the Solar System: *http://photojournal.jpl.nasa.gov/*

f)

for additional Solar System and planetary data, the website **Views Of The Solar System** is an excellent and accurate portrayal, including asteroids, comets and meteorites, but beware that some material might be copyrighted
http://bang.lanl.gov/solarsys/eng/homepage.htm

g)

for **asteroid and comet impact hazards**, which are important for understanding impact craters on Mars: *http://arc.nasa.gov/index.html*

h)

considering Mars' thin atmosphere and distance from the Sun, it might be helpful to learn more about the Sun at this excellent **SOHO (Solar And Heliospheric Observatory)** joint ESA/NASA website: *http://sohowww.nascom.nasa.gov/*

i)

Malin Space Science Systems (together with the Cal Tech Institute of Technology) built the MGS camera (Mars Orbital Camera), is doing exemplary work studying Mars surface sites. This web is well worth your time and effort. Many of the images are offered free to the public at this website, but show your respect for their request for some copyrighted images and their wish to receive a credit line: *http://www.msss.com*.

These nine "best" examples are sufficient to give an idea of pertinent Mars websites. Of course, there are many, many other websites that offer a large amount of data. Browsing the Net will eventually get you where you want to go. These sites often have public outreach and educational programs of considerable value to the education community, and data and imagery can be printed out.

There are a number of automatic messaging systems for space sciences available on the Internet to which students and teachers can subscribe free of charge simply by applying on the computer. One of the more exciting websites is managed by Linda Porter at the NASA Manned Space Flight Center in Houston, called NASA Science Headline; apply at: <*express-delivery@sslab.msfc.nasa.gov*>.
Some interesting recent topics have included the following:

Starquakes: *http://science.msfc.nasa.gov/newhome/headlines/ast09jul98_1.htm*

Urban Heat Island: *http://science.msfc.nasa.gov/newhome/headlines/essd01jul98_1.htm*

Solar 3-D Images: *http://science.msfc.nasa.gov/newhome/headlines/ast22jun98_1.htm*

Gamma Ray Bursts: *http://science.msfc.nasa.gov/newhome/headlines/ast09jun98_1.htm*

If you're interested in the X-33 spaceplane (VentureStar), you can get on the automatic mailing list simply by sending your request to: *Majordomo@treflan.shout.net* and you will receive occasional public information releases. Is this design suitable for a Mars surface transporter, or perhaps you will get some other ideas from the website?

TEACHING MATERIALS OFF THE SHELF

One of the most rewarding and user-friendly online sites is the program **PDS Planetary Image Atlas** developed by Rob Waltz and a development team of the U.S. Geological Survey at Flagstaff, Arizona. The URL is *http://pdsimage.wr.usgs.gov/ATLAS.html*. (PDS = Planetary Data System.) The program, which can be accessed and manipulated online, allows the user to get an image map from which to choose and print any area on Mars with a variety of zoom factors, image sizes, and map projections using data from NASA's Viking missions.

To create an image simply click the area you want on the browse map image and the **MapMaker** program calls up the image which can be enlarged, moved up and down or sideways to select an exact feature, and then printed. Figure 11 is an image taken directly from the program and used by a student for study. Teachers can use the same program to create a variety of posters and/or bulletin board pin-ups, or prepare entire lessons.

Figure 11 Mapmaker PDS printout called up by a student in the Missouri Scholars Academy computer lab. Artwork by the author.

Another useful online site is the **Astronomy Picture Of The Day (APOD)**. The URL is: *http://antwrp.gsfc.nasa.gov/apod/archivepix.html* which features a different astronomical object each day of the year. While there is a wide variety of cosmic objects to choose from, the site also furnishes a number of Mars images and considerable creative opportunities for the teacher to highlight facts and pictures about Mars. In Figure 12, a student at the Missouri Scholars Academy browses the Astronomy Picture Of The Day information board for new information about Mars. It is worth your while to browse the Catalog and the Index.

The **Lunar And Planetary Institute (LPI)** at Houston, Texas sponsored by the Center For

Advanced Space Studies, NASA Johnson Space Center, has four sections devoted to major Mars landscape features, followed by five classroom activities using the image shown in Figures 8 and 9. The website can be found at *http://cass.jsc.gov/expmars/edbrief/edbrief.html* titled *Exploring Mars: 1996*. Activities for examining specific Mars surface features can be found at *http://cass.jsc.gov/expmars/edbrief/classact.html*. Activities can be geared to middle school or (with additional data) to upper high school. The site is excellent for a lead-in to topographic features, and Mariner Valley in particular. Both sites offer innumerable ideas in planetary geology with images for teachers to prepare meaningful lessons, and for students to work through as personal exercises. The **Institute** also offers color slide sets of Mars, Venus, the Moon, etc., each accompanied by a well-written and researched booklet explaining each slide. The sets are affordable and can be ordered by email with a credit card. The slides are ideal for classroom use and for individual study.

Figure 12 A Missouri Scholars Academy student pores over the data board featuring Astronomy Picture Of The Day. Photo by the author.

Finley-Holiday Films located in California probably has the best selection of Video tapes about Mars and other space related topics, at *http:/www.finley-holiday.com*. The company has been in business since 1965 and also offers CD-ROM space programs and color slide sets of a number of space subjects. The company is mentioned here because both service and quality are reliable.

Many **commercial CD-Rom disks** are available under $20.00 featuring Mars. Two of the better ones are:

- Mission To Mars: Exploring The Red Planet, by American MPC Research Inc.
- Mars: Past, Present, Future, by Holiday-Finley Films.

The **National Space Science Data Center** online features a CD_ROM Catalog of 39 titles, at *http://nssdc.gsfc.nasa.gov/cd-rom/set_bd/voyager.html* as well as prices and ordering information. Mars and the Mars spacecraft missions, especially Viking, are featured prominently at this NASA website. Many disks sell for $10.00 and the selection is excellent.

Mars topic CD-ROM disks can be purchased from any of a number of sources including the NSSDC and space activist groups, or by searching through the space magazines. Other disks about exploring the universe or the Solar System invariably have a section about Mars. For example, a CD-ROM about "The Universe" is going to include the Solar System and the planets (and Mars) as topics.

Final Frontier magazine (tel. 1-800-24-LUNAR for U.S.; international calls at 626-932-1033), aside from being a very good magazine, has a product section in each issue. The products are often quite expensive but they also are usually scarce or unique at those prices. The magazine offers authentic and sometimes fascinating space-related products; material about Mars is excellent.

HIGH SCHOOL SPACE COURSES BY DISTANCE LEARNING: UNIVERSITY OF MISSOURI

The **Center For Independent Study** at the University of Missouri-Columbia scored a major breakthrough in space technology education recently by offering two high school for-credit science correspondence courses in space technology that are on the Internet. Written for 9th grade students and up, the courses can be completed right on the computer after gaining access to the website and paying the enrollment fee (*http://indepstudy.ext.missouri.edu*). However, the courses are not for the faint-hearted but offer academic alternatives for creative and talented high school students. Each course has mid-term and final exams as well as progress evaluations along the way.

A third course is in the writing stage about major unmanned space exploration achievements such as the Hubble Space Telescope, the assault on Mars, Antarctica from space, the planet that got knocked on its side, and other exciting subjects. Completion of the course is projected for early next year.

Other courses are in the planning stage, especially a detailed survey of Mars as a special single course which will be created during 1999. Written by this author, all the courses together will form a series of upper secondary school correspondence courses on space technologies designed to take Missouri into the next millennium as a leader in space technology education and distance learning by correspondence, at the cutting edge of space exploration. All the space courses will be on the world wide web.

For the two courses already on the web, I took great care to obtain photographs and illustrations that were appropriate and accurate. Both courses are the result of some 30-40 years researching and teaching space technology. Many foreign space agencies contributed to each course in order to make them as authentic as possible.

a)

Aerospace: Crossing The Space Frontier - a political and technological history of space exploration from the Treaty of Versailles that ended World War I and helped create the Nazi V2 rocket to the International Space Station of today. The course explains the many scientific principles of space technology, reviewing each decade of space technology. The former Soviet space program and the European Space Agency are reviewed in detail. The course is copiously illustrated with authentic photographs and illustrations.

b)

Studying Planet Earth: The Satellite Connection - this unique course about satellite remote sensing uses up-to-the-minute satellite images and airborne photography from the world's leading space agencies and allows students to study Earth from the vantage point of space. The course comes with a special packet of color images for study and has lessons on topics such as basic remote sensing, hurricanes, spies in the skies, midwest flood of 1993, Chesapeake Bay, Netherlands Polders, and the Northeast, killer volcanoes, synthetic aperture radar, and Mission To Planet Earth. Each lesson in this course is accompanied by a special study-exercise.

THE KEYS TO MARS SPACE EDUCATION

There are several critical keys to designing and teaching courses about Mars. I've always believed that nothing can really be accomplished in an hour; designing a course for a time allotment of less than 12 hours is non-productive.

An Earth Comparison - Earth has been and always will be an obvious comparison to Mars or any other planet. If we don't compare Mars to familiar landscapes and features on Earth, we just can't relate to the Martian environment.

Understanding Remote Sensing - The basis of all Mars imagery is remote sensing and digital data transmission. Students must learn the technology and how it works in order to understand how the imagery is created and then enhanced or manipulated.

Computer Driven - Because of the enormous amount of information about Mars, courses must be computer based so that imagery can be obtained accurately and quickly.

Image Study - To understand how Mars behaves, students must have access to as much Mars imagery as possible. Aside from pictures in books, a Mars course should include a packet of features, landscapes, and image comparisons.

Technology Development - Each successive Mars imaging mission was accomplished by a corresponding increase in the sophistication of the mission spacecraft. Mariner 4 was the beginning; Mariners 6 & 7 were improved craft; Mariner 9 was more than adequate to do the job entrusted to it; and of course Viking and Mars Global Surveyor as well as Pathfinder are the current stages in technology improvement.

National Mars Curriculum - In the long term, if America is interested in sending human teams to the Martian surface, then Mars courses for young people should be the same across the country. This approach, over time, will establish an authentic national Mars curriculum that is the same for everyone. Aside from the motivating factor, students in Texas will be learning the same material as students in Minnesota or Massachusetts.

A Mars Society Course - The new Mars Society is in a perfect position to initiate and spearhead a national Mars course. In America today, the space education community is too splintered and generally uncooperative to bring about a serious kind of national Mars course (Reference 3). Regional and local politics, defending the turf, trying to look good in the public view, are all unproductive and cannot be tolerated in the face of such a serious undertaking as a national course. A national course must reach far beyond these territorial issues if something of value is to be accomplished. Designing and implementing a national Mars course cannot be left to chance or to the personal whims of space education organizations which have amply proved their inability to cooperate with each other or to function adequately.

MARS BASIC SUBJECT MATTER: STAND AND DELIVER

The general study pattern for understanding Mars as a planet and as a future target for the next step in space is a logical group of subjects, as follows (References 23 thru 28):

Basic Statistics - understanding such basics as comparative sizes, diameter, moons, tilt, distances from Earth and Sun, seasonal changes, etc.

Climate And Climatology - climatic change, factors affecting climate, seasonal variations

Geological Driving Forces - impact cratering, mass wasting, faulting, absence of tectonics, permafrost, temperature as deformation processes, transport of soil material

Location Geology - types of rocks and structures according to location

Landscape Features (Geography) - volcanoes, canyonlands, basins, channels, chaotic lands, poles, place names

Mars Mission Technologies - Mariners 4, 6, 7, 9; Vikings 1 & 2; Mars Global Surveyor, Pathfinder, (future missions)

Atmospherics - temperatures at various altitudes, haze and frost, clouds, movement of the polar ices, aeolian transport features

History Patterns - birth of the Solar System, Mars evolution and current development, impact cratering, water and water flow, Mars development compared to the other planets and their satellites.

THE NEXT FRONTIER AND THE FUTURE

Time and time again the plea from the public sector has fallen on deaf ears in the Congress. The time for the Congress and the President to listen is now - the message is loud and clear. Recent Mars Society Special Reports are nothing short of a call to arms for the membership to stand and be counted and to once again remind the Congress of the power of the constituency.

If a human mission to Mars is to be undertaken, it will have to be America that makes it happen. No other culture has the resources, the technology, or the public will, but the task will not be an easy one and it will require the best thinking of our best creative scientists to bring it about.

Methods to reach and establish a foothold presently are under serious discussion by serious people. Alternative propulsion systems, en route survival systems, landing site choices, surface excursions by foot, scientific experiments on Mars - all are being examined in a search for the best systems. Figures 13, 14, and 15, a Mars Mission proposed by the author and technology artist Darren J. Gillett of London, England suggest a colonization system that might take place some time after the first foothold on Mars is accomplished. I met Darren about 8 years ago in London and, after several months of talking about how to get to Mars, he began drawing more than 30 engineering sketches based on ideas we had discussed. Only a couple of his marvelous sketches are included here.

By the time configurations such as these might be undertaken, already there will be human explorers at work on Mars. An armada of four ships are led by another ion propelled spacecraft shown in Figure 13 and operated by two astronauts. The craft carries supply modules to be set placed in Mars orbit and retrieved at will by the colonists. The main control center, the Bridge, is shown in overall detail consisting of two seats for Spacecraft Commander and Co-Pilot.

Figure 14, top, represents a multi-role Mars Lander capable of ferrying about two dozen passengers and a limited cargo of spare parts, foodstuffs, science equipment, etc. At bottom is an orbital forklift vehicle which retrieves cargo containers and ferries them down to the surface of the planet for unloading, and a “bundle” of cargo containers.

Figure 13 Ion propelled spacecraft operated by two astronauts. Below, the main control center (Bridge). Sketches Copyright 1993 by Darren Gillett.

Figure 14 Multi-role Mars Lander (top) to ferry passengers and limited cargo. Bottom an orbital forklift vehicle retrieves cargo containers from a “bundle.” Copyright 1993 by Darren Gillett.

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Figure 15 is a diagram of an armored mining environment suit used for mining operations on the open landscape. The suit features robotic hands for using tools, picking at rocks and soil, and lifting small objects. The inside of the helmet has a “heads-up” display which gives the worker messages about the direction back to the habitat, distance away from the habitat, heart rate, radiation readings, terrain map, time of day, and air/water survival supply. The life support and communication gear are carried on the worker’s back with a monitor unit located on the chest.

Figure 15 Armored mining environment suit for mining operations on the open landscape, featuring robotic hands and "heads up" display inside helmet Sketch Copyright 1993 by Darren Gillett.

While concepts of setting up Mars bases and colonies are in the thinking stage at the moment, they represent various approaches to solving everyday living and working problems in the Martian environment (References 9, 11, 14, 17, 18, 19). It is important for us to begin to solve these problems now, before we ever reach the Red Planet. There is no way of knowing what new directions the human future on Mars might take.

The settlers at Jamestown, Virginia and Plymouth, Massachusetts arrived with only what their ships could carry. As a result, they lived off the land and made the best use of the natural resources around them. Sickness claimed many lives; there were seemingly insurmountable problems to be solved; starting a New World was not an easy job. But these settlers not only survived - they endured, and raised up on the beaches of North America one of the most awesome civilizations in the history of planet Earth. There is no reason that kind of determination and commitment cannot take place on Mars.

Most of the books being written today about Mars have to do with the past and the present; histories of the public view of Mars, or the Mariner and Viking Missions, etc. These books are important and have their place in society and in the classroom, but now it is time to look ahead to Mars as the next step in human exploration and possibly human evolution. We now need to focus on the future and all that it holds for us. The public needs to be educated about the great potential of Mars settlement, and one of the surest ways to bring that about is by teaching teachers to teach young people, so that these young people grow into adulthood with the concept of settling Mars already fixed in their minds.

A system should exist for training teachers during their college years, before they graduate as teachers, so that they have the background to work with concepts of space education and Mars in particular when they begin teaching. The business of Higher Education is still education - it is the business of learning, and preparing teachers and young people for places of leadership in America's future. Unfortunately the business of most colleges and universities is business - making money and surviving.

The current structure for creating teachers is outdated and, for the most part, does not allow for reality technology training. Higher Education must set the pace for secondary school graduates if we are to build a brighter future and return standards to their previous normal levels. This will be Higher Education's most difficult role in the face of economic pressures of the 1990s and after the turn of the century.

Standardized teacher training seminars about Mars are needed so that Mars can be taught in the classrooms of America. The answer once more is a *standardized teacher training curriculum*.

In many cases, young people know more about space than their teachers. In other instances, many young people's perception of space technology is grounded in the Saturday morning television cartoons, and science fiction films made in Hollywood. If teacher training is to be done properly, teachers should be taught before students are taught, and we should not leave these efforts to chance.

If we are to achieve something worthwhile, there must be a consensus among the industry, government and education communities working in concert. In this *triad partnership* (Reference 4), the role of education is to (1) shape the public view and attitude toward a Mars human landing through an understanding of the importance of such an endeavor, (2) educate young people for their places in industry and government, and (3) help establish Mars as a reachable goal in the national will. This kind of cooperation and commitment begins with state and local Boards of Education and local school administrators.

There are only two references to education in the United States Constitution; evidently our founding fathers believed education should be left to the discretion of the individual states. But the development of our country has shown education to be a major factor in cultural affairs and a highly important segment of state government. State mandated curriculum begins with state Boards of Education, and it is those political arms that will have to lead the continued quest for technology education at the grassroots level.

Everyone involved in any way with space exploration is a learner because usually there are no precedents for what we are trying to accomplish. For these educational efforts, then, we may have to invoke what I have come to call the "Leonardo Connection" when DaVinci commented at the height of his career, "Learning is the only thing the mind never fears, never exhausts, and never regrets; and it is the only thing that never fails us."

Neither space nor space education should be viewed as an all-encompassing cure for the frustrations of humankind, but rather as a golden moment of rare opportunity to seek and encounter new dimensions of fulfillment for the human mind. In the final analysis, there can be no alternative for the age we live in, and no greater promise for centuries to come.

Every time I enter a classroom, I'm mindful of the fact that I may be teaching Martians that day. Perhaps someone in that classroom will be the first to set foot on Mars, or the first to make the journey to start a new colony on the Martian landscape. In the long term, then, when we speak of going to Mars we're talking about human evolution.

The colonization of Mars is the next stage in the ongoing evolution of the human species. America IS a spacefaring nation (Figure 16), and although the process of evolving is slow and cautious, evolution is taking place right now and we are all us a part of it. For this reason it is even more important that space education across the nation must show up on our list of priorities.

Figure 16 The human species has committed itself to the exploration of space, and in that commitment, America is a leader in the human quest for newer footholds in the universe - and we will go wherever we need to go. Graphics by the author.

We must explore. . .it is our destiny to reach out for the blinking lights in the sky, and to plant our feet on the beaches of faraway shores. If we ever lose that instinct, we are indeed lost to the centuries that lie before us and which could have made of us a far grander civilization. *Make no mistake about it - the Manifest Destiny of the 21st century is on the cold, hostile shores of*

Mars where creative human activities will be tested to their limits. We dare not fail in meeting that challenge, because it is not only the greatest test of the present but the greatest hope for the future of humankind in the universe.

Economist Gale Baker Stanton said it another way: “If we are to achieve all that is possible, we must attempt the impossible; if we are to become all that we can be, we must dream of being more.”

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The arts in education have been cut from many schools across the country. But the arts have many benefits and help kids develop on many fundamental levels.Â Where have the arts in education gone? Over the past several years, weâ€™ve all seen the trend of schools cutting the arts from their curriculum. Music, art, theaterâ€"gone for so many. Thereâ€™s no doubt that the arts are fun for kids. Diving into those finger paints and making a beautiful picture to hang on the fridge is awesome. Acting in a play is exhilarating. But the arts also help kids develop on many fundamental levels. Here are the top ten ways that the arts help kids learn and develop important characteristics they will need as adults: 1. Creativity. Established in New York in January 2006 as a joint venture between e-flux and Artforum, Art & Education reaches an international network of more than 80,000 visual arts professionals and academics on a daily basis through its website and e-mail list.Â The latest announcements from top art and educational institutions worldwide. There has been an error. Please enter your email address. sign up. Thank you! An email with a confirmation link has been sent to the email address you entered. To complete your subscription, click this link. IJEA is an open access platform for scholarly dialogue. Our commitment is to the highest forms of research and scholarship invested in the significances of the arts in education and the education within the arts. The journal publishes peer-reviewed research-based field studies including, aesthetics, art theory, music education, visual arts education, drama education, dance education, media education, education in literature, and narrative and holistic integrated studies that cross or transcend these fields. Arts education, on the other hand, does solve problems. Years of research show that it's closely linked to almost everything that we as a nation say we want for our children and demand from our schools: academic achievement, social and emotional development, civic engagement, and equitable opportunity. Involvement in the arts is associated with gains in math, reading, cognitive ability, critical thinking, and verbal skill. Arts learning can also improve motivation, concentration, confidence, and teamwork. Art education has its roots in drawing, which, with reading, writing, singing, and playing an instrument comprised the basic elementary school curriculum in the seventeenth century. Drawing continued to be a basic component of the core curriculum throughout the eighteenth and nineteenth centuries, when educators saw drawing as important in teaching handwork, nature study, geography, and other subjects. Art education later expanded to include painting, design, graphic arts, and the "plastic arts" (e.g., sculpture and ceramics), although art continued to be seen primarily as utilitaria