

**PREPARING FOR THE JOURNEY:
AN INTRODUCTION TO MARS EDUCATION**

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This paper is about Mars educational resources, both of the nuts-and-bolts type, and of the higher country of the mind.

During the past 25 years, much work has been done to prepare humankind for Mars. In technical, scientific, and economic terms, we are pretty well prepared to go, to explore, and to return. But a major Mars preparation task needs more attention. This is the education of the "Mars Kids"; the children now in school, who will design, fund, and conduct the human missions to Mars.

Those first Martians currently attend school here on Earth. A good education will be the foundation for their successful missions to Mars. This is even more true if we seek to develop the most efficient and cost-effective human missions. Teachers who are teaching the Mars Generation need resources to help them with the job.

One such resource is the set of nuts-and-bolts materials available to teachers who would prepare the Mars Kids. Another is a new way of thinking, along the lines described by NASA's Jesco von Puttkamer: "... a new frame of mind that shifts the emphasis from individual subjects to the interactions and relationships between them."

ON PREPARATION

During the past 25 years, much work has been done to prepare humankind to journey to Mars. In technical, scientific, and economic terms, we are pretty well prepared to go, to explore, and to safely return - repeatedly.

But a major task, while underway, needs more attention. The preparation of the "Mars Kids": Children now in school who will design, fund, and conduct the human missions to Mars.

Teachers are teaching the Mars Generation today; but they need lots of resources to help them with the job. This paper provides information about Mars Education resources to those teachers.

Since teachers have an immediate need for nuts-and-bolts resources - teaching activities, films and slides, news about space - the paper begins by describing such resources.

There is also a need for new ways of teaching, based on new ways of thinking. As NASA's Jesco von Puttkamer, writes:

"...we need a new frame of mind that shifts the emphasis from individual subjects to the interactions and relationships between them."

**Jesco von Puttkamer,
Spaceflight and the New Enlightenment**

So here, also, is a description of such a new frame of mind.

ON EXPLORATION

July 4, 1997—

A small rover begins to examine rocks on the surface of Mars. Playfully, the scientists name one rock Yogi.

On the World Wide Web, students of all ages observe this event in near-real time. Through their selection of images, they interact with Mars. In the weeks between July 4, and August 1, 1997, NASA web sites receive over a half a *billion* visits! During the coming months, through downloading images and examining them with public-domain image processing software, students will be able to do real descriptive science simultaneously with Mars scientists.

But working through the computer networks of Earth is not the same as walking Mars (or Earth). Students can benefit from studying data from Mars or images of Earth from space. But students also need fieldwork - to study real things in real places. They need places like parks and science museums to learn how to do the fieldwork. They need the *context* of knowledge that can be provided in classrooms, in discovery centers, parks, and museums.

Classrooms are important in their own right. Major outreach science programs like Nasals Aerospace Education Services Program are important. Equally important are the Mars education programs developed by organizations like the Mars Society.

Finally, in this age of systemic reform of education, this era of the Millennium, this time of Mars, it is prudent to take some time to consider new ways of thinking about research and education.

THE TOOLKIT: Resources for Educators

NASA offers educational support to formal and informal educators. Support includes national and Center-based workshops, educator activity guides, audiovisual materials, an educational television network, educator resource centers, World Wide Web sites, and personal services from NASA Educators.

The goal in all that we do is to enhance literacy in science, mathematics, technology, geography, and all education. We actively seek to work in partnership with all educators with a similar goal.

Some important information about NASA:

NASA is an independent agency, whose director reports directly to the President. NASA is therefore not in any cabinet department.

NASA works within the framework of 4 strategic enterprises: Aeronautics and Space Technology, Space Science, Human Exploration and Development of Space, and Earth System Science. Mars Exploration actually involves all four enterprises.

Some NASA resources are directed by the Washington NASA Education Office; others, by various missions or offices within the four NASA enterprises. This allows our agency to offer some resources which pull from all the enterprises, and others which go into great depth in a particular area of knowledge. Since so many missions currently focus on Mars, there is a lot of Mars material available to teachers and other educators.

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Resources from NASA's Washington Education Office:

AESP

It has been said that one year on the road as an Aerospace Education Specialist (or Spacemobiler) gives more hands-on, direct knowledge about the state of American education than most educators get in a lifetime.

The Aerospace Education Services Program (AESP) has existed for more than 30 years. It is run under contract by Oklahoma State University in Stillwater, Oklahoma. At the request of any school, public or private, the program will schedule an Aerospace Education Specialist to visit the school or District. There are some variations in program operation from region to region, but all Specialists provide educator workshops, and student programs. Informal science educators, like interpreters, can request support of specialists at public program or interpretive skills workshops.

AESP Specialists are *teachers*. Qualifications state that they possess three years of full-time classroom teaching experience, a Master's Degree, and teaching credentials. Specialists must also have the ability to interpret science educational concepts to a wide variety of groups, and to a new group every day. Within a given day, a Specialist may present programs for students from kindergarten to eighth grade, and to the adult educators after school.

Specialists are *educators*. That is, they have a deep knowledge of educational methods and materials. Specialists attend national educational conferences of science, math, technology, geography and other disciplines to present workshops for educators, and to consult with educators.

AESP Specialists are *connectors*. They connect different disciplines involved in Space and Earth science in an interdisciplinary fashion. They connect the lives of individual students and

educators to NASA's work. And they connect the educators of America to scientists and educational planners.

Specialists present workshops. They work with science museums, schools, parks, and museums to present educator workshops. There is no charge to the requesting organization for our participation in these workshops.

Check out the AESP home page, listed at the end of the paper, for more information. Make sure to follow the link to additional resources for educators, which will connect you with dozens of sites.

EDUCATOR RESOURCE CENTER NETWORK

To provide continuing support to educators, NASA established a national network of Educator Resource Centers (ERCs). Each NASA Center has a major ERC. Other ERCs - Regional ERCs - are established in conjunction with universities or non-profit educational groups. In some states, ERCs are located in planetariae.

Materials available in the ERCs varies, but each ERC does have the same basic items: NASA public domain films on VHS cassette and equipment to duplicate them, sets of slides for duplication, a small curriculum library, and educational publications for educators. A educator can visit a ERC, duplicate a film about Earth from space, and obtain an educator's activity guide and posters on Earth System Science - all in one trip, and at no cost for services.

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ERCs stock many Mars Education materials. Lithographs of Mars help students and educators become familiar with the landforms of the planet. Posters like that of the Pathfinder landing can become centerpieces of a classroom.

NASA TV

This programming service regularly schedules NASA public domain films, so that educators can view or copy them. NASA TV also schedules live national educational conferences. These conferences focus on different topics - recently, Earth System Science, Robotics, and Space Life Sciences. NASA TV is accessible to every school or museum which has satellite ground station connectivity. In addition, many local cable systems carry it.

NASA TV is a window into the history of science. Major announcements - For example, the discovery of possible Martian fossils - are presented live. All Shuttle Missions are broadcast in their entirety. Other missions are also broadcast live on NASA TV, and science museums take advantage of this fact: When the Pathfinder landed on Mars in July of 97, the Oregon Museum of Science and Industry projected the entire event live - and had to stay open extra hours to meet the public's interest.

ON THE WEB: SPACELINK, and other resources

NASA has a plethora of world-wide-web electronic resources. These include many Earth pages. Sites often contain links to curriculum materials: Lesson plans, educational activity guides, and pictures for educators to use. Most pages also point to dozens of sites for Space and Earth Exploration.

The major page is Spacelink, the electronic entry point for educators. It will direct you to other NASA pages, curriculum materials, and images. The “cool” and “hot” sections contain late-breaking information about NASA missions. Other pages of note are listed at the end of the paper.

EDUCATOR WORKSHOPS

For educators who wish to become more directly involved with NASA, there are many On-Center workshops available. These include national workshops like NEWEST (NASA Educational Workshop for Elementary Science educators) and Center-based programs like NASA-Ames’s Space Down To Earth. Note: NASA is currently offering a NEW (NASA Educators’ Workshop) for informal science educators such as those in science centers, parks, and museums. NASA also co-sponsors other workshops, offered at locations around the country. The GLOBE Workshops, for example, train educators in student collection of Earth System Data; this information is then entered by students into the Earth-wide GLOBE database. Mars scientists will often present workshops on Mars Exploration at national conferences.

RESOURCES FROM MISSIONS

Other organizations also provide materials. NASA now requires researchers to use a percentage of funded research budgets for education. The result has been an explosion of educational materials.

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Mars Missions have produced a plethora of materials - web pages and CD’s, for example. JPL’s web pages on Mars exploration include news, images, and educational materials. Ames Research Center’s Center for Mars Exploration - CMEX - has produced the excellent CMEX CD’s, which include NIH image and a complete atlas of Mars. Contractors working with NASA produce posters and other materials. For example, The SETI Institute and the Planetary Society co-sponsored the production of the CMEX Educational CD ROMs.

IN CONCLUSION

NASA tools for Educators - publications, films, Web resources, or personal services - can help science educators like yourselves to do good work.

The challenge is not to find NASA materials that you can use in your park, or science center;

but to find the *best* materials. Good starting points are the local Educator Resource Center, Spacelink, or the AESP program. AESP Specialists will help you plan programs to enhance scientific, geographic or other literacy.

But now it is time to consider grander educational tools for Mars exploration - new paradigms of thought, a necessary educational revolution.

A Wander ... Into the high country of the mind

We live in the dawn of a new Enlightenment, a new Renaissance, born of Apollo and the first photographs of Earthrise over the Moon. We need this Enlightenment, since it will help us to think in new ways, and we need to do that. The nature of our tasks for the next few decades demands it. But how do we get there?

Science, they say, always starts with question. And questions come from wandering and wondering.

Robert Pirsig says that we should enter the high country of the mind, to enjoy a kind of intellectual chatauqua. Since Boulder is home to a Chatauqua, and borders the high country, let us follow Pirsig's example in "Zen and The Art of Motorcycle Maintenance", and wander up to the high country chatauqua to consider some questions about education.

It makes sense to me. I began to consider these ideas when I was a Ranger, wandering around large or small wild places. And I note that new paradigms of the nature I offer here are developed in conjunction with wilderness or wild places.

Paradigm shifts, according to Kuhn, are not usually the work of teams, or committees. Individuals see new ways to consider the universe, and begin to apply them. As these new paradigms are adopted, it then requires teams of specialists to apply them. But in the early stages, loners develop the paradigm, and small informal groups begin to apply it.

Perhaps wilderness settings, or rural areas, allow more time and inspiration for the birth of such revolutionary ideas, and more freedom of communication necessary for them to be nourished and to grow.

One of the qualities of the Corporate/scientific State in which we live is its specialization. Doing everything in teams of specialists does permit drawing upon diverse strengths to achieve mega-projects like a Mars mission. The problem with this approach is that it often prevents the kind of thinking that leads to breakthroughs.

Let us consider for a moment the Scottish Enlightenment. From Edinburgh, Scotland, in the mid-18th Century, the entire modern world emerged. In the space of a few years, Edinburgh produced Adam Smith, David Hume, Robert Burns, John Locke, James Watt, Michael Faraday, Sir Walter Scott, James Hutton, Joseph Black, even Philadelphia's Dr. Benjamin

Rush (who went to school at the University during the Enlightenment).

Smith gave us Capitalism, Hume the theoretical basis for nuclear physics, Burns vernacular (i.e. the common man's) poetry, Locke the theory of the Social Contract, Watt the steam engine, Faraday the dynamo, Scott a literature of heroism and character and the land, Hutton geology, Black Carbon Dioxide, and Dr. Rush helped to give us the Declaration Of Independence and The United States Constitution.

Why Edinburgh? It was a backwater capital of sheep and highlanders, where the Stuarts had just been defeated in their attempted return to rule. Yet, the modern world was born here. The paradigm under which we live was created here.

How did these Scots think, to create such structures of the mind and of life? David McCullough, in a keynote speech to the National Trust for Historic Preservation, 1991, commented on this phenomenon, and suggested an answer:

“Edinburgh, that wonderful Edinburgh described by Robert Louis Stevenson, gave forth to what was essentially an English-Scottish-Western Renaissance of its own in the Eighteenth and early Nineteenth Century. In medicine, philosophy - people like David Hume - the origins, the beginnings of the whole idea of an Encyclopedia Britannica, not to say Sir Walter Scott, Robert Louis Stevenson.

And why did it happen in that tiny, little, northern, bleak, town?

Why did it happen in a place smaller than New Haven Connecticut?

Well, we don't know. But one of the things we do know is that in Edinburgh in that day everybody saw everybody. There were clubs, societies, and associations. They met almost every night. Lawyers, doctors, engineers, poets, people of all professions and all persuasions, saw each other, talked, worked, imagined. Together. No walls, no barriers, no status order.

We must encourage that.”

Indeed we must, if we are to create the paradigm for the explorations of a New World, as did the Scottish Enlightenment or the Renaissance.

One club such as the one described by McCullough was the Oyster. Here, many of these men met, regardless of social station, to interact socially with each other and each other's ideas. Members included Joseph Black, Adam Smith, James Watt, David Hume, even Benjamin Franklin (when he was in town), and the father of Geology, James Hutton.

We need to learn again to share ideas as people in those places and times did. More than that, though, we need a model of thought that also has nuances appropriate to the coming millennium.

In the spirit of the Oyster Club, and 18th Century Scotland, we need a paradigm which allows for developments of interdisciplinary thought, encourages the interchange of such developments; or, as von Puttkamer indicates, one which emphasizes “...*that shifts the emphasis from individual subjects to the interactions and relationships between them.*”

It seems wise also to have this paradigm begin close to nature, as did the Scottish paradigm. Is

there a model for such a new way of thinking?

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George R. Stewart and Geo.S

George R. Stewart was a professor of English at the University of California, Berkeley for most of his life. He was also the author of books which are described as “regional” or “geographic” or as “works of Place”. Two of these books were best sellers and Book-Of-The-Month club selections.

But Stewart’s work was much more profound than “best-seller” status might imply. Over the years, his works have become simultaneously cult works, and works with profound influence on all humankind. For example, few people know Stewart’s name, but most people know that we name storms. George Stewart was the one who popularized that practice in his scientific novel *STORM*, written in 1941.

As Pulitzer Prize winning author Wallace Stegner writes, “(Stewart) was a much more important author than the general public knew.”

Stegner writes, “Of George Stewart’s twenty-eight books, I find that I have seventeen on my shelves à Three or four of them I read all the time, and refer to, and quote, and steal from, and couldn’t get along without.”

The Geo.S Paradigm:

A Model For Mars Education, and Other Thought in the Next Millennium

In his works, fiction and non-fiction, George R. Stewart presented a paradigm for the organization of knowledge - useful for both research and education - of great value for teachers and students seeking to find new and better ways to study and to think about things.

Equally as important, Stewart’s paradigm is applied in his works to “place”. It can be applied to any domain, physical or intellectual, but it is clearly presented by Stewart in such a way that it can be easily applied to learning about a place. As “Sheep Rock” is a place, Mars is a place.

What are the characteristics of this educational paradigm?

Like the thought of the Scottish Enlightenment, it is interdisciplinary. Stewart’s works always combine art with various sciences, social sciences, details of industrial or social organization, the human mind, heart, body, and soul.

But Stewart also always considers a world from two perspectives, of ground and space. Here is the key to the unique usefulness of Stewart’s paradigm, for the coming Millennium - its two perspectives on worlds. “It is fine and important to know a place from the perspective of all the disciplines and arts,” Stewart seems to say in his work. “How else would you know it?”

“But,” we might continue to paraphrase his thought, “you must also know it from the two perspectives of ground and space.” You must study Earth and other places from the two perspectives of the Astronaut or Cosmonaut, and the Ranger/Poet.”

Some key passages from Stewart’s work illustrate the paradigm:

TWO PERSPECTIVES

“The reader must for a moment imagine himself raised in space some hundreds of miles above a spot near the center of the state of Nevada. Far to his left, westward, the onlooker from the sky just catches the glint of the Pacific Ocean; far to his right, on the eastern horizon, high peaks of the Rockies forming the Continental Divide cut off his view. Between horizons lie thirteen degrees of longitude, a thousand miles from east to west. The only mark of civilization is a tenuous trace winding from east to west, a faint pair of lines, the California trail.”

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... and ...

“Probably the best way to feel the actuality of the story is to travel through its setting. For the country is tangible and solid, now as then. I have in the telling often stressed the scene until the reader has, I hope, come to feel the land itself as one of the chief characters of the tale.”

George R. Stewart

“Ordeal by Hunger”, 1936

INTERDISCIPLINARY THOUGHT

“I, George Stewart, did this work.

I have looked into the blue and green depths of the spring, and have climbed the rock, and gazed out across the desert. That first night, the grim fascination of the place rose within me and I thought of this book.

That time I was with Charlie. I was there again — with Jack, with Selar, with Carl and Parker and Starker, with Brig and Roy. I said to myself, ‘I shall know more about this place than anyone knows of any place in the world.’ So I took the others there, and one looked at the beaches and the hills, and another at the grass and the shrubs, and another at the stonework among the hummocks, and so it went, until at least each had shared with me what he knew. Besides, I read the books.

But if you ask me, ‘What is true, and what is not? Is there really such a place?’ I can only say, ‘It is all mingled! What does it matter? In the end, is what-is-seen any truer than what-is-imagined?’ Yet, if you should look hard enough, you might find a black rock and a spring—and of the other things too, more than you might suspect. ...

And he who will brave the desert and come after me to the spring, he may find my traces, where I wandered wondering, and thus wandering wondered, and he too may take to himself a little of me as I in my time took to myself a little of those who had been there before me.”

George R. Stewart

“Sheep Rock”, 1951

THE RELATIONSHIPS BETWEEN DISCIPLINES

In his Paradigm, Stewart realized a truth about knowledge that other great minds have also realized. (John Muir wrote, “Whenever you try to pick out anything by itself you realize it is hitched to everything else in the universe.”)

Stewart knew that artificial divisions of space or time or the human heart help us to organize the world. But he also knew these artificial divisions could keep us from seeing its truth. He knew also that what was true of space was equally true of knowledge. Divide knowledge, and lose truth:

“...Certainly, every place is only a part of long continuous space, and every place therefore leads the way into every other. Like so much else in the world, then a place turns out to be nothing more than an abstraction fathered by the human mind, setting up artificial barriers, pretending that something ends at a hard and fast line, and that it is not in actuality running on continuously into something else...”

George R. Stewart
“Sheep Rock”

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So Stewart’s work truly reflects the interdisciplinary nature of the Edinburgh paradigm. As the first quotation from “Sheep Rock” shows, he did work in small collegial groups to learn about places.

In addition, Stewart’s work has that emphasis on seeking the meeting place of disciplines that von Puttkamer supports.

So it would seem that the body of Stewart’s work may give us the foundation for the way of thinking, learning and educating necessary for the tasks of the next millennium. Tasks like the exploration of Mars.

THUS, GEO.S

Geo.S is the abbreviation for Stewart’s name. And Geos is Greek for Earth, which symbolizes his concern with planetary place. So call his paradigm of thought the Geo.S Paradigm, if you will.

Does Geo.S Apply to Space Exploration? I would only note in passing that Konstantin Tsiolkovsky: grew up as the son of a Forest Ranger; learned from libraries; began by producing works of art - science fiction; and from these Geo.S type foundations, developed the basis for the astronautics which will someday carry us to Mars.

IN CONCLUSION. FROM GEO.S TO MARS

Time to return from the high mountains of the mind, and end our chatauqua. And to summarize:

To teachers of the Mars Generation, of the Mars Kids, NASA offers an extensive toolkit for the nuts-and bolts of teaching about Mars Exploration. From personal educational programs in schools, to interactive Internet projects, to Mars Experiment Design competitions for students, to workshops on NASA Centers - and all the rest - there are resources.

To those same teachers, George R. Stewart offers his paradigm. To help them help their students to understand the world and other worlds in new ways.

Nuts-and-bolts toolkits and a new way of thinking, together, will move the Mars Kids onto the surfaces of other worlds, and into a millennium which promises to be the most exciting in the history of humankind.

Our exploration of Mars will be the start of a successful Millennium of journeying throughout the cosmos. And the continuation of a great human adventure, in which we have seen the best of ourselves:

“... Our vessels consisted of six small canoes and two large pirogues. This little fleet, although not quite so respectable as that of Columbus or Captain Cook, was still viewed by us with as much pleasure as those deservedly famed adventurers ever beheld theirs, and, I daresay, with quite as much anxiety for their safety and preservation. We were now about to penetrate a country at least two thousand miles in width, on which the foot of civilized man had never trod. The good or evil it had in store for us was for experiment yet to determine, and these little vessels contained every article by which we were to expect to subsist or defend ourselves. However, as the state of mind in which we are, generally gives the coloring to events, when the imagination is suffered to wander into futurity, the picture which now presented itself to me was a most pleasing one. . . .”

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**Captain Meriwether Lewis, “The Journals
(Setting out from the Mandan Villages
Toward Terra Incognita)”**

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