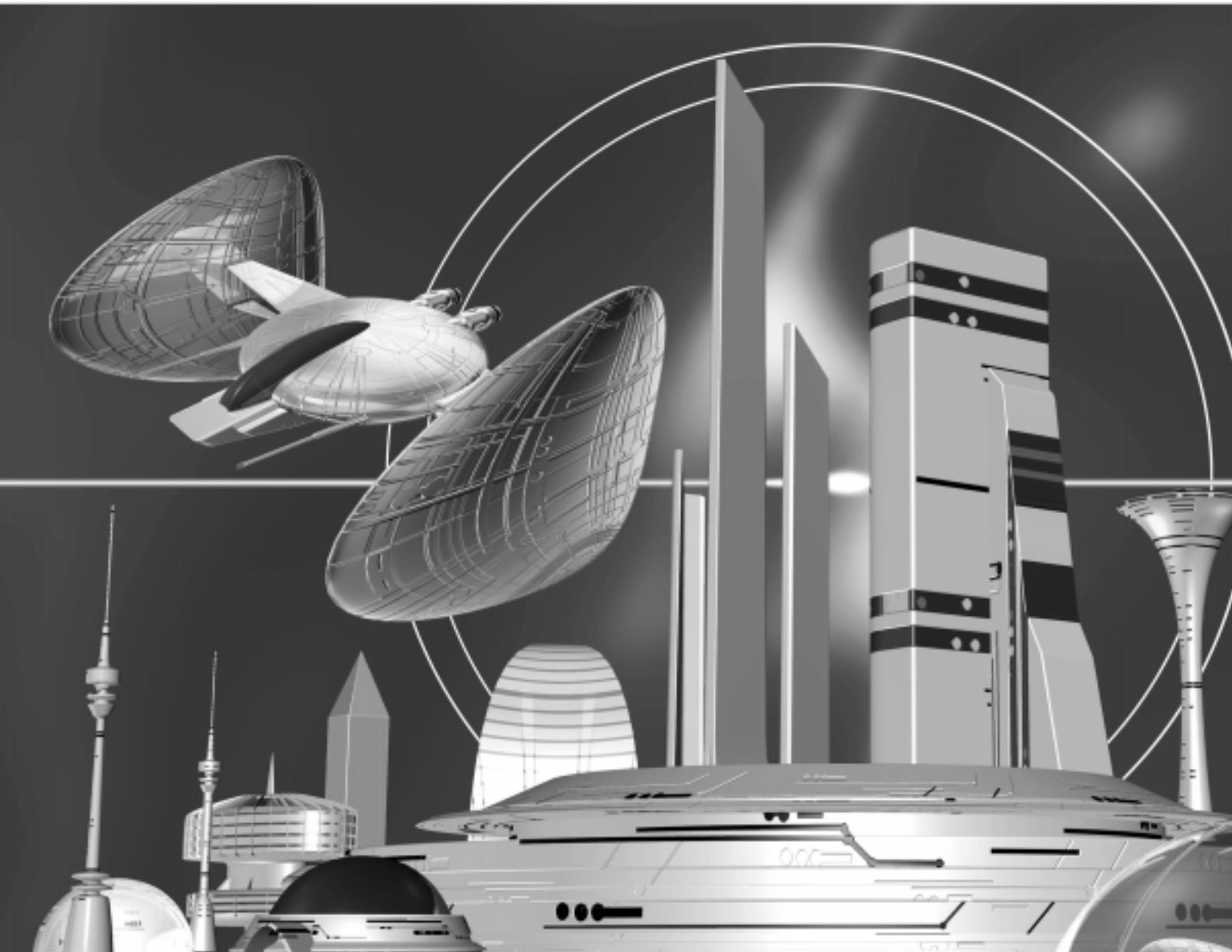


# *Learn from the Past, Invent the Future*



**Subject:** Space science, language arts, environmental sciences

**Grade Level:** 5–12 (Ages 10–18)

**Technology:** Internet/Web

**Online Supplement:** attached

*How do you predict a future from a past that hasn't happened yet? Albrecht and Davis show students how to review the past to reveal the future.*

*By Bob Albrecht and Paul Davis*

The Mars Millennium Project ([www.mars2030.net](http://www.mars2030.net)) challenges students across the nation to design communities on Mars for the year 2030. In our decades of teaching and mentoring, we haven't seen another nationwide project with such great potential to nurture holistic learning and teaching. In our first *Starship Gaia* column (September 1999), we encouraged you to participate in this project, suggested ways to begin, and pointed to resources. What? You haven't begun? No problem. Here are some ways we can help you and your students design a community on Mars:

- We'll share information and ideas in this column as we participate in the Mars Millennium Project.
- We'll share lots more information and ideas in the *Starship Gaia* e-mail newsletter. To "subscribe," send your request to [DragonFun@aol.com](mailto:DragonFun@aol.com). Tell us in the body of the message, "Please send *Starship Gaia* e-mail newsletter."
- We'll create instructional stuff in the Office 97 versions of Microsoft Word and Excel and offer it as our contributions to the *gift economy* (<http://hubcap.clemson.edu/~sparks/giftecon.html>) described by Kim Stanley Robinson in his *Mars Trilogy*. It's A-OK with us if you edit these files, improve them, or make them fit your style.

You and your students can communicate, cooperate, and collaborate with others on the Internet to design a community. You and your students can be part of a virtual world of communities on Mars.

### **History and Future History**

Here you are on Earth today designing a community on Mars for the year 2030. What happened before 2030? How can you design a community for the year 2030 without knowing the history of Mars exploration up to that year? What is the historical context in which you will design your community?

**History.** What is the history of Mars in art, astronomy, literature, music, mythology, et cetera, et cetera? What do we know about Mars? What exploratory missions have we sent to Mars? What did we learn from them? What missions are on the way to Mars as you read this?

Two of our favorite books provide answers to these questions. We enthusiastically recommend Eric Burgess's *Return to the Red Planet* and William Sheehan's *The Planet Mars: A History of Observation and Discovery*. Serendipity! You can read Sheehan's book online ([www.uapress.arizona.edu/online.bks/mars/contents.htm](http://www.uapress.arizona.edu/online.bks/mars/contents.htm)).

**Future History.** Here's your chance to write science fiction. Missions to Mars are on their way. If they are successful, what will we learn from them? What missions to Mars are planned in the next year or two or more? What will we learn from them? Will people land on and explore Mars? When? What sites on Mars will be selected as the best places for communities? What habitats, equipment, robotic factories, and other resources will already be on the surface of Mars before the year 2030—the year your community begins? What resources will already be available at your

landing site—the place where you will build your community? What resources will be in orbit around Mars, available via orbit to surface shuttle vehicles? What resources will arrive from Earth in the years following the beginning of your community in 2030? How frequently can ships be launched from Earth to Mars? How long does it take a ship to go from Earth to Mars?

We suggest: Before you design your Mars community, write the history of Mars exploration up to the year 2030 and make it the foundation of your design. On the Internet, collaborate with other design teams. Play together, learn together.

The Internet abounds in resources to help you write your future history. Go to NASA's Web site that describes past and future missions to Mars (<http://cmex.arc.nasa.gov/MarsNews/Missions/Missions.html>). Here you'll find links to

1. Early Missions
2. Past Missions
3. Present and Future Missions
4. Planet-B
5. 96 Pathfinder
6. 96 Mars Global Surveyor
7. 98 Mission
8. 2001 Mission
9. 2003 Mission
10. 2005 Mars Sample Return Workshop
11. 2009/2011 Human

Robert Zubrin's book *The Case for Mars* (1997) is an awesome resource. Chapter 1, "Mars Direct," describes a sequence of missions that culminates in

the establishment of a permanent base in 2018. It goes like this:

- **August 2005.** A robotic mission sends an Earth Return Vehicle (ERV) to Mars. The ERV contains a life-support system, food, and other necessities to return a crew of four to Earth. On landing, this mission deploys a nuclear power source, an automatic factory that manufactures rocket fuel ingredients from the Martian atmosphere, and assorted rovers that will explore Mars and send information back to Earth.
- **October 2007.** A mission is launched from Earth. It contains a crew of four and a *hab* (habitat) in which the human crew will live on Mars for 18 months. A few weeks earlier, a second robotic cargo ship left Earth for Mars to prepare for a second human mission to be launched December 2009 or thereabouts.
- **April 2008.** The first humans arrive on Mars. They live in the hab they brought with them and explore Mars for 18 months.
- **September 2009.** The Mars explorers climb aboard the ERV that was sent in 2005 and return to Earth. The trip home takes six months.
- **May 2018.** Several crews have gone to Mars, stayed there for 18 months, and returned to Earth. They have thoroughly explored Mars, and a site for the first permanent base has been selected. Habitats and other resources are waiting at the base. The crew that will occupy the base is launched. They will stay on Mars for many years. About this base, Zubrin

says, "Ideally this will be situated above a geothermally heated subsurface reservoir, which will afford the base a copious supply of hot water and electric power."

The Mars Direct plan sends a ship with people aboard about every 26 months. Why? Because every 26 months a *launch window* opens in which Earth and Mars are in the best relative locations in their orbits for an energy-conserving trip. This happens because the *synodic period* of Mars is 780 days, about 26 months. If the sun, Earth, and Mars are lined up in a certain way today, they will be lined up in the same way 780 days from now. For example, at *opposition*, Earth and Mars are on the same side of the sun with Mars and the sun in opposite directions from Earth. You can draw a straight line connecting the sun, Earth, and Mars. For reasons too technical to describe here, the time between oppositions varies from 764 days (give or take a few hours) to 810 days. There's a handy table of oppositions of Mars from 1901 to 2035 at [www.uapress.arizona.edu/online.bks/mars/appends.htm#1](http://www.uapress.arizona.edu/online.bks/mars/appends.htm#1).

We doubt that people will go to Mars as early as 2007 or 2009 as Mars Direct and NASA's 2009/2011 Human Mission suggest. We suggest that in your future history, you move these missions to later times. If you do so, remember that there are approximately 780 days between launch windows. Schedule your missions a multiple of 780 days later than those shown above, and then invent additional missions to prepare the way for your Mars community.

But what about Earth? What will happen on Earth between now and 2030? What will happen where you live now between today and 2030? How will the future history of Earth affect the future history of Mars and vice versa? For ideas on how to write a future history of both Earth and Mars, read Kim Stanley Robinson's novel *Red Mars*.

## A Word About Search Engines

While writing this article, we spent lots of time looking for information on the Internet. Along the way, we read a magazine article about search engines that suggested visiting Search Engine Watch: News, Tips and More about Search Engines ([www.searchenginewatch.com](http://www.searchenginewatch.com)). We checked it out, and we're glad we did. We found descriptions of the major search engines, reviews, and tutorials. We especially recommend a visit to Search Engine Reviews Chart ([www.searchenginewatch.com/reports/reviewchart.html](http://www.searchenginewatch.com/reports/reviewchart.html)).

As your community survives and thrives, it will be populated by the first “Martians,” the first humans born on Mars. What will they be like? What will you tell them about Earth? What will you tell them about your farm, home-town, city, or wherever you live today?

### Go to Mars on the Good Ship Internet

Go to Mars virtually on NASA's Manned Mars Reference Mission. NASA commissioned Bob Sauls, lead designer at John Frassanito & Associates, to create an animated simulation of this mission. You can view images from this animation at Visual Voyage to Mars ([www.vidi.com/experts/bobspage/marstrip.html](http://www.vidi.com/experts/bobspage/marstrip.html)). Here you'll see images depicting the takeoff, Earth orbit operations, sightseeing in space, approaching Mars, Mars landing, setting up base camp, leaving Mars, and returning to Earth.

After your visual trip to Mars, read about the Manned Mars Reference Mission ([http://cmex.arc.nasa.gov/MarsNews/Missions/human\\_missions/links/Human\\_Mars\\_Mission3.html](http://cmex.arc.nasa.gov/MarsNews/Missions/human_missions/links/Human_Mars_Mission3.html)). This site is a cornucopia of things you might include in your future history of Mars exploration. For example, three crews will land on and explore Mars from 2009 to 2017. Each crew will travel to and from Mars in 4 to 6 months and will spend 18 to 20 months on the surface.

The first three launches will not involve a crew but will send infrastructure elements to low Mars orbit and to the surface for later use. In other words, cargo ships will orbit or land on Mars with lots of goodies, including habitats, electrical power systems, robotic factories to produce fuel and life-support consumables, and assorted surface vehicles.

This takes you to the year 2017. Crank up your word processor, get creative, and extend this possible future history to the year 2030. Use

it as a starting place for your community design. We like the idea of using the *habs* (habitats) described in the Mars Reference Mission as “construction shacks” that you can live in while constructing more comfortable dwellings. You can invent more missions that deliver habs and other resources to the landing site where you have chosen to build your community.

### Living on Mars

On Earth, the air you breathe is about the same indoors and outdoors, 78% nitrogen and 21% oxygen at a sea-level pressure of 1013 *millibars* (1 *atmosphere*). The average outdoor temperature is a comfortable 15 °C (59 °F) and Earth's temperature range is about –60 °C (–76 °F) to +60 °C (140 °F). In July, it's really hot in Death Valley, California, and very cold in Antarctica. However, by wearing appropriate clothing, you can survive outdoors almost anywhere on Earth.

Not so on Mars. The atmospheric pressure on Mars is about 7 millibars, less than 1% of Earth's, and it is 95% carbon dioxide. The average temperature on Mars is –63 °C (–81.4 °F) and the temperature range is –128 °C (–198 °F) to +27 °C (+81 °F). To go for a walk on Mars, you'll wear a Mars walkabout suit that is much like a spacesuit. It will provide air, water, and snacks, and maintain a comfortable temperature as you explore Mars on foot. On longer excursions, you'll go to interesting places in a surface vehicle that provides life support, then don your walkabout suit for adventures outside your rover.

On Mars in 2030, you'll spend most of your time indoors in habitats that provide the necessities and some of the amenities of life. You'll build bigger and better habitats. If all goes well, your community will grow and prosper. For lots of information about Mars, living on Mars, and related information, browse the Internet sites in Table 1.

*Continued on page 41.*

Table 1. Mars-Related Web Sites

Mars	<a href="http://www.seds.org/nineplanets/nineplanets/mars.html">www.seds.org/nineplanets/nineplanets/mars.html</a>
Mars Fact Sheet	<a href="http://nssdc.gsfc.nasa.gov/planetary/factsheet/marsfact.html">http://nssdc.gsfc.nasa.gov/planetary/factsheet/marsfact.html</a>
Earth and Mars: A Comparison	<a href="http://cmex-www.arc.nasa.gov/VOViews/EARTMARS.HTM">http://cmex-www.arc.nasa.gov/VOViews/EARTMARS.HTM</a>
Exploring Mars	<a href="http://www.exploringmars.org/index.html">www.exploringmars.org/index.html</a>
Designing for Human Presence in Space	<a href="http://augusta.msfc.nasa.gov/ed61/papers/rp1324/rp1324.html">http://augusta.msfc.nasa.gov/ed61/papers/rp1324/rp1324.html</a>
Homesteading the Planets	<a href="http://science.nasa.gov/newhome/headlines/msad28apr98_1a.htm">http://science.nasa.gov/newhome/headlines/msad28apr98_1a.htm</a>
Bringing Mars into the Iron Age	<a href="http://science.nasa.gov/newhome/headlines/msad03mar99_1.htm">http://science.nasa.gov/newhome/headlines/msad03mar99_1.htm</a>
Imagineering on Mars (Imagineering On-Line magazine)	<a href="http://www.djandassoc.com/e-zine/mars.html">www.djandassoc.com/e-zine/mars.html</a>
Life Support	<a href="http://www.reston.com/astro/support.html">www.reston.com/astro/support.html</a>
HSF—International Space Station	<a href="http://spaceflight.nasa.gov/station/assembly/elements/transhab/">http://spaceflight.nasa.gov/station/assembly/elements/transhab/</a>
Nutrient Data Laboratory Food Composition Data	<a href="http://www.nal.usda.gov/fnic/foodcomp">www.nal.usda.gov/fnic/foodcomp</a>
Cornell News: Space Colony Menus	<a href="http://www.news.cornell.edu/releases/Jan98/nasa.food.ssl.html">www.news.cornell.edu/releases/Jan98/nasa.food.ssl.html</a>
Integration of Plant Growth into a Mars Habitat	<a href="http://www-sn.jsc.nasa.gov/explore/Data/Lib/DOCS/EIC016.HTML">www-sn.jsc.nasa.gov/explore/Data/Lib/DOCS/EIC016.HTML</a>
Future Garden—NASA's Gardens	<a href="http://futuregarden.com/about/nasa.htm">http://futuregarden.com/about/nasa.htm</a>
KSC-Breadboard—Biomass Production Chamber	<a href="http://atlas.ksc.nasa.gov/celss/BPC/BPC.HTM">http://atlas.ksc.nasa.gov/celss/BPC/BPC.HTM</a>
Crop Requirements and Mission Plan	<a href="http://www.freespeech.org/jalhor/mars/crop.htm">www.freespeech.org/jalhor/mars/crop.htm</a>
Greenhouse Layout and Structure	<a href="http://www.freespeech.org/jalhor/mars/Structure.htm">www.freespeech.org/jalhor/mars/Structure.htm</a>
Solar Energy on Mars	<a href="http://powerweb.grc.nasa.gov/pvsee/programs/SolarMars.html">http://powerweb.grc.nasa.gov/pvsee/programs/SolarMars.html</a>

## Alphabet Soup

In your quest for information about Mars, space, community building, and related topics, you'll find lots of acronyms, spacey jargon, and other alphabet soup. Table 2 offers a tiny taste of such stuff—a few tidbits in an ocean of alphabet soup—but for greater reading pleasure, you can also try some of the search engines listed in the Search Engine Review Chart ([www.searchenginewatch.com/reports/reviewchart.html](http://www.searchenginewatch.com/reports/reviewchart.html)) with search keys such as the following:

+Mars +CELSS  
+Mars +ECLSS  
+Mars +CO2 +H2O  
+Mars +TransHab

For a long list of acronyms used in NASA documents, go to Designing for Human Presence in Space—Acronyms (<http://augusta.msfc.nasa.gov/ed61/papers/rp1324/acronyms.html>). To look up the meaning of most any acronym or abbreviation, go to Acronym Finder: Look up 96,000+ acronyms or abbreviations and their meanings ([www.acronymfinder.com](http://www.acronymfinder.com)). If you'd like to spend many happy hours reading acronyms, crank up your favorite search engine and use the search key +acronym +list. You'll find many links to lists of acronyms.

Table 2. Alphabet Soup

ACS	Atmosphere Control and Supply
ARS	Atmosphere Revitalization System
CELSS	Controlled Ecological Life Support System
CH4	Methane (CH <sub>4</sub> )
CO	Carbon monoxide
CO2	Carbon dioxide (CO <sub>2</sub> )
ECLSS	Environmental Control and Life Support System
H2O	Water (H <sub>2</sub> O)
HAB	Habitation module
In situ	on site (Latin)
IR	Infrared radiation
ISS	International Space Station
LEO	Low Earth Orbit
LiOH	Lithium hydroxide
LMO	Low Mars Orbit
N2	Nitrogen molecule (N <sub>2</sub> )
N2H2	Hydrazine (N <sub>2</sub> H <sub>2</sub> )
PLSS	Portable Life Support System
ppm	parts per million
TransHab	An inflatable habitat
UV	Ultraviolet radiation

As you cruise the Internet looking for information, you'll encounter lots of alphabet soup, acronyms, and space exploration jargon. Table 2 lists a few tasty tidbits of alphabet soup.

We hope you find what you're looking for ASAP. Good luck and best wishes to your Mars community. We'll look for it on the Internet.

## References

Burgess, E. (1990). *Return to the red planet*. New York: Columbia University Press.

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