

Chapter Twenty-six

Networking with NASA

Judith A. Walker

When people think of the National Aeronautics and Space Administration (NASA), most conjure up visions of men bouncing around on the moon or perhaps a little robot rover encountering a large rock on Mars. NASA is “out there” where no one has gone before, right? Then why would a teacher in Minot, North Dakota, be interested in connecting to NASA? He or she has lots of other skills to teach kids such as reading, writing, and math. Why would NASA be interested in connecting to the teacher and students who live out on the wide-open prairie?

In an address to the U.S. House of Representatives Committee on Science on April 28, 1999, NASA administrator Daniel S. Goldin stated the connection very succinctly by saying:

NASA’s success depends on the educational system to produce the highly skilled and knowledgeable workforce that is necessary to perform this cutting-edge work. Likewise, the nation’s educational system looks to NASA for inspiration and to exemplify doing things that once were only imaginable—feats that motivate and encourage our students to study science, mathematics, technology, and engineering.

In fact, Mr. Goldin believes it is part of NASA's mission to use "its unique resources to support educational excellence for all." He also believes that NASA's role is to communicate the results of research so that the average American can understand that what NASA does is an investment in our future, and he also expects these results to be communicated in plain English.

This has not always been done very well in the past. As coordinator of the North Carolina NASA Educator Resource Center for almost fifteen years, I have seen a dramatic change in attitude toward K-12 education and the quality of educational materials produced by NASA for the classroom.¹ I became involved with NASA's educational outreach several years before Mr. Goldin took over the reins of NASA. At that time, educational outreach, which includes both formal (K-12, community college, undergraduate, graduate, and postdoctoral) and informal (general public) education, was rather haphazard. Those who enjoyed working with students and teachers did so; others felt they were too busy.

When Mr. Goldin suggested that each scientist spend approximately one hour per week with young students, sharing with them the excitement of discovery, to say the least, the scientists were a little uneasy with this concept. But they took up the challenge, and now NASA is the leader among government agencies in educational outreach.

The biggest reason NASA has been so successful in its educational outreach has been its ability to harness the educational potential of technology. Although NASA uses a variety of instructional technology (television, CD-ROMS, etc.), its presence on the World Wide Web is outstanding, creative, and accessible to anyone who wishes to avail themselves of the sites. Today, information technology allows NASA to share its discoveries almost instantly with students. It also allows students and teachers to participate in meaningful scientific activities from anywhere in the country. Students and teachers in Monument Valley, Utah, for example, can benefit from NASA Ames Research Center's programs as readily as those who live in Silicon Valley, California, where the center is located.

This chapter endeavors to introduce the reader to NASA's educational outreach philosophy as it pertains to his or her presence on the Web and to suggest ways that NASA's sites can be used in the classroom. It is necessary to provide a little background about the organization and structure of NASA. This massive agency is involved in many more activities than the general public knows. NASA is much more than space shuttles and probes to Mars. These just happen to be the activities that get the most media attention. The sites mentioned in the chapter (in *italic type*) are listed by chapter section at the end of the work.

Conceptually, NASA is composed of five divisions (or, as NASA likes to refer to them, enterprises). Aerospace Technology, Human Exploration and Development of

Space (HEDS), and Space Science seem logical. NASA's predecessor, NACA (the National Advisory Committee for Aeronautics), was originally created to oversee research in the field of aeronautics. Today, the Aerospace Technology Enterprise is still committed to creating a safe, environmentally friendly expansion of the aviation industry. It is heavily involved in airplane and rocket design. In many ways, that is still the mainstay of its work.

Since that fateful day in October 1957 when the Soviet Union launched Sputnik, NASA has been at the forefront of human exploration and development of space. The HEDS mission is to "open the Space frontier by exploring, using and enabling the development of Space and to expand the human experience into the far reaches of Space." Hand-in-hand with human exploration of space, the Space Science Enterprise concentrates on astronomy-based projects related to exploring the solar system and the sun and its interaction with earth and deep space. Based at the Jet Propulsion Laboratory, it is this enterprise that put the Rover on Mars.

The other two enterprises seem a little out of place but are not so. The Biological and Physical Research (BPR) Enterprise focuses on research into two fundamental questions basic to the future:

- How can human existence expand beyond the home planet to achieve maximum benefits from space?
- How do fundamental laws of nature shape the evolution of life?

This mission sounds somewhat vague and philosophical, but some very practical achievements in the area of medicine and technology have been a direct consequence of this enterprise's research.

The Earth Science Enterprise sounds as though it should be part of the U.S. Geological Survey. This enterprise puts NASA's satellite expertise to work on trying to discover patterns in climate that will allow us to predict and respond to environmental events (such as floods from El Niño and severe winters) well in advance of their occurrence. Its work is conducted in conjunction with several other government agencies such as the National Oceanic and Atmospheric Administration.

Knowing the basic structure of NASA helps in understanding the organization of its Web sites. Because it is the responsibility of each enterprise to "embed" education into its program, just about every NASA Web site has an "education" component. Keep in mind that NASA's concept of education spans the entire formal system (K through postdoctoral) and the informal education of the general public. Also keep in mind that some of the subject matter NASA deals with is really beyond most K-12 students and teachers. So even though a site has an education component, it may not be geared to K-12 students.

Resources geared for K-12 students and/or teachers are usually clearly labeled and easy to access. Currently, the NASA site is being reorganized into one site. Some

of the information in this chapter may well be placed elsewhere when the reader attempts to access the site.²

Commitment to Education Excellence

To help the different enterprises develop high-quality educational resources, including electronic-based materials, NASA has developed basic principles to guide the educational outreach programs. First and foremost is its commitment to the customer. Students and educators are both the beginning and ending point for all NASA education activities. It is the education agenda that serves as the starting point in defining an educational project or activity. NASA collaborates with experienced teachers to target areas within the science, mathematics, and/or technology curriculum that could benefit and/or be enhanced by NASA's expertise. These teachers help NASA translate the wealth of information and knowledge produced by NASA projects into practical, effective instructional strategies that can be used in the classroom. NASA takes very seriously suggestions and comments made by teachers. Every project, program, and/or resource has an evaluation component. These evaluations are used to create new products and improve existing ones.

Collaboration is another key element of NASA's educational outreach success, especially at the K–12 level. NASA looks to others to establish the education agenda and then seeks to align its educational outreach program to support that agenda. At the national level, NASA works closely with organizations such as the National Research Council (NRC), National Science Teachers Association (NSTA), National Council of Teachers of Mathematics (NCTM), American Association for the Advancement of Sciences (AAAS), International Technology Education Association (ITEA), and the Geography Education National Implementation Project. At the state level, NASA looks to the state departments of education for guidance in meeting their curricular needs. NASA's concept of collaboration is to get everyone involved.

There are times when it seems as if the *S* in NASA really stands for "standards" when referring to educational resources. NASA has played an active role with the Department of Education and the professional organizations already mentioned in developing standards in the areas of science, mathematics, geography, and technology. It utilizes the principles of standards-based, systemic education to guide the execution of its activities. Every educational resource NASA produces, whether in print or electronically, includes a listing of standards covered by the resource. Currently, NASA is working with each state department of education to correlate its products with the state's standards or competency goals. Again, Daniel Goldin has summarized NASA's commitment to standards by stating:

At the K–12 levels, content (knowledge) derived from the NASA Strategic Enterprises is tailored to meet customer needs and is guided by curriculum standards for

science, mathematics, technology, and geography at the national, state, and local levels.

NASA Involvement

Another guiding principle for NASA is involvement. NASA strives to involve students and educators as both participants and partners. Although NASA Web sites contain a wealth of information, the most successful (and popular) are those that encourage student participation such as *For Kids Only*, *Solar System Simulator*, and *Exploring the Environment*. NASA wants to find meaningful ways to involve students and teachers in real, ongoing research programs in which they can roll up their sleeves and practice science in order to learn about science, mathematics, and technology. The Web is the perfect vehicle to connect students, teachers, and scientists.

As mentioned earlier, NASA is also committed to evaluation and has a rigorous qualitative and quantitative evaluation program. Resources, including Web sites, undergo a thorough evaluation by educators before they are even released. Students and teachers are asked to evaluate programs and resources. Older materials are updated on a regular basis.

NASA: Accessibility and Privacy

Providing resources via the Web has presented two additional problems: NASA has not had to deal much with in the past with either privacy or accessibility. Section 508 of the Workforce Investment Act of 1998 states that federal agencies' electronic and information technology is to be as accessible to people with disabilities as to people without disabilities, whether they are employees or members of the public. Once again, NASA has been a leader in providing access to those with disabilities by not only creating accessible Web sites, but also by developing the "U.S. Government Website Accessibility Guidelines" for all government agencies. For a list of some of NASA's most accessible Web sites, check out NASA's Top Twenty Web Sites.

Privacy on the Web has become a critical issue for educators. To address the problem, every NASA Web site has a link to NASA's official Web Privacy Statement. And just to emphasize its commitment to accessibility, NASA includes on this page the following: "If you have any difficulty viewing any page with adaptive technology, click here to let us know."

On Web sites designed specifically for children, NASA also includes a link to the NASA KIDS Web Site Privacy & Accessibility Statement.

NASA and the Educational Technology Program

Finally, as mentioned earlier, technology has been the key to NASA's success. NASA

is committed to harnessing the educational potential of current and future technologies. To do so, it has developed an Educational Technology Program that:

- produces technology-based teaching tools and strategies that are grounded in or derived from the NASA mission;
- uses emerging technologies for, and applies existing technologies to, educational programs;
- utilizes technology to facilitate communication within the educational community;
- involves educators in NASA missions through innovative uses of technologies;
- conducts research into new teaching and learning practices that are made possible through NASA mission-derived technology. NASA then infuses its educational technology program and products into student, teacher, and curriculum support activities. These technology projects make up the backbone of NASA's Web presence, which is examined below in more detail.

What Is Out There?

It is difficult to ascertain how many Web sites are associated with NASA. One reason is that there are several different types of NASA sites. Some sites have been created and maintained directly by NASA and its respective divisions and research centers such as the NASA Headquarters, Kennedy Space Center's page, or the Space Science Enterprise and Spacelink maintained by Marshall Space Flight Center. Most of these sites include *nasa.gov* as part of their address. Other sites have been created as a result of a specific joint venture or program such as the *Volcano World*, *Windows on the Universe*, and *Tennis Sports Science*. These sites are all a result of NASA's Learning Technologies Project, which is discussed in more detail shortly. Each has the NASA logo on its opening page.

Still other pages use NASA information but have repackaged it, such as *Amazing Space*, which is connected to the Space Telescope Science Institute and *Space.com*, which is totally unrelated to NASA. For the purpose of this chapter, only those sites directly related to or sponsored by NASA are discussed (those that have *nasa.gov* in their address and/or the NASA logo on the opening page).

NASA Sites and the Classroom

As with the Web in general, NASA Web sites can be used in many different ways in the classroom. First and foremost, the NASA Web sites are repositories of information. Students and teachers alike can conduct research on a variety of topics. All of NASA's Web sites have a search component. In fact, most of them use the Spacelink search engine, which searches across all the NASA sites. If you want to limit yourself

to high-quality, reliable Web sites on your topic, it is advisable to use Spacelink over general search engines such as Google and Yahoo.

Although every NASA Web page includes content on its specific subject, it is a little more difficult to find historical information about NASA in general and its programs. The NASA History Office Web page is probably the best place to go for this information. Here it is possible to search through NASA's reference documentation on major aeronautics and astronautics programs, in addition to information about key NASA and NACA (1915–1958) officials, policy documents, statistics, a time line of air and space achievements, and current events in NASA history. Current issues are discussed in *NASA History News & Notes* and related NASA publications.

Another good place to start research is with the NASA Fact Sheets Web site. Fact sheets are four- to eight-page briefs on a particular topic. They are written for middle school students and above; some can be very technical. Each NASA center creates and updates fact sheets covering its mission, facilities, and projects. This page links to a specific research center's fact sheets page. If you are not sure which research center might have the information you want, you can go to Spacelink's advance search and search terms such as "wind tunnels" [must have] and "fact sheets" [must have in title].

The second most popular use of the Internet by educators is to locate lesson plans and get ideas for teaching a particular topic. As mentioned earlier, most NASA Web sites have a section for educators. The NASA's Observatorium Teacher's Guides have a wide variety of lesson plans ranging from the Sun to El Niño to 'Seasons and "How Planes Fly." Other good parts of the site for material on airplanes and flying are *Aeronautics Related Activities, Experiments and Lesson Plans. The For Kids Only Teacher Guides* is from the Earth Science Enterprise, which deals primarily with earth science topics.

The quintessential site for finding lesson plans and teacher guides created by NASA is Spacelink. Although you will find a list of the major teacher guides distributed by NASA under "Instructional Materials," using Spacelink's search engine will provide a wealth of guides. Searches on several topics using the advanced search yielded the following results:

- planets teacher guides (949);
- atmosphere teacher guides (722);
- weather teacher guides (563);
- oceans teacher guides (427);
- mathematics teacher guides (600);
- geography teacher guides (235);
- nutrition teacher guides (52).

Note that some of these topics are not space topics but, rather, are areas of concern and research within NASA.

To take full advantage of the education potential of the Web, teachers should participate in interactive, electronic projects. NASA excels in this area. One of the articles in Spacelink's Educator Focus explains how to participate in NASA Interactive Internet Projects. These projects include activities such as remotely controlling a telescope over the Internet (*Telescopes in Education*); taking a workshop from home or school; Web casting and/or Web conferencing with a NASA expert (*Ask the Space Scientist*); or tracking the international space station in real time. The Web page lists a few benefits for participating in such projects. Students can receive information from primary sources—the scientists themselves. Communicating with NASA scientists helps students learn the language of science and mathematics. It also is a great opportunity for students to explore careers and work with students from around the world. The biggest benefit of all is allowing students to participate in real-world events without leaving the classroom.

Although most of NASA's Web sites include some type of interactive elements, there is one site that specializes in these activities—NASA Quest. This site is dedicated to bringing NASA people, space, and science into the classroom through the Internet. NASA Quest includes a full suite of online resources: profiles of NASA experts and stories about their workdays; several live interactions with NASA experts each month; audiovideo programs over the Internet; lesson plans and student activities; collaborative activities in which students work with one another; background information and photo sections; a place where teachers can meet one another; a searchable Q & A area with more than 3,000 previously asked questions; and an e-mail service in which individual questions are answered. These programs are free to anyone, anywhere. Events include several Web casts to kick off the Centennial of Flight Celebration. One Web cast in particular allowed students to talk with Orville and Wilbur Wright! To find out what events are coming up, check the calendar.

Several other interesting interactive sites are:

- The Virtual Interactive Classroom (VIC) at the Glenn Research Center allows Internet users, specifically students, to remotely control and access data from scientific experiments.

- Interactive Atmosphere Simulator is an interactive program in which students can investigate changes in the atmosphere. It uses mathematical models of the standard atmosphere of the earth and Mars. Students can find the equations for the standard earth atmosphere at other Web sites in both English units and metric units. Similar information is available on the Martian atmosphere.

- The Telescopes in Space (TIE) program brings the opportunity to use a remotely controlled telescope and charge-coupled device (CCD) camera in a real-time, hands-on, interactive environment to students around the world. TIE enables students to increase their knowledge of astronomy, astrophysics, and mathematics; improve their computer literacy; and strengthen their critical thinking skills.

NASA CONNECT and the NASA “Why?” Files

Two of NASA’s most recent educational outreach projects have combined the Web with a somewhat older, but certainly underutilized, instructional technology—television. NASA CONNECT and the NASA “Why?” Files are educational programs delivered via television and the Internet, and are easily integrated into local, regional, and statewide instructional technology initiatives. Each program is accompanied by a lesson guide, a classroom activity, and a Web-based component and uses NASA projects, facilities, and researchers to integrate and enhance the teaching of mathematics, science, geography, and technology. The Web component complements and extends the lesson; establishes a connection between the home and the classroom; and allows homebound and children schooled at home access to resources and programs.

NASA CONNECT has been developed for grades 5–8 and The NASA “Why?” Files are for grades 3–5. These programs air on PBS, can be down-linked from NASA’s TV satellite, and are available from any NASA ERC- or can be purchased from NASA CORE. It should be noted at this point that NASA’s interactive programs are free and open to the public. Participants may be asked to register for a password, but the program is still free. NASA does this for a couple of reasons, but its primary reason to keep track of where participants are from and how many students/teachers are involved. These statistics then are used to encourage the U.S. Congress to continue funding these worthwhile programs. Representatives and senators like to know who in their district is taking advantage of these programs.

Only a brief smattering of NASA sites is on the Internet. However, there are several NASA Web sites every educator should become intimately familiar with if he or she really wants to know what resources are available and how to integrate them into the curriculum.

Premiere Sites: Spacelink

In the mid-1980s, long before the world was racing down the Information Highway lost in cyberspace, a group of men and women at NASA’s Marshall Space Flight Center in Huntsville, Alabama, was creating a new avenue by which the public could access NASA resources. As part of Operation Liftoff, the research centers were asked to recommend new projects/programs that would help NASA more effectively

communicate with students and teachers. The group proposed an electronic distribution system for educational resources.

They began working on the project in 1986 and finally had it up and running in February of 1988. The service started out looking like a bulletin board with numerical menus that led to various resources. It was a telephone dial-up service with the caller footing the bill for the call. Users had to register and had user names and passwords. They could leave a message for the NASA staff but could not communicate with other users. Most of the information found on the site just told people how to get the information they wanted. It was not actually accessible from the site. Slowly, original documents became available, but they all had to be keyed in individually. Like everything else electronic, Spacelink has undergone several transformations. In 1991, it became available on the Internet via telnet connection. That was its gopher phase. Finally, it emerged on the Web in 1993–1994.

Today, Spacelink is visited by an average of 150,000 unique visitors per month with about 45 gigabytes of information being downloaded in that same time period. It is maintained at the Marshall Space Flight Center by a full-time staff of four—one for primarily tech support and the other three for content. Because Spacelink has been created specifically for educators, two of the three content experts are experienced educators. One has over twenty-five years of classroom experience. The staff's goal is to create an interface for educators that does not require them to understand NASA's organizational structure in order to know where to find resources. They try to look at the content from the educator's point of view.

Spacelink does not generate its own content *per se*. It is actually a virtual library in which local files of official agency education documents such as educator guides, educational briefs, pictures and posters, and hundreds, if not thousands, of NASA Web links are arranged in a manner familiar to educators. Using its search engine, teachers and students can search for information and resources regardless of their location within NASA.

Although Spacelink's search engine is very powerful and used by most of the NASA Web sites, it has other features that truly make it a welcoming place for educators and students. The Spacelink staff constantly review the strategic plans of the various enterprises to see what is happening in each area. They then try to highlight programs and projects from each enterprise. "Hot Topics" is constantly changing to reflect current projects in the news. Here, again, at least one from each enterprise is included. "Cool Picks," on the other hand, is not as closely tied to the NASA organization. Sites highlighted in this section are chosen by the professional staff because they believe educators and students will find them interesting, fun, and educational. Topics in this section vary greatly and tend to be more interactive. There are two services specifically geared for educators. The "Educator Focus"

section is a series of Spacelink articles that offer helpful information on how to make better use of NASA educational products and services. NASA Spacelink Express is actually a mailing list by which NASA can notify educators about new resources and opportunities.

NASAExplores is NASA's newest Web site dedicated to lesson plans and instructional resources. It is a joint education initiative managed and operated by the Marshall Space Flight Center Education Programs Department on behalf of NASA's Aerospace Technology Enterprise and the Human Exploration and Development of Space (HEDS) Enterprise.

The site provides free weekly K–12 educational articles and lesson plans on current NASA projects. Each week, two new articles are published about a current NASA Aerospace Technology or HEDS project. NASAExplores' staff of educators adapt the articles for three grade levels: K–4, 5–8, and 9–12. Lesson plans/activities support the concepts raised by the articles. These materials incorporate and support national educational standards in math, science, geography, and technology. In addition, topics align with standard subject areas, such as chemistry, biology, algebra, and so on.

What makes this an outstanding educational Web site is the fact that it is staffed primarily by educators, including one school media specialist (check out the Staff Bios). This is a perfect illustration of NASA's commitment to include educators in all aspects of its education outreach. Educators do not have to go out to the sight every week—the lesson plans can be sent directly to them via e-mail by subscribing to the Weekly E-mail Alert Service.

Another agencywide effort, the Learning Technologies Program (LTP), provides demonstration projects and online programs dedicated to bringing NASA science to teachers and students in the classroom by using examples from NASA's unique missions. The goal of this program is to facilitate the use of technologies within the K–12 education systems. NASA, led by Ames Research Center, organizes various interactive online projects that connect classrooms with ongoing science and engineering work. The projects provide real and relevant content to enhance classroom curriculums. For example, the *Wright Flyer Online* allows students to follow the testing of a full-sized replica of the 1903 Wright Flyer in a wind tunnel at Ames Research Center. This remarkable program has created a wide variety of quality sites for educators.

NASA's Observatorium is another product of the Learning Technologies Program. It combines years of NASA exploration and discovery with the latest Web technology, giving visitors a site that is literally out of this world. It is probably one of the best virtual museums on the Web. All of NASA's favorite topics are here: Mars,

earth, space photos, the space shuttle and International Space Station, the Sun, stars, and much more. The body of knowledge is as vast and varied as the universe itself. From the continually updated "Observation of the Week" to in-depth articles on NASA projects, both acclaimed and inconspicuous, NASA's Observatory showcases NASA's American spirit and ingenuity.

The Classroom of the Future

The Classroom of the Future (COTF) is a major component of NASA's educational technology program. Its role is to translate NASA technologies and research results into learning tools, demonstrations, and teacher enhancement programs that support standards-based education. It specializes in creating complete courses and/or units of study. A premier example is a program called Astronomy Village, a ten-week course in astronomy for ninth and tenth graders. In Astronomy Village, students learn by becoming actively engaged in the scientific process. They conduct background research, collect and analyze telescope data, and present their findings just as real researchers would. Other online projects include:

- Earth System Science Courses were developed for NASA's Earth Science Enterprise. The K-4 and middle school earth systems science courses are each sixteen-week, for-credit, graduate-level courses for teachers. The courses are conducted online in a collaborative, inquiry-based format, the same format the teachers are expected to use when they return to their own classrooms. Logging on as their schedules permit, teachers from across the U.S. team up to study how events such as hurricanes, volcanic eruptions, and global warming impact the biosphere, atmosphere, hydrosphere, and lithosphere, and how the resultant changes in these spheres impact one another and, in turn, the event itself.
- BioBLAST provides students with a simulation environment that makes use of 3-D virtual reality technologies. The CD-ROM introduces students to NASA research aimed at balancing a planet-based, self-contained, life support system for long-term space habitation. Students are challenged to understand biological and chemical concepts related to human survival, plant survival, and waste recycling in order to design and balance their own simulated systems, whose viability they can then test using the test-run feature on the software.
- Exploring the Environment (ETE) consists of seventeen Web-based learning modules that address real environmental dilemmas worldwide. Students are trained online to use imaging software to help them use NASA's view from space to observe biological, chemical, and geological changes over enormous portions of the earth. Working in teams like real scientists, students are challenged to track a live hurricane,

predict the global impact of a volcanic eruption, investigate the shrinking habitat of the mountain gorillas in Rwanda, and examine issues and images of the Amazon Rainforest. ETE has received honors from Pacific Bell, the Geological Society of Canada, *Reader's Digest*, and numerous other organizations.

NASA Space Science Education Resource Directory

NASA Space Science Education Resource Directory is another Internet on-ramp to educational resources produced by NASA's Space Science Education and Public Outreach programs. The Web-based directory provides easy access to online space science educational resources for teachers and students from kindergarten through high school. Science educators can locate science lessons and activities for their classrooms by searching by keyword or browsing by subject, grade level, and topics that align with National Science Education Standards.

Finally, there is a set of sites that will not only be extremely helpful to educators in Ohio and North Carolina, but also to all educators who want to be a part of a grand celebration. The centennial celebration of the Wright Brothers' first flight took on mythic proportions within NASA. There was a slight competition between NASA Glenn Research Center [OH] and Langley Research Center [VA] as to who put up the best sites (each claims North Carolina as part of its heritage). And they have only just begun. Glenn's site has a lot of simulation and the CD-ROM they have created is wonderful. Here are a few of the NASA sites related to this celebration:

- *100 Years of Powered Flight*: NASA Langley Research Center presents this Centennial of Flight Web site in honor of the Wright Brothers anniversary.
- *A Century of First*: Students research facts about the history of spaceflight in the twentieth century and answer questions about selected events in this NASA On-line Educational Activity from NASA Spacelink.
- *Aviation for Little Folks*: Teach students the parts of an airplane and how to fold a super, duper paper airplane with this NASA Educational On-line Activity from NASA Spacelink. Designed for grades K–4.
- *Centennial of Flight Commission*: The official national site.
- *First Flight*: The North Carolina Commission site, which is working closely with Langley Research Center.
- *Off to a Flying Start*: This online telecommunications project incorporates aeronautics, math, science, technology, and FUN! Students learn about the principles of flight, build and fly their own Falcon Flyer, and create and test their own airplane design.
- *Re-Living the Wright Way*: Have fun while learning about the Wright Brothers' process of invention at this Web site from the NASA Glenn Research Center. Choose

from simulations, Web casts, videos, and activities. The simulations about the forces of flight are excellent.

- *Web Ground School*: Learn what makes an airplane fly, a balloon float, or a spacecraft stay in orbit. This site takes an informative and entertaining look at the science of aeronautics.

- *Wright Flier Online*: At this Web site, you will learn about the Wright Flyer Project, in which a full-sized replica of the 1903 Wright Flyer, flown in the first-ever powered flight, was tested in a wind tunnel at NASA Ames Research Center. Meet the people involved in the project, travel back in time to the early days of aviation, and use the activities to connect it all to the classroom.

As you can see from the descriptions of many of these sites, there is a strong emphasis on meeting educational standards and making the educational activities authentic and interactive. These are the pillars of NASA's K-12 educational Web-based outreach. NASA certainly does understand that it needs to do its part to educate, inspire, and encourage every segment of the population—girls and boys alike—from every walk of life, every color and creed, to reach out and prepare for the opportunities of the twenty-first century. And it is doing a darn good job of it.

Notes

1. Housed in the Curriculum and Instructional Materials Center of the J. Murrey Atkins Library at the University of North Carolina Charlotte.

2. If such is the case, refer to the new site home page <http://www.nasa.gov> and search by the sections outlined at the end of the chapter.

3. The amount of information on these sites on the itemized topics may well have changed from the first count, taken in 2002. This update has those links that are active as of April 18, 2006. If the link is no longer active or is a dead end, brackets [] have been placed around the site name and link.

NASA LINKS (Organized by chapter sections)

Introduction

NASA Home Page—<http://www.nasa.gov>

North Carolina Educator Resource Center—<http://library.uncc.edu/nasa/>

The NASA Organization

Enterprises

NASA Aeronautics Technology Web Site—<http://www.aero-space.nasa.gov/>

The Human Exploration and Development of Space Web Page (now Office of Space Flight) —<http://www.hq.nasa.gov/osf/>

Space Science—<http://spacescience.nasa.gov/>

Earth Science Enterprises: Destination Earth—<http://www.earth.nasa.gov/>

Space Research: Office of Biological and Physical Research—<http://spaceresearch.nasa.gov/> redirects to:<http://exploration.nasa.gov/>

NASA Research/Field Centers

NASA Headquarters—<http://www.nasa.gov/centers/hq/home/index.htm><http://www.nasa.gov/centers/ames/home/index.html>

Dryden Flight Research Center, Edwards, CA—<http://www.nasa.gov/centers/dryden/home/index.html>

Glenn Research Center at Lewis Field, Cleveland, OH—<http://www.nasa.gov/centers/glenn/home/index.html>

Goddard Institute for Space Studies, New York, NY—<http://www.giss.nasa.gov>

Goddard Space Flight Center, Greenbelt, MD—<http://www.gsfc.nasa.gov/>

Independent Verification & Validation Facility, Fairmont, WV—<http://www.ivv.nasa.gov/>

Jet Propulsion Laboratory, Pasadena, CA—<http://www.jpl.nasa.gov/>

Johnson Space Center, Houston, TX—<http://www.nasa.gov/centers/johnson/home/index.html>

Kennedy Space Center, FL—<http://www.nasa.gov/centers/kennedy/home/index.html>

Langley Research Center, Hampton, VA—<http://www.nasa.gov/centers/langley/home/index.html>

Marshall Space Flight Center, Huntsville, AL—<http://www.nasa.gov/centers/marshall/home/index.html>

Moffett Federal Airfield, Mountain View, CA —<http://www.nasa.gov/centers/ames/about/aboutames-moffetfield.html>

Stennis Space Center, MS—<http://www.nasa.gov/centers/stennis/home/index.html>

Wallops Flight Facility, Wallops Island, VA—<http://www.wff.nasa.gov/>
 White Sands Test Facility, White Sands, NM—<http://www.wstf.nasa.gov/>

NASA Education Pages (Headquarters and Research/Field Centers)

National Aeronautics and Space Administration [NASA] Education Programs—
<http://education.nasa.gov/home/index.html>

NASA Ames Research Center Education Programs—<http://education.arc.nasa.gov/>

Dryden Flight Research Center Education Homepage—[http://www.dfrc.nasa.gov/
 Education/index.html](http://www.dfrc.nasa.gov/Education/index.html)

Education at NASA Glenn Research Center—[http://www.nasa.gov/centers/glenn/
 education/index.html](http://www.nasa.gov/centers/glenn/education/index.html)

Goddard Space Flight Center Education Programs—<http://education.gsfc.nasa.gov/>

NASA Goddard Institute for Space Studies Education—[http://www.giss.nasa.gov/
 edu/](http://www.giss.nasa.gov/edu/)

JPL Education Gateway—<http://education.jpl.nasa.gov/>

Johnson Space Center Education and Student Programs—[http://education.
 jsc.nasa.gov/](http://education.jsc.nasa.gov/)

Kennedy Space Center Education Resources—[http://www.nasa.gov/centers/
 kennedy/education/index.html](http://www.nasa.gov/centers/kennedy/education/index.html)

Langley Research Center Education—[http://www.nasa.gov/centers/langley/educa-
 tion/index.html](http://www.nasa.gov/centers/langley/education/index.html)

Marshall Space Flight Center, Education Programs—[http://www.nasa.gov/centers/
 marshall/education/index.html](http://www.nasa.gov/centers/marshall/education/index.html)

Stennis Space Center Office of Education—<http://education.ssc.nasa.gov/>

Wallops Flight Facility Education Outreach—[http://www.wff.nasa.gov/pages/
 educationoutreach.html](http://www.wff.nasa.gov/pages/educationoutreach.html)

Commitment to Education

National Research Council—<http://www.nationalacademies.org/nrc/>

National Science Teacher Association—<http://www.nsta.org/>

National Council of Teachers of Mathematics—<http://www.nctm.org/>

American Association for the Advancement of Science—<http://www.aaas.org/>

International Technology Education Association—<http://www.iteaconnect.org/>

Geography Education National Implementation Project—<http://genip.tamu.edu/>

Department of Education—<http://www.ed.gov/>

EarthKAM(Earth Knowledge Acquired by Middle school students)—[http://
 www.earthkam.ucsd.edu/](http://www.earthkam.ucsd.edu/)

For Kids Only Teacher Guides—<http://kids.earth.nasa.gov/guide/index.htm>

Solar System Simulator—<http://space.jpl.nasa.gov/>

Exploring the Environment—<http://www.cotf.edu/ete/main.html>
 NSSDC Web Site Selected to Showcase NASA's Commitment to Accessibility—
http://nssdc.gsfc.nasa.gov/nssdc_news/sept00/web_accessibility.html
 Listing of NASA's Top Twenty Websites (and then some...)—<http://www.hq.nasa.gov/webmaster/accessibility/NASAtop20websites.html>
 Web Accessibility Made Easy (U.S. Government Website Accessibility Guidelines)—
<http://www.hq.nasa.gov/webmaster/accessibility/index.html>
 NASA Website Privacy, Disclaimer and Accessibility Statement—<http://www.hq.nasa.gov/congress/privacy.html>

NASA's Web Presence

NASA Home Page—http://www.nasa.gov/externalflash/nasa_gen/
 Kennedy Space Center Home Page—<http://www.ksc.nasa.gov/>
 Destination Earth—<http://www.earth.nasa.gov/>
 Spacelink—Link no longer active: Use <http://www.nasa.gov>
 Volcano World—<http://volcano.und.nodak.edu/>
 Windows on the Universe—<http://www.windows.ucar.edu/>
 Tennis Sports Science—<http://wings.avkids.com/Tennis/>
 Learning Technologies Program (LTP)—<http://learn.arc.nasa.gov/>
 Amazing Space—http://www.nasa.gov/audience/foreducators/5-8/features/F_Amazing_Space.html
 Space Telescope Science Institute—<http://hubblesite.org/>
 Space.com—<http://space.com/>

Premiere NASA Web Sites

Marshall Space Flight Center, Education Programs—<http://www.nasa.gov/centers/marshall/educ>
 [Spacelink]- Link no longer active.
 NASAexplores—<http://www.nasaexplores.com/index.php>
 NASAexplores: Staff Bios—<http://www.nasaexplores.com/aboutus-bios.php>
 [NASAexplores: Weekly E-mail Alert Service]—link no longer active
 Learning Technologies Program (LTP)—<http://learn.arc.nasa.gov/>
 Space Mysteries—<http://mystery.sonoma.edu/>
 Signals of Spring—<http://www.signalsofspring.net/>
 Qwhiz—http://learn.arc.nasa.gov/products/products01/ltp_html/individual_pages/qwhiz.html
 [PlaneMath—link no longer active]
 LEGO Data Acquisition and Prototyping System (LDAPS)—<http://www.workshop3d.com/cybertoy/>

Classroom of the Future—<http://www.cotf.edu/>

Exploring the Environment—<http://www.cotf.edu/ete/main.html>

Space Station Challenge—<http://iss.cet.edu/>

Using NASA Web Sites in the Classroom

Research

[Spacelink's search engine]-Link no longer active

NASA History Office—<http://www.hq.nasa.gov/office/pao/History/index.html>

NASA Fact Sheets—<http://www.nasa.gov/about/highlights/index.html>

NASA's Visible Earth—<http://www.nasa.gov/topics/earth/index.html>

GRIN (Great Images in NASA)—<http://grin.hq.nasa.gov/>

NeuroLab Online Photo Gallery—<http://quest.nasa.gov/neuron/photos/index.html>

Earth Observatory, Today's Image—<http://earthobservatory.nasa.gov/>

Astronomy Picture of the Day—<http://antwrp.gsfc.nasa.gov/apod/astropix.html>

Earth Science Picture of the Day—<http://epod.usra.edu/>

Hubble Telescope Animations/Movies—http://hubblesite.org/newscenter/newsdesk/archive/releases/video_category/

NASA Dryden Research Aircraft Movie Collection—<http://www.dfrc.nasa.gov/gallery/movie/index.html>

Liftoff to Learning Resource Guides—<http://quest.nasa.gov/space/teachers/liftoff/>

Public Use of Remote Sensing Data Program—<http://rsd.gsfc.nasa.gov/rsd/>

NASA's Neutral Bouyancy Tank <http://liftoff.msfc.nasa.gov/vr/>

[Spacelink Panoramic Image]-Link no longer active

NASA Image eXchange—<http://nix.nasa.gov/>

NASA Human Space Flight Web Page—<http://spaceflight.nasa.gov/home/index.html>

[Spacelink: NASA Pictures, Photographs and Images]Link no longer active

Human Space Flight Gallery—<http://spaceflight.nasa.gov/gallery/index.html>

NASA Multimedia Gallery—<http://www.nasa.gov/multimedia/highlights/index.html>

[Spacelink: Multimedia]-Link no longer active

[Spacelink: Using Internet Multimedia]-Link no longer active

NASA's Space Story—<http://town.hall.org/radio/NASA/>

Listen to a Black Hole—http://xte.gsfc.nasa.gov/docs/xte/learning_center/listen.html

NASA's Cassini Listens to Eerie New Sounds of Space Near Jupiter—<http://saturn.jpl.nasa.gov/operations/index.cfm>

Welcome to the Planets—<http://pds.jpl.nasa.gov/planets/welcome.htm>

Ask the Space Scientist—<http://image.gsfc.nasa.gov/poetry/ask/abholes.html>

Ask a High Energy Astronomer—http://imagine.gsfc.nasa.gov/docs/ask_astrol/ask_an_astronomer.html

Ask Dr. SOHO—<http://sohowww.nascom.nasa.gov/explore/drsoho.html>
 [Ask Dr. Gospace—<http://www-spof.gsfc.nasa.gov/istp/outreach/drgeo.html>]-Link
 no longer active: Dr. Gospace has retired.
 Mars Team Online, Asking Questions—<http://quest.nasa.gov/qna/glimpse/index.html>
 Human Space Flight Feedback (Ask an Expert)—<http://spaceflight.nasa.gov/feedback/>

Lesson Plans/Teacher Resources

NASA's Observatory Teacher's Guides—http://observe.arc.nasa.gov/nasa/education/teach_guide/index.html
 Aeronautics Related Activities, Experiments and Lesson Plans—<http://www.grc.nasa.gov/WWW/K-12/aeroact.htm>
 For Kids Only Teacher Guides—<http://kids.earth.nasa.gov/guide/index.htm>
 NASA Space Science Education Resource Directory—<http://teachspacescience.stsci.edu/cgi-bin/ssrtop.plex>
 [Spacelink's Instructional Materials—<http://spacelink.nasa.gov/Instructional.Materials/>]-Link no longer active]
 ROVer Ranch—<http://prime.jsc.nasa.gov/ROV/>
 [Plane Math—<http://www.planemath.com/>]-Link no longer active
 Goddard Space Flight Center, Science Question of the Week—<http://www.gsfc.nasa.gov/science.html>

Interactive

[Spacelink's Educator Focus—]-Link no longer active
 [How to Participate in NASA Interactive Internet Projects—]-Link no longer active
 [Telescopes in Education (TIE)—]-Link no longer active
 Ask the Space Scientist—<http://image.gsfc.nasa.gov/poetry/ask/askmag.html> (Although the service is no longer active, there is an extensive archive of Q & A.)
 Tracking the international space station—<http://spaceflight.nasa.gov/realdata/tracking/index.html>
 NASA Quest—<http://quest.nasa.gov/>
 NASA Quest > Calendar of Events, Year at a Glance—<http://quest.nasa.gov/calendar/year.html>
 Centennial of Flight Celebration— <http://www.centennialofflight.gov/index.cfm>
 NASA CONNECT—<http://connect.larc.nasa.gov/>
 The NASA "Why?" Files—<http://whyfiles.larc.nasa.gov/treehouse.html>
 Robin Whirlybird on Her Rotorcraft Adventure—<http://quest.arc.nasa.gov/test/rotorcraft/index.html>
 Adventures of Echo the Bat—<http://imagers.gsfc.nasa.gov/>

Amelia the Pigeon—<http://imagers.gsfc.nasa.gov/pigeon/>

EarthKAM—<http://www.earthkam.ucsd.edu/>

[Telescopes in Education]-Link no longer active.

Interactive Atmosphere Simulator—<http://www.grc.nasa.gov/WWW/K-12/airplane/atmosi.html>

Beginner's Guide to Aeronautics—<http://www.grc.nasa.gov/WWW/K-12/airplane/>

FoilSim—<http://www.grc.nasa.gov/WWW/K-12/FoilSim/index.html>

Curve Ball—<http://www.grc.nasa.gov/WWW/K-12/FoilSim/index.html>

Solar System Simulator—<http://space.jpl.nasa.gov/>

[Spacelink: Webcams/]-Link no longer active

Virtual Tours

Johnson Space Center's Distance Learning Outpost—<http://learningoutpost.jsc.nasa.gov/>

<http://centennialofflight.gov> (User name and password needed for access)

JSC's Distance Learning Outpost: Expeditions, ISS Virtual Tour—<http://learningoutpost.jsc.nasa.gov/expeditions.cfm> (User name and password needed for access)

NASA Human Space Flight Web Page—<http://spaceflight.nasa.gov/>

Mars Pathfinder QuickTime VR Panoramas—<http://mars.jpl.nasa.gov/MPF/vrml/qtvr.html>

Events

[Space Settlement—]-Link no longer active.

Sun-Earth Days—<http://sunearth.gsfc.nasa.gov/sunearthday/>

Send Your Name to Mars—<http://spacekids.hq.nasa.gov/2003/> (This project stopped taking names on November 15, 2002, midnight EST with a final count of 3,551,645 names.)

Multimedia

NASA CONNECT—<http://connect.larc.nasa.gov/>

The NASA "Why?" Files—<http://whyfiles.larc.nasa.gov/>

NASA CORE—<http://education.nasa.gov/edprograms/core/home/index.html>

Professional Development

Earth Systems Science Courses—<http://www.cotf.edu/products/main.html>

Additional Sites

NASA's Observatorium—<http://observe.arc.nasa.gov/nasa/core.shtml.html>. This site

is an archive as of 1999.

Athena, Earth and Space Science for K-12—http://observe.arc.nasa.gov/nasa/entries/entry_5.html

For Kids Only Games—<http://kids.earth.nasa.gov/>

Droplet and the Water Cycle—<http://kids.earth.nasa.gov/droplet.html>

Space Place—<http://spaceplace.nasa.gov/en/kids/>

Solar System Switch-a-roo—http://spaceplace.jpl.nasa.gov/en/kids/sse_flipflop.shtml
[100 Years of Powered Flight.]-Link no longer active.

Centennial of Flight: The Future of Flight—<http://centennialofflight.gov/> [First Flight—<http://www.firstflightnc.com/>]Link no longer active.

[A Century of Firsts]-Link no longer active

[Aviation for Little Folks]-Link no longer active

Re-Living the Wright Way—<http://www.grc.nasa.gov/WWW/Wright/>

NASA Glenn Research Center—<http://www.nasa.gov/centers/glenn/home/index.html>

Web Ground School—<http://www.aero.hq.nasa.gov/edu/>

Wright Flier on Line—<http://quest.nasa.gov/aero/wright/>

Conclusion

NASA Technology Portal—<http://nasatechnology.nasa.gov/>

NASA Technology Portal: Educational Tech—<http://nasatechnology.nasa.gov/index.cfm>

All URLs are current as of April 20, 2006.