SCIENCE INFORMATION SYSTEMS NEWSLETTER

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Welcome to Issue 50

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The NASA Science Information Systems Newsletter (SISN) is prepared for the Office of Space Science (OSS), Science Information Systems (SIS) Program through an agreement with the Jet Propulsion Laboratory. The newsletter, which has been an ongoing task for over ten years, is a forum for the space science and applications research community to report research and development activities, outreach activities, and technology transference. SISN offers a venue for articles that are not likely to appear elsewhere and provides the opportunity for information exchange within the science community, as well as a platform for accomplishments by that community. Related articles from other programs and agencies are also published.

Questions or comments regarding this newsletter task may be emailed to Sandi Beck at <sandi.beck@jpl.nasa.gov>.

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ADF and ADC —

Providing Web Access Tools for Astronomical Data and Metadata

Kirk D. Borne, Information Technology and Scientific Services, Raytheon STX Corporation, Goddard Space Flight Center

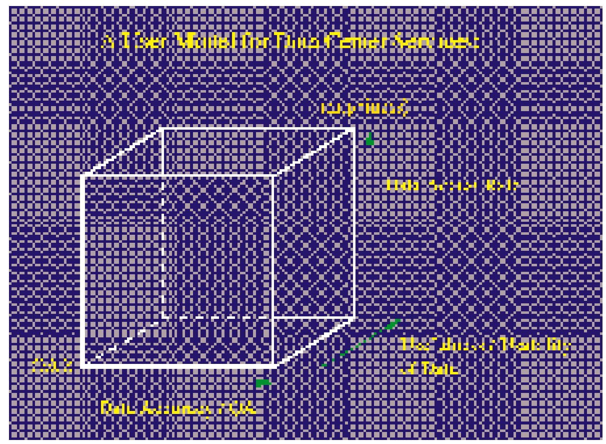
Successful interoperability among NASA's astrophysics data centers depends on transparent user access to data and metadata held at data centers around the country. To facilitate such interoperability, staff at the Goddard Space Flight Center (GSFC) Astrophysics Data Facility (ADF) and Astronomical Data Center (ADC) are implementing Web-based, object-oriented database (OODB), and XML (eXtensile Markup Language) technologies. This effort is driven by the demands of the research community for easy on-line mining, discovery, access, manipulation, correlative analysis, and scientific exploration of data and metadata. Reviewed here are a variety of Web-accessible solutions that are being developed to meet these needs, with particular emphasis on the following on-line tools: AMASE, ADC Data Viewer, AEQ, Catseye, IMPReSS, and WISARD. This article focuses on the capabilities and implementation of the ADF/ADC suite of tools and describes their interoperability with other astronomical data centers and services.

So why Interoperability?

Interoperability is a cost-effective method that enables researchers to do comprehensive correlative science using data, metadata, and information resources from multiple distributed data centers and information service providers. In other words, it enables researchers to do science better and faster.

Data centers must have a management plan that is responsive to users' demands for fast access to quality usable data.The ADF and ADC, both of which are part of the Space Science Data Operations Office (SSDOO) at GSFC, are working toward meeting these demands through the development of new and innovative data and metadata access tools.

The user model presented below simplistically represents the success of a data center's services in a 3D space where "large values" in each of the three dimensions (data accuracy, data usefulness, and data access rate) will lead to user happiness.



User model

There are several other critical factors not included here:

1. data volume (too little or too much could lead to user dissatisfaction)
2. metadata services (which have a similar set of axes in this multi-dimensional user space)
3. associated tools (are they useful? are they sufficient? are they easy touse? etc.)
4. documentation and information services (for which "QA" and "Usefulness" especially apply)

About the ADF

The ADF, part of NASA's Space Science Data Operations Office (SSDOO) located at GSFC, is a member of the Astronomical Data Centers Coordinating Council. Both the ADF and the SSDOO participate in NASA's Space Science Data Services.

The ADF serves three broadly-defined astrophysics disciplines: high-energy astrophysics, UV/ optical astrophysics, and Infrared / submillimeter / radio astrophysics. The ADF manages data for specific NASA astrophysics missions in collaboration with the GSFC Laboratory for High Energy Astrophysics (LHEA), the GSFC Laboratory for Astronomy and Solar Physics (LASP), and the Multimission,Archive (MAST) at STScI (Space Telescope Science Institute).

The ADF is responsible for designing, developing, and operating data systems that support the processing, management, archiving, and distribution of NASA astrophysics mission data and is responsible for supporting astrophysics community access to the metadata catalog and table holdings of the ADC. The ADF has historically been responsible for supporting astrophysics community access to multimission and multispectral data archives in the National Space Science Data Center (NSSDC). ADF facilities and services include:

- AscaDF - Advanced Satellite for Cosmology and Astrophysics (ASCA) Data Facility
- ASTRO-E - Data Facility for ASTRO-E (the next Japanese ISAS X-ray astrophysics mission with NASA participation)
- ADC - Astronomical Data Center
- COBE - Cosmic Background Explorer (COBE) Project Home Page
- FITS (data standard) - Flexible Image Transport System Support Office
- IRAS - Infrared Astronomical Satellite Archive Interface
- USRSDC - US Roentgen Satellite (ROSAT) Science Data Center
- WISARD - Web Interface for Searching Archival Research Data
- XSDC - X-ray Timing Explorer (XTE) Science Data Center

The ADF has on-going cooperative efforts with other data centers in AstroBrowse, a joint effort among all NASA astrophysics data centers to provide a single search interface for locating astronomical data stored in any number of individual databases or information services. The first functioning AstroBrowse prototype, called OZ, upon which current AstroBrowse implementation is based, was created by the ADF. OZ could be interfaced into any HTTP/HTML-based system that accepts the defined keyword/value pairs as a HTTP POST message and then returns a HTML file. The ADF also created a proof-of-concept AstroBrowse interface in 1995, named WISARD_ASTRO,that accepted the OZ queries and returned summary information for each WISARD database.

Additionally, the ADF implemented the STudy of Electronic Literature for Astronomical Research (STELAR). STELAR was the initial prototype for the astronomy and astrophysics abstract services as well as for on-line electronic publication of the science journals.

About the ADC

The ADC, a major archive and distribution center for computer-readable versions of astronomical catalogs and published (refereed) journal data tables, contains more than 2600 catalogs and tables of astrometric, photometric, morphological, spectroscopic, polarization, kinematic, and multi-wavelength data for stellar and non-stellar objects. Recent developments at the ADC now give researchers expanded location, browse, and retrieval capabilities for this rich and diverse collection of published data. The expanded capabilities of the ADC include:

- online data catalog previewing using the ADC Data Viewer and catalog data plotting using Catseye
- sky location maps of existing NASA archival mission data near positions of catalogued objects or near user-selected sky coordinates using IMPReSS
- vizieR relational database search and discovery tool for retrieving astronomical data listed in published catalogs and tables
- AMASE (Astrophysics Multi-Spectral Archive Search Engine) OODB, with capabilities to search for data by class and attribute.
- Quick Reference Pages (QRP) that organize the ADC data holdings by scientific discipline
- “How To” Info telling users how to find, access, use, visualize, and submit data at the ADC

The ADC data holdings contain a wealth of astronomical information, while the various tools and services described here provide capabilities to browse those data.

In addition to the services listed above the ADC created the Scientific User’s Guide to guide you through the collection of data access, browse, and visualization tools. The guide provides a sampling of user scenarios and examples of the appropriate usage of each ADC tool and data service.

The ADC is also currently developing several experimental software tools that can provide access to external data holdings maintained elsewhere. These experimental prototypes are taking advantage of the following emergent technologies: OODB (used in AMASE), XML (used in AEQ), and GLU. These new capabilities will allow researchers to identify scientifically interesting objects and correlations, carry out archival data-mining searches, locate existing archival data on user-selected objects, and prepare observing lists for further observational studies (mission planning). Additionally, the ADC has on-going cooperative efforts with other data centers in the AstroBrowse effort, including for example efforts to improve links between the abstract service, published journal tables, and ADC’s data that are held in computer-readable form.

More about tools and services

The WWW data access tools and services at the ADF/ADC include productions systems in operation and prototype systems under development. Production systems currently operating are WISARD, the ADC Data Viewer, Catseye, IMPReSS, and the ADC QRP. Prototype systems under development are AMASE, the AEQ, XML, and AstroBrowse.

WISARD is the Web Interface for Searching Archival Research Data. It allows archive data retrieval from distributed archives. It is a multi-wavelength, multi-mission interface to astrophysics data archives and is focussed primarily on NASA-supported missions and data sets. WISARD provides the ability to search and retrieve archival data located at several different sites. Archival data requests are handled by WISARD and then submitted to the appropriate data service / data center to obtain the data for the user.

The ADC Data Viewer is a tool that allows you to select subset (with user-selected ranges), view, sort, and manipulate

ADC catalogs and journal tables. A direct link from the Data Viewer allows the user to plot scatter plots of any of the displayed tabular data using the Catseye tool.

Catseye allows you to plot column data (X-Y scatter plots) from ADC's ASCII data tables. Catseye allows interactive user queries on clickable maps to retrieve metadata parameters on individual plotted data points, to access information on the selected point from remote distributed archives (e.g., NED), and to link to archival mission data on the selected object using the IMPReSS tool.

IMPReSS is the Image Perimeters of Sky Surveys tool. It visualizes observational data parameters from remote astronomical data archives. IMPReSS allows searches for all possible space-based targeted observations within a user-specified sky region (for a variety of space-based missions), displays color-coded aperture silhouettes of these observations in a map of that region, and then provides links directly to the corresponding archived data held at external sites.

ADC QRP allow you to quickly and easily to direct their search of ADC's data holdings for astronomical catalogs in specific scientific subject disciplines and subdisciplines. Catalogs are assigned to a given QRP according to science topic, and then the catalogs are further subdivided by subtopic within a given QRP. This allows fast search and retrieval of astronomical metadata according to a science user's specific domain interests.

AMASE is the Astrophysics Multispectral Archive Search Engine. AMASE is a metadata-base prototype built using OODB methodology, which allows mission data to be searched easily by scientific parameters. We capture fundamental astronomical measurements from published astronomical catalogs and obtain mission paramaters from NASA mission logs to use as search criteria. We are also building a rich astronomical classification scheme into the database to support the search. The power of the Object-Oriented database (OODB) is that it allows for parent-child relationships, inheritances, and complex dependencies between the objects.You may then submit complex (or simple) user-natural queries in a manner that is impossible with a relational database (e.g., "Tell me the names and coordinates of all quasars that have a high-Infrared flux and that have available X-ray flux measurements.") The OODB is integrated with a relational database gateway that allows access to metadata at remote archives.

AEQ is used especially for interoperability with other data centers, allowing specific queries to the ADC archives to be formulated and requested completely within the Web URL address. AEQ is essentially a "batch" tool that has all of the functionality of the ADC Data Viewer, without the need for user point-and-click interaction.

XML (eXtensible Markup Language) tools are being researched and developed. This is the next wave in Web information-exchange and resource-location protocols. XML provides access to your information (metadata and data) services through what is essentially an ASCII-based database. Each item in the data or metadata file can be tagged for its type, allowable value ranges, and other criteria. We are developing XML tools specifically for fielded content-based markup and to facilitate content-based searches of any data center resource (data, metadata, lists, hypertext, etc.).

AstroBrowse is a joint effort among all NASA astrophysics data centers. Both the ADF and the ADC, along with several other groups, are working on prototypes. The ADF/ADC Browse and Visualization Tools Suite is one of the working prototypes now available for use.

Conclusion

The ADF and ADC continues to develop tools to meet the astrophysics research community's demands for easy on-line mining, discovery, access, manipulation, correlative analysis, and scientific exploration of astronomical data and metadata. Editors Note: This paper was presented at the Third Annual Raytheon STX Science Data Centers Symposium in November 1998.The theme of this year's symposium was "Interoperability: The Next Generation of Data Access". The symposium was jointly sponsored by Raytheon and NOAA/NESDIS, and was held at the NOAA Science Center in Silver Spring, Maryland.

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Simpson Named One of Top Ten Female for '98

Recently Joanne Simpson, chief scientist for meteorology at Goddard Space Flight Center (GSFC), was selected as one of the Top Ten Female Role Models of the Year by the Ms. Foundation for Women. Simpson shares this honor with First Lady Hilary Rodham Clinton and astronaut Lieutenant Colonel Eileen Collins. Other inspirational female figures on the 1998 list include athletes, entertainers, and activists.

Simpson is honored for her determination and ability to overcome obstacles and reach her goal by becoming the first woman meteorologist in the world. She struggled to "earn her masters degree in 1945 at a time when women were being encouraged to leave their wartime jobs" and return home to care for their families. When she expressed her desire to earn her doctorate degree, she was told that it was "totally inappropriate for a woman to be a meteorologist." Simpson persevered and obtained her doctorate degree in 1949. She has devoted her entire professional career to studying cl and violent storms and has received many honors for her accomplishments from the scientific community.

"I am very honored and pleased to be regarded as a role model for professional women," stated Simpson. "Being honored by this fine organization is particularly gratifying because of the important programs they have started, such as ÔTake your Daughter to Work Day and other efforts to encourage women to equip themselves with the necessary skills to do exciting work."

Simpson has also recently been invited to submit her lifelong journals, personal letters and memoirs to the Schlesinger Library on the History of Women in America at Radcliffe College. Her meticulous notebooks comprise records of her observations of weather from boats, airplanes, radar screens, and satellite images and her analysis of what she has observed. The library is a national resource, which began by documenting heroic women of the suffrage movement. Today, it includes more than 2,000 manuscripts of such notable women as Susan B. Anthony and Amelia Earhart.

Simpson served as study scientist for the Tropical Rainfall Measuring Mission from 1986-1991, and the mission project scientist from 1991 until after the launch of the spacecraft in 1997. She became chief scientist for Meteorology in 1988 and a Goddard Senior Fellow in 1989. She is a member of Phi Beta Kappa and Sigma Xi, and was made a Fellow of the American Meteorological Society in 1968 and a Fellow of the American Geophysical Union in 1994. Simpson was elected to the National Academy of Engineering in 1988. She has been listed in Who's Who of American Women since 1972 and in Who's Who in America since 1980.

Among the awards Simpson has received are the Guggenheim Fellowship in 1954, the American Meteorological Society Meisinger Award in 1962, the Rossby Research Medal in 1983, and the C.F. Brooks Award in 1992. She also received the Department of Commerce Gold Medal in 1972, the Professional Achievement Award of the University of Chicago Alumni in 1975 and 1992, and the NASA Exceptional Scientific Achievement Award in 1982. She received the Women in Science and Engineering Lifetime Achievement Award in 1990 and was awarded the first William Nordberg Memorial Award for Earth Science in 1994. Simpson also received NASAÕs 1998 Outstanding Leadership Medal for her exceptional leadership in the atmospheric sciences culminating in the successful launching and performance of the Tropical Rainfall Measuring Mission satellite.

Excerpted from NASA press release 99-009, written by Cynthia M. O'Carroll. ■

NASA at SC'98 —

Showcasing Leading Edge Computer Technologies

The tenth anniversary of the IEEE/ACM High Performance Networking and Computing Conference, SC'98, was held in Orlando, Florida, where NASA was once again a prime exhibitor. NASA research and development depend on high performance computers and their simulation and analyses and the agency itself a leading-edge developer of supercomputing applications in aerospace engineering, earth and space sciences, and other areas.

According to Dennis Duke, SC'98 chair, Louis Turcotte, vice chair, and Ann Redelf, executive director, the annual supercomputing conference has "established itself as the pulse of our industry and the nexus for discussions about achievements and future goals."

NASA's exhibit featured demonstrations of more than 70 supercomputing related projects. The emphasis was on distributed collaborative engineering from six NASA centers and research facilities: Ames Research Center (ARC), Goddard Space Flight Center (GSFC), Jet Propulsion Laboratory (JPL), Langley Research Center (LaRC), Lewis Research Center (LeRC), and Marshall Space Flight Center (MSFC).

Visitors to NASA's exhibit arena were able to view a virtual spacewalk, watch a simulated wind tunnel test from a remote location, and manipulate atoms in a 3-D computer simulation. NASA researchers demonstrated their latest projects in computer modeling and simulation, immersive interfaces, parallel and distributed computing, as well as leading edge computer technologies that revolutionize the way aerospace missions are planned and executed.

Marshall Space Flight Center, Ames Research Center, Langley Research Center, and the NASA exhibit booth formed four network nodes in a distributed virtual spacewalk. Exhibit staff and researchers became virtual astronauts in a simulated spacewalk rehearsal of Flight 6A, a future space mission during which construction work will be done on the International Space Station. The "astronauts" wore virtual reality headgear displaying mock-ups of space station parts derived from computer-aided design (CAD) files while "maneuvering" around the components in virtual space. Computers at each site exchanged positional information over the Internet, continuously updating the scene from each user's point of view.

Also featured in the NASA exhibit was the new Intelligent Synthesis Environment (ISE) project, an integrated package of high performance hardware, software, and network connections that drastically accelerates the aerospace design, testing and manufacturing cycle. The ISE supports simulation-based design, high fidelity simulations, rapid prototyping, virtual telepresence, immersive interfaces, multidisciplinary optimization, and other engineering activities.The ISE promotes collaboration among geographically dispersed engineering teams, allowing "cradle-to-grave" analysis and planning of new aerospace missions.

Another demonstration showed ISE-type technologies are impacting research in non-aerospace engineering. ARC scientists have developed a virtual nanomanipulator device that allows users to explore matter on an atomic scale. The system links to an "immersive workbench" that has a rear-projection picture on its surface. The bench and a headtracked stereo display show 3D computer simulations of carbon molecules, such as diamondoid structures. Researchers can "grab" and "move" individual atoms around like blocks using a wand tracked by sensors. A force-feedback arm device even allows users to "feel" the forces at work between atoms.

"If you could scale atoms up to the size of ping pong balls and hold them in your hand, what would it feel like? That was the basic idea behind what we were trying to build," said Chris Henze, one of the ARC research scientists. In the future, Henze said engineers could use the nanomanipulator to rehearse complicated assembly sequences for molecular-scale devices.

The latest version of DARWIN was on display. DARWIN is a computerized system, developed at ARC, that provides real-time data to aerospace engineers who can be located in different cities or laboratories. The system feeds collaborative video to the engineers and has a web-based interface enabling data from wind tunnel experiments and supercomputer-based simulations to be shared by researchers.

"The DARWIN environment speeds up the aerospace engineering design cycle by allowing researchers remote, real-time access to wind tunnels, data, and collaborators," explained Christopher Buchanan, a network architect at the Numerical Aerospace Simulation facility at ARC. "With high-quality video, high-speed networks, and an intelligent interface, a researcher is no longer required to be physically located at Ames to conduct wind tunnel tests or analyze wind tunnel and/or computational results."

The popular 3D "stereo visualization theater" was back this year, with continuous showings of a six-minute ARC presentation on collaborative supercomputer-based simulation projects in aerospace engineering and telemedicine. Another theater presented a video produced at GSFC highlighting studies of the Sun, Earth's atmosphere, Martian canyons, and other locales around the solar system. In addition to the exhibit arena, NASA researchers presented more than a dozen tutorials, poster exhibits, panels and papers on subjects such as digital libraries, the next-generation Internet, and parallel computing in the modeling of solar-corona mass ejection.

The SC98 High Performance Networking and Computing Conference is sponsored by the IEEE Computer Society and the Association for Computing Machinery.

Material excerpted from NASA press release 98-59, written by John Bluck, Information Systems Liaison (Public Affairs), NASA Ames Office of External Affairs, and Michael Mewhinney, ARC, and the SC'98 Web site. ■

AWARDS

KidSat Work Honored

NASA astronaut, John Grunsfeld, presented an individual Space Flight (SFA) Award to Paul Andres, Jet Propulsion Laboratory, Science Data Processing Systems Section, for his significant contributions to the KidSat payload on STS-76. SFA awards are presented for exemplary work while accomplishing a task or goal in support of the human space program. Grunsfeld is a former senior research fellow at Caltech. KidSat, a NASA flight project run by students for students, employs a student camera on the Space Shuttle. ■

A Field of Martian Dreams

Dave Dooling and Tony Phillips, Marshall Space Flight Center

"It's a hit. The ball is flying flat and fast. All the outfield can do is stand there and watch. IT'S OUTTA HERE! MCGWIRE SLAMS ANOTHER HOMER! And we'll be back to the game between the Mariner Valley Engineers and the Olympus Mons Mound Builders here at Carl Sagan Stadium after this word from Six Flags Over The Face On Mars."

Baseball would be a whole different game on Mars. McGwire would have bagged the home run record several times this season, and the scores for every game would be in multiple digits. A bunch of outfielders would be in the hospital, nursing broken arms, too.

Mars vs. Earth

How easy would it be to score on Mars? A couple of important differences would change the game. Mars itself is only 11% as massive as the Earth, and is a lot smaller, just 6,788 km (4,216 mi) in diameter - 53% that of Earth. These differences in size and mass mean that the surface gravity on Mars is only 38% that of Earth. Therefore, a ball hit on Mars would sail nearly 3 times farther than the same ball hit on Earth, simply because of Mar's reduced gravity.

"Hey, guys - Is that the pitcher's mound back there?" Boeing artist Jack Olsen rendered this impression of the first manned mission to Mars with Olympus Mons - larger than Mount Everest - in the background.

The table below shows how the stats of Mark McGwire, Sammy Sosa, and Ken Griffey Jr. would change if they played on the Red Planet. In a normal, Earthling-sized ballpark on Mars every hit, even "singles", would rocket out of the park. All three players would have eclipsed Mars's record of 61 homers long ago. Interestingly, among the three players listed Mark McGwire does not lead the home run race on Mars — Sammy Sosa is in the lead. That's because Mars's lower gravity favors hitters over sluggers.

Major League Stats on Earth and Mars

	EARTH					MARS				
Player	**Weight**	**Hits**	**2B**	**3B**	**HR**	**Weight**	**Hits**	**2B**	**3B**	**HR**
M. McGwire	250 lb	130	19	0	59	95 lb	130	0	0	130
S. Sosa	200 lb	171	19	0	56	76 lb	171	0	0	171
K. Griffey, Jr.	205 lb	158	29	3	47	78 lb	158	0	0	158

Tabulated values were correct on 4 September 1998

But something else makes almost as big a difference as gravity: aerodynamic drag. Remember how the earliest computers were made to calculate artillery shell trajectories during World War II? It sounds like a simple task. The shell comes out of the muzzle at certain speed, rises, falls, and there it hits. Except that the atmosphere immediately starts dragging on the shell, so the last half of the trajectory winds up like an belly flop compared to the graceful arc it had at the beginning of its flight.

A good place for McGwire to set a world record? Located at 14.7¡ S, 184.5¡ W, Gusev Crater is a large, ancient, meteor impact basin about 150 km (93 mi) across) After it formed it was apparently breached by water in Ma'adim Vallis. The possibility that water flowed into Gusev Crater and formed a lake has led to the suggestion that the materials seen on the floor of this crater - smooth deposits, buried craters, and huge mesas near the mouth of Ma'adim Vallis—are composed of sediment that eroded out of the highlands to the south of Gusev Crater. NASA's Exobiology Program Office cites Gusev Crater as a possible priority site for future Mars exploration because it might once have been a lake.

The same thing happens to baseballs, footballs - anything you throw through the air. The results vary with the speed, the angle of ascent, and the aerodynamics of the ball (that's why golf balls have dimples - it helps them fly farther).

All that changes on Mars

The air pressure on the Red Planet is only about 0.2 inches of mercury at sea level, nearly 150 times less than that on Earth. With virtually no atmosphere to drag on the ball, its trajectory at the end of its flight will be pretty much what it was when it left the bat. And that alone might guarantee a home run record every inning. Outfielders count on the ball dropping a little more vertically when it arrives on Earth. On Mars, line drives and fly balls alike would be fearsome things, pretty much like standing in front of the batter and catching the ball the instant it left the bat. Ouch.

And pitchers will no longer be stars. Without aerodynamics that make sinkers, sliders, and curves possible, all they can throw are straight pitches.

Indulging this fancy for a bit longer, how would you set up a ball field? It's going to be big. The balls will fly three times as far as on Earth (pop flies, going three times higher, might require air traffic clearance). The back fence better be three times as tall, too, or the outfielders might become high jumpers and find themselves in the parking lot when they try to snag the ball.

So we set up a diamond that is 270 feet on a side and an outfield with a back fence 1,200 feet out. Landscaping the site will be a challenge. Mars is covered with rocks that you don't want to trip over. But even assuming that we find a nice smooth area in one of the ancient river valleys, we face another problem: we might have to import dirt from Earth.

This image was taken by Mars Global Surveyor.

If McGwire does get to play ball on Mars, he won't be the first space athlete. Alan Shepard (right) claimed that in 1971 when he fitted a golf club to a lunar tool and drove golf ball near the end of his last space walk on the Apollo 14 mission.

Most of the dust on Mars is probably pretty jagged from millennia of being blown around the dry planet. Smooth grains come from erosion in rivers; Mars lost those a few hundred million years ago. (The problem is not unheard of. Saudi Arabia actually imported sand from the United States because our beach sand is smoother than theirs.) Ragged sand grinding against the players' spacesuits will be downright expensive. They'll have to change suits every game, perhaps more often.

Indoor baseball? We've built domes here on Earth, so why not on Mars? The stadium will be immense, even by Texan standards, to accommodate a backfield almost a quarter mile out. Construction on the Red Planet will be at a premium, so the stadium will have to double as the colonists' recreational area and perhaps as part of the agricultural system to feed them. hmmm. Plant some corn and - well, if you build it ....

Editor's Note: This article is reprinted from the Space Science News, September '98 issue, published by Marshall Space Flight Center, Space Science Laboratory, with the permission of Linda Porter, web site curator. All images used are courtesy of same. The material presented has been edited to the style and format of this publication. ■

Celebrating IMP's 25th Anniversary

Joseph King and Natalia Papitashvili, National Space Science Data Center, Goddard Space Flight Center

NASA's Interplanetary Monitoring Platform (IMP 8) spacecraft was launched 25 years ago from Cape Kennedy on October 25, 1973. IMP 8 continues to provide important in situ cosmic ray, energetic particle, plasma, and magnetic field data. The spacecraft is in a nearly circular orbit about the Earth, at a distance a little more than half way to the Moon. The orbit is near 35 Earth radii (Re) and has a 12+day period.In this orbit, IMP is in the solar wind about seven days per orbit and is within the Earth's magnetospher/magnetosheath system about five days per orbit.

IMP 8 was built at and has been operated over its lifetime at Goddard Space Flight Center. It was the last of the series of IMPs intended for geocentric orbit. There were also two "anchored IMPs" intended for lunar orbit. Over the past 25 years more than one thousand scientific papers have been published in refereed scientific literature in which IMP 8 data were the sole data used or were important adjuncts to data from other missions also used in those papers.

New IMP 8 data set

Over the past 20 years the IMP 8 team at the University of Maryland (UMD) has been providing to the National Space Science Data Center (NSSDC) on magnetic tape selected processed data from their IMP 8 investigation. This investigation consists of two detector systems for measuring energetic charged particles: the Electro-static Engergy-Charge Analyzer (EECA) and the UltraLow Energy Telescope (ULET). The ULET system failed a few years after launch, but the EECA continues to provide important data after 25 years of operation in space.

The data came to NSSDC in IBM-binary format in 1991 and then in VAX-binary form thereafter. Each "normal" data record contains 11-min resolution EECA count rates and pulse height data, enabling determination of physical parameters. In additon, each record contains much ancillary and engineering information of little potential value for science data users. Finally, each record has many words devoted to data from the ULET instrument, where such words are meaningfully filled for ony the first five years of the IMP 8 life. In addition, each "normal" record was followed by zero, one or many special ULET records according to how many energetic particles were pulse-height-analyzed by ULET during the 11 minutes covered by the normal data record (how many such ULET records followed a given normal record was given in a daata work of the normal records.)

This new data set is acessible as monthly ASCII files (3-6 MB each) from the NSSDC Data Archive Distribution System's (NDADS) SPyCAT system. NSSDC consulted with UMD personnel in this data set definition and creation.

IMP particle data available

There have been several recent milestones reached at NSSDC in making the uniquely long data sets from IMP 8 investigations network accessible. Robert Decker of the Applied Physics Laboratory has provided to NSSDC more than 100 CD-ROMs containing 20-sec resolution count rate data from the Charge Particle Measurements Experiment and Energetic Particles Experiment supplemented by magnetometer and solar wind plasma data. NSSDC has now loaded all available data from 1973-1997 to NDADS for SPyCAT access.

Another key IMP 8 particle data set extended through 1997 is 15-min count rate data from the University of Chicago. Owing to its smaller data volume, this ASCII data set is held on magnetic disk for anonymous file transfer protocol access rather than for access through NDADS SPyCAT.

Additionally, data from the McGuire/McDonald energetic particle experiment have been added to NDADS very recently and are described in the IMP 8 holding file. They will be made accessible through SPyCAT imminently. ■

The goal of NASA's many outreach programs is to promote to the general public an understanding of how NASA makes significant contributions to American education systems and to institutions dedicated to improving science literacy. This newsletter provides one vehicle for reporting how applications and hardware used for space science other NASA research and development can be adapted for use by teachers and their students and by non-NASA organizations.

Report on MU-SPIN's Eighth Annual Conference

James Harrington, Jr., and Valerie L. Thomas, Minority University - Space Interdisciplinary Network, Goddard Space Flight Center

For the 8th consecutive year, the Minority University - Space Interdisciplinary Network (MU-SPIN) held its annual Users Conference. This year's conference, hosted by the Southwestern Indian Polytechnic Institute (SIPI) in Albuquerque, New Mexico, focused on the theme "Strengthening Partnerships Between Tribal and Non-Indian Institutions." A NASA educational outreach program, MU-SPI has sucessfully developed a strong infrastructure of hardware, software, and human resources and offers training and, as of recently, applications. The program has made some impressive impacts during its eight years.

Development phases

MU-SPIN evolved through four major phases: conceptualization; infrastructure (hardware, software, and human resources); training; and applications. The success experienced in each of the phases was enhanced by the recognition of the importance of collaboration at all levels of the project.

During the conceptualization phase, collaboration was demonstrated with the idea for the project emanating from NASA Headquarters and the formulation and structuring of the project being done at the Goddard Space Flight Center (GSFC). The infrastructure development involved collaborations with GSFC, the National Science Foundation (NSF), and the Association of Computer and Information Science/Engineering,Departments at Minority Institutions (ADMI). While GSFC,managed the project, NSF provided infrastructure grants to some of the MU-SPIN institutions for Internet connectivity, and support for the MU-SPIN Users' Conferences and ADMI provided,access to the deans of the engineering schools and heads of the computer science departments at minority institutions (and other institutions with large minority enrollments.)

With the establishment of the MU-SPIN Network Resources & Training Site (NRTS), MU-SPIN collaborations took off at an explosive rate. Collaborations include: NASA; seven NRTS institutions and other higher education institutions, Kindergarten Through Grade 12 (K-12) schools in their regions; other government agencies; and other organizations. This allowed the NRTS to train a large number of students, faculty, and staff through their education and research outreach initiatives as part of the applications phase. During the current phase of the MU-SPIN development, partnerships are being established which will bring them into the mainstream with an awareness of and experience with the cutting edge science and technology research.

Partnership with tribal institutions

This year's MU-SPIN Users' Conference was a unique experience for its attendees because it was hosted by a Tribal College. Understanding how NASA research and education resources can be implemented in Tribal Institutions is a critical goal for NASA. During the conference the welcome address was given by Carolyn Elgin, SIPI President. The keynote address was presented by Dave Warren, Professor Emeritus at the Institute of American Indian Art & the Smithsonian National Museum of the American Indian. Remarks or presentations were given by Karen Buller, President of the National Indian Telecommunications Institute (NITI); Jose C'de Bacca, American Indian Science & Technology Education Consortium (AISTEC); Maureen Smith, Wabanaki Science and Math Project; Michelle Bekaye and Alvino Sam, American Indian Network Information Center (AINIC); an Phillip Sakimoto, NASA Headquarters Tribal Colleges Program Manager.

In addition to the conference speakers mentioned above, Georgia Johnson, University of Idaho, gave a very interesting presentation on how the Space Grant Math and Science curriculum will work for Native American students if "the frame of reference and teaching strategies include the tribal world views and experiences of the Indian students." Johnson proposes that the theory of "Ethnoscience" helps to better understand the differences in world views between European thinkers and Native thinkers and will help frame instruction. Ethnoscience includes the methods, thought processes, mind sets values, concepts, and experiences by which Native American groups understand, reflect, and obtain empirical knowledge about the natural world (Cajete, G.,1986).

Adopting an Ethnoscience framework will aide the educator in adopting a broader view of knowledge systems. Successfully teaching Indian students requires a shift in thinking - western, scientific thought and knowledge is not THE TRUTH, it is ONE way of understanding the world. The following chart is an overview of world-view differences between European and Indian knowledge systems. The chart is a guide to aid the teacher as she/he plans inclusive lessons.

Ethnoscience

AMERICAN INDIAN	EUROPEAN
Cyclical Time	Linear Time
Harmony and Balance	Hierarchies
Matrifocal (Mother Earth)	Patrifocal (Laws)
Oral Knowledge Base	Written Texts
Group Identity	Individualism
Shared Resources	Accumulation
Observing	Talking
Respect for Elders	Challenge the status quo
Creation	Creation
Thinking	Making
1. Thought Woman	1. Deity
2. Rituals	2. Rewards/Punishes
3. Sacred Places	3. Churches - man made
4. Relatedness	4. Separateness

There are several visible results of these conference activities. In addition to everyone receiving a thorough education about tribal culture and education, some new tribal and non-tribal collaborations were initiated. California State University - Los Angeles established a new initiative to work with tribes in northern California on remote sensing and geographic information systems (GIS) concepts for managing tribal lands and resources. NASA is working with NITI to conduct a study of telecommunications capabilities for tribal colleges. Prairie View A&M University is planning to upgrade distance learning technology at Dine College.

NRTS technology expertise

Another major highlight of the conference was the opportunity to see the overall impact of the MU-SPIN project on the minority community in the MSET areas. This opportunity was available through the NRTS Principal Investigators and Consultants Poster Session, held on the first day, and the presentations and Student and Faculty Poster Session, held on subsequent days.

NRTS showcased their technology expertise in areas such as videoconferencing and distance education, multimedia, high performance computing, and cache servers. Videoconferencing and distance education topics such as the best set-up for the NRTS, curriculum-based distance learning opportunities, and a portal to emerging technologies were presented. Topics covered in the multimedia area were streaming content and courseware development, hypermedia and the textbook, design tools for developing web pages, object oriented programming, and graphical programming in the study of digital arithmetic. Hardware and software technology presentation topics included: a summer institute for faculty and student high performance computing technological and scientific investigations, and cache servers. To help strengthen the MU-SPIN institutions' ability to write winning proposals and their understanding of NASA research opportunities, Mildred Boyd gave a presentation on proposal writing and Dillard Menchan gave a presentation on research opportunities.

Education and research outreach activities were addressed in the presentations and poster sessions. NRTS showcased the impact of their programs mainly during the NRTS and the Student and Faculty Poster Session, presenting, in addition to topics previously mentioned, information on astronomy, astrophysics, robotics, CCNY Weather Network, material sciences, environmental science, the Internet and the science classroom, teaching multimedia in Kindergarten Through Grade 12, and creating and using Thread with Java. Additionally, there were presentations by others on students sharing their weather while learning math, Global Observations for a Better Environment (GLOBE), the Sun Earth Connection, Earth Science, ECHO the Bat (remote sensing/visualization curriculum), Project VISION, Mars Orbiting Laser Altimeter (MOLA), digital libraries, and using algebraic software and graphical calculators.

Because of the large number of conference activities, all of the presentations and posters have not been explicitly mentioned in this article; however, an attempt has been made to cover all of the main topic areas.

This conference opened the doors for new collaborations. They include NRTS and NASA science and education collaborations as well as tribal and non-tribal collaborations. The collaborations with the Tribal Colleges has strengthened MU-SPIN's ability to impact all of its constituent groups. ■

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GLOBE Program Expands Science Studies, Adds New Features

Since 1995, Global Learning and Observations to Benefit the Earth (GLOBE) students have been engaged in regularly taking and reporting of environmental data at their schools. Based on the recent recommendations of a National Science Foundation (NSF) peer review panel, GLOBE students will add several new measurements to their core of study over the next few years.

Current research

At Florida State University, Paul H. Ruscher is enlisting GLOBE students in measuring relative humidity. Relative humidity measurements will build on the existing suite of GLOBE atmosphere measurements and be useful in the analysis of various Earth systems phenomena. Dr. Ruscher is also assuming responsibility for student cloud observations.

GLOBE students will also undertake a study of surface ozone concentrations. The question of separating harmful surface ozone build-up from the overall concentration of ozone in the atmosphere is of great concern in understanding the global environment. According to Jack Fishman of NASA, who is heading-up this investigation, student observations hold great promise for adding to current knowledge.

Also, in the field of atmospheric science, David Brooks from Drexel University in Pennsylvania is seeking GLOBE student support in his studies of atmospheric haze. Haze layers affect the surface radiative balance of Earth and, therefore, are a factor in local and global environmental conditions.

In the hydrology field, Roger Bales and his colleagues at the University of Arizona are developing an aquatic macroinvertabrates protocol. Students will use this protocol to determine the diversity of bottom-dwelling macroinvertabrates at their hydrology site.

David Verbyla of the University of Alaska at Fairbanks will use GLOBE student data to improve understanding of changes in growing seasons, a major potential indicator of climate change. Expanding their current land cover studies, GLOBE students will help researchers track seasonal changes. While satellite images reveal the large patterns of seasonal green-up and green-down, they do not provide species specific data.

In the United Kingdom, the Wildlife Trusts is developing a new three-year program that will enable schools to participate in GLOBE. Andy Tasker, the Country Coordinator for GLOBE in the United Kingdom expects many schools to be eager to join GLOBE.

"Linking the Internet with the local environment in this imaginative way shows how technology can help provide solutions, as well as encouraging more people to find out about environmental issues," Tasker said.

GLOBE goes 3D

Recently GLOBE announced a new visualization tool that displays the Earth in 3D. From the GLOBE Visualization site on the World Wide Web, you can now display GLOBE student data, and reference data, on a 3D globe. By simply using the computer mouse, you can rotate the globe any direction or zoom in on a specific geographic point.

This new feature, created with virtual reality modeling language, provides a more realistic image of the true shape of our planet than possible with flat, 2D maps. The 3D technology requires some special (but free) software and a computer with certain specifications.

Founding KidsGLOBE

Finding money to buy scientific instruments and computers can be difficult for some schools in developing countries. With help from former Peace Corps volunteer, Bryan Garcia, many of these students may get their chance to be a part of GLOBE through KidsGLOBE, a non-profit organization founded in the summer of 1997.

"In my travels, I have met many young people who are eager to help contribute to our understanding of the environment by joining the GLOBE student and scientist network," he explained. "Unfortunately, many schools in developing countries have great difficulty securing the necessary equipment, such as scientific instruments and computers."

According to Garcia, KidsGLOBE is soliciting donations from private individuals and organizations to help defray equipment and training costs, particularly for those schools in developing countries. Garcia also plans to raise funds through the sale of items, such as GLOBE T-shirts.

"KidsGLOBE will significantly aid in the effort expand GLOBE around the world," said GLOBE Director Tom Pyke. "Bryan Garcia's experience working with the Peace Corps in developing countries will help to ensure the success of KidsGLOBE."

KidsGLOBE unveiled its own web site in May, 1998. In October of 98, KidsGLOBE released "The Sound of GLOBE" CD featuring music written and performed by GLOBE participants all over the world. Creation of the CD was spearheaded by the Netherlands GLOBE Country Coordinator, Martin Bosch; Czech Republic GLOBE Country Coordinator, Dana Votapkova; and Finnish GLOBE teacher, Mika Vanhanen. The CD includes four instrumentals and 14 songs about GLOBE and the environment, many of which are sung by GLOBE students and teachers.

Lessons in language

Anyone who has taken a foreign language class remembers starting with the fundamentals: introductions, conversing about the weather, or other hypothetical discussions. Many educators involved with GLOBE have discovered that participation in the program provides an opportunity for students to learn to conduct real conversations while also learning a second language.

GLOBE teacher, Teresa Kennedy, of Moscow, Idaho, reports that the GLOBE Program lends itself as a vehicle for learning foreign languages, social studies, and culture, and provides the perfect foundation for interdisciplinary study. Kennedy, who also teaches at the University of Idaho's College of Education, is incorporating GLOBE into the curriculum of the Idaho Foreign Language Elementary School Program. She and her colleagues at the University are beginning this initiative at the elementary school level, where they feel students have a greater aptitude for learning a new language.

Students in Kennedy's classrooms are using Spanish versions of the GLOBE printed and online materials. They are also using GLOBEMail to practice their Spanish by contacting their peers in Spanish speaking countries, such as students at Colegio La Misericordia, Colegio El Buen Aire, and GLOBE schools in Argentina. Kennedy emphasizes that, when kids enjoy using a foreign language, they are more likely to learn it.

"GLOBE brings everything into perspective. The students are not learning isolated vocabulary words. It's true to life. The kids love it, and I really think they are going to come out with a higher proficiency," Kennedy says.

Tony Magnelli, a GLOBE Teacher at the Quaker Valley Middle School in Sewickley, Pennsylvania, describes another example of the interdisciplinary model. Magnelli's sixth graders study South America in social studies and use GLOBE to study Spanish. The students are establishing an information exchange program with those South American GLOBE schools wanting to use GLOBE in their English studies. The students in Pennsylvania will get online assistance in sharpening their Spanish skills while offering to tutor the South American students in English. Magnelli's students will also be producing email bulletins and weekly videos - in Spanish - to report weather data to their classmates.

"GLOBE activities give these students the chance to really put their Spanish lessons to work, not just engage in role play," Magnelli said.

In other classrooms, GLOBE is being used to teach English to many deaf and hard-of-hearing students for whom American Sign Language (ASL) is their first language. The students are using GLOBEMail to help practice English writing skills.

"Deaf students are communicating among themselves in ASL when they're using their hands in sign language, but when it comes to writing or reading, they have to switch over to English," explains Jerry Jones, a GLOBE Teacher at the Mississippi School for the Deaf in Jackson. "There are grammatical differences between the two languages."

Jones students presented the results of research on El Nino at the GLOBE Learning Expedition in Helsinki, Finland. As part of their presentation, the students taught their peers from other GLOBE schools some GLOBE words and phrases in ASL.

Costas Cartalis, Country Coordinator for GLOBE Greece, reports that in schools where students are required to learn a second language, GLOBE materials are being used to improve English skills. "The students are excited about having a real opportunity to practice their English through communications with GLOBE scientists and students in other countries and by using the GLOBE Web site. According to Cartalis, participating in the GLOBE Web chats requires the students to quickly read and respond to messages in English.

Web site features

The GLOBE web site offers archives of data, news bulletins, and newsletters; an exchange listing partner countries and schools participating in the program; a library resource room and image gallery; a calendar of workshops and events, such as web chats and contests; teacher's guides; and messages from scientiests. The "Scientist's Corner" features scientists in the fields of soil, hydrology, biology, global positioning, and atmosphere and climate. Student investigators are able to publish their findings on the site.

Material for this article excerpted from GLOBE bulletins and the GLOBE web site. GLOBE images courtesy of the GLOBE web site. ■

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Internet Chats With Pioneering Women

From the first woman Space Shuttle commander, Eileen Collins, to actress Kate Mulgrew, the first female starship captain on prime-time TV, at least 14 female pioneers in their fields are participating in the NASA Internet "chats" and other activities for students. The Internet events are being held through March, Women's History Month, and beyond with the list of "female firsts" growing. The project is called "Female Frontiers."

Representing diverse careers, other female mentors include the first female to win the Alaskan Iditerod dog sled race, Libby Riddles; the first American woman to walk in space, Kathryn Sullivan; the first female captain of America's Cup, Dawn Riley; the first American female astronaut, Sally Ride; the first nurse to NASA astronauts, Dee O'Hara; first female computer programmer, Jean Bartik; the first female chief of protocol, Shirley Temple Black; the first female to hold a seat on the New York Stock Exchange, Ellen Tauscher; the first female astronaut to spend time on Mir, the Russian space station; the first female to hold an executive office in NASA, Nancy Roman; the first female president of Smith college, Ruth Simmons; the first female manager of NASA's SimLab, Julie Mikula; the first African-American woman to fly in space, Mae Jamision; the first female to be trained as an astronaut, Pat Cowlings; the first female to receive a Ph.D. in mechanical engineering from Howard University and the first African-American female to receive a Ph.D. in engineering at NASA GSFC, April Ericsson-Jackson; and the first woman to undergo training developed for the selection of the Mercury astronauts, Jerrie Cobb.

Libby Riddles explained to youngsters during her Internet chat on January 28 that math and science are an important component of dog sled racing. "Although you might not think so at first, math and science are important in my career," she said. "With the dogs, one of the most scientific aspects is the nutrition, which requires math to figure out proportions and calories per kilogram of different foods, etc."

The Internet events will culminate in a two-hour Internet broadcast live from Kennedy Space Center at the time of Collins' upcoming STS-93 Space Shuttle launch, yet to be scheduled. Student "ambassadors" will present the STS-93 webcast for other young people worldwide.

"By focusing on Commander Collins' remarkable accomplishments, we are giving young girls everywhere the message that they, too, can break traditional barriers in their career choices," said Tish Krieg, who organized the on-line events from NASA's Ames Research Center.

During an Internet 'chat,' youngsters use computers to converse live with interesting professionals by typing questions and reading responses and dialogue via the World Wide Web. Participation is easy according to Linda Conrad who is also organizing Female Frontiers.

"If you have a personal computer with Internet access, you can log onto the NASA site to see a schedule, background information about the featured woman, chat instructions, and pre-registration materials. Then, go to the chat room, and follow directions," said Conrad.

First-come, first-served pre-registration via the Internet is required in order for students contribute to the chats. Other people can observe the conversations without registering. Educators can also find instructional materials on the site. Materials are cross-curricular covering subjects such as social studies, science, language arts and mathematics. Female Frontiers chats are sponsored by NASA Quest based at Ames.

"The Female Frontiers project is just one of many Internet projects that we conduct to benefit students," said Karen Traicoff, manager of NASA Quest. "Quest hosts interactive Internet activities year round that connect students with interesting people and their work. Research has shown that students learn better by real-life experiences."

Learn more about Quest's Female Frontiers program at < http://quest.arc.nasa.gov/space/frontiers/>. ■

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Telescopes in Education —

Performing Remote Classroom Astronomy Projects

The Telescopes in Education (TIE) program provides to students around the world the opportunity to use a remotely controlled telescope and charge-coupled device (CCD) camera in a real-time, hands-on, interactive environment. TIE is a Mount Wilson Institute program that is sponsored by NASA and supported by Jet Propulsion Laboratory (JPL), the California Institute of Technology (Caltech), and other businesses and volunteers. The program enables students to increase their knowledge of astronomy, astrophysics, and mathematics; improve their computer literacy; and strengthen their critical thinking skills.

TIE provides an online user guide to explain the basics of the program, system requirements, and how to participate, and presents 12 projects with instructions to be worked remotely using the TIE equipment. Training workshops include basic operation of the 24 inch automated telescope from a classroom and image processing techniques.

About the program

TIE's fundamental purpose is to provide educators and students with convenient access to professional quality telescopes, allowing the performance of scientifically valid measurements. Because astronomical observatories are usually located in remote, mountainous areas (where the sky is clear and dark) few schools are able to arrange field trip visits due to costs for transportation, camping arrangements, insurance, time away from regular classes, and other practical considerations. TIE has made access to telescopes in distant places available by pioneering remote operation of telescopes via computer.

The program, which has been in operation for more than four years, has served more than 150 schools (250 educators) in the US, and recently extended service to other countries (including Australia, Canada, England, and Japan), serving over 25 foreign schools. TIE has been invited to demonstrate remote telescope operation and conduct workshops at both the National Science Teachers Association (NSTA) and the California Science Teachers Association (CSTA).

To participate in the TIE program you will need an IBM PC-class computer, or an Apple Power Macintosh running SoftWindows software, with at least four megabytes of RAM for operation of the software that controls the telescope. The telescope can be accessed with a 386 computer, but a 486 computer or better is preferable. You will also need a 9600 baud or faster modem plus a separate voice line to facilitate communication with the volunteer telescope operator during sessions. Additionally, you will need a SVGA monitor and driver card, which will provide the sharp image needed for quality imag processing. There is no charge for use of the TIE equipment.

You will also need the Remote Astronomy Software (non-frame site) package, that includes "TheSky" and "SkyPro." "TheSky" provides instructions for linking to the telescope, location selection, and communication language. "SkyPro" aids in planning your observation sessions.

TIE equipment

TIE utilizes a science-grade 24-inch reflecting telescope with a focal ratio of f/3.5 and a focal length of 84 inches. The telescope was originally designed in 1963 and installed on White Mountain in the Sierra Nevada Range for the Apollo space program. Later the telescope was moved to the Mount Wilson Observatory in the San Gabriel Mountains of southern California where it was used for two decades by Caltech graduates before being dismantled in 1988 and stored in the large dome at Palomar Mountain. In 1993 Dr. Robert Jastrow, Director of the Mount Wilson Observatory, acquired the telescope from Caltech for the TIE Project.

When the telescope was re-installed for TIE, it was refurbished and fitted with a Newtonian focus cage and an advanced computer controlled drive mechanism. When the telescope and its new auxiliary equipment, including the CCD camera system, were placed into service, the TIE program and students immediately started using the system to observe galaxies, nebulae, variable stars, eclipsing binaries, and other ambitious projects and experiments.

The electronic camera used for the TIE program, a Santa Barbara Instruments Group (SBIG) ST-6a, is based on CCD technology. As described in the TIE User's Guide and Workbook, "The CCD is a microchip that contains an array of thousands of pixels arranged in a matrix on its surface. A pixel is the basic element of the CCD, a place where photons are converted into electric signals. Pixels are quite small, typically measured in microns. An entire array of tens of thousands of pixels is typically less than a quarter of an inch square. The number of pixels in the array determines the resolution of the ultimate image made by the CCD. The higher the number of pixels per millimeter, the higher the resolution, and the closer the image will be to real life.

The SBIG has a very large array size. Camera specifications are:

- array size: 375 x 242 pixels
- total pixels: 90,750 o Resolution: 2.5 arc second/pixel
- image Field-of-View: 13.9 x 10.5 arc minutes
- ADC Resolution: 16 bits Cooling: Thermoelectric, two stage
- software: controlled by SkyPro from Software Bisque

An important feature of the TIE equipment is the ability to command the camera that is mounted to the 24" telescope to take an electronic picture of the sky and then download that image to the classroom computer. The telescope and CCD camera are completely computer controlled and can be operated remotely by educators and students from computers in their classrooms via modem and special astronomy software. Images are downloaded to a remote user of the telescope in five minutes or less, depending upon modem speed, and stored in the user's computer for later image processing and study. Observation time on the TIE telescope can be reserved any evening of the week for sessions of one hour to an entire night. Also, arrangements can be made for projects requiring special observation times or long-term, repetitive observing runs.

Using the workbook

The TIE User's Guide and Workbook provides 12 online astronomy projects geared for the beginning through the advanced astronomy student. Prior to beginning the projects, you must set up your system according to the system requirements referred to in a preceding paragraph (hardware and software) and familiarize yourself with the software. You should then arrange an online test, typically early in the evening when a TIE operator is present, with the Mount Wilson Institute. This test will determine if the remote setup is functioning properly.

Following a successful online test, you may then begin scheduling observation sessions. These sessions should be developed, with the aid of star charts that are available in monthly publications of Astronomy and Sky & Telescope, or in TheSky software, prior to contacting the TIE operator to schedule them.

Each of the Workbook's projects gives instructions and tips on accomplishing the objective. Some projects are best done in a group setting. The projects are briefly described in the following paragraphs.

Project 1, which can be performed by all, is the "Basic Use of the TIE 24" Telescope System," prepared by Blake Bartosh and Shelley Bonus. Project 1's objective is to give the student/amateur experience with efficient and planned use of the TIE telescope, while collecting a variety of images of various object types. Students need to have an observing program planned for the session.

Project 2, which can be performed by all, is "Adopt a Constellation," prepared by Shelley Bonus. Project 2's objective is to find your way around the sky season by season and constellation by constellation, and to learn the various cultural myths associated with each constellation. Students learn to identify many Messier and NGC objects in each constellation, and do an in depth and systematic study of those objects. Students need to know how to use TheSky software.

Project 3, which can be performed by all students/amateurs, is "Adopt a Galaxy—The Search for Supernovae," prepared by Blake Bartosh. Project 3's objective is to choose galaxies oof proper location for time of observation, and image these galaxies periodically. Students learn to examined images, validate by comparison, and record behavior.

Project 4, which can be performed by all students/amateurs, based on grade level, experience and number of sessions devoted, is "A Survey of Deep Sky Objects," by April Labrecque. Project 4's objective is to choose a type of deep sky object, nebulae, galaxies, globular clusters, planetary nebulae, etc, appropriate for season location, and record images to create a personal catalog and log book. Accurate photometry is required.

Project 5, which can be performed by the intermediate student/amateur, is "Near Earth Objects—Comet and Asteroid Studies," by Andre Bormanis. Project 5's objective is to obbserve, image, and catalog selected near-Earth objects (NEOs) using information published in various magazines, journals, and other publications. Catalog information will include object history, classification, orbital elements, photometric data, estimated size and mass, and other available data. Knowledge of NEO coordinates is required.

Project 6, which can be performed by the intermediate student/amateur, is "The Colors of the Stars" prepared by Blake Bartosh. Project 6's objective is to utilize advanced techniques, including filter wheel and photometry, to measure the color index (B-V, V-R, etc.) of stars using the TIE telescope system. Knowledge and use of filter wheel, photometry, color magnitude diagram are required.

Project 7, which can be performed by the intermediate student/amateur, is "The Colors of the Stars in Open Clusters," prepared by Blake Bartosh. Project 7 is an extension of Project 6 and has the same requirements.

Project 8, which can be performed by the advanced student/amateur, is "Advanced Imaging Techniques," prepared by Blake Bartosh. Project 8's objective is to learn about the sources of noise, signal to noise ratio, the importance of exposure time, dark frame, flat field, resolution, background and range on the quality of images. Images taken with different exposure characteristics are then compared. The project also includes introduction to the advanced image processing capability of SkyPro, including "Track and Accumulate" and "Unsharp Mask."

Project 9, which can be performed by the advanced student/amateur, is "Variable Star Studies—Keys to the Universe," Barret Duff. Project 9's objective is to familiarize students with three types of stars that vary in light: pulsating variables, eruptive variables and eclipsing variables.. Knowledge and use of filter wheel, photometry software, and light curves is required.

Project 10, which can be performed by the advanced student/amateur, is "Focus on RR Lyrae Stars—The Anatomy of the H-R Diagram," prepared by Barrett Duff. Project 10's objective is to measure the periods of as many RR Lyrae variables as possible in a given cluster and plot their light curves. Knowledge and use of filter wheel, photometry software, and light curves is required.

Project 11, which can be performed by the advanced student/amateur, is "Variable Star Search," prepred by Barrett Duff. Project 11 is an extension of Project 9. Knowledge and use of filter wheel, photometry software is required.

Project 12, which can be performed by the advanced student/amateur, is "Asteroid Rotation and NEO Search," prepared by Andre Bormanis. Project 12's objective is to observe and image selected NEOs with the intent of detecting periodic changes in apparent magnitude, i.e. light curves. Light curves are used to determine asteroid rotation rates. Searches for new NEOs are also conducted. Knowledge and use of photometry software and NEO coordinates light curves is required.

Conclusion

Automation of the 24 inch telescope on top of Mount Wilson allows the operation of a research quality instrument from computers in classrooms, greatly increasing the number of educators and students who can directly participate in observational astronomy, physics, and other projects. Currently, students must return to their classroom at night to operate the telescope, when stars and other celestial objects can be seen. Unfortunately, there are still many students who cannot, for a variety of reasons, return to their schools at night. The TIE program hopes to reach these groups by encouraging the automation of telescopes at observatories on the other side of the Earth (where it is night during our local day) and providing access to those sites through the Internet. Students would then be able to operate a telescope during their regular, daytime classroom hours. Additional benefits include cultural exchange and enrichment between educators and students in the US and other countries working on shared projects.

TIE has already established a cooperative agreement with Zvenigorod Observatory near Moscow, Russia, which will automate their large Zeiss telescope and add it to the TIE system. A TIE network of automated telescopes around the world will make possible more ambitious research, such as comet and variable star studies, asteroid searches, and identification of supernova. TIE is dedicated to establishing an international network of remote controlled telescopes and welcomes inquiries from astronomers and observatories from around the world.

TIE is the recipient of the 1996 Rolex Award for Enterprise for Applied Sciences and Invention, an international competition consisting of more than 2400 applicants, worldwide. TIE director, Gil Clark, was one of only five laureates honored in 1996. Additionally, Clark has received the Clifford W. Holmes Award for Innovative Telescope Design, as well as awards from NASA and JPL. In 1998 the TIE web site was voted Outstanding Education-Related Web site. Clark and Lori Paul, the TIE outreach coordinator, have had asteroids named after them.

Learn more about TIE, how to participate in the program, and where to purchase the software at
< http://www.mtwilson.edu/Science/TIE/>. ■

NASA's wealth of technology is being re-used in the fields of medicine, industry, and education and by the military to develop products and processes that benefit many sectors of our society. Spinoff applications from NASA's research and development programs are our dividends on the national investment in aerospace.

A World Map for the Millenium

America's schools will receive a unique gift during this year - a 4 by 6 ft. laminated, updated map of the world - produced by the Jet Propulsion Laboratory, a pioneer in the area of digital imaging to produce pictures from space exploration, for the National Geographic Society. Nearly two years ago JPL's Technology Affiliates Program forged a partnership between JPL's Cartographic Applications lab and National Geographic to produce a digital satellite image map of the world that would be distributed free to the nation's schools. The Technology Affiliates Program is designed to help American businesses and other institutions to utilize the knowledge and skills of the space program's scientists and engineers presents a unique challenge.

JPL accepted and met the unique challenge of "pulling the world together" into one seamless map for the National Geographic Society, which has a high standard for visual and photographic images. According to Nevin Bryant, manager of the Cartographic Applications Lab, who oversaw the 18 month project, the map is far more than just a "pretty picture." The satellite images were collated with relief and other geo-referenced data, so it is both an image and a precise physical map. Each pixel element of the digitized map is equal to one kilometer. This map can be used to support regional and global maps of the Society's mapping division, as well as visualizations for television.

"You can put your cursor on any point on the Earth, and it will be correct within a few tens of meters," said Bryant.

Making the mosaic

The cartographic group used more than 500 National Oceanographic and Atmospheric Administration (NOAA) Weather Satellite images, acquired over the past ten years by the Advanced Very High Resolution Radiometer (AVHRR) instrument, to produce a global mosaic. The AVHRR instrument, first developed at JPL in 1965 and continuously refined over the years, consists of an across-track scanner that covers a 1500km swath along its orbit track. However, this broad swath is at 1km resolution (or better) only for the center half of each scene, degrading to as much as 6.5km per pixel at the scan edges. Therefore, except for the center, most of the frame of each picture was thrown out.

To obtain cloud free imagery, twice as many passes were used, getting images in early morning and mid afternoon. JPL used 10 bit data to provide 1024 discrete levels of gradations for a higher resolution picture. This greater information allows you to discern subtle features in either the rainforests of South America, the icy domes of Nepal, or the deserts of the Sahara. The worldview of the Ocean's floors comes from the Scripps Institution of Oceanography in San Diego.

Bryant explained that it was necessary to use so many images 1) because many parts of the world are cloud-covered much of the time, and 2) because of the desire to use imagery that was a true 1km resolution per pixel (picture element). After acquiring the images several innovative processing steps were used in the preparation of the global mosaic. Using specialized software, formulas, and expertise gained from producing images from space, JPL was able to produce a world map that is the highest resolution and most consistent representation to actual natural colors yet available.

A special gift

The National Geographic Society is marking the new millennium by presenting the gift of the two-sided map to each of the nation's more than 100,000 public and private schools in the 1998-99 school year. One side depicts the political world as of June 1998. The other side is a digital picture of the physical world based on images collected by AVHRR. The political and physical maps are in the Winkel Tripel projection, developed in Europe to show the round earth on flat paper with minimum distortion.

"This relationship shows how well federal research can be leveraged for the public as well as science," said Merle McKenzie, manager of the Commercial Technology Transfer/Regional Development Program.

"In the closing decade of this century entire countries have come or gone, boundaries have shifted and place names have changed," said National Geographic Society President John Fahey. "What better way to start the new millennium than to make sure every one of our nation's schools is on the same map?"

The map also celebrates the 10th anniversary of the National Geographic Society Education Foundation, a fund dedicated to improving the geographic knowledge of America's students.

Material excerpted from JPL's Technology Transfer Success Stories web site. For information from the National Geographic Society on buying the map ($39.95, order number M8I22001C), call (800) 368-2728. Schools that have not yet received a free map can write to: School Map Giveaway, National Geographic Society Education Foundation, 1145 17th St. NW, Room 2430, Washington, D.C. 20036-4688. ■

NASA's wealth of technology is being re-used in the fields of medicine, industry, and education and by the military to develop products and processes that benefit many sectors of our society. Spinoff applications from NASA's research and development programs are our dividends on the national investment in aerospace.

NASA Partnerships Develop High Tech Medical Tools

NASA and Stanford University have teamed to develop high tech medical diagnostic and operational tools, such as the smart probe, which will be used for breast cancer detection and analysis, and the software scalpel, which helps doctors practice reconstructive surgery and visualize the outcome more accurately. The partnership formed Biocomputation Center, which is a national resource that uses computer technology to improve medical practices.

NASA also teamed with the Fetal Treatment Center at the University of California - San Francisco to develop a "pill transmitter" that monitors mothers and their babies following corrective fetal surgery. The "pill" will monitor body temperature, pressure and other vital signs in the womb, radioing this critical information to physicians.

Smart probe

The team is in the preliminary stages of developing a smart probe that can be used for breast cancer detection and analysis. The probe is designed to "see" a lump, determine by its features if it is cancerous, and then quickly predict how the disease may progress. Researchers say surgeons may be able to insert the computerized tool's needle-like tip into breast lumps to make instant diagnoses and long-term cancer predictions.

"This device will permit us to make real-time, detailed interpretations of breast tissue at the tip of the needle," said Robert Mah of Ames Research Center's (ARC) Neuroengineering Laboratory. "This instrument may allow health care providers to make expert, accurate diagnoses as well as to suggest proper, individualized treatment, even in remote areas."

Mah explained that special neural net software, which is trained and learns from experience, is used to enable the smart probe to recognize cancer and predict its progress. Scientists can teach the breast cancer diagnosis device to predict how aggressive the disease may be. According to Mah, the computer software uses pattern recognition to look for tell-tale characteristics of the lump.

"We hope to use this device not only to detect cancer, but to understand the nature of an individual cancer," said Stefanie Jeffrey, Assistant Professor of Surgery and Chief of Breast Surgery, Stanford University School of Medicine in Stanford, California. "This information may help us determine the distinctive features of a malignancy and how the disease may progress; more knowledge about the cancer may guide us to better individualizing treatment."

Jeffrey and Mah are working together to develop the new device. They predict that once the smart probe has completed laboratory tests, Jeffrey will begin testing the device on human beings, perhaps by early 1999.

Robyn Birdwell, Assistant Professor of Radiology, Breast Imaging Section at Stanford University, stated that ultrasound will help guide the doctor to properly insert the smart probe into a breast lump. According to Alex Galvagni, a neuroengineering team computer engineer, the same technology used in the portable, smart probe could be used in other instruments to help in diagnosing and treating cancers found in other parts of the body, including the prostate and colon.

The breast cancer tool is a spin-off from a computerized robotic brain surgery "assistant" that was previously developed by Mah and Neurosurgeon Russell Andrews. The larger brain surgery device is a simple robot that can "learn" the physical characteristics of the brain and may soon give surgeons finer control of surgical instruments during delicate brain operations.

Software scalpel

A “software scalpel,” combined with clear, accurate, 3D images of the human head, is helping doctors practice reconstructive surgery and visualize the outcome more accurately. Using the new Virtual Surgery Cutting Tool software, a physician wearing 3D glasses can see an image of a patient’s head from all angles on a computer monitor, or on the surface of a large “immersive virtual reality work bench.”

“To predict what the result will be in a real operation, the surgeon uses a computer mouse to mark the incision location and to ask the computer to ‘cut’ bone,” said Muriel Ross, director of ARC’S Center for Bioinformatics, part of the larger National Biocomputation Center. “The doctor can then remove the simulated piece of bone or can place it at a new angle or in a new position.”

Ross explained that because some patients have severe injury to the head or diseases such as cancer, there are times when physicians must rebuild a person’s head or face. The team is working on an addition to the scalpel software that will allow doctors to ‘snap’ a face back onto the 3D image of the skull on which he or she has practiced an operation. This will allow the doctor and the patient to then get a better idea of how the face will look after the actual operation.

“Eventually, we want to provide a virtual tool for surgeons to practice many sorts of surgery,” said Aaron Lee, a student from Princeton University, who worked in Ross’ lab to develop the Software Scalpel.

Each high-fidelity 3D picture of a human head is known as a computerized “reconstruction,” of an object. According to Ross, the computerized reconstructions are highly accurate, 3D visual models of the head, but can be made of any part of the human body. In the technique, a series of computed tomography (CT) scans are combined to make the 3D image using Reconstruction of Serial Sections (ROSS) software previously developed by researchers at ARC for Bioinformatics. The Ames team also combined features of the ROSS software with the CT scan version to reconstruct a breast tumor from magnetic resonance images.

The ARC bioinformatics team is working on a variety of virtual reality computer tools to aid in complex facial reconstructive surgery and other procedures. Surgeons can use the big-screen workbench, special gloves, as well as computer tracking wands and other devices to manipulate 3D computer images of patients. The team is also interested in working with mastectomy patients who require breast reconstruction, and with children who need reconstructive surgery to correct deformities of the head and face. Eventually, software systems could be used in other medical specialties or surgical procedures.

In the future, virtual reality will allow surgeons to rehearse a great many complex procedures before operations, according to Ross. The team expects that, eventually, virtual reality will be a powerful teaching tool for medical students. A digital library of computerized “virtual patients” will be created that physicians can use to share information about uncommon procedures, according to researchers.

Miniaturized transmitter

Early in 1999, the NASA-developed “pill transmitter” is expected to begin monitoring mothers and their babies following corrective fetal surgery. The “pill,” developed at ARC, is about one-third-of-an-inch across and one-and-one-third-inches long. Later, an even smaller pill will be developed that can be swallowed by astronauts so that NASA can track their vital signs during space travel.

“Nearly every time doctors operate on a fetus, the mother will later undergo pre-term labor that must be monitored,” said Carsten Mundt, an electrical engineer on the Sensors 2000 team at ARC. “Pre-term labor is a serious problem that is difficult to predict and monitor with conventional equipment, and often leads to the death of the baby. But if you implant our pill, you can measure pressure changes in the uterus that result from contractions. When doctors are able to monitor the magnitude and frequency of contractions, the physicians can identify the onset of preterm labor early enough to prevent it from becoming life threatening to the fetus.”

Earlier, pediatric surgeons at the Fetal Treatment Center pioneered a cesarean surgical approach to treat fetuses suffering from various birth defects including congenital diaphragmatic hernia. In this condition, a hole in the baby’s diaphragm lets internal organs shift from inside the abdomen into the chest cavity, leaving insufficient room for lung development. Sixty to 75 percent of babies born with this condition perish. During some of these earlier surgeries, physicians implanted larger sensor-transmitters to monitor mothers and their fetuses.

Recently, Fetal Treatment Center surgeons changed their technique from cesarean to a less-intrusive endoscopic method during which they make small incisions and insert tube-like devices through the mother’s abdominal wall. Normally, an endoscope is used to see into the interior of a body or hollow organ. Endoscopic instruments are now also used more frequently in surgeries requiring smaller incisions.

“This minimally invasive method represents the future of fetal surgery,” said Michael Harrison, M.D., founding director of the Fetal Treatment Center, who in 1981 performed the world’s first corrective surgery on a fetus before birth. Because there are no commercially available sensor-transmitters small enough to fit through the tubes used in the new endoscopic surgery technique, scientists and engineers on our team developed the pill-shaped device so that it can pass through the tubes,” said Ames team member Mike Skidmore. “Our first pill-shaped device can transmit temperatures as well as the pressure of uterine contractions.”

ARC scientists are testing a prototype version of another pill that can measure and transmit pH, or acidity in the fetus, according to Chris Somps, a scientist on the Sensors 2000 team. Somps explained that plans also call for even smaller pills that will measure the electrical activity of the fetal heart. These pills will transmit fetal heart data, as well as measurements of the baby's body chemicals including ionic calcium, carbon dioxide and glucose.

"We would also like to use this technology to study what happens to astronauts during space travel," said Skidmore. "Not only could they swallow the smaller pill transmitters we plan to develop, but we have a conceptual design of small, flat transmitters that can be taped to the body like plastic bandages.

According to Mundt there are many possible medical uses for this technology; pills could monitor intestinal pressure changes, or stomach acidity in ulcer patients - the acid-base balance in the body is a basic measure of health.

Excerpted from NASA press releases, submitted by John Bluck, ARC Public Affairs - Office of External Affairs. ■