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USGS Selects Loveland as 1994 Mendenhall Seminar Lecturer

Each year one scientist is selected by the Director of the U.S. Geological Survey to present a series of lectures to share his/her research results and its applicability to the research of other USGS scientists. The EDC's **Tom Loveland** is that scientist for 1994. Loveland was selected for this honor because of the research efforts of his team in developing "...comprehensive and dynamic land characterization data bases." In a letter announcing the 1994 Mendenhall Research Seminar Lecturer, USGS Acting Director **Robert M. Hirsch** wrote, "Your innovative approaches for mapping and describing land cover and use of the land surface are well recognized nationally and internationally." Loveland and his colleagues at the EDC developed a prototype land characteristics data base for the conterminous United States. This data base has since been used to meet the many needs of Earth science researchers involved with global modeling, monitoring, mapping, and analytic endeavors.

Tom Loveland

Since the Mendenhall Research Seminars were established in 1981, two previous winners have presented their lectures at the EDC. In 1986, **James Gardner** described "The GLORIA Project: An Amazing New View of the Seafloor." The 1987 honoree, **Samuel Luoma**, visited EROS to share his research on earthen dams, "Contaminant Impacts in Natural Waters."

After the initial shock of receiving the good news from the Director faded, Loveland was pleased beyond words. "I'm just really thrilled. I appreciate the long tradition the Survey has had as one of the scientific organizations of the government. To get a chance to do this is really a great honor for the EDC research program."

While the Mendenhall Seminar Lecturer is an individual honor, Loveland is the first to recognize the team effort that brought about this noteworthy achievement. "The good news is that this (award) really recognizes a project more than an individual. The Land Characterization Research Project is a cooperative activity between the EDC, the University of Nebraska-Lincoln (UN-L), and USGS headquarters - through **Lou Steyaert's** involvement. **Don Ohlen** and I were the first ones involved with this project and it grew with the addition of **Jim Merchant** and **Jess Brown** from Nebraska (UN-L), then **Brad Reed**, from EDC, and finally Lou (Steyaert). For the past 2 years, the six of us have worked hand-in-hand on this project every step of the way."

Loveland and the work of the Land Characterization Team were nominated last year but were not selected. He was unaware that the project had been nominated again this year so it was a big surprise. Science and Applications Branch Chief **June Thormodsgard** shares Loveland's excitement. "This is not just good for Tom, this is really good for the EROS Data Center. It will allow visibility, not only for the Land Characterization Team's work but the work of everyone at the Data Center. He will trek across the country talking to USGS employees, raising the visibility of the science agenda of the EDC and the NMD. It's just great news for us!"

The news of Loveland's honor also delights EDC Chief **Don Lauer**. "There wasn't anyone more deserving throughout the entire U.S. Geological Survey,"

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INSIDE

UP FRONT

We are all predicting that 1994 will be an interesting year in the history of the EROS Data Center.

We have had some exciting times in the past 20 years. Now we will enter a new phase of service to the land management and scientific user communities.

There have already been some major changes in our approach to assignments. The new EDC Concept of Operations (CONOPS) is being implemented in a number of areas, lines of responsibility have been streamlined from purchasing through program management. The Gore Commission report on reinventing government and the USGS Transition Team report are directing us to look at new, efficient ways to do the government's business.

Added to that are new approaches and opportunities in projects. Center researchers have shown real leadership in a major National Mapping Division initiative, the Multi-resolution Land Characterization (MRLC) project. Tom Loveland's nomination as the 1994 Mendenhall Lecturer is a prestigious recognition of the importance of the MRLC project and of the Center's role in land data management, data base development and land characterization research. Further, the newly established National Biological Survey will present many challenges and opportunities for EDC in the coming years.

And, of course, our physical plant will be changing in the new year. A great deal of building modification has already begun and, in late spring, we will break ground for the new building addition.

Brace yourself. We have an exciting year ahead.

Donald T. Lauer

Building Addition Takes Fresh Look

After 12 months of constraints, reductions, and modifications the EDC plans to break ground this spring on a 65,000 square foot building addition to house equipment and personnel supporting Landsat data handling and NASA's Earth Observing System (EOS) Program. According to EDC Building Task Force Chairperson, **Dennis Hood**, the building addition is a reality - but with significant changes to the original design. "We had planned a nice auditorium that would seat 300 for symposia and centerwide meetings. It was designed with a sloping floor, permanently attached furniture, and folding curtains dividing the auditorium to enhance its flexibility and accommodate multiple uses. While the auditorium remains, when you go from $12.6 million back to $8.75 million, the luxuries go away." Beyond these changes, Hood says some areas of the addition will be left for future development, the cafeteria will remain in its present location, and front and back parking lots will be delayed. "A plan is afoot to address some of these things, but the building addition, except for the computer floor area and limited offices will be pretty comfortable yet simple. While the lobby space stays in tact according to the original design, the level of trim won't be as nice."

Timing Constraints

Besides deciding what "niceties" to ax, Task Force members also are strapped with stringent timing constraints. "The estimate is that it will take 16 months to do the building addition to accommodate the scientists and equipment associated with Landsat and EOS data processing," said Hood. "We need to begin to occupy the addition by September of 1995. To do that we have to have a contract in place by April of 1994, so we're marching to a very tight construction and contractual schedule. We are strongly motivated to do that because 15-20 contractor personnel, hired by NASA, will show up between September and December of 1995. We have two ECS support staff on site already and more will be showing up in the interim."

Cost Reductions

The important question on the minds of EDC Building Task Force members is, Can we build a building addition with the current budget? Inflation and current construction estimates from professional contractors indicate that the $12.6 million building plans today would cost over $13.2 million. So, the problem facing the Task Force is larger than reducing from $12.6 million. "By eliminating some things mentioned earlier or by making contractors bid all alternates (put backs if money is available), the object is to get back to $8.75 million. Another wrinkle is $225,000 for postbid services and on-site representation to make "on the fly" decisions during the construction itself. So we had to find that amount in the $8.75 million also."

Drastic reductions in interior finishes, exterior site preparation (i.e., paving), and eliminating one of two elevators helped crunch the numbers. However, one other creative

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Upper Mississippi River Basin Flooding

by Wayne Rohde

During the summer of 1993, the upper Mississippi River basin experienced severe flooding that caused an unprecedented amount of destruction to many communities, homes, businesses, and natural ecosystems. Since the flood, many local, State, and Federal agencies have been involved in various aspects of flood recovery. Most recently, representatives from the Office of Science and Technology Policy (OSTP), the Office of Management and Budget (OMB), and the White House Office of Environmental Policy issued a White House directive establishing an interagency Scientific Assessment and Strategy Team (SAST) to provide scientific advice and assistance to officials responsible for making decisions about flood recovery in the upper Mississippi River basin.

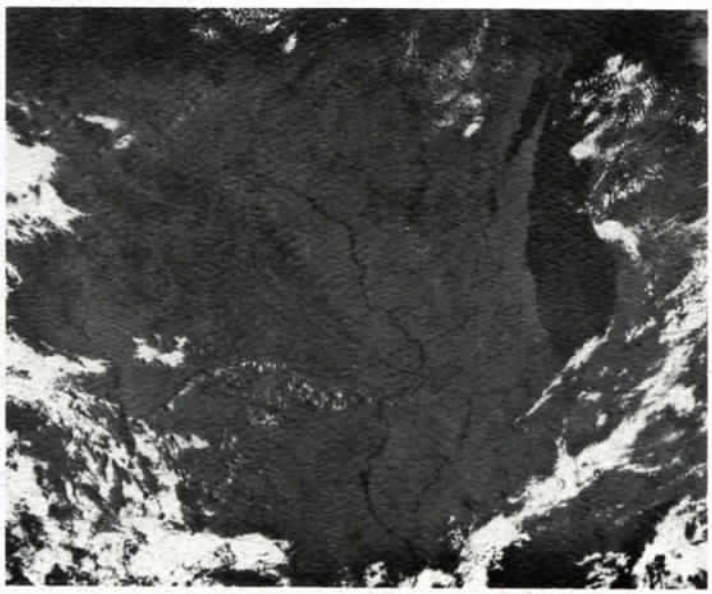
Specifically, the Team will compile information in existing data bases from a host of Federal, State and local agencies to identify broad areas of the upper Mississippi River and lower Missouri River flood plains, that, from a scientific perspective, are most suitable for alternative flood control approaches including wetland restoration. It is anticipated that the data base developed also will be useful to states and local communities, as well as other Federal agencies to address their specific flood recovery problems and to develop an integrated flood plain management plan for long-term protection and use of resources within the flood plains.

The SAST, comprised of representatives from several Federal agencies, including the Army Corps of Engineers, Federal Emergency Management Agency, Department of Interior, Environmental Protection Agency, and U.S. Department of Agriculture, will carry out its activities at the EROS Data Center. The SAST will be chaired by **John Kelmelis** from the NMD's Office of Geographic and Cartographic Research. **Wayne Rohde**, the Assistant Center Chief for Programs at EDC, also is a member of the SAST. The entire effort will be coordinated with **Mark Schaefer** of the White House Office of Science and Technology Policy and **Mollie Beattie** and **Michele Altemus** of the Department of the Interior.

The EROS Data Center is "hosting" this study because of our unique experience in data management, image processing, geographic information systems technology, and application of "geo-spatial" data to resource management problems. EDC is providing considerable technical assistance to this study with support coming from the Science and Applications Branch, the Data Services Branch, the Computer Services Branch, and the Program, Budget and Administration Office. This project will be conducted under our Research and Technology Program with **Charlie Trautwein**, Science and Applications Branch, as the Project Leader.

To accommodate SAST members, EDC has converted the Main Conference Room into a "project work room" for SAST members to use during their 8-10 week stay. The SAST began its work in December and will run into February or early March.

Upper Mississippi River Basin - July 17, 1992



Upper Mississippi River Basin - July 12, 1993

Images of the Upper Mississippi River Basin captured by the AVHRR sensor aboard NOAA's TIROS satellite. The smallest feature that can be observed on these images is one square kilometer - resolution adequate enough to see the widespread impact of last summer's severe flooding.

The USGS in Transition

by June Thormodsgard

The U.S. Geological Survey's (USGS) Transition Team's goal was to provide the new Director of the Bureau with a report to assist her/him in guiding the Bureau into the 21st Century. The Transition Team consisted of 17 members from diverse sites across the country; including Little Rock, Arkansas, Anchorage, Alaska, Sioux Falls, South Dakota and Tucson, Arizona. The team members represent a cut through the mid-management and scientific staff of the organization; rather than senior management. Most had many years invested into the organization, while a few were relatively new employees within the USGS. One-half of the team were women and most were around 40 years of age. I fit in perfectly - female, over 40 (slightly), mid-management, and just over 20 years invested in Federal service.

What was the process like? The first week was frightening for me and I was very quiet with thoughts of "how can I contribute?" running through my head. During the second week we focused on team-building. In one session we each introduced a member to the team; thus getting to know each other on a somewhat personal level. We also took the Meyer-Briggs test to establish our personality "type" and develop respect for each other and our differences. These activities were difficult to slow down for because we all felt a great deal of pressure due to the short timeline. Looking back, the exercises helped to build self-confidence and a comfort zone for all of us to participate within. We then set to work with a frenzy.

Bob Hirsch and **Bonnie McGregor**, the Acting Chief and Deputy Chief of the USGS, respectively, encouraged us to design an open process to gather ideas across the Bureau. The idea of using E-mail to communicate with our colleagues spawned the concept of GSIDEAS. The response to GSIDEAS was substantial and it was a tremendous job for all of us to read each and every message, but the thoughts and concepts presented to us were well worth the effort to read. Through GSIDEAS, central themes of both concern for our future and pride in our organization became apparent across the Bureau. We had several painful debates on whether we could afford the time for person-to-person contact with the USGS personnel. Eventually it was decided that we would spend two precious weeks on the road. One week we split into three teams to visit the USGS centers in Reston, Menlo Park and Denver. The next week we split into two-person teams to visit smaller facilities across the country. Thus, each member visited a large USGS center and several smaller facilities. While I was out stomping around the Northeast, **Richie Williams** and **Linda Bellisime** visited EDC. We got an overwhelming positive response from our site visits, and any concerns we had over these investments of time were dissipated. The team then broke into three sub-teams: human resources and organization structure, mission and programs, and organizational structure and operating systems. I participated on the mission and programs sub-team. The last three weeks were intensive; with each sub-team presenting text to the entire team and reworking the text. The sub-teams were then reconfigured and we all worked on other sections of the report. It was a challenging task to complete in 9 weeks.

I hope each of you reads the report compiled by the Transition Team. If we did our job well, you should see many of your ideas and thoughts reflected in the text. As the Transition Team came to the end of the 9 weeks, we felt that the report was not the primary result, but that our efforts will contribute to improving dialogue within the Bureau and the process of planning for the future.

*USGS Transition Team Members, **Rich Williams** and **Lynda Bellisimi**, meet with EDC employees at an open forum discussion in the cafeteria before ending their visit Oct. 7th.*

EROSDATA is published quarterly for EDC employees. The success of this publication depends on your input. EROSDATA coordinators welcome your comments and ideas for future issues.

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Ames Research Group Connects With EDC

The Science and Applications Branch (SAB) now has a three-person team located at the NASA/Ames Research Center at Moffett Field, California. The group was established by the United States Geological Survey (USGS) in 1975 to develop remote sensing applications jointly with NASA scientists and to transfer technology to other agencies. It has evolved to become an integral part of NASA/Ames' Earth System Sciences Division and a respected USGS research entity involved in developing and demonstrating techniques for mapping, monitoring, and modeling geographic data using remote sensing and GIS. The three SAB scientists at Ames are **Len Gaydos**, **Susan Benjamin**, and **William Acevedo**.

The Gaydos File

Len Gaydos was hired by the USGS Geography Program while in graduate school at San Jose State University (SJSU) to explore ways to use Landsat data to classify land use. Len spent most of his first year working for the USGS on the campus of SJSU. When NASA/Ames and the USGS got together to undertake a joint project to introduce state and local governments to Landsat applications, Gaydos accepted Ames' offer of lab and office space. He proceeded to recruit several graduate students to work on the project part-time. These were the beginnings of the small, but effective research group that has supported USGS ever since. In 1980, Gaydos and **Gail Thelin**, one of those original graduate students (now with the Water Resources Division in Sacramento), began reporting to nearby Western Mapping Center (WMC) when the National Mapping Division (NMD) was formed. Gaydos has spent his time since at both Ames and Menlo Park in several research management roles. He took time out in 1988 to go back to school at the University of California-Santa Barbara (UCSB), earning a PhD in geography in 1991. Though sharing in the excitement of WMC's development of the digital orthophoto, Gaydos didn't want to leave Ames and the collaborative bridge between agencies he helped build. Last April, NMD Chief, **Dr. Allen H. Watkins**, visited the WMC and Ames. Valuing the collaboration and research, but seeing that it was out of place as part of a WMC charged with digital orthophoto production, Dr. Watkins suggested that the group at Ames be managed by the EDC.

Len Gaydos

Early Research

Before AVHRR became a popular tool to map large areas, Len and his colleagues used multiple Landsat scenes to accomplish the same goal. As a result, the Ames group mapped vegetation in Alaska before EDC's Alaska Field Office was established in 1980. "I remember **Dave Carneggie** stopping by to talk to us on his way to Alaska to set up the Field Office (AFO)," recalled Gaydos. Eventually Susan Benjamin and Gaydos helped the AFO design the classification system used in Alaska to make interim land use maps.

Meet Susan Benjamin

Susan Benjamin joined the group in 1981 after working for a contractor running the ILLIAC super computer at NASA/Ames. She earned her M.A.degree in geography at SJSU and has since been a major contributor to a number of projects. "She started out by helping Gail Thelin on the High Plains Mapping Project. This was before **Tom Loveland** and **Jeff Eidenshink** came around with AVHRR," said Gaydos. "We digitally analyzed 100 Landsat scenes to map irrigated cropland for the Ogallala Aquifer of the High Plains covering parts of eight states. Since those early days, Susan has become an expert in using a variety of computer software systems. People around here are always relying on her expertise." Benjamin recently has worked in the field of geo-statistics. Her research focussed on estimating methane gas emissions over large areas using point samples collected by NASA/Ames scientists and satellite imagery. This work has shown how measurement error affects resulting estimates. It is an excellent illustration of how the USGS and NASA collaboration works. Benjamin and Acevedo are members of a team studying high latitude carbon led by **Leslie Morrissey** and **Gerry Livingston** at Ames. Their work in turn uses data from the AFO and feeds back into the Arctic Land Processes project led by **Mark Shasby**. Benjamin is currently working on a project with Gaydos which is now part of the Multi-Resolution Land Characterization (MRLC). Susan and Len have been investigating a new software system and tools developed at Los Alamos National Labs in New Mexico. Susan will be assisting MRLC collaborators in using these new tools for analyzing Landsat data.

Susan Benjamin

The William Acevedo Story

William Acevedo started working with the group in 1977 as a graduate student in Geology at SJSU. Acevedo is a physical scientist who joined the USGS in 1983. "He's terrifically talented," praised Gaydos. "He takes on new challenges and is able to excel in about anything he tries. His expertise these days is in scientific visualization, so he's worked with **Jay Feuquay** here at the EDC." According to Gaydos, Acevedo also has done a lot of work studying the utility of digital elevation models (DEM). One of the projects William is working on now is a model to predict urban growth with **Keith Clarke** of Hunter University in New York.

William Acevedo

In addition to modelling urban growth, William has also developed an interactive model illustrating potential affects of climate change on methane gas emissions in Alaska. The models have shown positive feedback because

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as an area warms up, more methane is released. This work also counts on the input of Ames scientists and contributes to the AFO's Arctic Processes project. William has helped USGS geologists visualize magma flows under Hawaii's Haleakala Volcano using seismic data.

Expanded Connections

Because of Acevedo's modelling expertise, the new EROS/Ames Research group sees its future involving more scientific visualization. For example, the first thing Acevedo did when he acquired the EDC's Normalized Difference Vegetation Index (NDVI) data was to generate an animation of it. The new affiliation with EDC also will mean stronger bridges between the scientific communities at NASA/Ames and EDC. Within NASA/Ames Earth System Science Division the group works in the Ecosystem, Science, and Technology Branch. NASA/Ames is vital to the Mission to Planet Earth because it operates NASA's high and medium altitude aircraft programs. Photography from those missions has been archived at the EDC for years. Recently digital data from several Ames aircraft sensors also have been sent to the EDC for the Distributed Active Archive Center (DAAC). NASA/Ames provides an excellent scientific test-bed for EDC data. NASA support for the new tie to EDC is enthusiastic. "**Jim Lawless** [NASA Earth System Science Division Chief] wants to lock us up in a room together with representatives of EDC and NASA until a dozen winning ideas emerge for exciting projects building on these new ties," recalls Gaydos. "We've already thought of several, and should have no problem meeting his goal." Just as EDC has bridged a relationship with the Goddard Space Flight Center, it is hoped that EROS/Ames Research will build another NASA bridge out west. "My own goal," shares Gaydos, "is to bring more science and applications to the Division as a whole. I see the NMD having real potential for helping to solve national and international problems, but we're not really there yet. We're mostly supplying and managing data rather than using data. I'd like for us to combine remote sensing data with geographic data and show by example what can be done." While the transfer of a small group may not seem very significant, it's great news for all concerned. "We are very excited and pleased with the switch to EDC management," says Gaydos with a smile. "We know everybody. I went to UCSB with **Don Lauer** (Lauer earned his PhD a year before Gaydos did). **June (Thormodsgard)** has been a friend and colleague for many years. So, it's a comfortable feeling being a part of this group. We want to do anything we can to contribute to EDC's mission and success."

Loveland continued from page 1

said Lauer. "We at the Center have known for several years the work that Tom has been leading - and that so many other people around the Center and at several outside institutions have been supporting - is truly among the most creative and effective research being done in the USGS. The Mendenhall Lecture is the most prestigious honor given in the USGS each year for outstanding research, so this honor brings national recognition to Tom Loveland, the Data Center and all those who worked with Tom on the project."

Loveland first will present his lecture at USGS headquarters in Reston, Virginia, before traveling to other major USGS centers in Denver, Colorado and Menlo Park, California. Depending on his schedule, Loveland also is encouraged to lecture at any of the Survey's smaller facilities as well (i.e., Flagstaff, Arizona, Woods Hole, Massachusetts, etc.).

Loveland is a Remote Sensing Scientist in the Science and Applications Branch. He has been associated with the EDC for over 13 years, serving in a variety of research and applications development positions. His current responsibilities include oversight of EDC research projects dealing with the relationship of satellite imagery to land cover. In addition to his research and management duties, Loveland serves on scientific advisory panels for several national programs.

The Mendenhall Research Seminar series is in its 13th year. The Mendenhall Research Seminars are sponsored by the USGS and named in honor of **Dr. Walter Curran Mendenhall**, who was USGS Director from 1931 to 1943. Under Dr. Mendenhall's leadership, and that of 11 other directors, the USGS has become the nation's largest Earth science research organization. The Mendenhall seminars recognize excellence in research by USGS personnel, foster communications between Earth science researchers within the agency, and provide a public forum for significant new research. Despite all of the excellent work that has taken place at the EDC since 1972, Loveland is the first USGS researcher at the EDC to be selected for this prestigious honor.

Employee News

The EDC Global Land 1-km AVHRR Data Set project earned a Federal Leadership Award November 30, 1993 in Washington, D.C. This is an honor that recognizes organizational accomplishments rather than individual performance. Selected from hundreds of nominations throughout the government, the Global Land 1-km AVHRR project was one of 24 recipients of the 1993 award. Congratulations to the project team, everyone throughout EDC, NASA, NOAA, European Space Agency, the International Geosphere-Biosphere Programme, and others that contributed to the success of the project.

A new GIS text book (conference proceedings) is out that features work by Science and Applications Branch staff: **Tom Loveland**, **Sue Jenson**, and **Don Ohlen**.

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Tracking Environmental Change in West Africa

Many challenges continue to face the nations forming the western bulge of Africa. Some of the primary difficulties include: limited physical resources, a long cycle of inadequate rainfall, a rapidly growing population, and stagnant economies. Complex challenges such as these dictate a critical need to properly manage and conserve West African resources. In addition to protecting their resources, West Africans also must take care to avoid further degradation of biophysical riches. As a result, since the early 1980s the United States Agency for International Development (USAID) has promoted improved natural and agricultural resource management to increase income and production to improve the quality of life for this part of the world.

The U.S. Geological Survey and the USAID Mission to Senegal have defined a cost-shared project ($1.7 million over 3 years) to monitor rapid changes in West Africa's natural and agricultural resources over the last 50 years. The collaborative project also aims to better understand how humans and climate influence these changes. EROS Data Center (EDC) Senior Applications Scientist **Gray Tappan** heads a pilot project featuring this monitoring framework in Senegal - a nation roughly the size of South Dakota. The project involves three stages of data collection:

1. acquiring data in the field,
2. acquiring airborne video,
3. using satellite remote sensing.

According to Tappan, the West African nation of Senegal is the best choice for the pilot-program because of the EDC's experience there, and a detailed data base already exits. "I participated in a project conducted 11 years ago in Senegal," explained Tappan, "which collected data for Senegal's national plan for land use and development. In 1981 USAID funded a project to collect the necessary data for the national plan, with goals of preserving the natural environment and improving the quality of life of Senegalese people. USAID contracted with South Dakota State University's (SDSU) Remote Sensing Institute to conduct the natural resource inventory."

The project attempted to evaluate whether detailed natural resource mapping could be performed using satellite remote sensing as a tool. "Our project team acquired a tremendous amount of Landsat data over Senegal in photographic formats," recalled Tappan. "We also collected Landsat data during both wet and dry seasons to understand landscape dynamics, which led to producing better maps."

After detailed photo-interpretation of Landsat, Tappan and his Senegalese colleagues traveled into the bush to begin acquiring information. "We collected a tremendous amount of field data over 3 years on vegetation structure, the biodiversity (flora), and the land-use in both the wet and dry seasons." Once data collected in the field were compiled with the satellite information, Tappan and his colleagues published a series of detailed maps featuring the vegetation, soils, hydrology, and geology of Senegal. "The resource delineations came from the Landsat interpretations, but the resource descriptions came from the tremendous amount of field work."

According to Tappan, while he and his colleagues were in the bush they witnessed many environmental problems. "There were many areas where sand dunes were encroaching on agricultural areas. Also, we were there during a drought so we experienced many dust storms, crop failures, and saw the decimation of livestock herds. While drought was producing a temporary impact, the longer-term efforts of humans on the environment were seen everywhere. Years of farming had depleted the soils, removed vegetation cover, reduced biodiversity, and resulted in local extinction of many wild animals. Only areas far from cultivation

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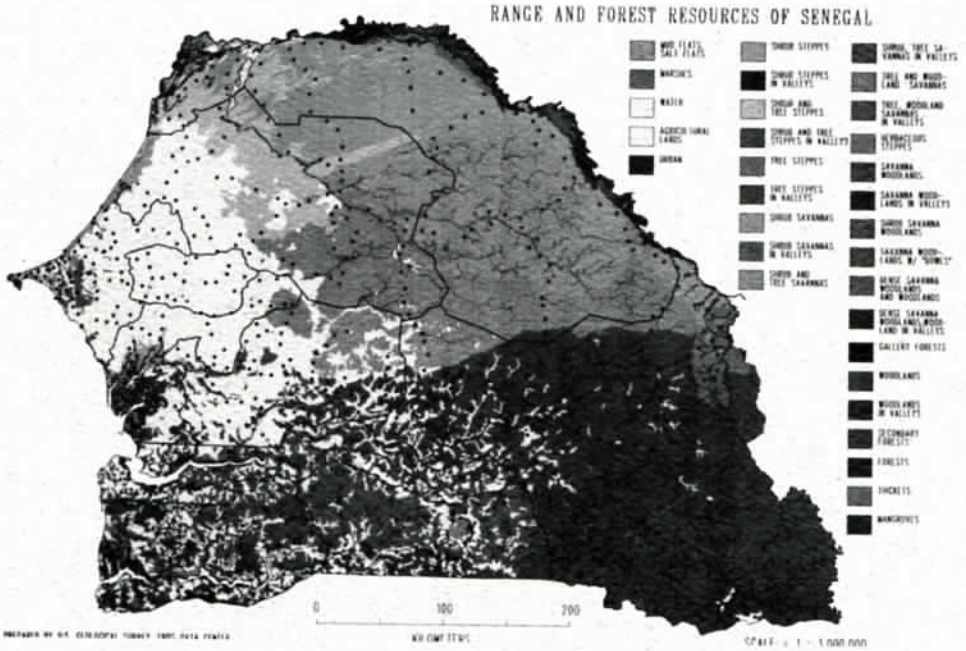

This map shows the locations of 574 permanent field sites established in Senegal in the early 1980s by Gray Tappan through an SDSU/AID collaborative project to monitor the human and climatic changes on the environment.

Map Projections for Global Data Sets

by John Hutchinson

When you look at a map, you're not looking at the world as it really exists. That's because you cannot show the round Earth on a flat map without distorting some part of its true shape or size. The only truly accurate way to portray the world is on a globe. However, globes are not very convenient for some uses. For example, the globe in the EDC lobby is about 72 inches in diameter, or at a scale of about 1:7,000,000. To make a globe the same scale as the South Dakota highway map (about 1:1,000,000), you'd have to make it about 42 feet in diameter!

So we need flat maps for convenience, and they're going to contain distortion. The best that cartographers can do is to manage and minimize distortion, by choosing the right projection based on how the map is to be used. **Dan Steinwand** and I recently completed a project with **John Snyder** (USGS, Reston) on map projections for global data sets. The goal of our work was to select a set of map projections to use for the kinds of large-area data sets, such as the global 1-kilometer data set, that we are producing here at EDC. We also wanted to document the effects of map projection on data quality, especially when data are transformed from one projection to another. Finally, we wanted to understand the special problems involved in reprojecting image data.

Choosing Projections for Global Data Sets

There are over 100 map projections in use, and an infinite number are possible mathematically. Take a look through Snyder and Voxland's book, An Album of Map Projections, and you'll get an idea of how many projections there are to choose from. The choice of map projection depends on the size and shape of the area to be mapped, and on the properties of the projection. For example, the Albers Equal-Area Conic fits the conterminous U.S. with little shape distortion, assuming standard parallels at 29.5° N and 45.5° N, but creates foreshortening toward the pole if applied to all of North America. The Lambert Azimuthal Equal Area, centered at 50° N and 100° W, does not fit the United States as well as the Albers, but its circular pattern of distortion gives a better fit to North America as a whole (figure 1).

In this study, we were concerned with data sets that cover large areas on the ground, from a continent to a hemisphere to the whole world. Showing correct areas was more important than correct shapes, so we needed a set of equal-area projections, not conformal or equidistant. In each case, the idea was to pick from the dozens of equal-area projections the one that produced the least distortion of shapes, meaning the one whose distortion pattern best fit the area to be mapped.

John Snyder chose the projections and associated parameters based on his analysis of their distortion characteristics. The only one out of the ordinary is the Oblated Equal-Area projection, a variant of the Lambert Azimuthal Equal-Area, that John developed to better fit North America (figure 2). Although computationally more complex, the Oblated Equal-Area has 30 % less distortion than the standard Lambert. However, just like with a new brand of peanut butter, people are reluctant to switch from the familiar to something new and exotic, no matter how much better it is, so John also recommended parameters for the standard Lambert Azimuthal to minimize distortion.

Changing Projections

The next step was to look at some real situations and see what the consequences of map projection are for data quality. To do so, we had to change how we thought about projections.

The ellipse plots in figure 1 are based on the idea of a circle on the globe and what happens to it when it's projected onto a map. However, we don't usually work with data that is in spherical coordinates; instead, our data is usually already projected. The standard problem at the EDC is to transform a data set in, for example, Lambert Azimuthal Equal-Area, into something like the Albers Equal-Area Conic. Instead of just a globe-to-projection, we have a projection-to-projection transformation.

To show this kind of distortion, a set of grid squares was created in the Lambert Azimuthal Equal-Area projection and reprojected to Albers Equal-Area (figure 3). The resulting grid squares show low distortion near the map center and along the standard parallels, but a high degree of skewing near the North Pole. The resulting grid squares maintain the correct size, because both Lambert and Albers maintain equal areas, but the change in shape of grids is caused by the differing patterns of angular distortion between the two projections.

We applied the same technique to another example, Mercator to Robinson, which showed extreme foreshortening toward the poles, an expected result from the combination of Mercator scale expansion and Robinson scale compression toward the North and South Poles (figure 4).

Projecting Image Data: the Raster Factor

The examples we used were not theoretical tests but came from actual data processing. With the range of projects ongoing at the EDC, there is frequent need to co-register data from several different sources. As we work with larger and larger data sets, the distortions introduced by changing data from one map projection to another become more and more significant. This is especially so for image data. Probably the most original part of the study was an analysis of how a change in map projection affected data quality when the data are composed of image pixels.

The grid square diagrams are handy for conceptualizing the stretching and squashing that happens to image data when it is reprojected. Images, however, are made up of pixels, and pixels cannot be stretched or squashed; they can only be resampled. With image data, distortions that can be conceived in terms of stretching and squashing grid squares are in reality manifested by resampling of pixels.

So the question of reprojecting image data becomes, "Where do my pixels go?" The answer is that some pixels are dropped out and some are replicated during the resampling that occurs when an image changes projection. To show this, Dan wrote a program that projected an elevation image from Plate Carée to Lambert Azimuthal Equal-Area, and also kept track of which pixels from the input image were actually used in the output image.

As it turned out, only 50% of the Plate Carée image was used in the Lambert; that means that the other 50% of the input image was simply resampled away, unneeded. To understand why, just imagine a projection where the North Pole is represented by a line of pixels, and changing to one where the North Pole is a point. In image terms, almost a whole line of input pixels that represent the North Pole would get thrown away, and that's what's happening in this example.

This is the kind of example that really gets the attention of data processing folks, most of whom would rather not be bothered with map projections, and assume that if their projection software runs properly, then there's nothing to worry about. If our project does nothing else, it will make them worry. Better yet, they will avoid casual changes of projection, especially on image data, and make use of the tools developed in this project to predict the effects on data quality of reprojection.

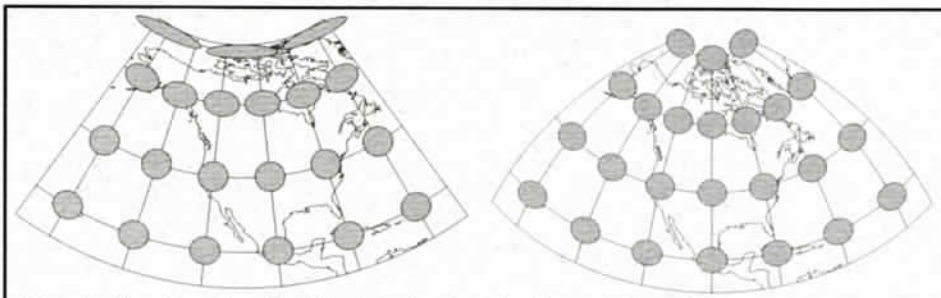

Figure 1. Albers Equal-Area Conic (l) creates foreshortening if extended to all of North America. Lambert Azimuthal Equal-Area, (r)gives a better fit to the continent as a whole because of its circular pattern of distortion.

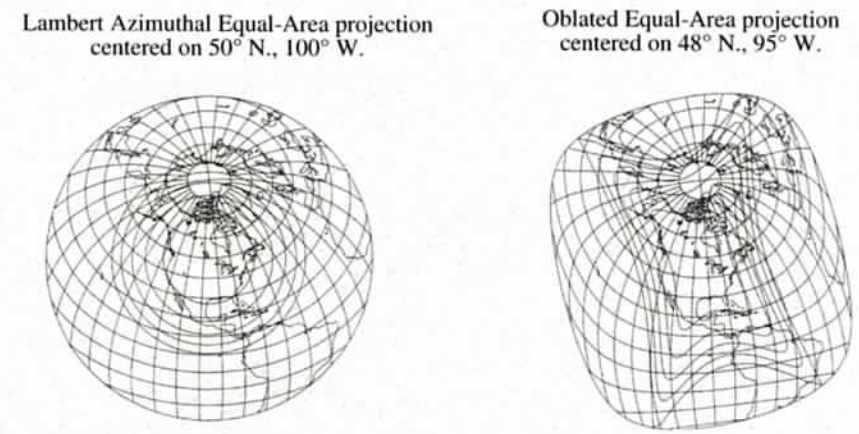

Figure 2. Projections for North America.

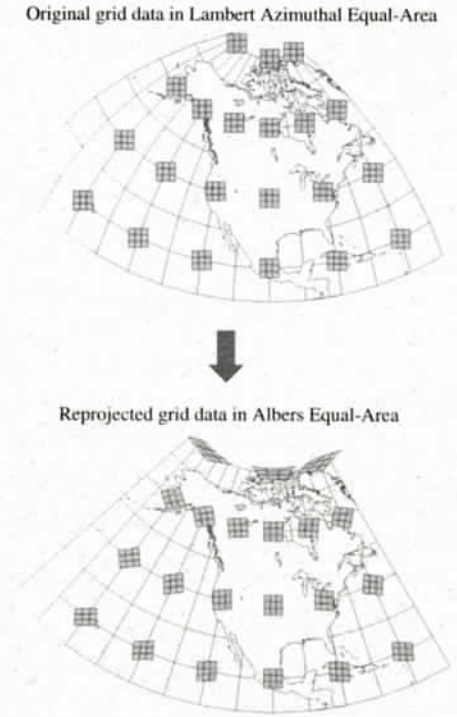

Figure 3. Reprojection from Lambert Azimuthal Equal-Area to Albers Equal-Area.

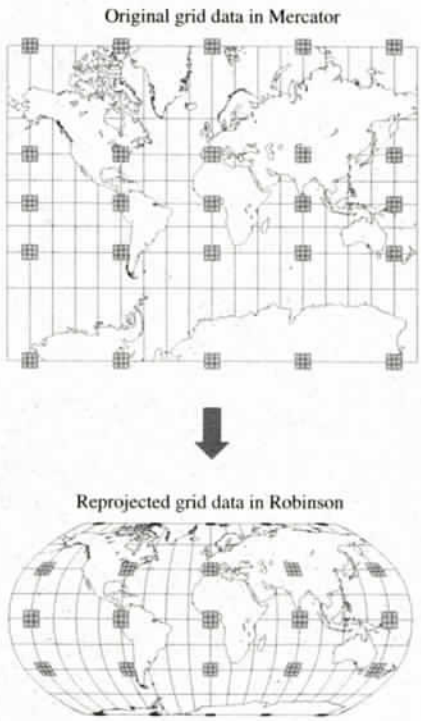

Figure 4. Reprojection from Mercator to Robinson.

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Employee News continued from page 6

U.S. Geological Survey

Len Gaydos, **William Acevedo** and **Susan Benjamin** transferred from the Western Mapping Center to EDC at the beginning of October. All three will remain stationed at NASA/Ames.

Mike Benson – Mike rejoins the EDC after managing a TGS contract at NASA's Johnson Space Center, Houston, TX. During Benson's first EDC tour of duty, 1981-1990, he served as an imaging scientist and Photo Lab supervisor. Mike's new position has him managing Landsat products with the Landsat 7 team. Originally from Sycamore, IL, Mike holds a B.S. in Photographic Science (1976) from Rochester Institute of Technology, Rochester, NY. He's currently living in Sioux Falls where he enjoys to golf and work with wood.

Wayne Boncyk – Wayne joins the EDC as a remote sensing scientist in the S&AB. His duties include investigating Landsat radiometric calibration as well as developing new calibration techniques. Wayne holds a B.S. in Physics from Youngstown State University (Ohio), 1977, and a M.S. in Electrical Engineering from Youngstown State, 1980. Before joining the EDC, Wayne worked 5 years for NASA in Microwave Remote Sensing at the Goddard Space Flight Center. Boncyk's hobbies include: photography, scuba diving, hiking, and home brewing beer and fruit wines. Originally from Youngstown, OH, Wayne now lives in Colman, SD.

Viola Ross – Viola has been hired as a procurement clerk in the Program, Budget, and Administration Office. The Flandreau, SD native was graduated from Flandreau High School and continues to call Flandreau home.

Hughes STX

Bill Kennedy – Bill joins the EDC as the Technical Area Leader for Customer Services. His resume includes work as an image analyst at the Defense Intelligence Agency, an applications specialist with EOSAT, and manager of the HSTX Commercial Remote Sensing and GIS group at HSTX corporate headquarters. Bill earned a B.S. in Earth Science at Lock Haven University, PA (1981). He completed a M.S. in Geology at Bowling Green State University, OH (1983). The Lorain, OH (30 miles west of Cleveland) native enjoys collecting coins, reading American history, and visiting museums and historical sites.

David Siver – Dave joins Software Development as a programmer to provide GLIS maintenance support. He holds a B.A. in Computer Science from Augustana College, May 1993. The Erwin, SD native enjoys hunting, fishing, and woodworking in his spare time.

Irene Callahan – Irene rejoins the EDC Photo Lab on a temporary basis to provide printing support. Irene worked in the EDC's Photo Lab from 1973 to 1985. Originally from Sioux Falls, Callahan now lives in Hartford where she enjoys sewing and painting shirts in her spare time.

Brad Kontz – Brad comes aboard as a digital data systems analyst in Digital Data Production. Brad will be performing tasks in all aspects of the specific production flow and in general image processing. Brad earned a B.A. in Geography at Augustana College and a M.A. in Geography at the University of North Dakota, Grand Forks, ND. From Revillo, SD, Brad now lives in Sioux Falls.

Chad Phillips – Chad comes to the EDC Photo Lab as a production lab specialist. Chad will be working with black-and-white, and color film and photo enlargements. He attended Vo-Tech school in Kansas City, KS where he earned a diploma in Photography and Commercial Art. The Sioux Falls native enjoys snowmobiling and is an amateur radio operator.

Neil Nachtigall (pronounced Knight-ing-gale)-- Neil has been hired as a senior programmer to work mostly on the NLAPS project. Neil earned a B.S. in Computer Information Systems from DeVry Institute and a M.S. in Computer Science from Colorado Tech. Before arriving at EDC, Neil worked as a computer programmer for Arthur Anderson and as a programmer/analyst for Geodynamics. Neil grew up New Underwood. SD. His interests include reading, biking, playing basketball and softball.

Jess Brown – Jess is excited to join the Data Exploitation Technical Area as a senior scientist. No stranger to the EDC, Jess was a Physical Science Aide and former EDC Summer Intern before becoming a Remote Sensing Research Analyst stationed here by the University of Nebraska-Lincoln in February of 1991. Jess earned a B.A. in Anthropology at Colorado State University, Fort Collins, CO and a M.A. in Geography from the University of Nebraska. Brown grew up in a small town in northwest Colorado called Meeker. Her hobbies

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The 1993 Federal Leadership Award for the Global Land 1-km AVHRR Data Set project was presented to a group representing the EDC, NASA, and NOAA at a ceremony in Washington, D.C., Nov. 30, 1993. On hand to accept the award are: (back l. to r.) ***Lynn Steenson****, DM,* ***John Faundeen****, ISM ,* ***Jim Fenno****, SSD,* ***Jeff Eidenshink****, SAB,* ***Bud Booth****, NOAA, and* ***Gary Metz****, EDC Deputy Chief. (front l. to r.)* ***Ken Klenk****, HSTX Project Mgr.,* ***Jeff Powell****, CSB,* ***Carolyn Van Beek****, DDP,* ***Martha Maiden****, NASA, and* ***Tom Holm****, DSB Deputy Chief.*

West Africa
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looked reasonably healthy. In the forested areas of Senegal, tremendous amounts of trees were harvested for charcoal, a primary source of fuel for cooking."

In addition to environmental problems, Tappan and his West African counterparts saw some encouraging steps being taken to counter the impact of prolonged drought, intense cultivation, and overgrazing. "To protect the environment, we saw semicircular troughs dug into the soil to collect rain water to feed the roots of newly planted trees, live hedges delineated agricultural fields, and trees provided wind breaks."

Tappan's original published maps from his work at SDSU provided the EDC with a base source of information about Senegal to generate a geographic data base from which it derived many other types of useful environmental data. "We can extract areas of current rain-fed agriculture, soil susceptibility to wind erosion, and potential agricultural lands."

Through the extensive field work of over a decade ago, Tappan's team established nearly 600 field sites around Senegal. Each site features a data base on flora, vegetation structure and land-use. Tappan and the team will revisit the exact field sites 10 years later. This time they will use GPS technology to accurately pinpoint each site, making them permanent monitoring points for future research. Tappan also will work with the same Senegalese field specialists. "The present project requires that we return to these 600 sites and assess the way humans and climate are changing West Africa's landscapes. This will help us construct a picture of long-term change and models of future landscapes."

Coinciding with the biophysical monitoring at each site Tappan says he will work with local socioeconomists to conduct surveys at villages adjacent to his sites to get local insights on why some of these changes are happening. "Obviously humans are one of the primary agents in changing West African landscapes." Another appropriate tool to measure the impacts of humans on the African landscape is airborne video. According to Tappan, if an airborne video camera is flown at low altitude, vertical and oblique recordings will allow EDC to inventory agricultural practices, declining vegetative cover, and the adoption of good resource management practices.

The final stage of collecting data in the pilot monitoring program involves satellite remote sensing. "We need a way of consistently looking at the Earth's surface," explains Tappan. "Because the Landsat series of satellites has been in operation since 1972, the potential exists to map changes in the Earth's surface over that period." Tappan plans to use Landsat Multispectral Scanner (MSS) and Thematic Mapper (TM) data to examine land cover patterns. In addition to information derived from the Landsat sensors, he hopes to use historical aerial photography (from the 1930s) to examine how Senegal's traditional system of cropping and fallowing has declined over time.

Working with Tappan on the Senegal project is **Eric Wood**, an EDC part-timer currently working on his PhD in Environmental Monitoring at the University of Wisconsin. "We're looking at taking the bio-physical data, which the EDC has been addressing for a long time, and coupling that with the modeling that USAID is doing from a socioeconomic standpoint." Wood added, "This is an interesting opportunity for the EDC to study relationships between biophysical and socioeconomic data."

According to Wood, much of the success of the Senegal project will hinge on the following objectives:

- successfully evaluate and field test the proposed long-term monitoring framework so that it may be used throughout West Africa,
- establish linkages between environmental conditions and what people are doing to the environment through socioeconomic research.

If these criteria are met, Wood believes many new opportunities could result for the International Program at EDC. "As we move towards understanding the socioeconomic side, it will improve our data collection on the biophysical side." In summary, the Senegal project offers a great opportunity to enhance EDC's visibility in the international development community as well as allow EDC scientists to "get their boots dirty."

*This pair of photographs were taken by **Gray Tappan** 10 years a part at a permanent monitoring site near Thies, Senegal to monitor long-term land use, land cover, and biodiversity changes. Notice the large tree in the left foreground in the 1982 picture has disappeared by the time the site was revisited in 1992.*

Employee News
Continued from page 10

include snow skiing, volleyball, and golf when she's not reading a book.

Gwen Moritz – Gwen has been hired as a part-time clerk in Customer Services to reorganize and update files. Gwen grew up in Omaha, NE and holds a B.S. in Meteorology and Climatology from the University of Nebraska-Lincoln (1993). In her leisure time, Gwen follows Pittsburgh Penguin Hockey, knits, bowls, reads poetry, and experiments with creative writing.

Lisa Lambert – Lisa is a computer operator for Ron Mofle's Computer Operations group. Lisa joins the EDC after 14 years with Midland National Life in the same capacity. The Sioux Falls native enjoys parenting, reading, and baking when she's not following Minnesota Viking Football.

Cherie Bernard – Cherie joins the Photo Lab in a temporary capacity for the next 4 months to support printing and processing. Cherie was graduated last May from Gallaudet University, Washington, D.C., with a B.A. in Television, Film, and Photography. Originally from Aberdeen, SD, Cherie now lives in Sioux Falls. Her interests include photography and collecting miniature figurines. According to Cherie, "I would love to teach you (anyone at EDC) sign language if you're interested."

Terry Sohl – Terry joins Digital Data Production as a Digital Data Systems Analyst to support the Multi-Resolution Land Characteristics project. Terry comes to EDC from Washington, D.C., where he worked as a photo technologist for the Defense Intelligence Agency. Terry holds a B.S. in Meteorology and M.A. in Geography from the University of Nebraska-Lincoln. Originally from Beatrice, NE, Terry and his wife, Lauri, live in Sioux Falls. Away from work Terry enjoys softball, bowling, music, and drawing.

Bob Van Roekel – Bob has been hired as a programmer by the Computer Services Branch to work on the NLAPS project. Bob holds an A.S. in data processing from National College (1990) and a B.A. in COSC from Augustana College (1993). The Sioux Falls native spends as much of his free time as possible bike riding, trap shooting, singing, and participating in family activities.

Ann Dvorak - Ann joins the EDC as one of two part-time External Relations Specialists. Ann holds a B.A. in Speech Communication from Creighton University, Omaha, NE 1990). Before joining the EDC Ann worked 5 years at Mount Rushmore National Monument as an Interpretive Park Ranger. She also has served as Office Manager for the Financial Assistance Office at Mount Marty College, Yankton, SD. Originally from Belle Fourche and Rapid City, Ann now resides in Sioux Falls. Some of her many interests include: singing, playing the flute and guitar, reading, and hiking.

Julia Towns-Marso - Julia fills the remaining External Relations Specialist position. She attended The Ohio State University, Columbus, OH (1989), and National College, Sioux Falls, SD (1992). Julia presently attends Huron University where she soon will earn a B.S. in English. Born in Ohio, Julia lived 10 years in Brandon, SD before moving back to Ohio. She returned to Sioux Falls in 1991.

Building Addition
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approach was needed. "Rather than issuing hard specifications for brand name or equal kinds of requirements, we gave the contractors the opportunity to offer alternatives." According to Hood, this places the incentive with the contractor to find things that offer equal performance for less money.

Basement Modifications

The building addition will cause the demolition of the current customer services area and UNEP/GRID offices. Given this and the fact that new staff continues to arrive, how does EDC plan to handle these displacement and space issues? "We plan to make more space available in this building," explained Hood, "by renovating 23,000 square feet of space beneath Customer Services, UNEP/GRID and S&AB - turning that into archive space. We'll then take the existing film archives in this building and move them downstairs. That frees-up all the area by Data Management for office environment."

According to Hood, modifying the basement also will allow the EDC to do something it has wanted to do for some time. "We currently rent archive space off-site, mostly for film storage and increasingly for digital data storage. It's expensive. This modification will allow us to bring back that storage and save about $260,000 a year beginning in fiscal year 1995."

In summary, timing constraints and cost reductions are making the EDC Building Task Force take a fresh look at the building addition. Reexamination of the design in light of appropriations means that the building addition will be completed as NASA and EDC budgets permit. A tentative date for breaking ground for the building addition is May 2.

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