June 8, 1999

Ms. Venonica A. Braxton
Research Grants Specialist
NASA-Ames Research Center
Grant Office
JAC: 241-1
Moffett Field, CA 94035-1000

RE: Contract No. NCC 2-964

Dear Ms. Braxton:

Enclosed are the final reports, which include the summary of activity, final SF
272 and inventory for the above referenced Cooperative Agreement. There were
no inventions made pertaining to this grant.

Should there be additional information needed, I can be reached at (520) 724-
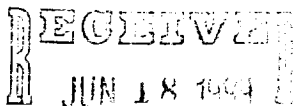6801. Thank you very much in closing this contract.

Respectfully,

Rachael Arviso
Senior Accountant

Formerly Navajo Community College

cc: Beatrice Morales, Grants Officer
    Financial Management Branch
    File

ENCLOSURES

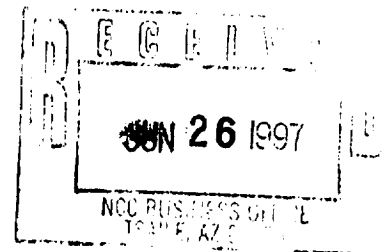RECEIVED
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CASI

DINÉ COLLEGE

Tommy H. Lewis, Jr., Ed. D.
President

James K. McNeley, Ph. D.
Vice President

IMPORTANT NOTICE!

Subject: Name Change to **"Diné College"**

I would like to inform you that the name of our college has officially been changed from "Navajo Community College" to **"Diné College"** effective May 17, 1997, as approved by the Navajo Nation Council and the Diné College Board of Regents. *(Diné means "Children of the Holy People", pronounced Dineh.)*

Please make note of this name change. Thank you.

Sincerely,

Dr. Tommy Lewis
President

*Note: The college address, telephone number and fax number will remain the same.

Diné College
The Navajo Learning Network
and
The NASA Life Sciences/AFOSR Infrastructure Development Project
Final Report: April, 1999

The NSF-funded Navajo Learning Network project, with help from NASA Life Sciences and AFOSR, enabled Diné College to take a giant leap forward technologically — in a way that could never had been possible had these projects been managed separately. The combination of these and other efforts created a network of over 500 computers located at ten sites across the Navajo reservation. Additionally, the college was able to install a modern telephone system which shares network data, purchase a new higher education management system. The NASA Life Sciences funds further allowed the college library system to go online and become available to the entire campus community.

NSF, NASA and AFOSR are committed to improving minority access to higher education opportunities and promoting faculty development and undergraduate research through infrastructure support and development. This project has begun to address critical inequalities in access to science, mathematics, engineering and technology for Navajo students and educators. As a result, Navajo K-12 education has been bolstered and Diné College will therefore will better prepare students to transfer successfully to four-year institutions.

Due to the integration of the NSF and NASA/AFOSR components of the project, a unified project report is appropriate.

Introduction

The Navajo Learning Network was charged in 1995 with the task of developing, coordinating and implementing distance learning and high performance computing capabilities at Diné College's eight campus facilities and assisting the region's schools in developing their own resources.

The NLN's first goal was to provide connectivity for delivery of electronically mediated learning resources. The second was to train faculty and develop courseware appropriate to emerging instructional technologies. Initially, the following were proposed:

- establishing a "network of networks" on the Navajo Nation;

- providing greater access to Diné College's educational services;

- extending Internet access into under-served regions of the Navajo Nation;

- providing networking assistance to college and K-12 students and faculty; and

- developing and piloting distance learning and multimedia capabilities on the Navajo Nation.

The Navajo Learning Network took on tasks and responsibilities normally associated with departments of academic computing and distance learning. The college's Computer Services department had lacked a director in over five years and had been reduced to a staff of two, who managed the college information system. There had been no infrastructure upgrade since the VAX mainframe was installed in the 1980s. Shiprock's network had been managed for years by a technician provided through grant funds, and the community campus centers each had one or two personal computers and a VAX terminal.

The lack of personnel and an organizational structure for promoting academic computing was exacerbated by the absence of policies and procedures which would encourage educational or technological innovation, and by the lack of experience most faculty and staff had with technology.

The absence of adequate computer equipment and the undeveloped local area networks further added to the difficulties encountered by the NLN staff. In 1995, Internet connectivity was non-existent. The only intercampus network connected VAX terminals to the mainframe. Adequate bandwidth would be needed for eight campus centers, which was either prohibitively expensive or unavailable.

The college's funding had failed to keep pace with inflation for over a decade, which had resulted in a series of cutbacks and reorganizations, at a time when demand for academic programs in the rural communities was on the increase. The erosion of funding had resulted in poor morale, high turnover, and fewer resources with which to provide even the most basic services (Sixty-six percent of the college's funding comes from federal appropriations; there has not been a significant increase since 1991. Increases in the cost of living has eaten away at the college's purchasing power, thus forcing closure of programs and resulting in a pay scale which is 30 percent below national norms.)

Faculty and staff at the college and at the region's schools had little training in appropriately incorporating computers into the classroom. Beyond the task of building a network and buying computer hardware was the need for computer-competent educators. Educators would be required to acquire new knowledge. Many would have to change their beliefs, attitudes and behavior, so sustained and focused staff development efforts would be required.

In order to ensure that the technologies employed were to become useful and used to improve teaching and learning, access was viewed as the most important factor. Adequate computers. peripherals and appropriate applications need to be easily accessed by users. This meant that a large number of computers would be needed. These, in turn, would have to be connected together in a network capable of handling the large amounts of data which would be transmitted and received by the users, and a solid connection to the Internet itself would be necessary.

As computer networks, equipment and software are installed, they have to be convenient to use, and be relatively easy to learn to operate, and they eventually have to provide for improved delivery of educational services. Ultimately, the network would not be fully effective until training, support, and sustained funding was found to support the academic programs.

The Schools

In 1995, only one or two Navajo Nation schools had any Internet access beyond long distance modem connections. Most of the schools in the region had very few modern computer systems or technologically capable staff. In many ways, they were in the same position as the college – little bandwidth, few computers, no networks, novice computer users, insufficient policies and very limited personnel structures.

Originally, the NLN was slated to extend computers and computer support into several schools. Upon revisiting the fact that no such capabilities existed at the college, it was decided that our initial focus should be the college. During the course of the project we worked with many schools, however, finding that they had far more fiscal resources than the college, but often lacked experienced computer experts or leaders conversant with the new technologies.

Technology use, for the most part, was nearly at the level it was ten years ago, when ENAN (The Educational Native American Network) was organized by the BIA and the University of New Mexico. A few teachers, often working at home, communicated with their peers over slow modem lines while waiting for "real" networking to arrive in their schools.

Funding Sources

National Science Foundation

The National Science Foundation funded the Navajo Learning Network and three other projects which directly impacted the project. The Arizona State Public Information System (ASPIN) project out of Arizona State University provided our first webmaster, our first Internet server, and helped set up the system. The webmaster also provided network information and helped train staff and students in the use of the World Wide Web. Through ASPIN, we also received some Research Experiences for Undergraduates (REU) funding, which provided several students with valuable experience. New Mexico Technet also received an NSF subsidy on behalf of the college for its first two years of network costs.

Without this support, it would have been nearly impossible to bring up the network or connect to the Internet. The NLN further provided a mechanism to carry out the project goals identified by the NASA/AFOSR project. At the same time, the NASA/AFOSR funding provided critically needed funds for building the infrastructure and connecting to the Internet, without which the college might not have been able to afford its basic connectivity.

NASA Life Sciences and AFOSR

Simultaneous to the development of the initial NLN proposal, NASA and AFOSR were approached to provide funds for the development of the college's infrastructure. Just as the NLN began, there was a need for some structure within the college to implement these goals. With the approval of NSF, the NASA Life Sciences/AFOSR Infrastructure Development project was incorporated into the Navajo Learning Network and managed through three funding cycles which ended in 1998.

The project was divided into four phases. Phase One funding (August through June, 1995) provided Diné College's initial link to the Internet and much of the hardware required to bring up the Local Area and Wide Area Networks at Tsaile, AZ and Shiprock, NM.

Phase Two funding (July 1, 1996 through April 30, 1997) extended that development to build Local Area Networks at all seven NCC campus locations, link them into a single wide-area network and add state-of-the-art computing facilities. Phase Two also supported faculty and staff development as well as development of computer-mediated learning materials and academic program supplements.

The third phase of the project focused on modernizing NCC's libraries and

completing the inter-campus local and wide area network. A complete automated library system has been installed, remote access capabilities will be improved, and training in modern informational sciences has begun.

NASA Life Sciences is now providing a fourth phase of funding. The American Indian Network Information Center (AINIC) was established in 1998 to provide K-12 teacher enhancement activities at several of the region's schools and encourage the academic uses of the Internet.

Additional funding would expand college faculty and staff training opportunities and assist the development of an Academic Computing department. User support (including software, hardware, and curriculum development assistance) remains under-funded and inadequate. Current college revenues are unavailable to support this mission.

Program Accomplishments, 1995-1999

Infrastructure and Internet Access

In 1995, there was no Internet access at Diné College. A handful of faculty members and students utilized long distance services to utilize the Internet. Networking was limited to the VAX system which had not been upgraded since the mid-1980s. At the same time, there were no more than 100 personal computers throughout the college system (fifty-three full time faculty, 1500 students and seven locations scattered throughout the Navajo nation).

Since 1995, the Navajo Learning Network has

- provided 221 new networked computers (107 provided by NSF, 124 by NASA/AFOSR;
- obtained, upgraded and distributed another 118 used computers;
- established the college Internet connections (T-1 and 56kb/s) and paid for two years of service;
- purchased, installed, configured and maintained the college' first Internet and email server for over two years;
- purchased all the tools and equipment to network, upgrade and repair almost every computer at the college;
- installed computer laboratories at ten campus locations (including two at regional high schools);
- established remote access at Tsaile and Shiprock;
- automated the college library system, which now provides catalog, circulation and research services to all networked computers in the college system;
- expanded the installed base of networked computers from 0 to over 500;

- through satellite technology, provided high speed Internet access at Window Rock, St. Michaels, and Crownpoint and paid for services for two years.
- Provided support to curriculum projects involving the Internet and multimedia tools (including the Navajo Place-names Project);
- Nearly 80 percent of the college's current installed base of computers were provided by the Navajo Learning Network and funded by NSF and NASA Life Sciences/AFOSR.

As a result, the college handles over 1000 faculty, staff, and student email accounts, hosts up to 50,000 visitors each month to the web site. Most of our instructors now have personal computers in their offices and two thirds of them utilize the Internet and communicate with their students via email. Faculty and student computer use has, in just a few years, approached that found in other colleges and universities around the country.

The following table illustrates that the combined effort of NASA/AFOSR and NSF has had a significant impact on educational computing in the region. While the total number of computers has sky-rocketed in recent years, there is an increased need for user support, training, and teaching resources.

Location	Networked Computers
Tsaile	250
Shiprock	123
Crownpoint	31
Chinle	20
Greyhills Academy H.S.	15
Continuing Education	5
Tuba City Center	5
Kayenta Center	14
Ganado Center	15
St. Michael High School	15
Tohachi Youth Center	11 (not networked)
Tsaile-Wheatfields Chapter, Teec Nos Pos Chapter	6 (not networked)

Library Access: The Diné College Libraries

The NASA Life Sciences and AFOSR grants were instrumental in automating the Diné College Library. The college library catalog is now available at all campus locations, as are a number of other services, including Ethnic Newswatch, Genderwatch, Newsbank, PsychCrawler, and other reference materials.

Planning for modernizing the library and extending library services to the rural communities began in 1993, and was later included in the NASA/AFOSR project. Funding came through in the winter of 1997.

Most library patrons will never see the complex system that tracks acquisitions and circulation, maintains thousands of volumes of print and digital resources, and vastly expands access to its services. Nevertheless, the library is the foundation of the college.

Until very recently, half of the college's students had to travel great distances to locate appropriate information services. Some students would have to travel hundreds of miles to and from the closest college libraries (primarily Northern Arizona University in Flagstaff, AZ, the University of New Mexico in Albuquerque or the Gallup,NM, branch, and San Juan College in Farmington, NM).

Now the college community can access these services from their home communities, through networked computers located in our community campus centers or through Internet connections provided by the region's schools. Internet library access at our community campuses provides a critically important service to the communities we serve. There are very few Internet service providers on the Navajo Nation, and the vast majority of dial-up accounts require long distance service. Library access is one argument for extending more remote access options to the community.

Training and User Support

Hundreds of hours of personal and small group training has been provided to faculty, staff and K-12 teachers, including

- basic Internet and email
- image processing (provided by the Center for Image Processing in Education)
- multimedia presentations
- office applications
- web page design
- hardware and software troubleshooting.

Online and print-based Internet and email orientation was provided to aid new users. Part time student assistants were employed at several campus locations for three years, who helped staff and students with computer problems. In the absence of a viable computer science academic program, virtually all computer training fell on the NLN staff to conduct. The formidable task of building the networking infrastructure, while working with the community campus centers and the region's schools, allowed little time to provide a great deal of direct, classroom-based instruction.

Nevertheless, two image processing workshops were conducted, using the Center for Image Processing in Education (Tucson, AZ), another program supported by NSF. Introductory sessions for students and faculty were offered at least once each semester during the first three years of the program. Ten staffers from the community campus centers were provided with commercial training workshops in Phoenix, Flagstaff or Albuquerque, and the NLN and Computer Services staff attended several workshops. In the fall of 1998, a consultant was hired to provide multimedia tutorials to faculty at the main campuses.

Students were often helpful in providing user support and helping with training sessions. As we strengthen our computer science program, we anticipate even greater student involvement in training and user support.

Curriculum

In a survey undertaken in May of 1998, 75 percent of our full time faculty had computers in their offices and were using the Internet to stay current in their fields. Sixty-two percent were exchanging email with their students and asking them to conduct research on the World Wide Web. Thirty-one percent of faculty had posted their syllabi or course materials on the Web.

By December, 1998, faculty use of the Internet had increased significantly beyond the May survey -- comparing favorably to similar surveys at other colleges and universities. Nevertheless, only one faculty member had created a course designed to be offered entirely on the World Wide Web.

The influx of large numbers of networked computers has not yet translated into significant changes in instruction. Funding for faculty development is scarce, incentives which would promote instructional innovation are not yet in place, and other policies (bonus pay, release time, teaching load, etc.) are being adjusted to promote the increased use of computer-assisted instruction, distance delivery, directed study and other educational options. In the specific areas of math, science, engineering and

technology, our current instructional resources are so overburdened that faculty has not been able to put instructional alternatives in place. Computer-assisted GED and basic skills instruction has just begun this year. Faculty is looking for math and science learning modules which will be used as supplemental methodologies.

One education student is working with us to publish a children's book in Navajo. We will develop an audio component to this book, which could become the first Navajo book published on the World Wide Web.

Projects Initiated by the Navajo Learning Network

SEEDS Computer Distribution Program. Dr. Gary Coulter discovered this program in Pueblo, Colorado. It was set up to locate, repair and distribute surplus government computer equipment in the region. We were able to obtain 157 computers and other assorted equipment through this program. The NLN has repaired and distributed 118 computers since the summer of 1998; about 93 are in service. Software, numerous printers and other peripherals have also been deployed. We hope to continue and expand this program.

Community Outreach. Donated computers have been provided to the Tohachi Youth Center (11), the Tsaile-Wheatfields Chapter (2), the TeecNosPos Chapter (4), and the Lake Valley Chapter (3), the Tsaile Sunrise Coffee Shop (4). This equipment was
largely obtained through the SEEDS program in Pueblo, Colorado.

The Navajo Education Technology Consortium (NETC). Early in 1997, the NLN was instrumental in forming this consortium of school administrators from thirteen public school districts in the region. In 1998, the consortium was awarded a 6.7 million dollar grant from the Department of Education to promote technology integration in their classrooms.

Lucent Enterprise Network. In an effort to electronically link all campus centers, the NLN persuaded the college to install a system of Lucent routers and PBXs at campus centers which combine voice and data on leased lines. Computer Services has been in charge of this project since early 1997.

Satellite Internet Delivery. While viewed by some as impractical, we have proven the usefulness and economy of satellite delivery for Internet access. More recently, we helped introduce a satellite Internet solution which does not require the use of telephone lines. In both cases other schools have or are planning to install satellite systems. It may be several years before sufficient bandwidth will be provided using conventional (wire or cable) methods.

Related Projects

NASA's Jet Propulsion Laboratory. The NLN staff has established a partnership with the Educational Outreach staff at JPL in order to help develop science programs on the Navajo Nation. In addition, JPL has generously donated 14 computers and assorted scanners and printers. JPL is sponsoring internships for students from Greyhills Academy this coming summer.

TIIAP Microwave Project. Funded by the Department of Commerce, this project will link Tsaile with Shiprock via a microwave system spanning the Chuska mountain range. Early project implementation tasks were conducted by the NLN staff. NASA Life Sciences funds paid for radomes and installation costs. The project was turned over to Computer Services in March of 1997.

The Information Engineering Technology program. This NSF Advanced Technological Education program was funded in 1998 to develop a training program to provide the skills required to install, service, and maintain computers, peripherals, networks, and microprocessor and computer controlled equipment. It will include training in both hardware and software, emphasizing operating systems concepts to provide a unified view of computer systems. The project plans to become a certified testing center and teach certification related curriculum using certified teachers in coordination with national industry leaders.

Higher Education Management Software (CARS). The purchase of new computers and the establishment of Internet capabilities allowed the college to move to upgrade its entire management system. Currently, business functions are conducted on an aging VAX system. The department of Computer Services initiated this project, which should be completed late this year.

AIHEC Satellite Telecommunications Project. The American Indian Higher Education Consortium has been constructing a satellite system linking the tribal colleges for over a decade. The uplink/downlink system will allow tele-courses to be offered at numerous sites. Currently, the AIHEC schools are offering 10 courses a semester.

The Navajo Nation's Schools

Having a web site is a rough indicator of how educational networking has progressed in the past few years. When the NLN project began, only Greyhills Academy, the Tuba City School District and Hopi Junior/Senior High School had Internet access, provided by Northern Arizona University's Interactive Instructional

Television network. As we end the project, the Apache County Schools now have web sites (Chinle Unified School District #24, Ganado Unified School District No. 20. and the Red Mesa School District). St. Michael Indian School, Seba Dalkai Boarding School, Tohatchi High School, Monument Valley High School, and Central Consolidated School District #22 all have a web presence now, but over 100 schools are still without any form of Internet access at all.

The schools face many of the same barriers that existed several years ago: unavailable bandwidth, lack of in-house expertise, and a lack of commitment. One system administrator insists on closing down his school's web server every evening and on weekends, and doesn't allow teachers to access their email from locations other than within the school.

Most schools have installed many computers, built networks, and encouraged teachers and students, but have not expanded their computer support staff. At least three districts of three or more schools and nearly 2,000 students have only one full time computer specialist. In each case, these men are competent but overworked and lack experience in educational applications and responding to the needs of teachers. Often, basic user support is unavailable; unused computers lie waiting for repair. And students are not recruited or trained to help with computers.

Most noticeable among the schools is that a critical mass of computer-using teachers has been slow to develop. The use of the Internet to conduct research has begun, in schools with good networks and Internet access, to be an almost daily occurrence among students and teachers. Once teachers get computers at their desks, they readily begin to use their email, take their attendance, and use the Internet.

Yet the routines of our schools are extremely resistant. The schedule is very tight, and teachers are under pressure to "deliver." Teachers often feel that there is not enough time to add anything to an already crowded curriculum. At the same time, teachers have little time each day to plan, and even less to learn how to use technology effectively.

After school and weekend activities, and remote access provided for teachers, offer ways to provide opportunities to those whose schedules otherwise prohibit much computer use. Schools often close up promptly at 3:30 or 4:00 pm, and teachers as well as students are whisked away. We've observed that students often come to the college's networking facilities after school. On at least one occasion, students who had been suspended from their school came to our Crownpoint Center to use the computers, and they were watching space shuttle launches at a NASA site.

Educators are often worried about how the computers are being used. Students like games, web chat, music, and sites related to their interests -- sports, teen culture, country music, etc. Some of these activities are not strictly "educational," and are typically discouraged. We've tried to explain that when students engage in these activities, they are learning how to use computers as tools -- they are learning how to read, practicing their writing and keyboarding, crashing computers and learning how to recover, exercising their social skills, communicating with others, collaborating and strategizing -- a whole range of potentially beneficial skill sets, concepts, and lessons are being learned

Challenges, Opportunities and Research Issues

"Learning to use a computer is much more like taking up a musical instrument than following instructions on how to use an electrical appliance, such as a toaster." (Charles Rubin, 1983, quoted in Rogers, 1986).

Until early in 1996, the college community had practically no access to the Internet. Similarly, most of the schools on the Navajo Nation were just beginning to pay attention to the national movement to network them. While we have brought the college and some of the schools into the information age, we have paid close attention to the challenges and barriers shared by the college and the region's schools, and the process of the adoption of the technology and its impacts.

"World Wide Web? What's the World Wide Web?"
-- an elementary math teacher from Leupp, Arizona, May, 1996.

Leupp is only 43 miles from Flagstaff, Arizona. It has cable television, and most everyone goes to "town" at least once a week. Many teachers live in Flagstaff and commute to the school each day. We were surprised to find a teacher, in 1996, who didn't know what the World Wide Web was. This response has not been unique.

A Microsoft Certified Engineer asked, "Why would they need to access the Internet?" responding to a discussion of how important it would be to provide Internet access to our community campuses (December, 1998). Even a computing specialist wonders why our faculty and staff would need access to the Internet. This young man is now teaching a course at one of our campus centers

After spending over three years connecting our campuses, automating the library system, and implementing a new, comprehensive management information

system, we computer "experts" complain about our clients' lack of knowledge of computing, but we have to remember that many of them are very new to computers. That has been one of the most central challenges of the Navajo Learning Network -- most of those who used computers before 1996 learned only what they needed to know to do their jobs. Most computers were (and still are) used as word processors.

We live in a very isolated region of the country, have traditionally had rather poor educational institutions, and most of our people live in poverty. Several years ago, a study reported that 83 percent of the households in Silicon Valley owned personal computers. We can only speculate, but perhaps no more than 10 percent of Navajo households own computers. This setting compounds the problems involved in bringing educational computing to the schools.

The challenges and barriers we have identified are not at all unique among schools across the country. They include the following:

1. Bandwidth Shortage and/or High Networking Costs
3. Limited Infrastructure, Shortage of Equipment
4. Lack of Expertise, Ignorance of the Benefits of Educational Networking
5. Inadequate Funding, Sub-Standard Wages
6. Inadequate Planning
7. No Organizational Structure to support Academic Computing
8. Limited Commitment, Resistance to Change -- Institutional and/or Individual
9. Physical & Social Isolation
10. Cultural Concerns
11. Lack of Policies and Incentives to Promote Innovation

Given these considerations, it is amazing that we have come this far. Sheer determination and persistence has slowly overcome some of these barriers. Urban colleges and universities have had, in some cases, over 20 years to develop their Internet and distance learning capabilities.

The Internet was more or less ubiquitous more than 13 years ago, and was an important tool not only for scientists and scholars, but became an important political tool during the Chinese democracy movement in the mid-1980s. Chinese scholars and students were the main conduits of information that flowed to the outside world during that era -- through the Internet.

Meanwhile, Navajo Community College was geographically and culturally isolated from many of the changes occurring in higher education. A number of our professors had worked here for many years -- and had not able to participate in the kinds of activities or utilize the technologies available to other colleges.

The development of the infrastructure at Diné College had to precede serious changes in planning, funding, curriculum, staffing, and organization. The analogy we've used is this: without a highway, we can merely tell people what a car is for. Without an automobile, we can only describe how to drive a car. Once you have a car and a highway to drive on, then you can begin to discover all the places you can go, how fast you can get there, and what to do when you arrive.

The Future of Technology at Diné College

Over 500 computers have been networked. Email and WWW usage has become

ubiquitous. The library is accessible to all students. It will be necessary to consolidate, extend and sustain efforts to fully take advantage of appropriate educational technologies. In addition to other deserving educational programs (teacher education, developmental education, construction of new facilities, etc.), the following are also proposed:

- Construct a Technology Center at Tsaile to provide a media laboratory, a training classroom, a Computer Services Annex, and faculty offices. New facilities in the field will be designed to fully utilize computers and telecommunications technologies.

- Strengthen the college's depth in computer and technology education (additional full time and associate faculty); establish a new instructional department of computing and technology, updating and revising the program.

- Upgrade, extend and enhance the campus and intercampus network (classrooms, dormitories, and offices)

- Increase available bandwidth at all campus centers (utilizing additional satellite delivery systems) and complete the Tsaile/Shiprock microwave link.

- Extend remote access to students and faculty in remote regions.

- Upgrade and replace existing computing equipment.

- Provide additional training opportunities and materials for faculty, staff and students in high performance computing, distance education technology and curriculum development.

The Computer Education Program. A recent assessment of the need for computer and technology courses suggested that, if resources were available, the

college would need between <u>five and seven full time equivalent instructors</u> to meet the demand for computer courses in the field. We currently have <u>one full time instructor</u> in Shiprock. The Tsaile position has not been filled permanently since 1996, largely because faculty salaries are so low that there have been no applicants.

Instructors in the field are all adjuncts, and many have had little computer experience or are not accomplished instructors. Most of the equipment in place in the field is between three and ten years old, and human resources are scarce at the outset. Nevertheless, the community campuses could fill at least two computer-related courses each semester.

The demand at all of our campuses arises from the proximity of health clinics and hospitals, schools and local government offices. Employees at all of these institutions are highly motivated to upgrade their skills and engage in life-long learning. Further, there are many young people, some of whom are in school now, who have need for computer education. Our staff is also in constant need of courses in a variety of computer-related subjects. A strong instructional capacity in computing would have an immediate and beneficial impact on our staff and faculty, as well as the communities we serve.

The computer curriculum itself needs revision to reflect the learning needs of students and the demands of industry, business, and higher education. The curriculum needs also to become more platform independent, supporting a variety of operating systems and applications. Students interested in networking or computer science need access to Linux or other Unix systems. Education or arts students may prefer the Macintosh. Modern programming languages have not been taught at the college, so computer science students should be exposed to self-paced, competency-based courses in scripting languages as well as C++. The list goes on, but the college must be able to quickly respond to changing needs, and computer science is one area which is constantly changing.

Significant resources need to be applied to developing the department, which at least partially hinges on the salary schedule. It is possible, however, to develop a capacity to meet some learning needs more effectively. Students interested in computer science, for example, are often self-starters and learn best by working on their own projects. Yet there is no curriculum in place which could take advantage of this student's talents. Secondly, computer faculty tends to teach groups in uniform ways, which might not be as efficient or effective as working in individualized fashion with students -- thus allowing small groups of students to engage in learning projects

appropriate to their needs and interests, yet still rigorous and exchangeable for college credit.

Mentorship and assistantships also bring resources into the institution and apply them effectively. Advanced students from universities could be utlized to teach at Diné as part of a fellowship. Visiting professors could likewise bring their energy and ideas to the college in support of instruction. Our own local resources (there is always at least one potential "wonk" in each community) could be recruited and trained to offer instructional support under the supervision of an instructor.

Instructional Computing Support. Several years ago we proposed a "faculty development center," or a "media center" to provide a central location for faculty to utilize for their high performance computing needs. The concept arises from the fact that the vast majority of computer users work in instructional and student services. Most of the equipment, software, and peripherals are purchased and operated by their programs. Yet there is no support structure in place to provide the services required by faculty – a place where good equipment and software is available, where they can reasonably expect to find help, and where they can work on their individual projects. Similarly, there is no open computing environment for students to work on their projects – tearing down and repairing equipment, recording audio or video, constructing websites or publishing documents.

In response, we have proposed a department of Academic Computing, which would work closely with the also proposed department of Computing and Technology to utilize student and professional support in an open computing environment. Academic Computing would coordinate faculty development, computer-related grants and funding, user support, web development, and technical support for the academic divisions. Distance learning initiatives would also be coordinated by this department.

Computer Services has always focused on MIS and telecommunications, not on the educational mission itself, or support in office automation or applications. It has been suggested that the kind of faculty and student support that is needed could best be provided within the academic divisions.

Faculty and Instructional Development. Those of us with business experience know that we have to try to recruit the best people and retain them. To do that, wages have to be high and working conditions have to be good. Faculty and staff wages at Diné are thirty percent below the national norm. After suffering ten or fifteen years of financial decline, the goal of achieving wage parity has not been seriously pursued, but is one of the best ways to improve educational effectiveness and efficiency. Specific

strategies need to be developed in order to achieve appropriate salary levels as rapidly as possible.

Aside from the "bottom line" issues of salary schedules and workloads, we have proposed that a number of policies be changed or established in order to encourage integration of technology into the teaching and learning process. Some colleges have merit systems which rewards instructors for innovation or exemplary service. Others have release policies which allow faculty to develop their skills. Sabbaticals are also a good way to provide educators with time to learn new skills. Even if funds are limited, policies could be put into place; there are very strong arguments for strengthening the academic programs through them. For example, more effective instruction could translate into higher enrollment – by virtue of the quality of instruction or the ability to effectively reach more students.

Working with Schools. Beyond the college, the region's schools graduate 3,000 students each year. Some 72,000 Navajo children attend school in the region, half of them in the border towns. There are county public school districts, BIA boarding schools, BIA day schools, Contract schools, BIA residential halls in the border towns, and parochial schools. Some schools have only 200 children; others have over 1,0

Our experience suggests that the schools may be best served by independent agencies, such as educational non-profits. Consortia do provide benefits (such as the $6 million Challenge Grant received by the NETC group), but frequently the most powerful school or school leader dominates the consortium. Local politics dictates that one's first loyalty is to one's own school (or college).

Secondly, there is a need for a central clearinghouse for network information, user support, technical support and school projects. Educators in Navajo country have special needs, concerns, and problems which such an entity would help them address. We envision this to be an "ENAN" for Navajo educators and students.

After school and weekend programs, open computing environments, and computer clubs offer a partial solution to "curriculum overload." Community groups, Chapter Houses, and other locations could provide important points of presence for potential Internet users. Local ISPs need to be set up to further extend access to the communities (schools with Internet access could provide this service).

Alternative learning options, often difficult to find in the common school, may some day become the norm rather than the exception. There is some promise that "real" school innovation will be partly driven by parents and students who have begun to use the new technologies outside of school, who then demand that the schools adapt to better meet the needs of the students and the community.

Increasingly, the Navajo Nation's schools are coming on line and upgrading their networks. It will be interesting to observe the processes they go through and what uses they put their new connectivity to. At the same time, they are not yet prepared for the skill sets they will need, and they are quite vulnerable as a result.

Theoretical Perspectives

Innovation Diffusion

The chief theoretical perspective behind the NLN project was that surrounding the concept of "innovation diffusion," a well-researched approach to the adoption of technological innovations. Innovation diffusion follows established patterns which have been described by Everett Rogers and others.   Rogers' studies of the diffusion of hybrid corn, birth control and other innovations have suggested methodologies which diverge from "common sense" approaches in that the adoption and implementation of new technologies is an organic process, intensely personal, and follows rather well-defined stages. Rogers deserves extended consideration here to clearly illustrate the processes that underlie the progress of the NLN project.

"For the past forty-five years and through 3,500 research publications, a model of the diffusion of innovations has guided investigations of the spread of new ideas.

"... Here we summarize the main elements of this framework, and discuss its applications to new communication technologies.

"The main elements in the diffusion of new ideas are: (1) an innovation, (2) that is communicated through certain channels, (3) over time, (4) among the members of a social system. An innovation is an idea, practice, or object perceived as new by an individual or other unit of adoption. The characteristics of an innovation, as perceived by the members of a social system, determine its rate of adoption. Five attributes of innovations are: (1) relative advantage, (2) compatibility, (3) complexity, (4) reliability, and (5) observability.

"A communication channel is the means by which messages get from one individual to another. Mass media channels are more effective in creating knowledge of innovations, whereas interpersonal channels are more effective in forming, and in changing, attitudes toward a new idea, and thus in directly influencing the decision to adopt or reject a new idea. Most individuals evaluate an innovation that they are considering adopting, not on the basis of scientific research by experts, but through the subjective evaluations of near-peers who have previously adopted the innovation. These near-peers thus serve as social models, whose innovation behavior tends to be imitated by others in their system.

"Time is involved in diffusion in (1) the innovation-decision process, (2) innovativeness, the degree to which an individual or other

unit of adoption is relatively earlier in adopting new ideas than other members of a social system, and (3) an innovation's rate of adoption. The innovation-decision process is the mental process through which an individual or other decision-making unit passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision. Five steps in this process are: (1) knowledge, (2) persuasion, (3) decision, (4) implementation, and (5) confirmation. An individual seeks information at various stages in the innovation-decision process in order to decrease uncertainty about the innovation.

"A social system is a set of interrelated units that are engaged in joint problem-solving to accomplish a goal. A system has structure, defined as the patterned arrangement of the units in a system which gives stability and regularity to individual behavior in the system. The social and communication structure of a system facilitates or impedes the diffusion of innovation in the system. For example, an opinion leader is an individual able to influence other individuals' attitudes or overt behavior informally in a desired way with relative frequency. The opinion leaders embody the norms of a system, the established behavior patterns for the members of a social system. If the norms of a system are favorable to an innovation, the opinion leaders are more likely to adopt it, and other individuals will tend to follow their lead." (*Communication Technology: The New Media in Society*, Everett M. Rogers, The Free Press, 1986).

Rogers extended diffusion theory to communication technologies: First, "a critical mass of adopters of an interactive communications technology are necessary for the utility of the new idea to be sufficient for an individual to adopt."

Secondly, the new communication media are tool technologies which are often characterized by a high degree of reinvention. "Reinvention is the degree to which an innovation is changed or modified by a user in the process of its adoption and implementation." The adopter customizes the innovation to fit his or her situation. Finally, communications technologies are more characteristically looked at in terms of implementation, rather than merely a decision to adopt.

Innovation diffusion theory and research has been especially instructive for the Navajo Learning Network project. Creating a networked environment where virtually everyone uses computers in their teaching and learning is not a simple matter of announcing that the innovation has arrived. It is a slow process that moves from individual to individual within the organization in a very informal manner.

Official proclamations by experts, or efforts to impose the innovation on the public by authorities, are not particularly effective. Instead, critical mass is achieved through the efforts of early adopters of the innovation and their interaction with peers who eventually come to evaluate the innovation as something worth attempting. Further, the norms of the social system need to be favorable to an innovation – and thus provide incentives for adoption.

Exemplars need to be established which near-peers may observe and which will serve as starting points for adopters to begin to experiment on their own. At the same time, institutional policies should reward early adopters and provide incentives for additional diffusion activities.

For example, one project hopes to provide in-service training to teachers in 32 schools. In each school, teachers will be rounded up for a one or two day session on Microsoft Powerpoint. A second project identifies 32 "heat seekers" who will be provided with support in a variety of projects and applications they are interested in. Innovation diffusion theory would imply that the latter approach would have greater long-term benefit than the former. (There are other issues here, as well: Powerpoint would support a school culture focused on traditional teaching, and might well be a big hit as a supplement to teacher-centered instruction. On the other hand, the heat-seekers identified for support might be over-committed, apt to move on to other positions, or not particularly good at sharing what they do with others, or they might threaten the status quo within the school.)

Other perspectives

Several other theoretical and research perspectives informed the NLN project. Chief among them was Hersey & Blanchard's work in situational leadership. The challenge of moving Diné College forward technologically was not simply a matter of wiring and computers. What was required was a model of leadership that enabled the staff to effectively introduce a new approach to teaching and learning -- one which the college had somehow escaped, in its isolation. Simply stated, this framework concerns itself with the readiness, willingness, and abilities of employees to accomplish tasks that further the enterprise. Employees differ in their needs for supervision and guidance.

Different people need different levels of attention, direction, and instruction. They also have differing learning styles, and come to the task with differing skill levels. Thus, and effective program needs a variety of approaches. Some individuals (the "early adopters") needed little support and worked on their own. We call them "heat-seekers." Needing little guidance or supervision, they are "ready, willing and able" to accomplish complex tasks, if they have <u>access</u> to the <u>tools</u> needed and if they have the <u>time</u>.

Conversely, "insulators," for a number of reasons, are less ready, willing or able to adopt an innovation, and will need varying degrees of support, supervision, information, direction, or guidance before they are "ready" for adoption. Often, insulators are the last people to adopt an innovation, but are in a position to slow, or even stop, the innovation process.

The vast majority of individuals fall in between these two extremes, and can be persuaded depending on the relative strength of the factions working in favor of change and those working against it.

The NLN responded by providing a variety of learning experiences: one-on-one instruction, informal classes, workshops provided by professional training organizations, and so on. Our own research suggests that access, time, and administrative support are among the most important factors influencing people's decisions with regard to accepting and utilizing the new technology (*The Impacts of*

Computer-Mediated Communication on Rural Educators, Unpublished Doctoral Dissertation, David A. Basham, 1991).

As stated earlier, the new technology must be perceived as being useful, convenient, and not requiring a steep learning curve. If the machinery is not reliable, or if it is perceived as too difficult, it will not be used. One of the reasons we have so aggressively sought donated equipment is to deal with the access issue. Although the donated equipment is often considered obsolete, many of our clients have not had access to <u>any</u> computing equipment before. It also serves a purpose in driving the institution forward -- once computers are in place, the institution must respond with services, network cabling, and user support.

Appendix 1. Chronology of Events:
Navajo Learning Network & NASA Life Sciences Infrastructure Development Project

1995-1996

Received authorization for NLN, NASA/AFOSR, ASPIN, and TIIAP (intercampus microwave) projects

Established the college's connection to the Internet (Shiprock and Tsaile)

Purchased, installed and configured Tsaile's web browser and email host

Established the college's web site

Developed the college's email and web policies

Recruited and hired project secretary, ASPIN staffer (webmaster and trainer) and a networking technician

Upgraded Shiprock technician's position and supplemented his salary (2 years)

Purchased networking tools, wiring and equipment

Purchased nearly 300 new computers and upgraded another 40

Established and networked computer labs at Crownpoint, Tsaile, Shiprock, St. Michaels High School, and Greyhills Academy High School

Provided funds for part time user support at the community campus centers (3 years)

Secured memoranda of agreement with St. Michaels High School and Greyhills Academy High School

1996-1997

Purchased and deployed satellite Internet delivery systems at Tsaile, Crownpoint, Window Rock and St. Michaels, providing high speed access at those locations

Helped establish the "Navajo Education Technology Consortium," consisting of the major public schools on and around the Navajo Nation (February, 1997)

Coordinated training activities at Tsaile and at urban training centers (included basic computer operations, World Wide Web, image processing) for 50 faculty and staff

Registered over 25,000 monthly "hits" on the college web site, 400 email accounts

Completed nearly 90 percent of the local area network connections (all sites)
Piloted satellite delivery at Cedar Unified School District

Provided technical assistance to other schools, including Ganado, Sanders, RedMesa, Window Rock, Chinle, Leupp, Flagstaff, Hopi, Dennehotso, Many Farms, Low Mountain, Pinon, Cottonwood, Black Mesa, Dilcon, Lukachukai, Seba Dalkai, Rough Rock, Rock Point

Provided assistance to the BIA Office of Indian Education's networking project

Negotiated with Lucent Technologies and secured authorization to proceed with a telecom system which would allow network access along with telephone traffic -- turned over to Computer Services in spring of 1997

Negotiated with Wave Wireless and obtained authorization to build Tsaile-Shiprock intercampus microwave project -- turned over to Computer Services in spring of 1997

Released NLN technician to department of Computer Services (spring, 1997)

1997-1998

Negotiated with vendor and assisted library staff in selecting a library automation system

NASA funding for network connections ended, spring 1998

With the help of the Arizona Corporation Commission, was able to get the local telephone company to finally provide the college with a T-1 circuit between Tsaile and Shiprock

Over 1000 email accounts administered

Released email and web management to Computer Services (spring, 1998)

Seventy-five percent of faculty had computers in their offices, 62% were exchanging email with their students

Additional training included multimedia and image processing in Ganado, St. Michaels, Tsaile and Shiprock

Community campus staff were provided with urban training opportunities

Assisted in obtaining NASA funding for the "American Indian Network Information Center" (AINIC) -- project set up under the Development Office

1998-1999

Funding for community campus user support ended, December, 1998

Networked computers reached beyond 500

Completed library automation project, allowing all students and faculty to access the college library over the Internet

Obtained 175 donated computers and deployed them throughout the community, establishing additional laboratories in Window Rock, Kayenta, Tsaile, Shiprock, Ganado

Repaired and refurbished over 93 donated computers (Shiprock staff refurbished another 25)

Provided computers to Tohachi Youth Center, Tsaile-Wheatfields Chapter, and Teec Nos Pos Chapter

Continued providing user support at various campus locations

Proposed permanent office of Academic Computing and a new academic department of Computing and Technology

Wrote and submitted a proposal to NSF for another three year project

Completed a history of college technology planning

With the help of the college president, established the "web development team" and supervised the reconstruction of the site following a fatal server crash (January, 1999)

      Throughout the entire period, NLN was involved in establishing policy, developing strategic planning documents, assisting with the management team and vice president's staff, and helping on various grant proposals for the college.

NASA and NSF support for network circuits ended, July 1998

Provided funding to one instructor to develop the college's first online course