Project Definition Study

for DOE/ER/40885--T1

Research Facility Access & Science Education

October 1994

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1. Executive Summary

This UTA/SMU project definition study describes critical customer services and research programs which draw upon SSC assets to meet regional needs in two major components:

- Science Education
- Academic/Small Business R&D Facility Access

The location of the SSC in Texas constituted a significant stimulus to R&D activities in Texas, encouraging new initiatives in high energy physics, as well as stimulating other areas of physics and related sciences.

An important aspect of maximizing the utility of the investment in the SSC should be to re-allocate SSC assets in ways that maintain that momentum. This study addresses several ways to achieve that end, extending benefits to all of physics, the sciences in general and particularly, to science education.

1.1. Science Education/CyberScience Coalition

Just as information technology has become an integral tool for the practicing mathematician, engineer or scientific researcher, it now also belongs in our science and math classrooms as a day-to-day tool in the hands of our students and teachers. Advances in hardware capabilities, user interface, and software technology allow students to use computers as transparent extensions of their hands and minds to explore the world around them.

In the CyberScience Coalition, we propose to use TENET, THEnet, Internet and information technology as primary catalysts to involve scientists and engineers in the enhancement of science education. We believe:

- Integral use of information technology will impact the value of student experiences and result in a broader range of students excelling in science and mathematics literacy;
- Offering learners more relevant and meaningful learning environments will result not only in greater mastery of concepts but also a better appreciation of the value science and mathematics in solving real world problems; and finally, that
- Teachers and students must use today's leading edge information tools if they are to invent and apply tomorrow's problem solving technology.

The CyberScience Coalition is proposed as a new connectivity mechanism involving:

- Technical components continuing as part of the reconfigured Texas Laboratory,
- Public schools and regional service centers,
- 2 and 4-year degree-granting academic institutions,
- State and federal agencies,
- Professional societies,
- Businesses and industries, as well as
- Foundations, community organizations

  and others concerned with educational reform.

Furthermore, the CyberScience Coalition is designed to involve these interested constituents in building a sustainable base for the application of telecommunications technologies to science and math education.

Texas' core industry bases, from oil to electronics to agriculture, all have a continuing demand for a science literate workforce. In addition to involving key industry representatives as members of our advisory board, exploratory discussions with representatives from internationally recognized firms such as Texas Instruments, Rockwell International, Apple Computers and E-Systems, indicate an interest and willingness on the part of industry to participate in the formation of the CyberScience Coalition. Letters of Support will be provided as an appendix, delivered under separate cover.

For organizational and management purposes, the CyberScience Coalition will be divided into four components, addressing the following program needs. With appropriate funding, components 1 and 2 describe program elements for which we can begin **immediate delivery**.

1. **Science Education Enhancement Center**, providing:
    - Computer Literacy Training for Teachers
    - Lab Equipment Lending Pool
    - Students/Classrooms On-line
    - School Administrator Seminars
    - Software on Science (SOS) Clearinghouse
    - Student Internship Opportunities
2. **Connectivity Support Center**
    - Technology Deployment Services
    - Technology Maintenance Services

- Internet Data Repository/Gateway for Science Education Users (NII/WWW/Mosaic)
- Digital Libraries
- Linkages with International Educational Communities, beginning with Mexico

In a survey of Texas science teachers conducted for this study, 89% of respondents reported that their classrooms are not connected to a network, 69% felt that they had "zero" or "weak" networking skills, and 90% wanted to learn more via a variety of training vehicles.

According to a 1993 national survey, 80% of the installed base of computers in American elementary and secondary schools are essentially incapable of supporting multimedia graphical applications; presently, only Apple Macintoshes and IBM compatible 386s or 486s are capable of supporting the higher level applications which facilitate teaching good science visually.

Almost all of the Macintoshes, PCs, PowerBooks/portables, workstations, servers and computer peripherals currently a part of the SSC Laboratory inventory can meet the higher level applications criteria and could be very efficiently used in a Texas outreach program that will also coincide with the national agenda for improving the use of NII and telecommunications technologies in classrooms .

A critical feature of the CyberScience Coalition is the use of this current SSC inventory of appropriate computer hardware and peripherals (Current inventory indicates as many as 2925 Macs/PCs, 906 workstations and 9375 various peripherals available) to link Texas science teachers on to Internet as part of the Connectivity Resource Center efforts.

Using the rural community science classrooms in South Texas, East Texas and West Texas as a priorities, demonstration models and test beds can be established in ways that allow successful approaches to be cost-efficiently replicated both nationally, and eventually in Mexico.

Components 3 and 4 describe research program elements that are needed to build sustainable, on-going research efforts that feed cutting edge technology back into the front-line programs, such as those outlined in points 1 and 2 above. Investments of seed dollar funding are necessary to initiate research programs such as the following:

3. **Educational Technology Research Group**
    - Technology Test Beds
    - Learning Styles Research
4. **Workforce Development Research Group**

- Data Base on Workforce Needs and Skill Assessments for Science and Engineering
- Executive Institute for Advancement of Science Education

1.2. R&D Facility Access Program

No one university or small business has all of the state-of-the-art equipment, or adequate space to carry out all the work it might wish to undertake. A market survey conducted as part of this project definition study has determined that interest in shared-use access to SSC assets was highest for high performance computing. In order to demonstrate the true need for sustained access to this high priority asset, we propose to manage a fund which provides subsidized access and use of high performance computing and available shop capabilities for users from all Texas universities, national labs, and small high-tech industries, with special emphasis on efforts that facilitate equitable access for minorities and females.

The mission for the proposed Academic/Small Business R&D facility Access Program is to provide a broad array of state-of-the-art technical services in one central location to serve the research and development communities in universities and in high-tech enterprises in Texas. This program will enhance many universities' abilities to collaborate in forefront research projects, will allow industries to develop their ideas more economically, and can interface efficiently with the on-going scientific programs remaining as a permanent part of the Texas Laboratory.

For organizational and management purposes, the R&D Facility Access Program will include the following components:

- R&D Facility Access Fund;
- R&D Lab Equipment Lending Pool; and
- Stand-Alone Electronics and Machine Shops, if necessary.

1.3. Findings & Recommendations

After careful study and consideration, with input from an especially helpful and experienced Advisory Board, the following recommendations are made as a part of this UTA/SMU project definition study:

A A critical service niche in science education has been identified which uses existing SSC computing assets to support science education by

providing on-going teacher enhancement on the use of computers and connectivity resources on a daily basis in science classrooms.

For science education, the project has definite uses/needs for pieces of SSC equipment, including almost all of the Macs/PCs/workstations (3500+) as well as permanent staff, budget and facility space, independent of any other technical and/or high performance computing elements which may continue to exist.

An outreach program will be implemented to loan SSC/DOE computer workstations to schools and to provide expertise to "information-poor" school districts in Texas to enable them to connect to the NII. Ownership would be retained by the CyberScience Connectivity Resource Center, which will also maintain the computers and networking hardware.

In addition to providing all available Macs, Pcs, workstations and computer peripherals available for the enhancement of science education, the Department of Energy can leverage both their education and research dollars well by providing:

1) Immediate start-up funding of \$1.6M direct costs for the 1995 and \$1.7M direct costs for 1996; and

2) Base line support of \$1M direct costs for each of the subsequent three years, plus leadership assistance in securing long-term self-sustaining research funding and development activities for the CyberScience programs during the first five years of operation.

B Use of the SSC assets will be maximized by the establishment and funding of an Academic/Small Business R&D Facility Access Fund, a service program to provide universities and small businesses in Texas (and if feasible the region) with access to the electronic and machine shops and parallel computing capabilities that are retained at the site.

The mission of the proposed Academic/Small Business R&D Facility Access Program is to provide a broad array of state-of-the-art technical services and training in one central location to serve the research and development communities in universities and in high-tech enterprises in Texas, relating to all branches of physics. This service program will enhance the abilities of universities, most especially undergraduate and minority institutions, and small businesses to participate in leading research collaborations, to establish new ties with one another, and could contribute to the economic feasibility of new idea development.

Twenty percent (20%) of the Academic/Small Business R&D Facility Access Fund will be prioritized for minority and/or female users, or project teams involving minorities and/or females in principal roles.

The Department of Energy (DOE) should finance this Academic/R&D Facility Access Program at an annual amount of $2M per year over the next 5 years in order to provide those in both the scientific and regional business communities with a different, yet on-going, R&D stimulus similar to that which might have been anticipated to exist due to the existence of the SSC Laboratory in Texas. Five years' cumulative direct costs requested from DOE for the R&D Facilities Access Fund and minimal Fund administration total $12.5M, and five years' cumulative direct costs for the R&D Equipment Lending Program total $1.8M.

C Training needs for R&D technicians, as well as for production technicians, were also investigated during this project definition study; however, our evidence suggests that other DOE-funded studies, specifically those led by industry-driven Texas Manufacturing Technology Center (TMTC) and its proposed Inland Regional Technical Institute, as well as by the Texas Engineering Extension Service (TEEX)/UTA's Automated Robotics Research Institute, are competent endeavors perhaps better suited to this task, and as such, are endorsed and supported to meet training needs.

D Our project has identified no justifiable needs for the Central Facility (CF), in and of itself, but does have facility space needs which could be met by allocation of space either at CF or N-15, depending on what and where other technical and/or high performance computing elements will continue to exist on a long-term basis.

E To prevent a loss of continuity between completion of this study and implementation of defined projects, the CyberScience Coalition and the Academic/Small Business R&D Facility Access Program, we recommend that modest funds be made available immediately for program development work to continue. To support base line program development activities would require approximately $30,000 per month plus indirect costs; funds requested represent direct costs to support four program development and technical staff, appropriate administrative support, and basic travel and operating expenses.

2. Background & Organization of Study

2.1. Overview

As Congress voted to terminate the Superconducting Super Collider (SSC) Laboratory in October of 1993, the Department of Energy was encouraged to maximize the benefits to the nation of approximately $2 billion which had already been expended to date on its evolution.

Having been recruited to Texas from other intellectually challenging enclaves around the world, many regional scientists, especially physicists, of course, also began to look for viable ways to preserve some of the potentially short-lived gains made by Texas higher education in anticipation of "the SSC era."

In fact, by November, 1993, approximately 150 physicists and engineers from thirteen Texas universities and the SSC itself, had gathered on the SMU campus to discuss possible re-uses of the SSC assets. Participants at that meeting drew up a petition addressed to the state and federal governments requesting the creation of a Joint Texas Facility for Science Education and Research. The idea was to create a facility, open to universities and industry alike, which would preserve the research and development infrastructure and continue the educational mission of the SSC.

Shortly thereafter, in December of 1993, Texas Governor Ann W. Richards appointed a committee of distinguished citizens, chaired by Jess Hay, to review the SSC situation and to make recommendations for state action. At the request of the Hay Committee, the National Research Council (NRC) quickly assembled a panel of National Academy members to visit the SSC, and provide technical advice. Advice from the NRC group included retention of a core group of scientists; maximizing uses for the high performance computing capabilities, and encouragement for evolution of some "joint facility supporting science education and research."

The Hay Committee made three recommendations to the Governor in February, 1994:

- Retain a core group of scientists and engineers to maintain the viability of complex SSC facilities and to develop alternative uses for them;
- Establish (or was it authorize) a research agency to direct the work of the core group; and
- Focus initial efforts on regional centers for superconductivity, high-performance computing, and medical technology.

In addition, the Hay Committee recommended that the SSC site be restored to its native Blackland Prairie condition.

While these recommendations were being developed, the Department of Energy (DOE) issued a call for "Expressions of Interest" for use of SSC assets and established a procedure for reviewing formal proposals. DOE also entered into negotiations with the State of Texas, represented by the Texas National Research Laboratory Commission (TNRLC), to determine what compensation should be given the State in return for its approximate $539M already contributed in land acquisition costs, as well as facilities, to the SSC Laboratory endeavors.

Outcome of these parallel processes consisted of an agreement between the State and DOE, which was announced in July, 1994, and two specific sets of project definition studies regarding alternative uses of the SSC assets:

SET 1 evolved under the leadership of the TNRLC:

- Regional Medical Technology Center (RMTC)
- Applied Superconductivity & Cryogenics Technology Center (ASCTC)
- Southwest Center for Computing, Information and Learning (SCCIL)
- Blackland Prairie Restoration Project (BPRP)

SET 2 consisted of several of the expressions of interest (EOI's) originally requested by and subsequently funded directly by DOE:

- Joint Texas Facility Supporting Research, Training and Science Education (UTA/SMU)
- Inland Regional Industrial Technology Institute (TSTC)
- Manufacturing Deployment Center (TEEX/ARRI)
- Minority Institution Network Access to the Central Computing Facility (PVAMU)
- Measurement of Velocity of Light in a Magnetic Field (JPL) and in a Strong Magnetic Field (Colorado State U.)
- Cryogenic Helium Gas Convection Research (Yale/Duke/U of Oregon)
- Geotechnical Facility for Environmental Research at the SSC Site in Texas (LBL)

This document, is the final report for the project definition study regarding the "Joint Texas Facility Supporting Research, Training and Science Education, " one of those EOI's funded directly by DOE as a part of SET 2.

One of the underlying tenets of this project definition study is that the sharing of resources is inherently more economical than duplication. For

example, it is assumed that the required computer support is supplied by a dedicated High Performance Computer Center, and that the shops are actually maintained by a primary user. Leading candidates to serve as primary technical users of the facility include:

RMTC. The Regional Medical Technology Center (RMTC) will include both a proton cancer therapy facility and a radioisotope production facility. Having already passed DOE peer review, as well as state endorsement, the RMTC is well on its way to receiving appropriations to formalize its existence.

ASCTC. Functioning as the Applied Superconductivity and Cryogenics Technology Center (ASCTC), the magnet complex can become a national center for the development of superconducting magnets for many different purposes, ranging from highly specialized "one-of-a-kind" magnets to magnets for magnetic levitation. Such a center can be of great service to the nation by helping superconductivity become an economically viable technology with widespread applications.

Under the terms of the preliminary agreement between the State and DOE, the superconducting magnet complex will become the property of the State. It is the most up-to-date facility of its kind in the country with the capacity to cable and wind the highly specialized wire alloys that become superconducting at liquid helium temperatures. It also has a very large capacity to produce liquid helium and is fully equipped to design, fabricate, and test superconducting magnets of all shapes and sizes. One obvious use of the complex in the field of High Energy Physics is the development and fabrication of special magnets for the Large Hadron Collider (LHC), an accelerator about one-third the energy of SSC which is likely to be built in Europe in the next ten years. Indeed the National Research Council panel emphasized in its report that this could provide the basis for a United States contribution to the LHC.

BPRP. The Blackland Prairie Restoration Project proposes restoring approximately 6,000 acres of endangered prairie ecosystem at the former site of the Superconducting Super Collider (SSC). The restoration project is proposed to be an integrated land management system compromised of restored tall grass prairie together with approximately 150 acres of riparian woodlands and associated wetlands. Park programs will be phased in as the area of land restored to Blackland Prairie increases. Educational, recreational and interpretive programs will be instituted gradually. It is proposed that educational programs could target students who are interested in actually working on the restoration project, or host science class field trips to observe the restoration process. The proximity of the SSC land to Waxahachie and the Dallas and Fort Worth Metropolitan areas suggests that the park could support a strong educational program that targets elementary, middle, and high school students in these areas.

SCCIL. The Southwest Center for Computing, Information & Learning (SCCIL) recommends that the computing networking and many other SSC resources be used to create a regional center which would be a major regional node on the National Information Infrastructure (NII), a large data repository and a high performance computing center. The use of technology to deliver education, particularly with an emphasis on science education through a proposed on-site school as well as through interaction with the CyberScience Coalition science education initiative, will be an important strategy with which our project definition will collaborate and compliment.

At the time of SSC funding termination in October of 1993, the "SSC assets" included about 2000 highly skilled staff members, several large buildings, and much sophisticated equipment. Inevitably the staff, the single most valuable asset, has all but evaporated during the past year as the scientists, engineers and technicians at the SSC Laboratory have moved on to other jobs and other careers, many out of state and/or the country.

The physical facilities remaining consist of a partially completed 600 million electron volts (MeV) linear accelerator, a complex of superconducting magnet laboratories and helium liquifiers, and an enormous 525,000 square feet central facility building. The central facility (CF), totally wired and networked for modern electronic communication, houses state-of-the-art engineering shops, offices, a library, and a massively parallel computer farm.

The most versatile of SSC assets, and possibly the most fragile, is the collection of computer hardware assembled at the SSC laboratory, including personal computers and work stations. As the centerpiece for a node on the National Information Infrastructure, these resources could enable education in Texas to join in the cyberspace revolution that is sweeping through our society, and to develop educational programs based on them serve as a model for duplication in other places, in addition to benefiting Texans.

The ability to access large databases, to connect students in one location with master teachers and researchers at the other end of the world, and to eventually create interactive simulations of key scientific experiments will open up vast new possibilities for science education, many of them not even imaginable today.

Use of the SSC site and SSC assets provides a unique opportunity to realize the goals envisioned in Joint Texas Facilities Project. Conceived as a collaboration involving relevant state agencies, universities and forward-looking industries, the Joint Texas Facility for Science Education and Research would receive technical leadership from scientists and engineers who are thoroughly versed in the developing lines of their fields, and who have the flexibility to adapt to changing scenarios. With state endorsement and support, such a facility could earn the respect of both industrial and political communities and provide an effective interface between them and the

technical community. As noted by the National Research Council panel, the path for providing shared academic access to these R&D facilities will not be easy, but it is well worth exploring.

2.1.1. Study Goal & Mission

Study Goal: To provide realistic advice and recommendations for using SSC Assets to enhance science research, education and economic competitiveness in Texas.

Study Mission: To study the benefits and costs of including the following broad, Texas outreach programs as permanent parts of whatever science/physics facility evolves at Waxahachie, Texas.

2.1.2. Detailed Study Objectives

During the course of this study, we have researched and analyzed the proposed purposes, benefits and costs of the elements of a Joint Texas Facility for Support of Research, Training and Science Education. The objectives of such a Facility would include: science education, particularly teacher enhancement, precollege instruction assistance, and intern activities; and infrastructure support for Texas physics research in areas of machine shops, electrical and electronic shops, engineering design, and training programs in these areas. The goal would be to provide new resources, not to compete with existing facilities. Special attention would be paid to full participation by minorities and women and predominantly minority institutions.

For science education, the objectives were examine the feasibility to:

- Develop and manage teacher enhancement programs;
- Support efforts by Texas schools in K-8 in all sciences and at the high school level in physics;
- Conduct undergraduate, graduate, and postdoctoral activities at the site;
- Manage appropriate intern activities at the site for students and teachers.

Regarding infrastructure support for Texas physics research, the objectives were to investigate the feasibility of a facility which could:

- Provide machine shops, electrical and electronic shops, engineering design expertise, CAD/CAM facilities, and other related infrastructure elements for physics research in Texas, basic and applied, in universities and industry;

- Develop and conduct, in cooperation with industry, appropriate training programs in the broad areas of mechanical and electrical engineering shops that would constitute the core of the research infrastructure support.
- Operate so as to supplement institutional infrastructure for those challenges requiring resources not available at individual institutions and companies;
- Facilitate cooperation among multiple Texas institutions and companies in responding jointly to major technical challenges; and
- Seek to maintain a balance among different parts of physics that would furnish appropriate support to various sub fields, taking into account national and state priorities as well as advancement of the field.

In pursuing both science education and infrastructure initiatives, the project would be defined in such a way as to meet the following common objectives:

- Work in close coordination with the other specific on-site uses selected for development;
- Structure operations and activities such as to encourage and to promote participation of women and minorities and minority-serving institutions;
- Attempt to ensure maximum exploitation for technical training, teacher enhancement, and other educational programs of its research infrastructure activities;
- Attempt to ensure that its activities utilize the best in educational technology and pedagogic research and practice; and
- Structure its activities so as to reinforce and enhance existing efforts in education and research.

2.1.3. Affirmative Action

Insufficient participation by women and minorities is a problem in physics at the national, state and local levels. A major objective of JTF must be to ensure that its programs are designed, to the maximum extent possible, to aid in addressing that problem. A variety of appropriate features have been incorporated into the programs defined in this study. These include:

- Twenty per cent (20%) of the Academic/Small Business R&D Facility Access Fund will be prioritized for minority and/or female users, or project teams involving minorities and/or females in principal roles. This could be particularly important in facilitating research at minority institutions which tend to be very limited in infrastructure assets to support faculty creativity; and

- Intern arrangements for minority and female high school students. A working arrangement in this area, with TEXPREP is under discussion with its director, who sits on the advisory board of this study, as discussed in section 3.3.1.6;
- Special efforts in staffing. To this end, the advisory board for this study contains several minority and/or women who are well qualified to aid in identifying suitable candidates;
- Workshops with those in Texas with expertise in fostering women and minorities to identify further programs for collaboration . The object would be to augment the many efforts in this area being made by people and organizations around the State and to avoid duplicating such efforts or competing with them.

2.2. Study Management

The organization of the Study consisted of the following elements:

A Full Time Director. Dr. Jane Armstrong was recruited and served as Project Director for the Study. Prior to initiating her consulting practice in 1990, Dr. Armstrong served as Vice President for Strategic Development for the Houston Advanced Research Center, a university research consortium. Having worked in the field of university research program development and technology ventures for approximately 15 years, Dr. Armstrong is familiar with Texas education and research programs as well as with SSC historical evolution.

Administrative Support to the Staff. Rebekah DeLaughter, a journalism graduate from University of Texas at Austin and former employee of the SSC Technical Publications Division, provided key facilitating skills in the position of Project Coordinator.

Knowledgeable SSC staff. The SSC lab technical division has provided staff assistance from the following individuals: Kate Morgan; Dr. Jheroen Dorenbosch; Dr. Georges Jamieson; Linda Walling, as well as various administrative staff, where needed.

Consultants. External advice and expertise were provided by Dr. Dan Howard; Dr. J. E. Gonzales; Bill Stotesbery; Dr. Ron Johnson; and Dr. Lynne Bowers.

Market Research. Both staff time and specialized assistance were devoted to this important element. Dr. Dan Howard, chair of Southern Methodist University's College of Business Marketing Department, worked with project staff to complete market survey research for research and development infrastructure and training issues, while Dr. J.E. Gonzales, Texas Center for

Educational Research with the Texas Association for School Boards provided data tabulation and analysis of survey information solicited from physics and biology teachers in Texas.

The R&D infrastructure study attempted to ensure objectivity of market research into use of SSC assets for infrastructure for R&D. Dr. Daniel Howard, Chair of Southern Methodist University's College of Business marketing department, whom the Principal Investigators never met, was selected on advice of the dean of the college of business. Dr. Howard is a recognized national expert in his field. He has consulted on marketing for such major firms as Airco Electronic Gases, Honeywell, Prudential, JC Penney, and the May Company. Dr. Howard is making use of technical advice from study staff, developed a survey instrument and managed its execution. Dr. Howard analyzed the responses and wrote a report independently without staff assistance.

Workshops. Two workshops, one on educational aspects, and one on research infrastructure elements, were held early in the Study to ensure maximum participation in formulating detailed questions to be studied and in answering those questions.

Advisory Board. A committed group of leaders from industry, education and government were involved as "working" advisors during the evolution of our project definition study (See Advisory Board Directory in beginning of document). In order to adequately address all of the relevant questions and issues, the Advisory Board was divided into two subcommittees: one for R&D Infrastructure, chaired by Dr. Charles Tapp, Director of Quality Improvement at Sandia National Laboratories; and a second for science education, chaired by Dr. Bill Baker, Professor, University of Texas at Arlington. Advisory Board members were included in both workshops and two board meetings, as well as one-on-one interaction as needed in order to meet the deliverables of the study in a timely fashion.

Volunteers. The concept for this proposal traces back to a statewide meeting of physics faculty at Southern Methodist University in October, 1993. At that meeting an informal organization was created, co-chaired by the Principal Investigators and Dr. Richard Wigmans, Bucy Professor of Physics at Texas Tech University. Many of the more than 100 members of the organization participated in one or more of the workshops or as individual resources, and that participation was used as a measure that plans drafted during the Study are truly responsive to Texas science needs, and to physicists in particular.

Interface with Parallel Studies. Both formal and on-going informal arrangements with parallel DOE and TNRLC studies of on-site uses of SSC assets were utilized wherever possible, to avoid unnecessary duplication and to share relevant information.

3. Science Education Program

3.1. Introduction: Scientific Inquiry as a Life Skill

For the past several years, committees from both the National Academy of Sciences and the American Association for the Advancement for Science (AAAS) have debated and highlighted the urgency for developing a science-literate citizenry.

The SSC was the first national laboratory to include the creation of an international science education program as part of its original mission. In light of the current circumstances, a reconstituted, reinvigorated science education initiative remains a compelling need, both on a state and national basis.

The process of scientific inquiry, more commonly known as "problem-solving, " is a critical life-skill. In addition to encouraging talented students to become scientists and engineers, concentrated efforts must be made to infuse science awareness, appreciation, inquiry and understanding into classroom activities so that students are effectively prepared to solve problems, make decisions and perform successfully as they enter the global workplace.

What is this process of scientific inquiry? Exploration of questions, critical data collection and analysis, plus working together to share ideas and information freely with each other and team-members, or to use modern instruments and technologies to extend intellectual capabilities.

As we analyzed what "SSC Assets" might truly be fortuitous in a reconfigured science education initiative, we realized that we had several elements of a very exciting, cutting edge science education effort right at our fingertips. . . scientists. . . their favorite tools, computers. . . and connectivity to the world via a national information infrastructure.

3.2. Definition of Need

A four-pronged approach was used in reviewing existing science education programs and in identifying specific niche services which might use specific SSC assets to be both collaborative and mutually beneficial to all involved:

- Advisory Board Science Education Subcommittee
- Review of College of Education Math/Science Programs in Texas

- Science Education Workshop
- CyberScience Survey of Science Teachers

3.2.1. Advisory Board's Science Education Subcommittee

To examine, document and address the compelling need for science-literate citizens, principal investigators invited participation of key representatives from industry, public schools, the scientific arenas and the local community to serve on a Science Education Subcommittee and an Advisory Board to provide guidance and advice in fulfilling the following charge:

CHARGE: To examine and make recommendations regarding cost-effective activities, structure, operation, and possible funding sources of an on-going educational outreach effort to strengthen and enhance Texas science education initiatives utilizing existing SSC assets, including:

- On-going science teacher enhancement;
- Programs involving university, industry and government to strengthen science appreciation, understanding and awareness for all students in Texas schools;
- Intern activities for teachers & students of science; and
- Network access to TENET, Internet, interactive computer-aided instruction and technical library holdings

Members of the Advisory Board's Science Education Subcommittee represent a vast array of expertise, as well as interest in the issues surrounding science education, including a member of both the academy of science and the academy of engineering who currently chairs the scientific advisory board for a major foundation; director of the math and science Eisenhower Grants programs for the Texas Coordinating Board for High Education; a 1994 Tandy Scholar (100 teachers recognized nationally); director of university research liaison for a Fortune 100 electronics firm; president of a small business providing skill assessment and interactive training packages for federal contracts; university leaders in science education and information technology; director of a large DOE-funded, minority-targeted math/science preparation program; key community leaders; and science education director for the Texas Education Agency; as well as general participation from advisory board members serving on the R&D Infrastructure subcommittee. These individuals are identified at the beginning of the document.

3.2.2. Survey of Math & Science Education Programs in Texas

According to the administrator responsible for Eisenhower Grants for math and science education programs at the Coordinating Board for Higher Education in Texas, a directory of math and science education programs available from/delivered by Texas colleges and universities does not currently exist. As part of our study, therefore, letters were sent to Deans of Education at all Colleges and Universities in Texas, requesting descriptive information regarding their on-going efforts in these areas. Follow-up phone calls were made during the last two weeks in October 1994, to make sure that the survey data included in appendix A was as complete as possible given our time frame for data collection.

Seventeen universities responded to the survey with descriptions of their science education and teacher enhancement . The major thrusts of these programs are the enhancement of teaching skill, knowledge of subject matter, and the development of new courses and curricula. Five of these institutions emphasize the development of teaching technology and only one mentions networking. Two universities mention summer programs for elementary and high school students.

Computer literacy and connectivity training for teachers appear not to have been emphasized in these programs and so there exists a clear need and important niche for the aims of the CyberScience Coalition. Several institutions have expressed great interest in joining this effort.

3.2.3. Science Education Workshop

The Science Education Workshop was held Thursday, September 1, 1994 at Southern Methodist University (Agenda is available in Appendix B). Approximately 65 educators and industry representatives attended the day-long event. Topics of discussion included the settlement between the U.S. Department of Energy and the State of Texas, an overview of the Joint Texas Facility Project and other collaborations including reports from the Regional Medical Technology Center, the Southwest Center for Computing, Information & Learning, and the Inland Regional Industrial Technology Center.

Kate Morgan and Dr. Jane Armstrong described the evolution of a CyberScience Coalition and how it might involve SSC assets, as well as connectivity to scientists and engineers in the enhancement of science education.

Keynote presentations were made by Lourdes Monteagudo, Executive Director of the Teachers' Academy for Math and Science at the Illinois

Institute of Technology, and by Lauren Williams, Director for the VISION program of the Triangle Coalition for Science and Technology Education.

Breakout sessions provided opportunities for the following topics to be discussed:

- What are the currently connectivity, equipment and training needs to link science teachers onto TENET and/or InterNet? with other scientists?
- Are there ways to integrate workplace skill requirements into curriculum modules that teach TAAS science essential elements?
- Could the Coalition development process avoid duplication of efforts?
- Are there suggestions for clarifying the scope, priorities, research opportunities or funding scenarios for the CyberScience Coalition?

Connectivity was identified as a primary barrier to science teachers, inhibiting science classroom participation in educational opportunities becoming available via TENET and Internet. Workshop leaders were encouraged to move ahead quickly with the proposed survey of science teachers to measure the extent of the needs to be filled by a coalition effort delivering computer literacy training, services and support in ways that complement other science education programs.

3.2.4. CyberScience Survey of Science Teachers

Intended to measure the computing capabilities and connectivity of science classrooms in Texas, the CyberScience Survey was designed by Project Director, Dr. Jane Armstrong, and one of the project's advisory board members, Evelyn Restivo, a 1994 Tandy Scholar who teaches physics and chemistry at Maypearl ISD, and was reviewed by a workshop session during the Science Education Workshop.

The CyberScience survey was sent by mail to two teacher groups in Texas: the Physics Teachers Association of Texas (n = 265); and the Texas Association of Biology Teachers (n = 630) The survey sample therefore totaled: 895.

Respondents returned surveys directly to the Texas Center for Educational Research (TCER) which had agreed to participate in the study by providing independent data entry, quality assurance, and data analysis. TCER is a subsidiary of the Texas Association of School Boards (TASB).

From an adjusted response rate calculated to be 27%, (240 completed returns received out of the 895 sent), the following relevant findings can be summarized:

1. Computers in the Classroom

- 69% have some kind of computer(s) in their classrooms;
- 95% use some sort of technology for their Science and Math classes ranging from TV to software: 34% used TV; and 61% used some combination of TV, CD-ROM, databases, and software; and
- **86% would like to add computers to their science classrooms.**

2. Network Connections in the Classroom
   - **89% of the respondents indicated that their science classrooms are not connected to a network, by virtue of having no phone or modem; and**
   - **89% of students did not have access to networks from the classroom.**
3. Computers at Home
   - 85% of science teachers have computers at home; and
   - half of the respondents have access to networks from their homes; of those that did, 28% accessed TENET.
4. Training Needs
   - **69% felt they had "zero" or "weak" networking skills;**
   - **90% wanted to learn more via one or more of the training services listed;**
   - 79% of respondents indicated that they thought their schools would pay release time for them to attend training session; and
   - 86% would attend a training class that was provided free of charge on a weekend.
5. About the Respondents
   - All are on mailing list of either Texas Association of Physics Teachers or Texas Association of Biology Teachers;
   - 60% are female;
   - 44% are between the ages of 40-50; 92% between the ages 30-60;
   - 90% are white; and
   - 50% teach at the 10th-12th grade levels.

A copy of the CyberScience Survey instrument, as well as a complete report of findings prepared by Dr. J.E. Gonzalez for the Texas Center for Educational Research, can be found in Appendix C.

3.3. CYBERSCIENCE COALITION

Massachusetts Institute for Technology (MIT) students now need an Internet account to get a dorm room; Stanford students use Internet to register for classes; and University of California at Berkeley students are e-mailing their professors via Internet, rather than trying to catch them during office hours. "Ability to Internet" may soon become the latest screening device for determining who "surfs" up the ladder of life-long learning and employability.

Actually, the evolution of Internet is so inherently "science driven" that we do our science students a great disservice if we do not quickly provide them with not only exposure to its existence, but expertise in its use as a dynamic new "tool of the trade" in scientific inquiry. Originally developed as a way for scientists in the defense communities to communicate, Internet now has about 20 to 30 million active users and that number is said to be growing at the rate of approximately 160,000 per month.

The newest information service on Internet is definitely "science driven" World-Wide Web, a hyper-text based client/server system was primarily developed by scientists at CERN European Particle Physics Laboratory. In addition, the most popular WWW client for Windows is Mosaic, developed at the National Center for Super computing Applications (NCSA) at the University of Illinois at Champagne-Urbana.

What are the roles for our national information infrastructure (NII) and related educational technology in addressing the challenges of science and mathematics education reform? An often repeated phrase is let's *do* science and mathematics not learn about science and mathematics. Many educators have found that today's information technologies (computers) have become important tools in addressing the objectives of reform movements.

Just as information technology has become an integral tool for the practicing mathematician, engineer or scientific researcher, it now also belongs in our science and math classrooms as a day-to-day tool in the hands of our students. Advancements in hardware capabilities, user interface, and software technology allow students to use computers as transparent extensions of their hands and minds to explore the world around them.

In the CyberScience Coalition, we propose to use TENET, Internet and information technology as a primary catalyst to involve scientists and engineers in the enhancement of science education. We believe that the integral use of information technology will impact the value of student experiences and result in a broader range of students excelling in science and mathematics literacy.

Offering learners more relevant and meaningful learning environments will result not only in greater mastery of concepts but also a better appreciation of the value science and mathematics in solving real world problems. Teachers and students must use today's leading edge information tools if they are to invent and apply tomorrow's problem solving technology.

The CyberScience Coalition is proposed as a new connectivity mechanism involving:

- Technical components continuing as a part of the reconfigured Texas Laboratory;
- 2 and 4-year educational institutions and universities;
- State and federal agencies;
- Professional societies;
- Businesses and industries; and
- Foundations, community organizations and others concerned with educational reform.

Furthermore, the CyberScience Coalition is designed to involve these interested constituents in building a sustainable base for the application of telecommunications technologies to science and math education.

For organizational and management purposes, the CyberScience Coalition services will be divided into four components, addressing the following program needs. With appropriate funding, components 1 and 2 describe program elements which can begin **immediate delivery**.

1. Science Education Enhancement Center, providing
    - Computer Literacy Training for Teachers
    - Lab Equipment Lending Pool
    - Students/Classrooms On-line
    - School Administrator Seminars
    - Software on Science (SOS) Clearinghouse
2. Connectivity Support Center
    - Technology Deployment Services
    - Technology Maintenance Services
    - Internet Digital Data Repository for Science Education Users (NII/WWW/Mosaic)
    - Digital Libraries
    - Linkages with International Educational Communities, beginning with Mexico

The immediate services will be organized, administered and delivered in ways that are measurably tied to:

- national education goals
- Texas Assessment of Academic Skills (TAAS)
- Benchmarks for Literacy as defined by AAAS

Using the rural community science classrooms in South Texas, East Texas and West Texas as a priority, demonstration models and test beds can be established in ways that allow successful approaches to be cost-efficiently replicated both nationally, and particularly in Mexico.

Components 3 and 4 describe research program elements that are needed to build sustainable, on-going research efforts that feed cutting edge technology back into the front-line programs, such as those outlined in points 1 and 2 above. Investments of seed dollar funding are necessary to initiate research and human resource development programs such as the following:

3. Educational Technology Research Group
    - Technology Test Beds
    - Learning Styles Research
4. Workforce Development Research Group
    - Data Base on Workforce Needs and Skill Assessments for Science and Engineering
    - Executive Institute for Advancement of Science Education

3.3.1. CyberScience Education Enhancement Center

Initially, the CyberScience education enhancement center will be comprised of the following initiatives:

- Computer Literacy Training for Teachers
- Lab Equipment Lending Pool
- Students/Classrooms On-line
- School Administrator Seminars
- Software on Science (SOS) Clearinghouse
- Student Internship Opportunities

3.3.1.1 Computer Literacy Training for Teachers

At the Science Education Workshop (see section 3.2.3), connectivity was identified as a primary barrier to science teachers, inhibiting science classroom

participation in educational opportunities becoming available via TENET and Internet.

A resulting survey of science teachers to measure the extent of the needs to be filled by a coalition effort delivering computer literacy training, data services and on-line support discovered the following :

- 69% felt they had "zero" or "weak" networking skills;
- 90% wanted to learn more via one or more of the training services listed;
- 79% of respondents indicated that they thought their schools would pay release time for them to attend training session; and
- 86% would attend a training class that was provided free of charge on a weekend.

There are many well researched and equally well documented reasons to provide computer literacy training to teachers in general, and to science teachers in particular. Connectivity, and networking skills are an emerging skill set for science teachers, however, and information regarding effective ways to integrate and/or InterNet learning opportunities into the classroom are paving the way for a whole new array of educational resources to be incorporated into ANY classroom or learning environment. For detailed information regarding InterNet learning resources, please see "Riding the Internet Schoolbus: Places to Visit and Things to Do," *Technology & Learning*, October 1994, provided in Appendix D.

A teacher with sound basic computer skills can make immediate and concrete contributions to a scientific project, and can quickly become a valued asset in the research at hand rather than an initial burden. Connectivity is one of the long term benefits that will empower the teacher to remain an active partner in learning and problem-solving, to collaborate with other teachers of science in the development of lessons, and to stay abreast of developments both in science and in pedagogy.

The computer literacy training and connectivity components of this project definition study are designed to allow each teacher to follow a course of instruction that is tailored to his or her individual level of competency and individual schedule. The CyberScience Education Enhancement Center will be available to teachers after classes and classes are also planned for weekends.

Maximum use will be made of interactive software that can assess skill level and deliver course modules at the appropriate level, allowing teachers to progress at their own rates of interest and learning. Using an innovative new learning operations management system, called Power OS, and client/server technology, many Macintoshes will access a central data base of courses so that from each individual learning station a teacher can access the

full range of courses taught at the CyberScience Education Enhancement Center.

In addition, a computer coach will provide instruction and be available to answer questions. Formally structured classes will be offered for teach introductory courses and other courses where high demand makes classroom teaching an economical approach. Topics for these formal courses are introductory computer skills and networking skills. A basic curriculum of introductory computer skills, networking to learning resources, curriculum authoring tools and data base manipulation will be included in initial offerings.

Experienced science teachers who have completed initial course offerings will be considered as candidates to serve as Computer Coach/Trainers in subsequent summers or weekends. They may also contribute by helping teach computer courses or by staffing a hot-line/e-mail to provide assistance to the CyberScience Education Enhancement Center clients. All science teachers who participate in one or more of the center's programs will be encouraged to maintain their involvement in the Center's programs and to continue their exploitation of the Center's facilities to network with other science professionals around the country.

The immediate services will be organized, administered and delivered in ways that are measurably tied to:

- National education goals;
- Texas Assessment of Academic Skills (TAAS); and
- Benchmarks for Literacy as defined by AAAS.

3.3.1.2 Teachers/Students/Classrooms On-Line

According to a 1993 national survey, 80% of the installed computers in American elementary and secondary schools are essentially incapable of supporting multimedia graphical applications. Only that part of the base of current classroom computers made of Apple Macintoshes (10%) and IBM compatible 386s or 486s (8%) is capable of supporting the higher level applications which facilitate teaching good science visually.

ALMOST ALL of the Macintoshes, PCs, PowerBooks/portables, workstations, servers and computer peripherals currently a part of the SSC Laboratory inventory meet the higher level applications criteria and could be very efficiently used in a Texas out-reach program which will also coincide with the national agenda for improving the use of NII and telecommunications technologies in classrooms (Currently, SSC inventory indicates as many as 2925 Macs/PCs, 906 workstations and 9375 various peripherals available).

An outreach program will be implemented to loan SSC/DOE hardware to schools and to provide expertise to "information-poor" school districts in Texas to enable them to connect to the NII. Ownership would be retained by the CyberScience Connectivity Resource Center, which will also maintain the computers and networking hardware.

Using the rural community science classrooms in South Texas, East Texas and West Texas as a priorities, demonstration models and test beds can be established in ways that allow successful approaches to be cost-efficiently replicated both nationally, and particularly in Mexico.

3.3.1.3 TAME Collaboration

The Texas Alliance for Minorities in Engineering, Inc. (TAME) which had its beginning in 1976, is a non-profit 501(c)(3) organization whose main objective is to increase the numbers of minorities and women in the engineering and science professions. Headquartered in Austin, Texas, TAME and its 20 alliances work cooperatively with Texas school systems (K-12), colleges and universities community organizations, state and local government agencies and private industries to sponsor and conduct programs and activities that will enhance student preparation in mathematics and science and that will motivate them to choose careers in science and engineering.

The proposed CyberScience Coalition and its CyberScience Education Enhancement Center offers both a means and a mechanism to assist TAME in its efforts to provide programs and activities for students and teachers of math and science education in areas such as the following:

- On-going math and science teacher enhancement workshops;
- Deployment of teacher workstations and student workstations to science education classrooms in ways that connect them to learning resources via the InterNet and the growing information superhighway;
- Increased access to state-of-the-art science, math and engineering educational materials; and
- Workshops for school administrators, parents and community.

The TAME alliances in Dallas (DAME) and Waco (representing over 10,000 minority students in the area) are extremely interested in the development of this project due to the close proximity of the proposed CyberScience Education Enhancement Center headquarters in Waxahachie, and have expressed interest in becoming leaders in defining ways that these services may be of immediate assistance to enhance some of their on-going activities and programs.

function with intensity, appropriate life-long learning and professional development workshops will be delivered on an on-going basis in order to fill a dynamic need for interactive, on-line instructional capabilities which are to be teacher tools for enhancing classroom learning.

3.3.1.6 Student Internship Opportunities

The environment which affords teachers a learning experience in real-world science is equally valuable to allow students to experience the excitement of science. Two types of student involvement are envisioned: individual internships and classroom activities. We envision two kinds of internships, on-site and off-site.

With regard to on-site internships, we believe that the scope of the Blacklands Prairie Project and the Regional Medical Technology Center would eventually permit a program involving on the order of 20 high school students for a ten week summer period. Such a program would, of course, depend on acceptance by the management of those programs. The budget for such a program has not been included in our baseline calculations.

With regard to off-site internships, we envision that the CyberScience Education Enhancement Center would be in regular contact with well over 100 academic and industrial users around the State. Thus, one could plan on a program of 50 internships using these connections. By placing students in their local areas, room, board, and travel would be eliminated from the budget, and it is possible to envision stipends as low as $2000 for a ten week period. In many cases, the entity at which the student is placed might contribute toward that stipend.

There is sufficient detail involved in recruiting and making arrangements for such a program involving on the order of 70 students that we estimate a requirement for one junior FTE of additional staff.

A significant portion of the Internship Program would be devoted to minority students and women. There is a very successful Texas program of summer workshops for minority students under the direction of Dr. Manuel Berriozábal, called TEXPREP. Students who have been through that program by the beginning of their junior or senior year of high school would be prime candidates for the internship program the following summer. This program would, on the one hand, keep up the student's momentum in technical accomplishment. On the other hand, selecting from the most promising of the students engaged in the TEX PREP program would guarantee to the host units interns "pre-tested" to be most apt to succeed in a summer program.

3.3.1.7 School Administrator /School Board Seminars on Connectivity

In conjunction with Texas Association of School Boards, the CyberScience Coalition will develop and host regular seminars for public school administrators, school board members and interested community leaders and parents regarding connectivity topics related to public school implementation and cost-efficiency for educational technology.

3.3.2. Connectivity Resource Center

Given the continued existence of a high performance computing center and the preservation of the existing ESNET connections and associated equipment which have been an integral part of the SSC high performance computing program efforts, SSC computing and network assets could serve as an effective, convenient resource to promote the rapid, efficient, and effective introduction of the NII into K-12 schools.

The goal of the Connectivity Resource Center is to provide the necessary resources to Texas educators to foster effective student use of the NII (Internet) in Texas public schools.

Using the Texas rural community science classrooms in South Texas, East Texas and West Texas as a priorities, demonstration models and test beds can be established in ways that allow successful approaches to be cost-efficiently replicated state-wide, nationally, and particularly in Mexico.

The connectivity resource center will be used as a central Internet distribution site for educational software and computer hardware (loan of computers, modems, printers etc.). A massive storage system will be created to "mirror" files (or whole sites) that are frequently accessed by schools. A request for a file located in Europe, for example, by a student at a school connected to our network would result in a copy of that file being placed in our storage system. Subsequent requests for this file by any person connected to our site would result in the local copy being accessed and not the overseas one. This feature is extremely important since secondary school students do not have the option of working at non-peak hours. Also important is the fact that if the bottleneck is at the source end (overloaded server), then no increase bandwidth can improve access times.

Such a storage system would allow faster access to files and decreased load on the InterNet links to Europe or other heavily used sites in this country. All of this activity would be transparent to the user. There would be no need for the user to change the address of the requested file. Software will automatically seek out and update files during non-peak hours. Also software would detect cases where files must be accessed live (for example weather satellite pictures

which change several times per hour). Inherent in this system is the ability to prevent access to certain sites or sections of sites (always a concern to parents and school administrators). Resource Center computing staff would be heavily involved in cooperative efforts with other NII nodes to develop improved networking software to improve "peak hour" use of the Internet.

Present network links will be upgraded to T3 or ATM to provide the necessary bandwidth for this activity. Much of this capability exists today but special tailoring for educational purposes would be needed. All public domain software would be freely available to anyone and this site would become a major educational NII node.

An outreach program will be implemented to loan SSC/DOE hardware to schools and to provide expertise to "information-poor" school districts in Texas to enable them to connect to the NII. Ownership would be retained by the CyberScience Connectivity Resource Center, which will also maintain the computers and networking hardware.

Targeting science classrooms in East Texas, South Texas and West Texas rural regions will enable many minority students to participate in information rich learning environments usually available to schools with large education technology budgets.

3.3.2.1 Technology Deployment Services

An outreach program will be implemented to loan SSC/DOE hardware to schools and to provide expertise to "information-poor" school districts in Texas to enable them to connect to the NII. Ownership would be retained by the CyberScience Connectivity Resource Center, which will also maintain the computers and networking hardware.

The office of technology deployment services will provide necessary resources for schools that need help to connect to the Internet and/or the CyberScience Digital Data Repository.

Existing SSC/DOE computer equipment will be loaned to schools to enable connectivity. Initially the primary recipients of this equipment will be rural science classrooms.

The CyberScience school connectivity program requires several components:

1) Building Administrator/Principal must attend a School Administrator Seminar;

2) Science Teacher must complete core courses for CyberScience Computer Literacy, or test out;

3) Phone-jack, modem and dial-up connection services must be installed in the designated science classroom;

4) Teacher station will be located in the science classroom, have access to Internet and the CyberScience Digital Data Repository via the 1-800 # and dial-up connectivity and be staffed by a CyberScience trained teacher; and

4) Student computer stations in the science classroom will be connected to Internet and the CyberScience Digital Data Repository via the LAN.

In order for a school to receive equipment on loan and to participate in the CyberScience Coalition programs, the local campus is required to pay for, or to request a CyberScience School Scholarship to cover costs of a LAN-phone jack in the science classroom; schools must agree to pay for local phone line charges on a regular basis, as well as science teacher's tuition to annual teacher enhancement workshop.

Teacher Stations in the Classrooms

Much has been written about the failure of many teachers to integrate technology into their teaching practices even though access was provided to their students with laboratory or check out CPUs. The Apple Classroom of Tomorrow (ACOT) research found that teachers need to personally experience the benefits of computer technology before they grasp its power for their students.

Despite new "ease of use" features, a significant effort and sacrifice of personal time is required to master today's information technology. It is understandable that teachers are unwilling to dedicate the time and energy required unless they have convenient access to a computer assigned to just them. In a recent Electronic Learning issue focused on "A Computer on Every Teacher's Desk, " many testimonials were given to support the notion that successful adoption of technology required a teacher station.

Evidence shows that even one computer, in the classroom, permanently assigned to the teacher effects the quality of instruction. Like doctors, plumbers, or electricians, teachers need a tool box for their profession. Teachers are information professionals and require tools and skills for access, manipulation, and communication of information on a daily basis.

Classroom Student Research Stations

Research has shown that the culture of the classroom can only be changed when technology is easily accessible by students at all times. While this could be interpreted as one CPU per student, this is rarely required or even desired. One of technologies surprising benefits is support of collaborative learning environments.

Instructional research indicates that learning should be social to be meaningful. In addition, collaborative skills for problem solving have been identified as critical for success in most careers.

Five to six student learning stations per classroom is often a critical mass for a positive impact on instructional methods. With technology in the classroom, students can use discipline specific tools as an integral part of their research on a daily basis.

Empowered with technology, individuals learn to rely on student stations for information access, computation, problem solving, producing reports and presentations, and for collaboration. The result can be a dramatic change in motivation, a shift from knowledge transfer mode by the teacher to a knowledge construction mode by the students.

3.3.2.2 Technology Maintenance Services

A major obstacle to Internet connectivity for many schools is simply the lack of trained people who know how to "wire up" a school or school district. The resource Center would make available such trained persons to local school districts and would offer training to their permanent networking staff.

Center staff will maintain, service and upgrade computer equipment. There will be an on-site electronic shop for repair and upgrade of computer equipment. Software will also be maintained and upgraded as necessary. A database will be created to provide information on product reliability, repair history, and usefulness in an educational environment. This will allow schools to make hardware and software purchasing decisions based on experience in a school environment.

3.3.2.3 CyberScience Digital Data Repository

A major obstacle to Internet use in a school setting is that the Internet is often slow during peak hours. Some "interesting" sites even limit access during peak (i.e. school hours) times. A solution to this obstacle is to provide large amounts of storage at one location that is used to "mirror" interesting sites. This storage would be "dynamic" in the sense that request for files would result in a copy of that file being placed on a local disk. Subsequent requests for that file would result in the local file being made available. this would reduce traffic on the out-of-state InterNet links and provide faster access to information. Sites that "refuse" service during peak hours would be automatically queried at later times and the requesting student or teacher notified when the file became available.

Existing software already permits much of this to be done. For example, automatic downloading of selected files at midnight from heavily used sites is simple. However, effective use of these concepts will require new software tools and this center will become a major developer of NII related software and collaborate in development of NII policies related to K-12 use of the Internet. It will be especially important to ensure that copies of files are kept current. Some files are updated every time a request is made. Such files can not be stored locally. The "connectivity software" will need to be able to distinguish these cases from cases where file are updated only infrequently.

The repository concept will evolve with time. It is important that the repository function to enhance the use of the Internet and not just become another bottleneck. It is also unclear whether schools should connect only through this site or whether it should be optional. This needs to be decided in conjunction with TENET administrators and advice from the Texas Education Agency, after initial operation has started since operating experience will help answer the question.

3.3.2.4 Digital Libraries

In addition to the "automatic repository" described above, there will be a digital library of information deemed to be of value to K-12 schools. Repository information will be automatically stored by software.

Digital Library information will be selected by professional educators and will be supported by the center. Support will include providing assistance in using stored educational programs, cataloging the contents of the library, and providing a database so users can share information about their experience using items in the Digital Library.

Access to library volumes which have been converted to digital storage would also greatly enhance limited library holdings for science education in many rural communities.

3.3.3. Educational Technology Test Beds

The use of SSC assets to foster science teacher computer literacy and to put SSC/DOE workstations in science classrooms can be done in a way that not only improves classroom connectivity, but also creates a controlled environment for testing technology advances which can aid, improve or increase cost efficiency for providing similar connectivity on a scalable basis for other communities and classrooms, especially with the focus on rural delivery systems inherent in this project definition study.

For science education initiatives, we will create research efforts designed to provide leadership in delivering the latest science education technology products to CyberScience NII research test-beds comprised of participating science classrooms in Texas, through a public/private partnership effort called the CyberScience Coalition (Appendices L & M).

- HARC.C Data Compression Technology (patents pending): Houston Advanced Research Center
- APPLE Internet Tools: Apple Computers
- NIH Imaging Software / University of Arizona, Center for Imaging in Education
- PowerOS, VerCom Systems (software protection pending)
- Learning Styles Research, utilizing psychometric tools such as Kolbe Cognitive Index and Dunn, Dunn & Price's Learning Styles Inventory

3.3.4. A Community Resource for Workforce Development

¬The Texas Council on Workforce and Economic Competitiveness issued "The Changing World of Work: A Strategic Plan for Building a World-Class System for Workforce Education and Training," in June 1994. As a critical element of goal four, the Council recommends establishment of a "skill standards and certification system for literacy/basic education, workforce skills and occupational areas."

The opportunity exists using digital data storage capabilities resident as part of a functioning High Performance Computing Center to define "workforce needs and skill assessments for science and engineering" and to construct data resource information storage and retrieval processes which can be shared with staff at the Texas Education Agency to guide evolution of Texas Assessment of Academic Skills (TAAS) for Science, and to provide the basis for student awareness programs regarding careers in science and engineering.

The education survey that is described in section 3.2.4 of this report establishes the need for enhancing the computer skills of science teachers. Several other sources establish a very similar need for enhancing both basic computer skills and more specific job skills in the general population. Designed to provide such training for science teachers, this facility is equally well-equipped to meet training needs of the private sector.

3.3.5. Executive Institute on Educational Technology

Increasingly, leaders of business, industry and government are called upon to commit corporate staff and/or funds to support education initiatives -- often math and science education initiatives

For many of the executives who are most likely to be key decision-makers, however, the plethora of educational technology applications and approaches which they might be asked to support, or acquire, can be vastly different than those they encountered in their own educational experiences. Even for scientists and engineers.

Computers, software and connectivity tools are advancing so rapidly that educators -- much less executives -- struggle to stay current with the best educational applications.

In addition, experts estimate that perhaps half of the information learned by freshmen engineers (maybe scientists too) is obsolete by the time that they graduate. Over 1000 books are published every day, and the growth of international information networks is exponential. Yet new demands on management for teaming and coaching roles leave less time for staying current. Most of today's executives did not receive their education in a computer literate environment.

The Executive Institute on Science Education is designed to fulfill a two-fold purpose for busy executives:

- To provide intense, hands-on briefings and experiences regarding state-of-the-art educational technology and performance evaluations for science education initiatives; and
- To highlight recent advances in science, information technology, engineering or technology tools for human resource management which would of benefit to them in fulfilling their corporate management responsibilities.

The Executive Institute will conduct short, 2 or 3 day symposia for executives in a relaxed learning environment which provides on-going insights into individualized learning styles through a variety of technology applications and experiences.

The SSC Central Facility connectivity capabilities can serve as a primary base; other sites can be added in an evolutionary fashion. Other than initial start-up funding to draft curriculum and generate initial marketing activities, this program is anticipated to become self-supporting within 1 to 2 years of implementation, if the SSC facility infrastructure (meeting rooms, computers, office space, LAN's, etc.) continue to be available. Fees for participation would range from $1000 to $2000 for such a symposium and 50 to 100 could be accommodated at each session.

An outreach program will be implemented to loan SSC/DOE computer workstations to schools and to provide expertise to "information-poor" school districts in Texas to enable them to connect to the NII. Ownership would be retained by the CyberScience Connectivity Resource Center, which will also maintain the computers and networking hardware.

In addition to providing all available Macs, Pcs, workstations and computer peripherals available for the enhancement of science education, the Department of Energy can leverage both their education and research dollars well by providing:

1) Immediate start-up funding of $1.6M direct costs for the 1995 and $1.7M direct costs for 1996; and

2) Base line support of $1M direct costs for each of the subsequent three years, plus leadership assistance in securing long-term self-sustaining research funding and development activities for the CyberScience programs during the first five years of operation.

3.4.1. Budget Projections by Cost Center - CyberScience Coalition

Budget projection spreadsheets are presented under the following Table.

3.4.1BUDGET PROJECTIONS BY COST CENTER – CYBERSCIENCE COALITION

	%FTE	1995	1996	1997	1998	1999
ADMINISTRATION						
Executive Director, CyberScience Coalition	1.00	$85,000	$89,250	$93,713	$98,398	$103,318
Administrative Assistant	1.00	$25,000	$26,250	$27,563	$28,941	$30,388
Receptionist	1.00	$15,000	$15,750	$16,538	$17,364	$18,233
Subtotal	3.00	$125,000	$131,250	$137,813	$144,703	$151,938
Fringe Benefits @ 30%		$37,500	$39,375	$41,344	$43,411	$45,581
Personnel Total		$162,500	$170,625	$179,156	$188,114	$197,520
Travel		$10,000	$10,000	$10,000	$10,000	$10,000
Equipment		$15,000	$15,000	$15,000	$15,000	$15,000
Materials & Supplies		$15,000	$15,000	$15,000	$15,000	$15,000
Facilities Space Rental		$4,000	$4,000	$4,000	$4,000	$4,000
Other--Miscellaneous		$10,000	$10,000	$10,000	$10,000	$10,000
Total	3.00	$216,500	$224,625	$233,156	$242,114	$251,520
SCIENCE EDUCATION ENHANCEMENT CENTER						
Program Director, Science Ed Enhancement Ctr	1.00	$50,000	$52,500	$55,125	$57,881	$60,775
Administrative Assistant	1.00	$25,000	$26,250	$27,563	$28,941	$30,388
CyberScience Coach/Trainers (6)						
4 FTE for M-F classes in summers	1.00	$30,000	$31,500	$33,075	$34,729	$36,465
2 FTE for S/S classes year-round	2.00	$60,000	$63,000	$66,150	$69,458	$72,930
SOS MultiMedia Curriculum Specialist	1.00	$40,000	$42,000	$44,100	$46,305	$48,620
Lab Equipment Clerk	1.00	$20,000	$21,000	$22,050	$23,153	$24,310
Subtotal	7.00	$225,000	$236,250	$248,063	$260,466	$273,489
Fringe Benefits @ 30%		$67,500	$70,875	$74,419	$78,140	$82,047
Personnel Total		$292,500	$307,125	$322,481	$338,605	$355,536
Travel		$10,000	$10,000	$10,000	$10,000	$10,000
Equipment		$25,000	$25,000	$25,000	$25,000	$25,000
Materials & Supplies		$25,000	$25,000	$25,000	$25,000	$25,000
Facilities Space Rental 3800sq FT @$10/sq ft		$38,000	$38,000	$38,000	$38,000	$38,000
Other--Phone & Miscellaneous		$5,000	$5,000	$5,000	$5,000	$5,000
Total		$395,500	$410,125	$425,481	$441,605	$458,536

	% FTE	1995	1996	1997	1998	1999
CONNECTIVITY RESOURCE CENTER						
Program Director, Connectivity Resource Ctr	1.00	$60,000	$63,000	$66,150	$69,458	$72,930
Administrative Assistant	1.00	$25,000	$26,250	$27,563	$28,941	$30,388
Technology Deployment Specialists (2)	2.00	$50,000	$52,500	$55,125	$57,881	$60,775
Technology Maintenance Specialists (2)	2.00	$50,000	$52,500	$55,125	$57,881	$60,775
Networking/Telecommunications Specialist	1.00	$50,000	$52,500	$55,125	$57,881	$60,775
Digital Library Specialist	1.00	$40,000	$42,000	$44,100	$46,305	$48,620
Subtotal	8.00	$275,000	$288,750	$303,188	$318,347	$334,264
Fringe Benefits @ 30%		$82,500	$86,625	$90,956	$95,504	$100,279
Personnel Total		$357,500	$375,375	$394,144	$413,851	$434,543
Travel		$25,000	$25,000	$25,000	$25,000	$25,000
Equipment		$100,000	$100,000	$100,000	$100,000	$100,000
Materials & Supplies		$15,000	$15,000	$15,000	$15,000	$15,000
Facilities Space Rental 2750sq FT @$10/sq ft		$27,500	$27,500	$27,500	$27,500	$27,500
T1 Connection (250 addresses + 800 #s)		$17,500	$17,500	$17,500	$17,500	$17,500
Computer Mass Storage @ $25/Gigabyte/mo		$3,000	$6,000	$12,000	$24,000	$24,000
Phones & Long-distance		$12,000	$12,000	$12,000	$12,000	$12,000
Science Class Connectivity Scholarships 250@$500/yr		$125,000	$125,000	$125,000	$125,000	$125,000
Other-- Miscellaneous		$10,000	$10,000	$10,000	$10,000	$10,000
Total		$692,500	$713,375	$738,144	$769,851	$790,543
PROGRAM DEVELOPMENT EFFORTS						
Faculty Director,Ed Technology Research	0.50	$40,000	$42,000	$44,100	$46,305	$48,620
Faculty Director,Workforce Development	0.50	$40,000	$42,000	$44,100	$46,305	$48,620
Faculty Director, Executive Institute	1.00	$80,000	$84,000	$88,200	$92,610	$97,241
Subtotal	2.00	$160,000	$168,000	$176,400	$185,220	$194,481
Fringe Benefits @ 30%		$48,000	$50,400	$52,920	$55,566	$58,344
Personnel Total		$208,000	$218,400	$229,320	$240,786	$252,825
Travel		$25,000	$25,000	$25,000	$25,000	$25,000
Equipment		$15,000	$15,000	$15,000	$15,000	$15,000
Materials & Supplies		$25,000	$25,000	$25,000	$25,000	$25,000
Facilities Space Rental 2850sq FT @$10/sq ft		$28,500	$28,500	$28,500	$28,500	$28,500
Other--Phone & Miscellaneous		$18,000	$18,000	$18,000	$18,000	$18,000
Total		$319,500	$329,900	$340,820	$352,286	$364,325
GRAND TOTAL DIRECT COSTS	20.00	$1,624,000	$1,678,025	$1,737,601	$1,805,856	$1,864,924

3.4.2. Sources of Funds

The ability to utilize SSC assets to create the CyberScience Coalition programs outlined creates an unheralded opportunity to build a significant, competitive NII training/demonstration site for education, technology test beds for improving cost-effectiveness and efficacy of this new learning paradigm, and a major Internet accessed, digital data repository supporting science education.

Costs associated with initialization of these efforts can be significantly reduced by naming the CyberScience Coalition, or its parent organization, as custodian of all of the current SSC inventory of appropriate computer hardware and peripherals (Current inventory indicates as many as 2925 Macs/PCs, 906 workstations and 9375 various peripherals available) to train and link Texas science teachers on to Internet, including access to the CyberScience Data Repository.

By invoking section 2 of Executive Order no. 12821, IMPROVING MATHEMATICS AND SCIENCE EDUCATION IN SUPPORT OF THE NATIONAL EDUCATION GOALS, the Department of Energy(DOE) could:

1. Vest the CyberScience Coalition, or its parent organization, with the responsibility for transfer excess education-related equipment (referenced in the above paragraph) to Texas schools in support of math and science education, and
2. Fund training and training assistance to recipients of education-related a Federal equipment to ensure that the equipment will be used to its fullest capability.

Discussions have already been initiated to start the process for a proposal to be submitted for matching funds to the Texas State/Federal Matching Pool, thus leveraging the immediate impact of such action by DOE in beginning immediate delivery of CyberScience services.

Long-term, CyberScience programs can generate funding through a variety of vehicles:

1. Federal Funding for NII, networking/connectivity research, and related science education initiatives.
2. State funds through new legislative appropriations;
3. User fees generated from tuition/registration/nominal subscription fees for training and resource services.
4. CyberScience Coalition Membership Fees from private sector.

5. Public school commitments of future Technology Allotment Funds.

3.4.2.1 Federal Funding

Federal funding opportunities are emerging on several fronts, and are summarized most succinctly in "Putting the Information Infrastructure To Work: Report of the Information Infrastructure Task Force Committee on Applications and Technology," prepared by the Department of Commerce (NIST), Summer 1994:

"The Department of Commerce provides support and direct funding for telecommunications infrastructure planning and development, and plans to support improvements in workplace training using the NII. Commerce's National institute of Standard and Technology supports standards development.

The Department of Defense provides lifelong education and training to hundreds of thousands of military personnel. It supports R&D for education and training and is expected to transfer knowledge and software to schools and non-Defense workplaces under its Dual-Use and Technology Reinvestment programs. The Department of Defense Dependents Schools are expected to serve as a testbed for new applications.

The Department of Education advocates for the needs of all learners in the development of the NII. The Department is the principal source of Federal support for distance learning, via the Star Schools Program. In FY 1995, the Department will also support applications and programming development, pilot projections, teacher networks, research, and planning grants to states and districts.

The Department of Energy is in the forefront in the development and use of information technologies, such as high performance computing, high speed networking, data storage and data bases, and other information services and system integration technology. The Department is developing K-12 computing and communications applications that support a new learning paradigm and take advantage of the regional presence and capabilities of the Department's laboratories. Emphasis is placed on reaching a broad range of students, including women and underrepresented minorities. The Department will initiate pilot projects that have scalability as an important characteristic so that schools can bridge the period until network and system costs decline to the point that the education establishment can take over this support. Another key technology initiative is the development of digital libraries that will enable users speedy and economical access to Energy information over an electronic data highway.

The Department of Labor has direct and indirect interaction with employers, workers, business and labor organizations, and other government entities and administers most Federal training programs. The Department hopes to use the NII to enhance the skills, education and training of the American workforce.

The National Aeronautics and Space Administration continues to build on its HPCC program, its aeronautics and space science research and engineering missions, and its existing education outreach infrastructure to facilitate the general development of the NII to support mathematics, science, and engineering education in K-12 education. this program consists of pilot projects at 7 NASA Centers involving many of their local schools and school districts. The goal of the K-12 effort will be to produce and distribute curriculum materials to a very broad user community over the Internet. A video is in production in cooperation with the Department of Education to provide guidance on appropriate steps for implementing Internet access and utilization in the classroom. NASA continues to operate and improve its "Spacelink" computer information system for the education community, principally teachers and students.

The National Science Foundation supports research on digital libraries for capturing, categorizing, and organizing data of all forms (text, images, sound, speech) in electronic form to allow utilization of networked databases distributed around the nation and the world. A networking infrastructure for education program will establish test beds and implement prototypes that explore the role of electronic networks in support of reformed education. The NSF will also support the development of national facilities and centers such as NSFNET, High Performance Computing and Communications Centers and National Challenge Centers needs to support the research, education and training activities required to broaden the impact of NII.

In addition, the High-Performance Computing and Communications initiative, an interagency effort under the aegis of the Office of Science and Technology Policy, includes several components that directly support the development of NII uses for education, training, and lifelong learning. These include:

- The National Research and Education Network (NREN). The NREN will establish a very fast communications infrastructure for research and educational use. NREN efforts include increasing the availability of advanced network products and services at affordable cost to research and education communities.
- Information Infrastructure Technology and Applications (IITA). This component supports the development of software, interfaces, and tools necessary for the educational use of the NII, including access to digital libraries."

Several specific funding opportunities for the CyberScience programs are already identified on the immediate horizon; work to generate proposals must begin shortly for the following:

- expression of interest letter already submitted in conjunction with Texas A&M University regarding GLOBE project (Appendix N);
- NSF Program Solicitation: Networking Infrastructure for Education Supplements, New Projects and Planning Grants;
- NSF Program Solicitation: Rural Systemic Initiatives in Science, Mathematics and Technology Education;
- NSF Institute for Science Education;
- NTIA, Department of Commerce: National Telecommunications and Information Infrastructure Assistance Program (TIIAP).

3.4.2.2 State Funding

Prepared by Texas' Comptroller of Public Accounts, the Texas Department of Information Resources and the General Services Commission, the *Texas Telecommunications Strategic Plan* (September 1994) hones in on the critical funding issues for educational connectivity that our project definition study is designed to address for science education efforts:

> "Existing services tend to be community based pilot projects that do not achieve a critical mass of users for any one service. Costs have been a major obstacle, given the chronic budget pressures confronting schools and the lack of predictable costs associated with educational networking. Cost is the key reason that data networking in the educational community has trickled down slowly from the major universities to other four-year schools and then two year schools, with the K-12 schools and public libraries still lagging.
>
> . . .
>
> "The Technology Allotment Fund provides money that regional service centers may apply to the K-12 schools if a plan is submitted for technology integration. The amount of $30 per child is based upon the average daily attendance of the school district. This fund is a start, but Texas schools need a plan for a continued investment in the underlying infrastructure which includes the transmission facilities, equipment and programs for curriculum development."

Bottom line, the DOE can leverage dollars well by supporting the CyberScience programs for the first five years of operation.

3.5. Summary Recommendations

- A critical service niche in science education has been identified which uses existing SSC computing assets to support science education by providing on-going teacher enhancement on the use of computers and connectivity resources on a daily basis in science classrooms.

  For science education, the project has definite uses/needs for pieces of SSC equipment, including almost all of the Macs/PCs/workstations (3500+) as well as permanent staff, budget and facility space, independent of any other technical and/or high performance computing elements which may continue to exist.

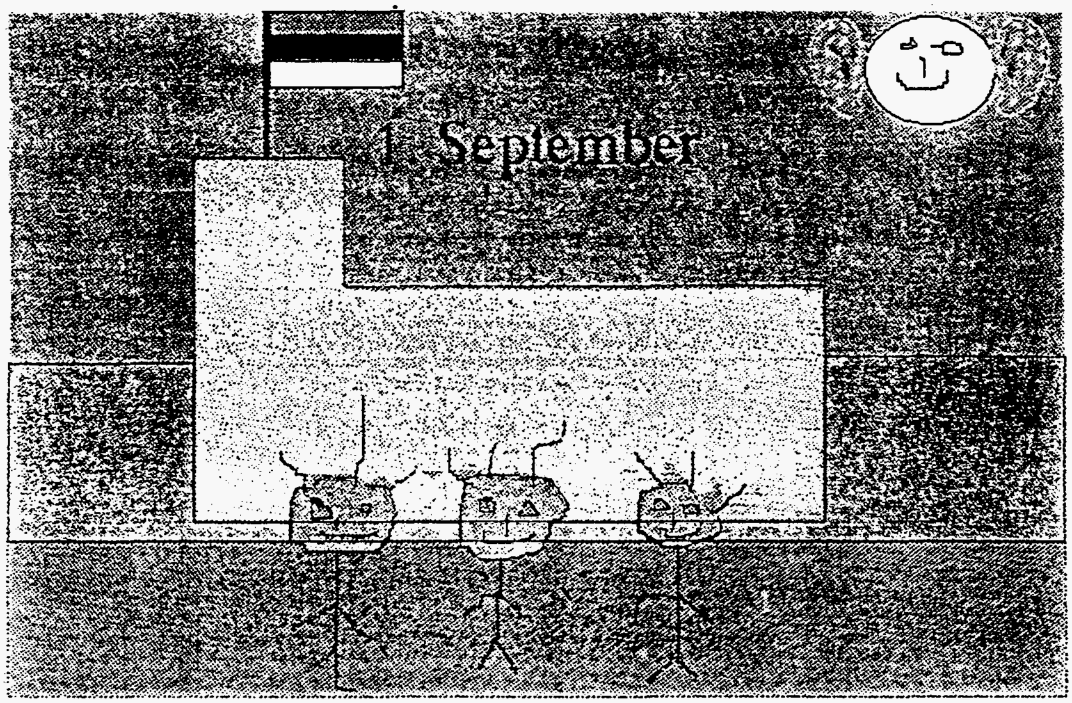
  An outreach program will be implemented to loan SSC/DOE computer workstations to schools and to provide expertise to "information poor" school districts in Texas to enable them to connect to the NII. Ownership would be retained by the CyberScience Connectivity Resource Center, which will also maintain the computers and networking hardware.

- In addition to providing all available Macs, Pcs, workstations and computer peripherals available for the enhancement of science education, the Department of Energy can leverage both their education and research dollars well by providing:

  1) Immediate start-up funding of $1.6M for 1995 and $1.7M for 1996; and

  2) Base line support of $1M for each of the subsequent three years, plus leadership assistance in securing long-term self-sustaining research funding and development activities for the CyberScience programs during the first five years of operation.

A Selection of Pictures
From
Internet WWW Schools



Tere tulemast Eesti koolide WWW serverisse

Welcome to Estonian Schoolserver

Thank You for selecting our URL!

Estonian Schoolserver is offering texts in both English and Estonian languages.

We wish to tell You about the Estonian Schools connected to Internet.

We also give You some links to other servers telling You more about Estonia and its people.

In Estonian language we try to give some starting points for Estonian pre-university students. As a special topic, we want to teach students how to install and use Linux and UNIX in general.

Before You try to read texts in Estonian, it is wise to tune Your WWW-client to handle the ISO-Latin letters properly.

As an acknowledgement, we have to announce that our server has become a reality thanks to EENET.

Tere külaline! Meilt saad Sa infot Internetti ühendatud Eesti koolide kohta. Ka tahame me Sulle jutustada operatsioonisüsteemidest, mille nimed on Linux ja UNIX ning anda Sulle terve hulga pidepunkte INTERNETi tundmaõppimiseks.

Võta kuulda head nõu ja uuri, mida arvab Sinu arvuti ISO-Latin 1 standardi täpitähtedest!

anto@siil.edu.ee

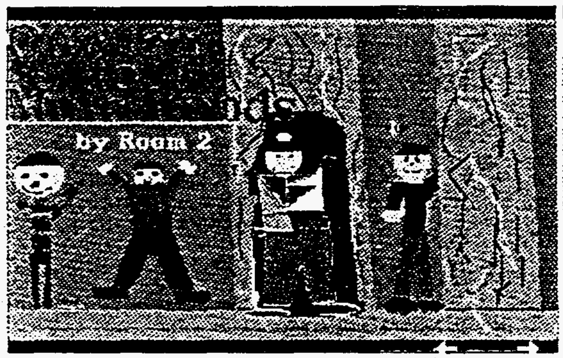
Last modification: 02. Oct. 94

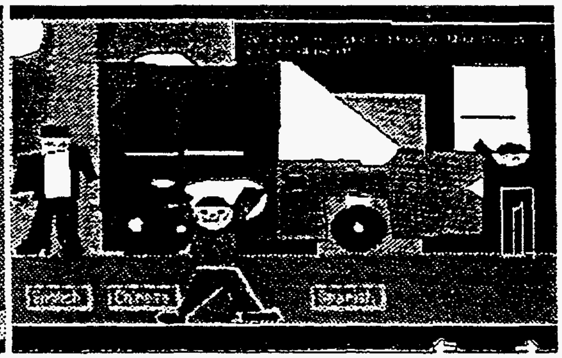
to return Home

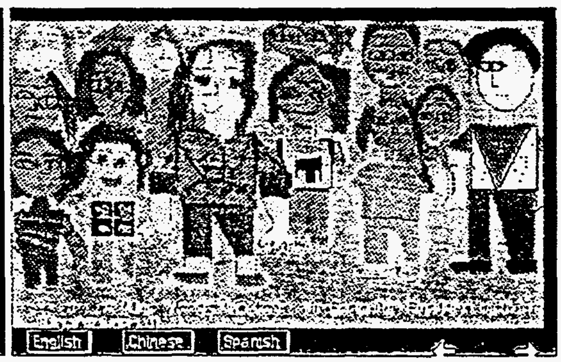
Muir Woods:

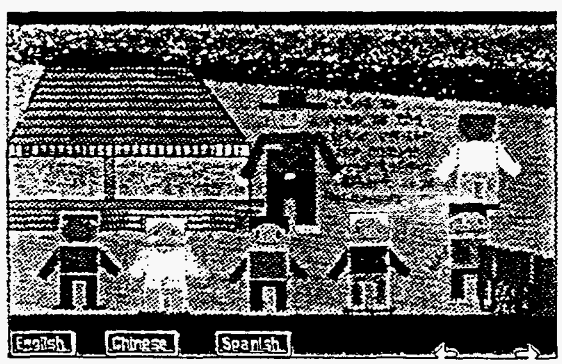
Yvette Sagan, Special Education teacher (grades 3-5) and her students at Bryant Elementary School visited Muir Woods in the Northern California Bay Area. Afterwards, they went into their computer la managed by Virginia Davis, to create multimedia presentations (color images, text, and sound in thre languages: English, Spanish, and Chinese) to show other students at the school. Each of these docume were placed on the menu of their school Lan and made available to all. Here are some of the graphic without sound (sorry, but maybe soon).

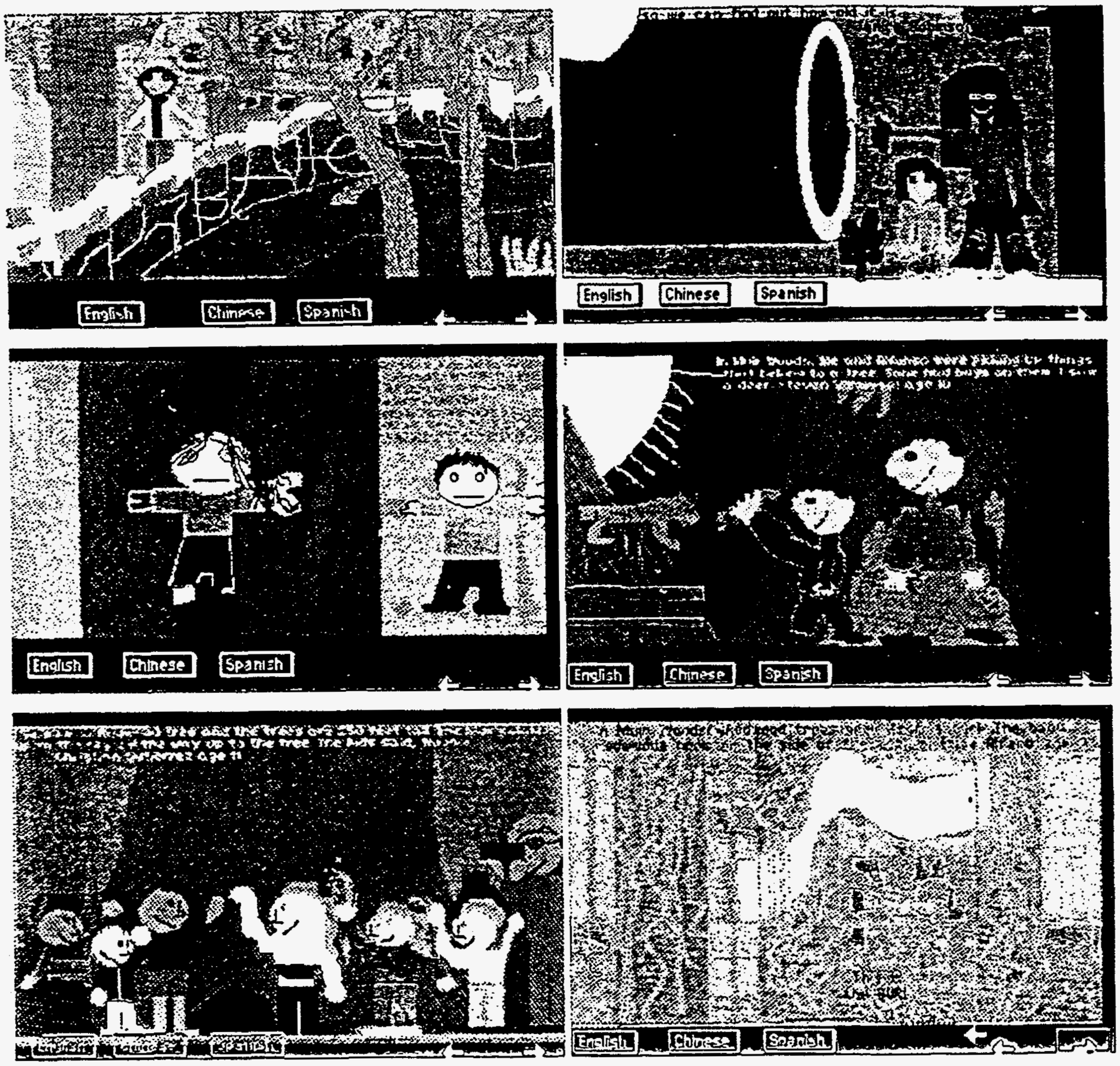
We will be featuring more of this school's projects in the coming weeks. To find out more about Brya visit SARC under the Administrative menu item off the Home page. Enjoy.



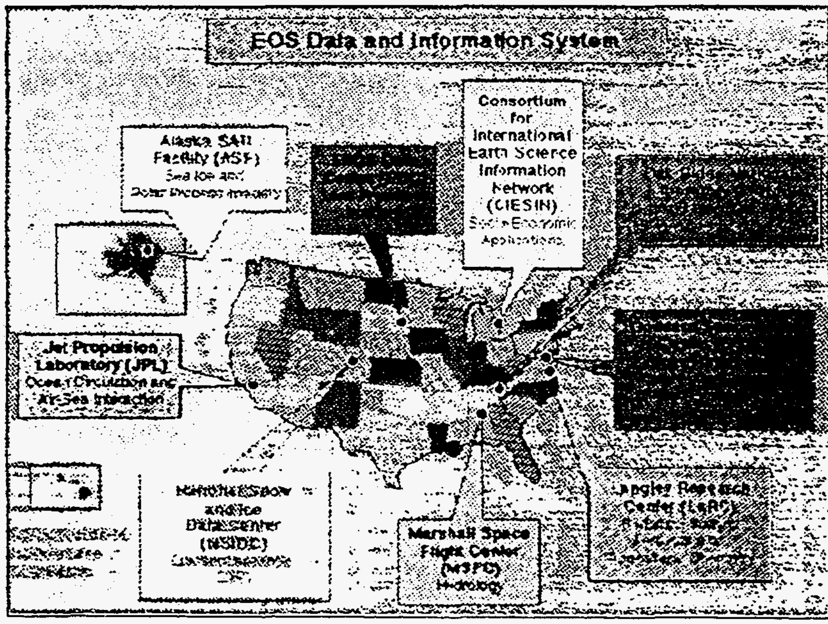







English
Chinese
Spanish

Networked Data Archives

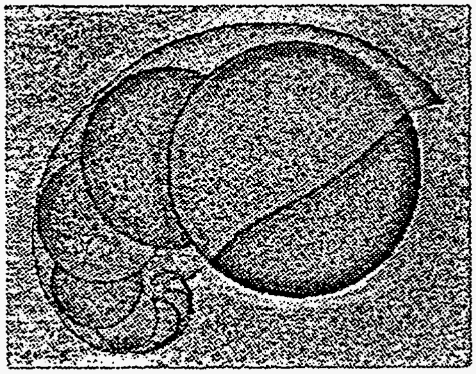


Earth Observing System Distributed Information System

Distributed Active Archive Centers

(under construction)

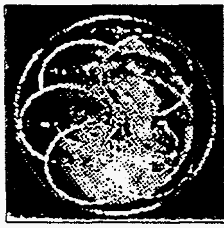
- Goddard Space Flight Center GSFC
- NODIS
- Langley Research Center LaRC
- EDC DAAC – EROS
- University of Alaska – Fairbanks UAF
- University of Colorado – CU
- Jet Propulsion Laboratory – JPL
- Marshall Space Flight Center – MSFC
- Oak Ridge National Laboratory – ORNL
- CIESEN Data and Research Center – CDRC
- National Oceanic and Atmospheric Administration Data NOAA



Welcome to the...

Earth System Science Community Curriculum

Gonzaga College High School Student Project Reports



Visit the site of the new (6/15/94) and future Curriculum–driven server. [wear hard hat]

Overview

The Earth System Science Community Curriculum serves to facilitate interactions and communications among members of the Earth system science community by providing curricula designed to guide student investigations of the Earth system, and access to **data,** tips, techniques and guides, **tools,** and expert support.

Earth System Science

Earth system science is "a holistic approach to the study of the Earth that stresses investigations of the interactions among the Earth's components in order to explain Earth dynamics, Earth evolution and global change."* The objective of Earth system science curricula is to develop a collective understanding of the Earth system through collaborative investigations, and the skills needed to practice Earth system science and contribute to the advancement of the community.

Systems Thinking

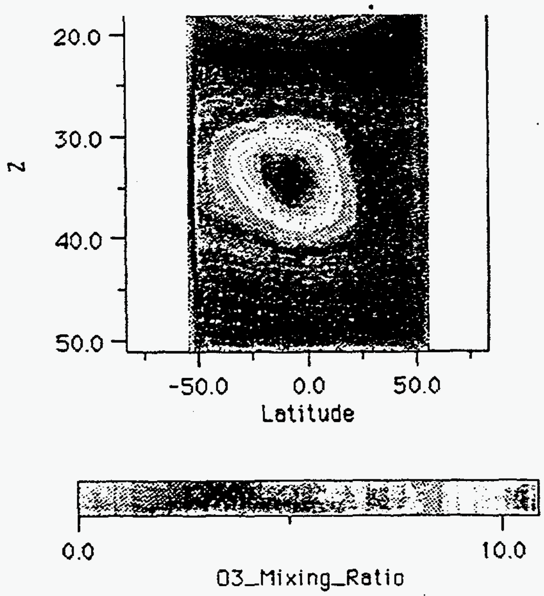
Working collaboratively in teams, students investigate the Earth system by conducting extensive background research and modeling the Earth system using remotely sensed data.

Scientific Communications

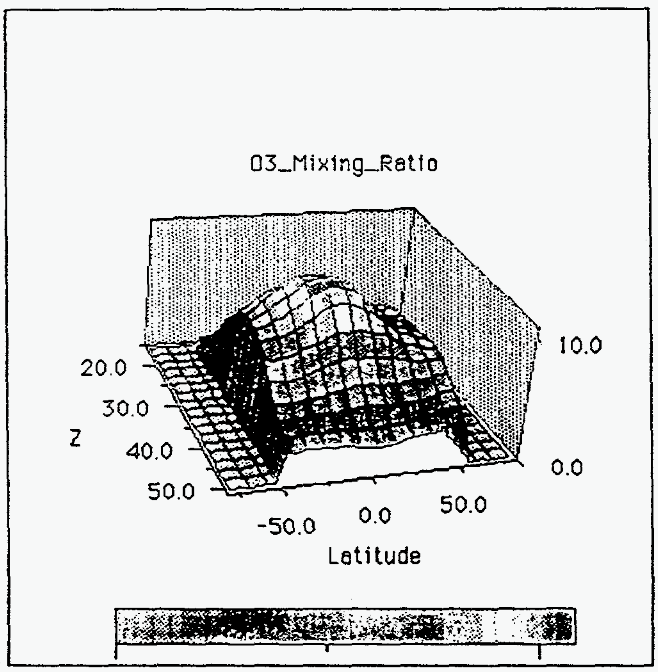
Participating students communicate the findings of their investigations by publishing hypermedia documentation (what you see here) for review and comment of the Earth System Science community and the benefit of the general public.

Student are encouraged to use any relevant resources developed in the process of their investigation in order to communicate their findings.

Publications include data visualizations like this interpolation

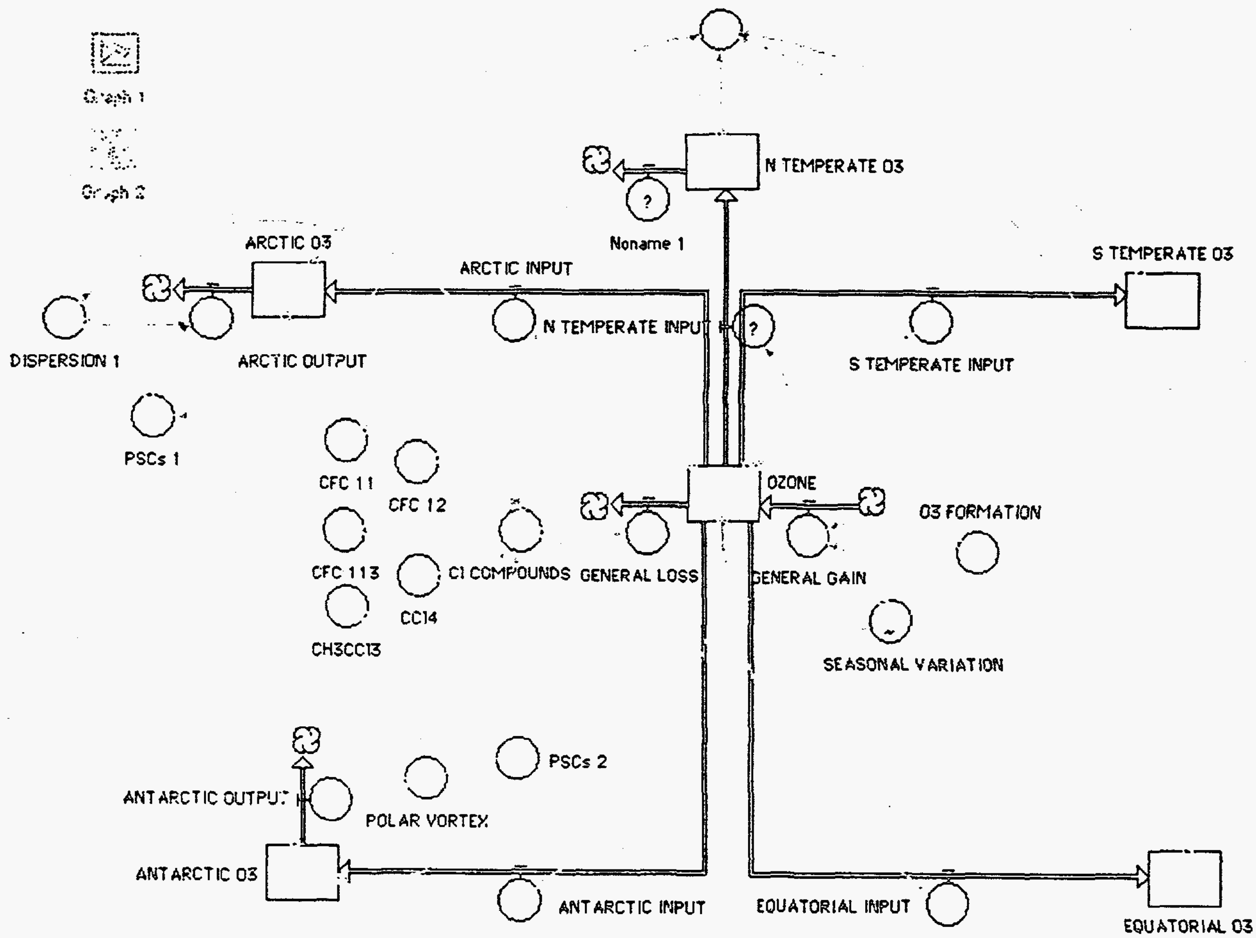


or this surface plot



These are visualizations of data from the SAGE II mission, showing ozone mixing ratios for January 1985, measured as a vertical profile of ozone concentration (at altitudes of 16 kilometers to 50 kilometers) in parts per billion by volume for a global area −80 to +80 latitude. As the visualizations indicate, data was not collected for the polar regions.

Publications also include quantitative and qualitative models such as this



static model of global ozone distribution and this dynamic model which requires that Stella II (Macintosh and PCWindows) is installed on your local machine.

We invite all students of Earth system science to publish their findings and link to our server. Please contribute to the WWW community of researchers and browsers and help us build our understanding of the Earth together.

Ecologica is currently under development with funding and support from NASA and the AGU.

Note the status of this server.

Contact information:

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keeler@jacks.gsfc.nasa.gov

Welcome to the Earth System Science Curriculum–driven...construction site

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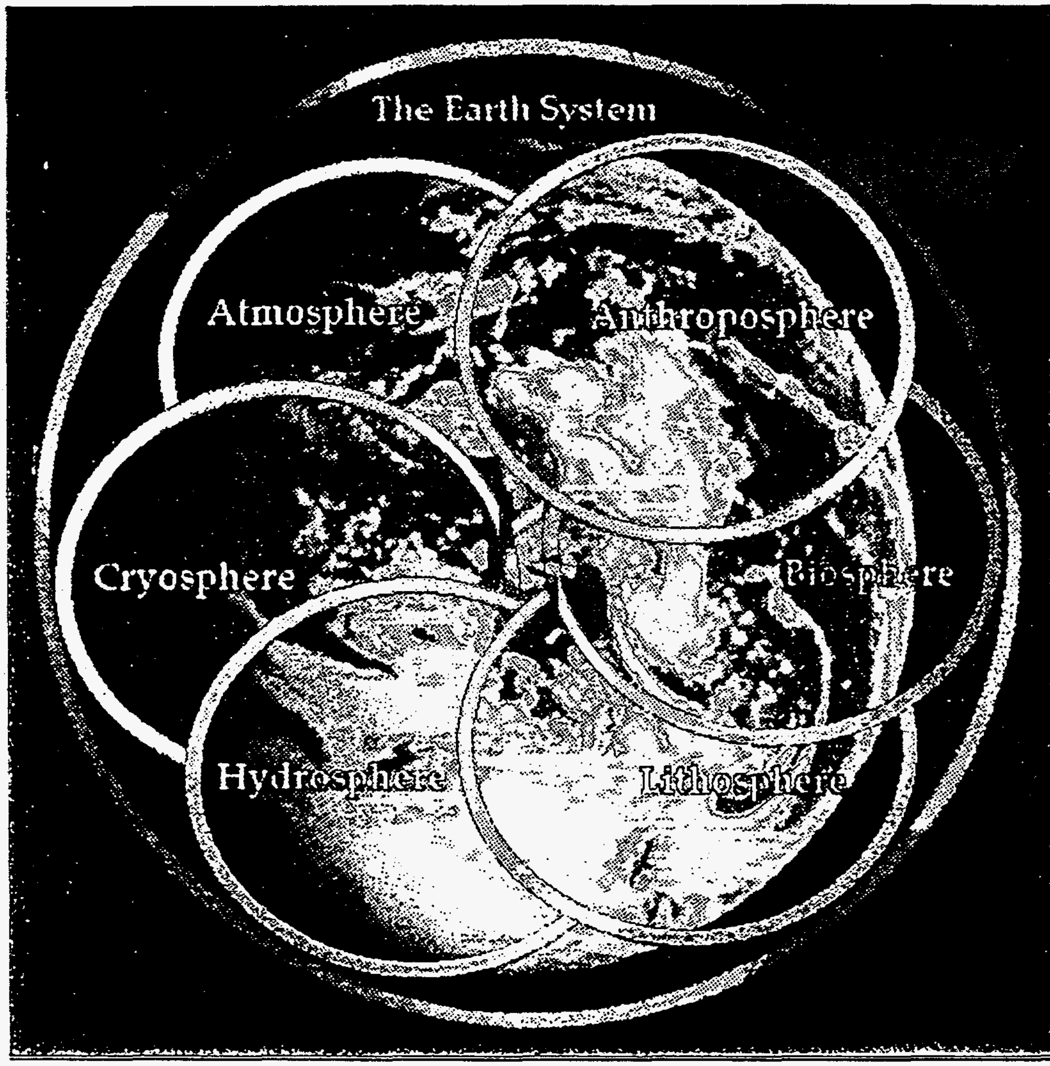
See the **Biosphere** for the direction we are heading...



The Earth System Science Community Curriculum

Atmosphere

Cryosphere

Hydrosphere

Lithosphere

*Biosphere

Anthroposphere

*Only branch developed thus far...

4. R&D Facilities Access Program

Most of the future scientific projects proposed for retention at the former SSC site will require highly specialized technical support. Whether building an accelerator for medical use or completing a cryogenic research center, many technically complex components are not always available off-the-shelf, and their on-site design and timely production can contribute to the overall success of the programs. At this writing, it is anticipated that a Regional Medical Technology Center, High Performance Computing Center, and an Applied Superconductivity and Cryogenics Technology Center will be developed from SSC assets, and that the current electronics and machine shop equipment and facilities will be maintained to support these three major activities.

The sophisticated electronic and machine shops and parallel computing capabilities of the SSC Laboratory significantly contributed over time to the research efforts of over 100 universities. Because of the highly specialized technical staff and equipment needed for physics-related R&D, most universities do not have all of the state-of-the-art equipment needed or adequate space to carry out all of their work. Also, specialized skills and equipment may only be needed for a short time. These limitations also apply to small businesses for which it is not economical feasible to retain highly specialized technical staff and facilities to cover all areas of potential development.

Use of the SSC assets will be maximized by the establishment and funding of a service program to provide universities and businesses in Texas (and if feasible the region) with access to the electronic and machine shops and parallel computing capabilities that are retained at the site. The mission of this proposed program is to provide a broad array of state-of-the-art technical services and training in one central location to serve the research and development communities in universities and in high-tech enterprises in Texas, relating to all branches of physics. This service program will enhance the abilities of businesses, most especially undergraduate and minority institutions, and small punishes to participate in leading research collaborations, to establish new ties with one another, and could contribute to the economic feasibility of new idea development.

The level of need and feasibility of a service program to provide universities and businesses in Texas with access to SSC assets retained on site were investigated using an independently contracted market mail-in survey, survey follow-up, university/industry workshop and a telephone survey of existing university R&D shop facilities. The results, conclusions drawn and recommendations are discussed below.

4.1. Original SSC Assets

At the time of cancellation of the SSC, parts of the project were in fairly advanced stages of completion, while others had hardly started. A large fraction of the tangible assets that were in place in 1993 are still available and are described below.

The SSC assets are located at two building sites near Waxahachie. The larger site is located a few miles from I35E, the main Texas north-south corridor and one mile north of US 287. This 42-acre site has excellent accessibility by road and is adjacent to a railroad. The Central Facility at this site is a 550,000 square feet building with 100,000 square feet of warehouse space and 160,000 square feet of laboratories and mechanical shops. The remaining 290,000 square feet are used as offices, conference rooms, computer rooms and a food service area. Machine shops and assembly areas are organized in 10 high bays with crane capacities varying from 3 to 25 Tons. Some of the cranes also serve covered loading docks. Electrical power of up to 15,700 kVA is available, as well as low conductivity cooling water and compressed air. Nine computer rooms provide uninterrupted power Supply (UPS) capability.

The Central Facility houses an excellent technical library. It has a collection of 10,000 books and 700 journals. The main collection areas are physics, accelerator theory, design and construction and magnet technology. Supporting collections cover computing, software engineering, mathematics, science education, EH&S, and Total Quality Management (TQM).

The second site, called N15, is located 6 miles west from I35E on FM 1446. It has several industrial buildings with a total area of 90, 000 square feet. They house cryogenics facilities, as well as the magnet construction and testing laboratories.

The SSC sites contain assets in the following major areas: 1) High performance Computing and Communications; 2) Information Technology; 3) Mechanical Shops; 4) Cryogenics; 5) Magnet Fabrication; 6) Electronics; and 7) Data Acquisition. Each of these assets are described in greater detail in Appendix F.

Briefly, the SSC High Performance Computing Center provides 12,000 MIPS computing power on a UNIX workstation farm. A total of 120 workstations are organized in groups that are tightly coupled by optical fibers and Ethernet. Voice communications includes 10,000 connections and the buildings are connected with T1 lines. On-site networking is primarily via Ethernet. SSC assets at the Central Facility include extensive video teleconferencing and video production capabilities

The mechanical shops include CAD/CAM and over 150 major pieces of machining equipment and a complete welding facility. Precision instruments are available for quality control. The cryogenics facility houses the world's largest cryogenic capability. The magnet fabrication facility is equipped to design and produce superconducting and resistive dipoles and more complex magnets, including two 25 ton cranes and fully automated cablers, winders and a 16 meter long shell welding press. The specialized electronics shops can handle analog and digital design, surface mount, programmable logic, RF and high power.

4.2. R & D Infrastructure Market Survey

A market survey was conducted to measure marketplace needs for equipment and services developed using existing assets of the Superconducting Super Collider near Waxahachie, Texas. The entire document is included in Appendix G. The study objective was to determine the types of equipment/services with the highest demand and the characteristics of the groups with the greatest needs.

The survey sample of 2505 was comprised of Texas physicists, half the technology firms in Texas, and deans of schools of science of Texas universities. Five-hundred forty-two usable surveys were returned for a response rate of 21.6%. The response rate for the sub-samples is given in the table below. An assessment of possible sample bias was conducted and not supported. The response rates for the survey were judged to be adequate for making population generalizations.

Sample	physicists	firms	deans	total
N	1044	1330	131	2505
usable survey	341	177	24	542
response rate	32.7%	13.7%	18.3%	21.6%

4.2.1. R&D Market Survey Results

Seven assets were described for possible use high performance computing, information technology, mechanical shops, cryogenics, magnet fabrication, electronics and data acquisition. Most respondents (65.7%) indicated a willingness to use at lease one asset for either research or training purposes. The use of assets for both research and training was most common (35.4%), followed by research use (23.1%) and training use (6.8%).

Estimates of high performance computing use for research ranged from 40.2 - 45.8% of the respondents. Estimated utilization of the information technology, mechanical shops, electronics and data acquisition assets ranged

(over two measures) from 26.6 - 31.8% and 27.5 - 34.7% of the respondents. Estimated use of the cryogenics and magnet fabrication assets were lowest and ranged (over two measures) from 8.2 - 11.9% and 10.0 - 12.5% of the respondents.

Estimates of asset usage for training purposes revealed a ranking similar to research although the anticipated usage levels were lower. High performance computing was ranked first (33.3% of the respondents), followed by information technology, electronics and data acquisition (average of 25.5%), mechanical shops (16.6%) and cryogenics and magnet fabrication (usage of 10.1%).

The manner in which assets would be utilized was examined. Across assets in general, use of assets for design, as opposed to fabrication, was preferred. There was about equal interest in having design and fabrication done by Facility personnel as to having it done by the respondent's employees, using SSC assets. However, for the mechanical shops support by Facility personnel was most desired.

The extent of asset usage was examined. Respondents estimated using the high performance computing asset on average of 16.26 weeks annually. Information technology had the next highest average estimate (11.87 weeks). Small differences were observed for remaining assets and ranged from 7.95 to 9.86 weeks.

Data were obtained on annual rental costs for comparable assets if Facility use was not provided. Those estimates varied widely and ranged from $152, 714 for magnet fabrication to $39, 111 for data acquisition. A mid-range estimate of $91, 065 was provided for high performance computing.

4.2.2. Stratified Survey Results

Results were stratified by employment group. Corporate respondents anticipated less research and training use on every asset than university respondents. Nevertheless, 50.8% of the corporate respondents still indicated use of at least one asset in the Facility for either research or training purposes. Higher percentages of both university faculty/staff (78.6%) and deans (83.4%) provided such indications.

Corporate respondents estimated fewer weeks (9.14 wk.) of high performance computing use than either university faculty/staff (19.27 wk.) or deans (16.53 wk.). Estimates on remaining assets were not significantly different across groups. Thus, although the fraction of the corporate population expected to utilize Facility assets may be less than the fraction of university population, the extent (amount) of usage is likely to be similar between customers from both groups on most assets.

Estimated annual rental costs revealed substantially higher estimates by corporate respondents, relative to university faculty/staff, for most assets. However, faculty/staff indicated higher estimates of magnet fabrication costs.

Data were stratified by principal orientation and area of specialization for the Texas physicist sub-sample. The intent was to identify groups with the highest likelihood of using Facility assets. A higher likelihood of asset use for research was found for respondents with experimental, design or training orientations. A higher likelihood of asset use for training was found for respondents with experimental or training orientations.

Higher anticipated asset use for research was indicated for the following specializations: astrophysics, biophysics, high energy physics, nuclear physics, physics of beams, superconductivity and mechanical engineering. Higher anticipated asset use for training was indicated for the following specializations: astrophysics, biophysics, condensed matter, high energy physics, nuclear physics and superconductivity. In general, the higher asset use among these target specializations was reflected in both higher percentages of respondents and a higher number of weeks of usage. The target specializations also estimated higher annual rental costs across assets.

Data were stratified by type of business for corporate respondents. The intent was to identify businesses with the highest likelihood of using Facility assets. For research purposes, those target businesses were as follows: computers, parts and equipment, electrical equipment and components, industrial chemicals, drugs and medicines, plastic and synthetic materials, optical and medical instruments and other. For training purposes, the target businesses were as follows: computers, parts and equipment, electrical equipment and components and aircraft and parts.

Data were stratified by respondent responsibilities for making decisions on use of the Facility assets. Respondents with sole decision making responsibilities were found to be less likely to utilize the assets, relative to other levels of responsibility.

Analyses were conducted to determine if the asset wage results varied by the number of miles from respondent workplace to Waxahachie, Texas. They did not. One possible explanation is that respondents anticipate use of the Facility assets for non-routine and specialized projects.

Analyses were conducted to determine if the asset usage results varied by annual corporate revenues. The highest revenue group (greater than $400 million) was more likely than other groups to indicate use of the high performance computing, cryogenics, magnet fabrication, information technology and data acquisition assets for research purposes; and the high performance computing and magnet fabrication assets for training purposes.

Finally, analyses were conducted to determine if asset usage varied as a function of the amount of externally funded research obtained by universities. Results revealed a consistent tendency for greater asset use (for both research and training purposes) at universities with high external funding.

4.2.3. Market Potential

The total market (dollar revenue) potential for use of the SSC assets within the proposed Facility can be estimated as a function of four parameters. Costs of renting comparable assets elsewhere were judged to be a reasonable equilibrium market entry price. These annual rental cost figures for each asset were adjusted to reflect the proportion of a year involved in asset use.

These figures were then multiplied by the estimated total number of potential users. This number of "potential users" was defined by: (A) current APS members principally employed by Texas universities; and (B) the number of technology firms in Texas; it was assumed that "companies, "rather than employees within those firms, would purchase Facility access. This number of "potential users" (A+B) was 3322. Finally, these figures were multiplied by estimates of the population proportions likely to utilize the assets. Using this equation [(annual rental costs) x (percent year in use) x (N of potential users) x (percent of population expected to use)], the estimated market potential for the assets is as follows:

Asset	Maximum Market Potential
High Performance Computing	$31,430,403
Information Technology	$10,587,645
Mechanical Shops	$ 4,088,928
Cryogenics	$ 4,458,312
Magnet Fabrication	$ 6,988,784
Electronics	$ 9,177,146
Data Acquisition	$ 5,868,921

Across assets, the total market potential is $72,600,139. These figures should be regarded as an upper limit. Two major factors were not taken into consideration in this estimate, namely the availability of comparable assets elsewhere, and the tendency to quote rental costs for more assets than are actually needed by a potential user.

Differences in assumptions in the development of the market potential parameters can greatly affect the resulting estimates. In the analyst's view, the market potential estimates are best regarded as exactly that -- market potential. They represent optimistic projections of what might be obtained in

the absence of limiting circumstances (e.g., the need to provide a price discount significantly lower than competitors to attract customers, the resistance of key decision makers to use of assets at the Facility etc.). In general, the possibility that respondents' statements of "intended" (or expected) use of assets may overstate their "actual" use needs to be considered when interpreting the market potential figures.

For the purpose of this study, we will assume that the scale of operations should be governed by the "optimistic" numbers for market potential that were generated by the market research, divided by at least ten to take into account the cautionary notes that accompany those estimates.

In addition, we are assuming that as with any start-up operation, this is not an immediate projection of revenue, but what might be possible given a quality management, marketing and sales force to identify and reach customer demands.

4.2.4. Follow-up

Respondents to the survey could request to be contacted for further information (See Appendix H). Currently we are contacting respondents that requested information. Some preliminary results of this effort indicate:

- The value of requested services is indeed lower than is indicated by the quoted equivalent rental value of the asset;
- High expectations exist about the skills and expertise of the personnel remaining at the SSC; and
- Capabilities and expertise at the SSC do not always provide a good match with the needs of the potential users.

This confirms that marketing potential estimates may indeed be high. However, we also find that:

- A large unsatisfied need for computing exists in the Texas academic community; and
- Some of the needs of small and medium size businesses coincide well with the capabilities at the SSC.

The large need for computing in the physics community was already well established. The HPCC was made available to High Energy Physics users in March 1993 and has since been used at near saturation levels.

4.3. R&D Infrastructure Workshop

The Research Infrastructure Support Workshop was held August 30, 1994 at the Superconducting Super Collider Central Facility (See Appendix K). Approximately fifty people from industry and higher education attended the half-day event. Topics of discussion included the settlement between the U.S. Department of Energy and the State of Texas, an overview of the Joint Texas Facility Project and other collaborations including reports from the Regional Medical Technology Center, the Southwest Center for Computing, Information & Learning, and the Inland Regional Industrial Technology Center, and a tour of the Super Collider's machine and tooling shops.

In addition, breakout sessions gave attendees opportunities to provide input on the following topics:

- What specialized equipment and expertise are necessary at such a common research facility?
- What potential price levels would stimulate sustainable usage?
- What is the availability/demand for trained technicians to support R&D at Universities? to support on-site technical programs? to support corporate R&D labs?

As intended, the presentation and ensuing workshop breakout sessions fostered a mood of collegiality in addressing the difficult issues associated with reapportionment of current SSC assets. During the wrap-up sessions, discussions and summary comments vacillated between enthusiasm for using the facilities to benefit R&D, and pessimism regarding short-term sources of funding necessary to demonstrate long-term viability.

4.4. Existing Regional University R&D Shop Facilities

In order to gauge the needs for mechanical and electronic shop facilities by research personnel in the local area and over a broader region (Texas), a survey of such facilities already in place was conducted. The scope of the survey was confined to all colleges and universities in the local area, the larger universities (especially those granting M.S. and Ph.D. degrees) state wide, and selected companies in the local area. The survey was conducted by telephone.

Although the survey was designed to question all colleges in the area, it soon became apparent that eliminating community colleges (two-year junior colleges) from the list would be necessary. It was found that the instructors at the community colleges generally do not engage in research. Teaching is the

prime objective at community colleges and instructors have heavy teaching loads. In general all laboratory facilities are intended for instruction. Three (3) of the approximately sixteen (16) community college in the area were surveyed.

At the smaller colleges and universities (student populations of 3, 000 or less) the faculty are interested or engaged in research. There are however no dedicated shop facilities at these institutions. Researchers generally collaborate with others at larger universities or research laboratories and use the facilities at these larger institutions.

Among the educational institutions in the area only the larger universities (student populations of up to 27, 000) have mechanical and electronic shop facilities. Typically the mechanical shop will have 1, 000 to 5, 000 sq. ft. with one or two machinists/technicians. The shop will contain 1 to 3 milling machines and 1 to 5 lathes. These machines may have numerical readout but are not numerically controlled. Other equipment typically includes drill presses, band saws, grinders and may or may not include welding and sheet metal equipment. These shops do not have CAD capabilities. Similarly the electronic shops are rather basic facilities with one or two engineers/technicians. At these shops they have the capability to design and build boards and systems but rarely using CAE tools. Test equipment includes oscilloscopes, meters, power supplies but not in general more sophisticated equipment such as spectrum analyzers, network analyzers, etc.

4.5. Anticipated Availability of SSC Assets

The assets described in the previous sections are not at all guaranteed to be available. Moreover, efficient access for small users is only possible for those facilities that are already operated for other major clients. Large scale operations will depend critically on the outcome of other re-use studies. Clearly, a phase of extensive coordination will be needed after submittal of the other studies. Below we list the expected modes of operation for the different assets mentioned in the market survey.

4.5.1. High Performance Computing Center

The High Performance Computing Center (HPCC) will likely remain available at the SSC site. Initial operation will be provided by a very small crew. Most of the HPCC income is projected to be generated by medium and large commercial users.

The TNRLC proposal for HPCC includes several major upgrades: additional clusters, a Massively Parallel Processor, and huge mass storage devices.

Services will be extended with software development capabilities in areas of visualization, data retrieval, parallel computing etc. Software development will be done in collaboration among in-house engineers, academic experts and industry.

Additional upgrades could be implemented as necessary to meet the ever-increasing computing needs of academic and small business users.

4.5.2. Information Technology

Currently some information technology services remain available to cover the SSC's internal needs for communication. Manpower is scarce; however, a large amount of equipment is available, such as servers and network equipment.

The TNRLC proposal for the HPCC includes planned upgrades in the information technology area. For example, improved external links will be provided to increase communication bandwidth. Extensive synergy is expected with proposed educational and training activities. For example, high-tech classrooms and computing infrastructure can be used for training in software engineering, communications and computing, mechanical CAD, electronics CAD and, as mentioned in section 3 of this study, for improving teachers' computing proficiency.

4.5.3. Mechanical shops

The mechanical shop at the N15 site is part of the assets that become property of Texas and will be available for shared use. However, as machining was coordinated between shops in the Central Facility and N15, the N15 shop does not cover the full range of capabilities.

The TSTC and TEEX/ARRI studies propose additional activities at the site related to conventional and advanced machining applications. Such programs would provide first class opportunities for shared facilities access.

4.5.4. Cryogenics and Magnet Development

The TNRLC project definition study entitled, "Applied Superconductivity and Cryogenics Technology Center," proposes to continue operations of the cryogenics and magnet assets at N15, with a strong emphasis on business incubation. The ASCTC study includes provision of access to the facilities for academic and small business users. This study proposes to refer any

university or small business interests in cryogenics and magnet development to the ASCTC program, as long as it continues in operation at the site.

4.5.5. Electronics

Activities in the electronics area are planned under the TSTC project definition study entitled, "Inland Regional Industrial Technology Institute," ranging from silicon chip fabrication, clean-room services and surface mount technology, to more conventional through-hole printed circuit boards.

Implementation of the TSTC project would permit shared use access to a wide range of electronics technologies and expertise. Under the current settlement terms, however, hardly any of the electronics assets will become Texas property.

4.5.6. Data Acquisition

Under the settlement between DOE and Texas, the majority of the data acquisition assets at the SSC remain DOE property. No major local use or user has been identified yet. Also, much of this equipment is highly specific to High Energy Physics experiments. Several requests have been received by DOE for re-deployment of these assets in HEP Laboratories, where they could be put to good use. Re-establishing a DAQ effort at the SSC would require an investment of a few million dollars for equipment and newly hired and trained engineers.

4.6. Academic/Small Business R&D Facility Access Program

The R&D Infrastructure Market Survey and survey follow-up, R&D Infrastructure Workshop, and the telephone survey of existing university R&D shop facilities carried out during the course of this study and described above, combined with information gleaned from parallel SSC asset studies supported by DOE indicate that there is an unfulfilled need for additional computing facilities for the Texas academic community and that some of the needs of academe, as well as small high-tech businesses in Texas can be met by access to the SSC assets.

It is currently assumed that a Regional Medical Technology Center, High Performance Computing Center, and an Applied Superconductivity and Cryogenics Technology Center will be developed from SSC assets, and that the current electronics and machine shop equipment and facilities will be maintained to support these three major activities. Based upon this

assumption, it is recommended that these facilities have both their dedicated operational mission and a service mission. The service mission will include the science education program, described in section 3 above, and an Academic/Small Business R&D Facility Access Program.

For organizational and management purposes, the R&D Facility Access Program will include the following components:

- R&D Facility Access Fund;
- R&D Lab Equipment Lending Pool; and
- Stand-Alone Electronics and Machine Shops, if necessary.

4.6.1. Academic/Small Business R&D Facility Access Fund

Many opportunities in physics-related R&D require resources in staff and equipment that are larger than a single institution is able to commit. But formidable difficulties to inter-institutional collaboration can exist. In 1990, the principle investigators of this study learned of these difficulties first hand as founders of the Physics Association of North Texas; the objectives of this organization is to foster cooperative activities and communication. An Academic/Small Business R&D Facility Access Fund will aid physics-related R&D in Texas universities and industries by not only providing needed facilities and expertise, but by fostering patterns of cooperation and by facilitating unique and otherwise difficult research collaboration.

The basic concept for an Academic/Small Business R&D Facility Access Fund is to provide R&D equipment and services too specialized and/or too expensive for individual institutions to provide independently. For example, experimental apparatus can be designed and/or constructed on-site and utilized at the home institution or some other experimental site. A central facility for these purposes is cost effective, avoids unnecessary duplication, and encourages new collaborative R&D initiatives. An investigator would submit a budget and a short proposal describing his/her needs. The proposal would be reviewed and funds/credit extended for use of the facility.

4.6.2. R&D Equipment Loan Program

In the course of the R&D Infrastructure Workshop conducted as a part of this study (see section 4.3 above), a suggestion was made that R&D in Texas would benefit greatly from an equipment loan program that would provide for limited time use of SSC equipment at off-site locations. This suggestion runs counter to the thrust of the present study, that is on-site uses of the SSC assets. Nevertheless, a limited loan program for specific equipment might be feasible

and would be consistent with the overall objective of maximizing the utility of SSC assets.

Additionally, a loan program could make a large difference in the capacity of smaller institutions to carry out sophisticated experiments and consequently could contribute greatly to the research programs of predominately undergraduate and/or minority institutions and small businesses. Investigators would be able to propose research to federal funding agencies with budgets based on the availability of the equipment.

The loan program could provide a service for short-term experiments that need sophisticated electronics equipment. Equipment could be made available to experimenters to use off-site for a specified period of time. A loan program would not be advisable for machine shop equipment due to its large size or for computer equipment due to the facility of accessing additional computing power through Internet connections.

A reasonable estimate of the size for the equipment pool for the loan program would be 10% of the SSC electronic equipment. As a rough estimate, the present electronics store is valued at $25M, so that the Loan Program store would be valued at $2-3M in value and consist of 100-150 items with useful lifetimes of about six to ten years.

The R&D Equipment Loan Program would be managed similar to a competitive grants program, with the applicant providing a description of the planned use for review. The major elements of cost for the program would include: 1) the equipment, 2) a staff member to supervise, store, maintain, transport, and process requests for the equipment, 3) insurance costs, and 4) maintenance and provisions for loss and uncovered damage to equipment. A storage room will be needed for the equipment. We are assuming that transportation and insurance costs will be borne by the borrower.

4.6.3. Conferences and Collaborative Outreach Activities

The Physics Association of North Texas has successfully arranged conferences and workshops. Sharing the financial burden made a scale of activity possible that could not have been easily attempted by an individual institution. At the same time, the organization suffered from being decentralized.

The Academic/Small Business R&D Facilities Access Program could, in many cases, provide that centralization and the expertise that comes with experience. In addition, this program could assist physics departments and industrial R&D units in their efforts to increase professional interaction and community awareness by joint sponsorship of lectures and related programs, for example a newsletter. Initially, only a part-time staff member would be required for these activities; especially if volunteer leadership and guidance is

also provided by an organization such as the Physics Association of North Texas.

4.7. Financial Considerations

The concept of providing universities and small businesses involved in physics-related R&D with access to the High Performance Computing Center and the electronics and machine shops retained on the SSC site is supported by the findings of this study.

4.7.1. Cost & Competitiveness

Use of the infrastructure and equipment already in place at the SSC avoids the costs of constructing and equipping a new facility. A reduction in cost is assumed when existing facilities are shared by many users. Operational costs for the Regional Medical Technology Center, High Performance Computing Center, and the Applied Superconductivity and Cryogenics Technology Center will not increase significantly if the service mission, namely, the science education program and the R&D facility access program is implemented. More specifically, pooled resources will yield a reduction in cost for the businesses and educational institutional served and an increase in competitiveness for the small businesses involved by:

- Possible use of excess capability of the facilities with a dedicated mission.
- Synergy of R&D activities with training and educational activities at the site. Small, challenging projects can serve as training for students and interns.
- Collaboration of universities and small businesses with other high-tech companies. Small production projects can be handled by the aggressive small businesses involved, for example, in the business incubator established by the Applied Superconductivity and Cryogenics Technology Center. These companies are expected to be very efficient and the universities and other small R&D businesses seeking access to the former SSC facilities will provide these companies with an early set of challenging clients.
- Joint ventures between industry, state and federal institutions and academia. Some of the high-tech challenges identified by the academic and small business users will lead to collaborative projects. All parties involved may contribute funds, hardware, software and expertise to create alpha- and beta-test sites to prove and demonstrate the feasibility of leading edge technologies.

4.7.2. Pricing

The proposal for this project definition study was based upon the following two assumptions for R&D facility access:

1) REQUIRED COMPUTER SUPPORT WILL BE SUPPLIED BY A DEDICATED HIGH PERFORMANCE COMPUTER CENTER (HPCC)

2) SHOPS ARE ACTUALLY MAINTAINED BY A PRIMARY TECHNICAL USER.

In keeping with these assumptions, the Academic/Small Business R&D Facility Access Fund is proposed as a mechanism which permits and facilitates access by these important user communities in an efficient, easily managed, low-overhead process that allows the HPCC and technical applications centers to concentrate on their primary technical functions.

Presently, the high performance computing center is marketing cpu cycles at a maximum rate of $4/cpu hour for small users. Billing algorithms for use of electronics shops and machine shops are currently under development by the project definition study groups proposing to become the primary technical users of the shop equipment.

In both billing circumstances, the Academic/Small Business R&D Facility Access Fund anticipates paying similar rates for uses by its scientific user community; budget projections have been prepared accordingly.

4.7.3. Budget

In drawing up an illustrative budget, for the R&D Facility Access Program, there are two top-level decisions to be made: (1) the relative apportionment among the four areas covered in the baseline program (HPCC, Infotech, Mechanical Shops, and Electronics Shop); and (2) the overall scale of the effort.

The first decision is relatively easy. One can use directly the ratios computed from the market potential estimates in the Market Survey. These are derived from respondents estimates of the cost of securing comparable assets elsewhere. Alternatively, one can begin with respondents estimates of time of use and compute values based on SSC Laboratory costs in delivering the service. The two methods agree roughly. The result is about 70% of the budget should be devoted to computer-based services and about 30% should be devoted to shop services.

The scale of the Program is the more difficult decision. It is clear that the cautionary factors identified in the Market Survey require it be considerably

below the maximum $70M. It is also clear that in starting such a program, it is preferable to err on the side of caution, rather than on the side of optimism. It is also important that the scale of the program clearly be practical. After considerable study and consultation, a judgment was made that a total program on the order of $2M/year meets these criteria and the budget has been scaled based on this assumption.

A projected budget for the Academic/Small Business R&D Facility Access Fund is presented in the table below. Its most important feature is the $2M R&D Access Fund. This, based on the 70/30 split would be used to "purchase" from the operating entities of the computing and shop facilities $1.4M and $0.6M of computer and shop services. The computer services would be split among large jobs, small jobs and information technology. Large jobs would naturally take the majority of the CPU-hours while choosing among small jobs and information technology proposals would take the majority of the peer review effort. The shop services would be split among mechanical shops, electronics shops and engineering design. While a significant amount of work was done by this study on incremental costs of the various services as a basis for the bottom line budgeting, that work is not presented here. The scale of shop services provided, with a roughly even split between electronics and mechanical, would be on the order of fifty jobs of each sort per year.

The R&D Equipment Lending Program is budgeted here separately from the Educational Equipment Lending Program; actual operations will be integrated.

An estimate of the value of the SSC assets, computers and shop equipment, that would be required to support operations at the scale selected, $4M, is given. Illustrative tables of equipment are given in Appendices I and J. With the concept of operations selected, this equipment is covered under the requests from the primary operators of the facilities involved.

At this writing, it appears relatively certain that there will be continued operation of computing facilities. However, timing and extent of shop services is in much more doubt. We have therefore prepared a budget for the shop portion of the R&D Access program as a "stand alone facility" without the advantages of the $0.6M being incremental to functioning shops, but with the same scale of operations. It should be noted that the cost is about 50% higher. We believe that this provides some measure of the efficiencies inherent in the incremental, shared use concept proposed.

Finally, we note that one can deduce from the stand alone shop budget that a bare-bones, low budget partial infrastructure operation could be run on the basis of strictly user-supplied operation of machine shop assets; such an operation would eliminate the salary items except for security and operations supervision.

R&D FACILITY ACCESS	FTE	1995	1996	1997	1998
PERSONNEL					
Access Fund Program Director	1.00	$60,000	$61,800	$63,654	$65,564
Administrative Assistant	1.00	$25,000	$25,750	$26,523	$27,318
FRINGE BENEFITS @ 30%		$25,500	$26,265	$27,053	$27,865
CONSULTANTS -- Peer Review					
12 @ $1000 ea		$12,000	$12,000	$12,000	$12,000
TRAVEL		$10,000	$8,000	$8,000	$8,000
EQUIPMENT					
Office Equipment		$10,000	$2,000	$2,000	$2,000
R&D Facility Access Fund		$2,000,000	$2,200,000	$2,420,000	$2,500,000
FACILITIES/SPACE RENTAL					
Administrative Offices/600SQFT		$6,000	$6,000	$6,000	$6,000
MATERIALS & SUPPLIES		$10,000	$10,000	$10,000	$10,000
TOTAL		$2,158,500	$2,351,815	$2,575,229	$2,658,746

R&D EQUIPMENT LENDING	FTE	1995	1996	1997	1998
PERSONNEL					
Equipment Lending Clerk	1.00	$30,000	$30,900	$31,827	$32,782
FRINGE BENEFITS @ 30%		$9,000	$9,270	$9,548	$9,835
EQUIPMENT maintenance & upgrades		$300,000	$300,000	$300,000	$300,000
FACILITIES/SPACE RENTAL/800 sqft		$8,000	$4,000	$4,000	$4,000
MATERIAL & SUPPLIES		$3,000	$3,000	$3,000	$3,000
TOTAL		$350,000	$307,000	$307,000	$307,000
JTF R&D program total		**$2,508,500**	**$2,658,815**	**$2,882,229**	**$2,965,746**
SSC ASSETS from DOE		**$4,000,000**			

STAND-ALONE SHOPS BUDGET	FTE	1995	1996	1997	1998
PERSONNEL					
Shop Supervisor	1.00	$60,000	$61,800	$63,654	$65,564
Machinists 3 @ 45k	3.00	$135,000	$139,050	$143,222	$147,518
Electronics Engineers 4@55K	4.00	$220,000	$226,600	$233,398	$240,400
FRINGE BENEFITS @ 30%		$124,500	$128,235	$132,082	$136,045
EQUIPMENT maintenance & upgrades					
Machining Equipment		$25,000	$25,000	$25,000	$25,000
Electronics		$150,000	$150,000	$150,000	$150,000
FACILITIES /SPACE RENTAL					
Machine Shops 10,000 sqft		$100,000	$100,000	$100,000	$100,000
Electronics Shops 8000 sqft		$80,000	$80,000	$80,000	$80,000
TOTAL		$479,500	$483,235	$487,082	$491,045

4.7.4. Sources of Funds

We have identified three basic sources of funds for the proposed access program: federal, state, and private. Federal funds are available through the High Performance Computing and Communications (HPCC) Program in which the following federal agencies participate:
ARPA, NSF, DOE, NASA, NIH, NOAA, EPA, ED.
The total budget of these agencies for the fiscal year FY 94 is $938M and the proposed budget for FY 95 is $1,155M.

In addition to the HPCC program, we anticipate that other programs within these agencies could be sources of funds for our program. In NSF, for example, efforts to direct research into strategic areas could support our efforts to bring together university researchers and small businesses to develop new enabling technologies and new products. Similarly, programs in DOE directed towards Technology Transfer could support interactions with various National Laboratories.

At the State level, there exists the Texas State Matching Pool, which provides funds to match federal and other dollars brought into the state through programs in state and private entities. Thus it is anticipated that some portion of federal support for this program might be matched on a one-to-one basis by the state.

In summary, we propose that DOE finance an Academic/Small Business R&D Facility Access Fund at an annual amount of $2M per year over the next 5 years in order to provide those in both the scientific and regional business communities with a different, yet on-going R&D stimulus similar to that which might have been anticipated to exist due to the existence of the SSC Laboratory in Texas.

Not only is demand for this level of support demonstrated by our market survey (See Appendix G), but we also suggest that twenty percent (20%) of the Academic/Small Business R&D Facility Access Fund be prioritized for minority and/or female users, or project teams involving minorities and/or females in principal roles.

4.8. Recommendations

- The mission of the proposed Academic/Small Business R&D Facility Access Program is to provide a broad array of state-of-the-art technical services and training in one central location to serve the research and development communities in universities and in high-tech enterprises in Texas, relating to all branches of science. This service program is expected to enhance the abilities of universities, most

especially undergraduate and minority institutions, as well as small business, to participate in research collaborations, to establish new ties with one another, and to contribute to long-term state and national economic competitiveness.

- Use of the SSC assets will be maximized by the establishment and funding of an Academic/Small Business R&D Facility Access Fund, a service program to provide universities and small businesses in Texas (and if feasible the region) with access to the electronic and machine shops and parallel computing capabilities that are retained at the site.
- Twenty percent (20%) of the Academic/Small Business R&D Facility Access Fund will be prioritized for minority and/or female users, or project teams involving minorities and/or females in principal roles.
- The Department of Energy (DOE) should finance an Academic /R&D Facility Access Program at an annual amount of $2M per year over the next 5 years in order to provide those in both the scientific and regional business communities with a different, yet on-going, R&D stimulus similar to that which might have been anticipated to exist due to the existence of the SSC Laboratory in Texas. Five years' cumulative direct costs requested from DOE for the R&D Facilities Access Fund and Fund administration total $12.5M, and five years' cumulative direct costs for the R&D Equipment Lending Program total $1.8M.

5. R&D Training Activities

5.1. Endorsement of Other EOI Projects

Although training needs for R&D technicians were investigated during this project definition study, evidence suggests that other DOE-funded repurposing projects, specifically those led by Texas State Technical College (TSTC) and by the Texas Engineering Extension Service (TEEX)/UTA's Automated Robotics Research Institute, are competent endeavors which should be endorsed and supported to meet training needs which might arise.

5.2. Manufacturing Technology Deployment Center TEEX/ARRI

Manufacturing companies must face increasingly fierce competition in the global market. "The U.S. share of world production has declined from about 50 % in 1955 to about 15% today." Because this is the case, it is crucial that immediate steps be taken to assist small manufacturers in improving their effectiveness and competitiveness, and to help them safeguard against failure. The result of the feasibility study conducted by the Advanced Robotics Research Institute (ARRI) and the Texas Educational Extension Service (TEEX) shows that the most logical, productive, and financially advantageous applications of the SSC facility to be the development of a Manufacturing Technology Deployment Center (MTDC). The MTDC will contain the following applications:

- Product Development Center
- Business Incubator/Accelerator

A Product Development Center is an industry driven facility that provides services to facilitate the process of product development for the manufacturing community. Included in the services to manufacturers by such a center are a comprehensive approach to prototype design and fabrication, a concurrent design of product and manufacturing processes, and market research.

A business Incubator/Accelerator is also an industry driven facility that allows start-up companies to use shared facilities to develop products and processes, and allows them to initiate low rate production.

The Manufacturing Technology Deployment Center (MTDC) is a private-public partnership between industry, academia, and government that will enhance global economic competitiveness of small and medium size manufacturers in a five state region (Texas, New Mexico, Oklahoma, Arkansas, and Louisiana) through industry driven training and education, technical assistance, and the deployment of clean, agile, environmentally conscious, and energy efficient manufacturing technologies that reside in the DOE, other federal laboratories, regional universities and colleges.

5.3. Texas State Technical College Initiative

The Teaching/Learning Factory and Technology Training Center of TMTC's Inland Regional Industrial Technology Institute (I-RITI) will interactively function as a support mechanism to prepare R&D and production technicians. In this effort, industry-driven TMTC will link resource partners, TSTC Waco, state and regional universities, and other R&D laboratories at I-RITI to:

- Integrate the teaching environment with the manufacturing environment for rapid applications of technology through experiential learning; and
- Link technical, engineering, and management education in applied projects that integrate newer design, manufacturing and management technology for opportunities that teach "real time" concurrent engineering.

5.4. Recommendation

- Although training needs for R&D technicians were investigated during this project definition study, evidence suggests that other DOE-funded repurposing projects, specifically those led by Texas State Technical College (TSTC) and by the Texas Engineering Extension Service (TEEX)/UTA's Automated Robotics Research Institute, are competent endeavors which should be endorsed and supported to meet training needs which might arise.

6. Summary & Recommendations

6.1. Introduction

This section summarizes the chief elements of the project definition study funded and undertaken as the "Texas Joint Facility Supporting Research, Training and Science Education," as the detailed in sections 3-5 above. Recommendations concerning management are made in section 6.3.; while recommendations concerning activities in the interval between completion of the study period on October 31, 1994 and the time at which Texas and DOE finalize their arrangements for what will continue as functioning components long-term. Section 6.5 contains other recommendations.

6.2. Summary Description

This project definition study was undertaken based upon the following assumptions:

- Maximum use should be made of existing tangible SSC assets; a minimum of acquisition of new equipment or construction should be required.
- The operations concept should minimize duplication of services and resources already provided by other institutions; areas of overlap are desirable only where significant deficiencies exist.
- Where possible, use should be made of intangible SSC assets.
- Other, technical uses of SSC assets will be selected for primary funding as on-going technical components. These are likely to include design and construction of an accelerator for medical therapy and research and radioisotope production as well as the Blacklands Prairie recovery project. Other uses, such as physics experiments using SSC assets, cryogenics work, and superconductivity, and the high performance computer center are possible. Academic and small business users will be able to share facilities with those selected and to draw, even if in limited amounts, on the expertise of their personnel.
- The concept of operations must be broad enough so as to benefit, not just the local region, but the entire state, and possibly be expandable beyond state borders to be of service in a still broader region.

Within these bounding assumptions, the projects defined by this study, in outline, include the following:

- Computer Literacy for science teachers and science education programs whose core is maximal exploitation of the personal computers, work stations, mass storage capabilities and connectivity access assembled by SSC. These would be used both on-site and in Texas schools. The programs of section 3 are designed to use that asset to position science teachers in Texas to make maximum use of the rapidly growing pool of educational resources available on, and from, computers and networked connections of computers.
- Intern activities for teachers and students drawing on both on-site activities related to other uses of SSC assets selected and off-site activities. The Science Education Enhancement Center will be in a unique position to facilitate such off-site internships in view of the unique lines of communication it will develop with a variety of R&D activities in Texas through its infrastructure arm.
- An Academic/Small Business R&D Facility Access Fund, which will aid physics-related R&D in Texas universities and industries by providing access to infrastructure facilities and expertise in a variety of areas, including computing, information technology, machine shops, electronic shops, advanced engineering and design capabilities. These infrastructure activities will ensure that the benefits from SSC shop and related assets will extend to R&D throughout the State and not be limited to the local region and the specific technical SSC asset uses selected.
- Long-term, elements of the CyberScience Coalition would compete for funding for its programs from federal and other funding agencies. In time, the majority, if not the entirety, of its educational activities could be so funded.
- At a measured pace, the Academic/Small Business R&D Facility Access Fund would assist the reconfigured TNRLC to move to essentially full-funding of its infrastructure support activities, as modes of operation for best serving the needs of a variety of types of users throughout the State were developed.
- Both the CyberScience Coalition and the Academic/Small Business R&D Facility Access Fund are designed to ensure that the uses of SSC assets, tangible and intangible, are distributed throughout Texas as broadly as possible to the people -- science students, teachers, and researchers in schools, colleges, universities, and industries -- best equipped to benefit from such use.

6.3. Management

The reconfiguration, and resulting management structure, of the present Texas National Research Laboratory Commission (TNRLC) as the designated

asset management organization is anticipated to have a major influence on recommendations regarding specific management structures for the Academic/Small Business R&D Facilities Access Program and the CyberScience Education Programs.

Since a TNRLC reconfiguration has not yet been completed by the state legislature, the discussion below is limited to management philosophy issues and internal operating issues related to the two programs which are defined in this study.

Members of the Advisory Board should represent universities and small businesses who have vested interests in use of the facilities. Independent peer reviewers should be used at least annually to evaluate specific fund disbursements.

The nature of this effort makes it a prime candidate for the developing concept of "virtual organization." In this management approach, each activity or "cost center" has a managing program director and an allocated resource level. The Program Director then has responsibility for assembling the "virtual organization" that will define and deliver the cost center's services, as well as for supervising its execution -- rather than assigning portions of the activity to various units of the parent organization. The members of the virtual organization can come from inside or outside the parent organization. The virtual organization exists for the life of the particular activity. The people involved in the activity report to the manager with respect to it -- although they may also be involved in more than one business line, or cost center, at a time -- rather than to someone supervising their participation in various diverse activities.

This project management style is particularly suited to the proposed activities. The nature of the project staff will vary depending on how best to meet human resource needs; options for filling positions include staff, participating faculty and others.

The virtual organization approach to internal management is psychologically particularly suitable in this case. Both education and science are fundamentally dependent to a much greater degree than many other human activities on the judgment, creativity and enthusiasm of their practitioners. The same attributes are needed for those who would support, facilitate and enhance these activities. Putting responsibilities in the hands of individual managers of talent, rather than in an organizational matrix, is clearly the preferable route for attracting, retaining and most fully exploiting the capable people the education and research programs will need to succeed.

6.3.1. Academic/Small Business R&D Facilities Access Program

Personnel requirements for the Academic/Small Business R&D Facilities Access Programs are designed to be nominal. An Access Fund Program Director will work with members of an unpaid, appointed Advisory Board to design and implement a simple application and peer review process in the administration of the Fund to provide timely access to high performance computing capabilities, as well as access to available electronics and machine shops. The Access Fund Program Director will supervise an Administrative Assistant and an Equipment Lending Clerk, who will handle daily responsibilities for the R&D Lab Equipment Lending Program.

Space requirements for the R&D Facilities Access Fund and the R&D Equipment Lending program total less than 1500 square feet.

6.3.2. CyberScience Education Programs

Personnel requirements for the CyberScience Coalition education programs include an Executive Director, Program Directors for both the Science Education Enhancement Center and the Connectivity Resource Center, and Faculty Directors for program development initiatives in the areas of Educational Technology Research, Workforce Development and the Executive Institute. Faculty Directors are anticipated to be joint employees with a coalition member university; such joint appointment might also be true of the Executive Director. As currently projected, a total of 20 FTEs are necessary to provide the science education and connectivity services as defined in this study. Space requirements for these programs are projected to total approximately 10,200 square feet.

Due to the evolving technical and research components of the CyberScience Education Programs, this effort might well be considered as a separate technical application center, akin to the other technical EOIs and TNRLC projects. As such, it too might be a candidate for external contractual management by joint venture groups. If that were to occur, however, budget figures presented herein must be adjusted to include some negotiated indirect costs, since only direct cost figures have been outlined in this document.

6.4. Interim Period

To prevent a loss of continuity between completion of this study and implementation of the defined projects, the CyberScience Coalition and the Academic/Small Business R&D Facility Access Fund, we recommend that

modest funds be made available, starting immediately. The program of work during this period would include the following:

- **Pursuit of funding opportunities,** for the defined project activities; submission, where appropriate, of non-binding letters of intent, and preparation of elements of full proposals for immediate use in the event of a favorable decision.

  Such activity is particularly important for the educational arm. There are specific programs in this area already announced and more are expected. A small, near-term investment is important in keeping open as many options as possible and in ensuring that well though out proposals could be submitted rapidly.

- **Identification of specific R&D Facility Access needs** in the first year of operation. Such an effort now, even at a low level, would capitalize on the wide distribution of the market research survey. Potential users who requested follow up information at study completion would be contacted. A general mailing could solicit candidate projects in the event of favorable action. Working with those most interested would permit generation of detailed operational procedures beyond the scope of the present study.

- **Maintenance of open lines of communication** developed in the course of the present study. The study has been in contact with a wide variety of individuals and institutions which have expressed interest in using and/or supporting the projects defined in this study. Interim activity would keep open those contacts, eliminating needless duplicative efforts to re-establish them in the event of a favorable decision after a lengthy hiatus. These include educational organizations, staff members of such organizations, and teachers; they include industrial and academic scientists; and they include those participating in the other studies.

To support baseline program development activities such as those described above would require approximately $30,000 per month plus indirect costs; funds requested represent direct costs to support four program development and technical staff, appropriate administrative support, and basic travel and operating expenses. The present study grant could, we believe, serve for the administrative entity for the interim effort. Effort in the interim period would be augmented by supervision and assistance by the Principal Investigators on the present study. It could also be augmented by participation by various physicists and others, around the State, who have taken an active interest in the Joint Texas Facilities concept and its objectives since before the November, 1993, meeting at Southern Methodist University cited in Section 2. Most importantly, efforts in this period would be augmented by members of the Advisory Board, who have expressed a willingness remain constituted and to meet a limited number of times, as

needed, in connection with maintaining present momentum during an interim period.

6.5. Recommendations

After careful study and consideration, with input from an especially helpful and experienced Advisory Board, the following recommendations are made as a part of this UTA/SMU project definition study:

A A critical service niche in science education has been identified which uses existing SSC computing assets to support science education by providing on-going teacher enhancement on the use of computers and connectivity resources on a daily basis in science classrooms.

For science education, the project has definite uses/needs for pieces of SSC equipment, including almost all of the Macs/PCs/workstations (3500+) as well as permanent staff, budget and facility space, independent of any other technical and/or high performance computing elements which may continue to exist.

In addition to providing all available Macs, Pcs, workstations and computer peripherals available for the enhancement of science education, the Department of Energy can leverage both their education and research dollars well by providing:

1) Immediate start-up funding of $1.6M direct costs for the 1995 and $1.7M direct costs for 1996; and

2) Base line support of $1M direct costs for each of the subsequent three years, plus leadership assistance in securing long-term self-sustaining research funding and development activities for the CyberScience programs during the first five years of operation.

B Use of the SSC assets will be maximized by the establishment and funding of a service program to provide universities and small businesses in Texas (and if feasible the region) with access to the electronic and machine shops and parallel computing capabilities that are retained at the site.

The mission of the proposed Academic/Small Business R&D Facility Access Program is to provide a broad array of state-of-the-art technical services and training in one central location to serve the research and development communities in universities and in high-tech enterprises in Texas, relating to all branches of physics. This service program will enhance the abilities of universities, most especially

undergraduate and minority institutions, and small businesses to participate in leading research collaborations, to establish new ties with one another, and could contribute to the economic feasibility of new idea development.

Twenty percent (20%) of the Academic/Small Business R&D Facility Access Fund will be prioritized for minority and/or female users, or project teams involving minorities and/or females in principal roles.

The Department of Energy (DOE) should finance this Academic/R&D Facility Access Program at an annual amount of $2M per year over the next 5 years in order to provide those in both the scientific and regional business which might have been anticipated to exist due to the existence of the SSC Laboratory in Texas. Five years' cumulative direct costs requested from DOE for the R&D Facilities Access Fund and minimal Fund administration total $12.5 M, and five years' cumulative direct costs for the R&D Equipment Lending Program total $1.8M.

C Training needs for R&D technicians, as well as technicians for production, were also investigated during this project definition study; however, our evidence suggests that other DOE-funded studies, specifically those led by Texas Manufacturing Technology Center (TMTC) and its proposed Inland Regional Technical Institute, as well as by the Texas Engineering Extension Service (TEEX)/UTA's Automated Robotics Research Institute, are competent endeavors perhaps better suited to this task, and as such, are endorsed and supported to meet training needs.

D Our project has identified no justifiable needs for the Central Facility, in and of itself, but does have facility space needs which could be met by allocation of space either at Central Facility or N-15, depending on what and where other technical and/or high performance computing elements will continue to exist on a long-term basis.

E The N15 shop capabilities should be augmented with a small set of equipment from the Central Facility. A list of machine shop equipment anticipated to be available for use is given in appendix I. The total value of the listed equipment is about $250,000. Most of the equipment listed in the appendix is also requested by other re-use studies; some is associated with the Linac and becomes Texas property.

7.0 SUMMARY BUDGET REQUIREMENTS – Direct Costs

	% FTE	1995	1996	1997	1998	1999
CYBERSCIENCE COALITION						
Administration	3.00	$216,500	$224,625	$233,156	$242,114	$251,520
Science Education Enhancement Cente	7.00	$395,500	$410,125	$425,481	$441,605	$458,536
Connectivity Resource Center	8.00	$692,500	$713,375	$738,144	$769,851	$790,543
Program Development	2.00	$319,500	$329,900	$340,820	$352,290	$364,330
Total	20.00	$1,624,000	$1,678,025	$1,737,601	$1,805,860	$1,864,929
ACADEMIC/SMALL BUSINESS R&D FACILITY ACCESS PROGRAMS						
R&D Facility Access Fund	2.00	$2,243,500	$2,351,815	$2,575,229	$2,658,746	$2,662,369
R&D Equipment Lending Program	1.00	$389,000	$347,170	$348,375	$349,616	$352,212
Total	3.00	$2,632,500	$2,698,985	$2,923,604	$3,008,362	$3,014,581
GRAND TOTAL	23.00	$4,256,500	$4,377,010	$4,661,205	$4,814,222	$4,879,510

8. Appendices

Appendix A Survey of Texas Universities and Colleges

Science Education and Teacher Enhancement programs at Texas Colleges and Universities

Baylor University

•Programs aimed at improving teaching skills of teachers already in the field using state-of-the-art technology but finding resources is a problem.

•Collaboration between Baylor and the Holmes Group - a Professional Development elementary school in Waco.

East Texas State University

•Physics Department holds workshops for middle school and elementary school teachers to enhance their skills in teaching physics. Currently, to encourage participation, graduate credit is given, tuition is paid for the teacher, a stipend is paid, and teachers are given materials to use in their classroom.

•Has received Eisenhower funds in the past and anticipates requesting additional funds in the future.

Houston Baptist University

•Eisenhower grant to teach bilingual elementary teachers physical science with emphasis on chemistry--training, books & materials--3 graduate hours credit for participating teachers

Rice University

•Model Science Laboratory - funded by $6 million dollar NSF grant and approx. $6 million in corporate donations - operated under the auspices of the Rice University Center for Education. Aimed at retraining inner-city middle school teachers in science education.

Sam Houston State University

- Very large year-round, graduate program where teachers develop curriculum to take to their classroom.

- Developing programs with area school districts to monetarily reward teachers who pursue an advanced degree.

- Would like to see state-wide ISD networked so teachers (especially rural) can communicate and share information, and expose students to technology. Need resources such as computers and training to do so.

Southwest Texas State University

- Science departments use educational grants to provide graduate-level courses in physics, biology and chemistry specially designed for teachers - especially middle-school level teachers

- They also sponsor an 180-hour (3 credit hours graduate credit) course called "Southwest Wild", which is a field ecology class

- In addition they do workshops to provide in-service training for teachers

Southwestern University

- Education department has required education courses in process (emphasizing discovery and inquiry to develop curiosity) as well as content courses for science education

- Have applied for several NSF and Eisenhower grants to develop science enrichment programs but they weren't funded

- They have an Eisenhower grant to work with area teachers for mathematics enrichment

- There are no initiatives from the Science Departments for science education

Texas A&M University - Kingsville

- In collaboration with the Region II Education Service Center, they sponsor an Eisenhower Mathematics and Science Program to provide in service training to secondary teachers of mathematics (grades 7-12). The programs are summer institutes ranging from 9 to 15 days. Instruction is based on the premise that teachers teach in the way they were taught--therefore

participants are taught by using hands-on activities, large and small group settings, lecture and discussion. Manipulatives and graphing calculators are employed extensively as tools for learning and teaching mathematics. Cooperative learning techniques are a major focus.

Texas A&M University

- Currently writing a 5-year grant proposal to the NSF for an initiative to restructure Middle Grades (6-9) for the State of Texas. The goals of the proposal will be to create instructional materials and to develop and pilot new science courses.

Texas Christian University

- NSF multiple year grant focusing on teacher enhancement in teaching math and science in the elementary school (year-round program). Teachers from area schools meet every week during the school year with TCU professors for exploratory exercises in science and math. During the summer area elementary students are invited to participate in science/math activities. Major goal is to improve teaching of math and science by promoting and enhancing teachers knowledge and understanding of math and science.

- Grant sponsored by Southwest Education Development Laboratory--goal is to enhance science instruction in upper elementary and middle school classroom through use of technology and community resources.

Texas Tech University

Certifications programs in science and mathematics including graduate study.

- "Minority Mathematics and Science Education Cooperative" (Eisenhower grant)--involves faculty members of two elementary schools in Lubbock. Also developing Science I curriculum materials.

- Eisenhower-funded program in mathematics education for area K-6 teachers.

- Summer program in science and mathematics for junior high school students.

- Hosts large area science fair each year.

•Grants from Hughes Foundation for outreach to area biology teachers

•Clark Scholars Program supports high-ability high school junior and senior students to work in research project with faculty member for 8 weeks in summer (students come from all over nation)

Texas Women's University

•Graduate level hands-on course for elementary teachers to develop materials and ideas in science and mathematics

Trinity University

•Program funded by TEA and administered by Centers for Teacher Enhancement. Program is in its 5th year and in San Antonio involves 2 middle and 2 elementary schools. Interactive TV and video, computers, TENET training and Satellite are used. Technology is the theme.

University of Houston

•Program funded by NSF titled "Great Investigations for 6th Grade Science". Program involves 6 school districts in Houston and 21 teachers. Program aimed at developing a new approach to teaching science through new curriculum, upgrading teachers technology knowledge by providing software training (limited - classes mainly teach how to use spreadsheets).

University of North Texas

•Operates the Science and Mathematics Academy for 11-12 grade academically gifted students

•Working to establish the High Performance Learning Center at the SSC which will include virtual science laboratories placed around the state, development of curriculum and instruction materials emphasizing the use of technology, plus extensive distance-learning and professional development activities relating to science education.

University of Texas at Arlington

•Year-round program of enhancement for Math teachers. Texas Instruments supports program and distinguished Chair to lead program.

University of Texas at Austin

- Extensive Masters and Doctoral programs in science education
- ?? grant outreach programs (still waiting for info)

Appendix B Science Education Workshop Agenda

A WORKSHOP

Hughes Trigg Student Center, Ballrooms C & W

Southern Methodist University

Thursday, September 1, 1994

AGENDA

8:30 a.m.	Welcome & Overview of Settlement between Texas and DoE	Peter Rosen
8:45	Overview of JOINT TEXAS FACILITY Study	Vic Teplitz
9:00	Concept for CYBERSCIENCE COALITION	Kate Morgan
		Jane Armstrong
	Mission: to involve active research scientists and engineers in the enhancement of science education	
9:30	OTHER PROJECT STUDIES--SOURCES FOR SCIENTIST INVOLVEMENT	
	•Regional Medical Technology Center	Ben Prichard
	•Applied Superconductivity & Cryogenics Ctr.	Adnan Yucel
	•Southwest Ctr. for Computing, Information & Learning	Dave Gurd
	--High Performance Learning Center	Kathleen Holmes
	•Manufacturing Technology Deployment Center	Mike Huddleston
	•Minority Institution Network	Dennis Judd
10:30	BREAK	
10:45	MORNING BREAKOUT SESSIONS	
	A•Promenade A	Jane Armstrong/Kate Morgan
	What are the current connectivity, equipment and training needs to link science teachers onto TENET and/or InterNet? with other scientists?	
	B•Promenade B	Michael Brown

Are there ways to integrate workplace skill requirements into curriculum modules that teach TAAS Science essential elements?

11:45 a.m.	LUNCH	
1:00 p.m.	SAMPLE ORGANIZATIONAL MODELS	
	•TEACHERS' ACADEMY FOR MATH AND SCIENCE	
	Illinois Institute of Technology, Chicago	Lourdes Monteagudo
	•TRIANGLE COALITION FOR SCIENCE & TECHNOLOGY EDUCATION	
	College Park, Maryland	Lauren Williams
2:00 p.m.	AFTERNOON BREAKOUT SESSIONS	
	C•Atrium C	Robert James
	Could the coalition development process avoid duplication of efforts?	
	D•Atrium D	William B. Baker
	Are there suggestions for clarifying the scope, priorities, research opportunities OR funding scenarios for the CYBERSCIENCE COALITION?	
3:00	BREAK	
3:30	REPORTS FROM SESSIONS	
4:00	WAYS TO STAY INVOLVED	

Appendix C CyberScience Science Teacher Survey

Final Report to the

Joint Texas Facility Project Supporting Research Training & Science Education

on the findings of the

CyberScience Coalition Survey

October 13, 1994

J. E. Gonzalez, Ph.D.

Texas Center for Educational Research

P.O. Box 2947

Austin, TX 78768

512.467-0222

The Texas Center for Educational Research (TCER) was contacted by Dr. Jane Armstrong, on September 16th, regarding participation in the CyberScience Coalition Survey. TCER agreed to participate in the study and provide data entry, quality assurance, and data analysis. Preliminary findings were presented to the Joint Texas Facility Project Supporting Research Training & Science Education advisory group on October 11th, at Dallas, Love Field, Texas. This report constitutes the final report to the advisory group and is due on October 14th. All project materials will be returned to Dr. Armstrong on October 17th.

The CyberScience Coalition Survey which was developed by Dr. Armstrong and her staff, was mailed to two teacher groups in Texas: the Physics Teachers Association of Texas (n = 265); and the Texas Association of Biology Teachers (n = 630). The survey sample therefore totaled: 895. The cut-off date for responding to the survey was midnight on October 3rd. Respondents returned surveys directly to TCER. The survey response flow was steady from 9/26 through 10/7 as shown in Table 1. No surveys have been received by TCER since 10/7.

Table 1

CyberScience Coalition Survey Response Flow

Date	Number	Sum
9/26	9	9
9/27	6	15
9/28	14	29
9/29	15	44
9/30	43	87
10/3	88	175
10/4	23	198
10/5	19	217
10/6	12	229
10/7	16	245

After review of the materials received by TCER, it was found that five (5) surveys, although returned to TCER, had not been completed at all by the respondents. These surveys were therefore removed from the statistical database, reducing the total number of responses to 240. With the adjusted number of responses totaling 240; the adjusted response rate was calculated to be 27%.

If it can be assumed that the sample is representative of teachers in these two science groups, a margin of error can be calculated based on estimates of the size of the population of interest, and the number of respondents. Utilizing formulas found in W. G. Cochran (1977), Sampling Techniques, 3rd ed., pp. 75-76; the estimated adjusted margin of error for the CyberScience Coalition Survey is ± 7%.

C.1. Findings

C.1.1. Computers in the Classroom:

Respondents indicated that the average science class size was 27 (std.=6.84; range: 2-55). The average number of computers in science classrooms was 3 (std.=4.25;range: 1-32). 166 respondents (69%) indicated that they had computers in their classrooms; of these computers: 27% were IBM, 14% were Apple, and 18% were Macintosh (10% of respondents also indicated that they had different combinations of computers in their classrooms). 122 respondents (52%) indicated that they had printers in their classrooms; 36% of

which were dot matrix printers. 93 respondents indicted that they could get their computers repaired.

95% of respondents indicated that they utilized some sort of technology for their Science and Math classes ranging from TV to software: 34% used TV; and 61% used some combination of TV, CD-ROM, databases, and software. 66% of respondents indicated that there were computer labs that they did not have access to. 86% of respondents indicated that they would like to add computers to their science classroom. By brand; 42% of respondents indicated they preferred Macintosh, 11% preferred IBM, and 46% listed some combination of computers for their classroom.

C.1.2. Network Connections in the Classroom:

89% of respondents indicated that they were not connected to a network, by virtue of having no phone or modem. The question regarding modem speed was moot, as 89% of respondents indicated they did not know, the question did not apply to them, or they simply did not respond to this item. (A follow-up question regarding network connection speed resulted in a similar response; as 87% indicated they did not know, the question did not apply to them, or they simply did not respond to this item.) However, in terms of connectivity, 70% of respondents indicated that they had access to: TENET (45%) and Internet (10%). 89% of students, however, did not have access to networks from the classroom. This was verified in a follow-up question where respondents indicated that 92% of students did not have an e-mail address. Of 240 respondents, only 51 listed an e-mail address.

C.1.3. Computers at Home:

85% of respondents indicated that they had computers at home; 46% were IBM users and 22% were Macintosh users. Half of the respondents did not have access to networks from their homes; of those that did, 28% accessed TENET. In a follow-up question regarding e-mail addresses, only 39 respondents listed an e-mail address.

C.1.4. Training Needs:

69% of respondents had "zero" or "weak" networking skills. However, respondents were willing to learn, as 90% listed the type of training or help they would like to receive; ranging from the use of telephone hotlines to extensive training. 79% of respondents indicated that they thought their schools would pay release time for them to attend training session; and 86%

indicated that they thought they would attend a training class that was provided free of charge on a weekend.

C.1.5. About the Respondents:

Sixty percent of survey respondents were female; 44% were between the ages of 40-50 (92% between the ages of 30-60). The majority of respondents (90%), were white; and 50% taught at the 10th-12th grade levels. 30% of respondents taught at a 4A school (schools with a student enrollment between 715 and 1,599); 25% taught at a 5A school (schools with a student enrollment greater than 1,600); and 16% taught at a 3A school (schools with a student enrollment between 295 and 714).

Appendix D "Riding The Internet"

See attached document

Appendix E Equipment For Science Education Lending Pool

See attached document

Appendix F Detailed Descriptions of SSC Assets/Capabilities

F.1. High Performance Computing and Communications

The SSC High Performance Computer Center was established for the simulation of SSC physics experiments and the design of the accelerator systems. It provides 12, 000 MIPS computing power on a UNIX workstation farm. A total of 120 workstations are organized in groups that are tightly coupled by optical fibers and Ethernet. Several types of stations are used, such as Hewlett Packard 9000/735s, SUN SPARC 10s, and Silicon Graphics SGI 4D/360s. Each station has at least 64 MB RAM and 1 GByte disk. Four SGI Challenge L file servers provide an additional 160 GBytes disk space. Two Summus STL-2300-12 tape robots are used for archiving.

The center is being used for technical and scientific applications, and is easily accessible via Internet. All computer equipment is housed in secure, air conditioned and fire proof computer rooms.

The workstations in the farm normally run in course grain parallelism and are available for batch and interactive use. Batch queuing is provided using distributed operating systems like NQS. Applications that require fine grain parallelism can run under the Parallel Virtual Machine operating system. The large amount of disk space allows use of advanced distributed databases and information retrieval systems. Due to its modular architecture the system is easily upgradable and expandable. It can be used as test bed for emerging hard and software technologies and new interoperability concepts.

The center has an Intel iP860 Hypercube with 64 tightly connected nodes. It can be used for massively parallel scientific and technical applications in areas of image processing, ray tracing, climatology and hydro-dynamics, etc.

F.2. Information Technology

The SSC has excellent internal and external communications infrastructure. Extensive capabilities in areas of data processing, networking and multi-media make an ideal facility to develop and exploit the emerging information technologies.

F.2.1. Voice Systems

Each SSC office has at least 4 connections for phone and data. Voice communication relies on AT&T PBX equipment able to serve 10, 000 connections. Redundant long distance links are available and buildings are connected with T1 lines. Pagers are also available and radio links assure contact with mobile crews.

F.2.2. Data Network

On-site networking is typically done using Ethernet. Ethernet concentrators are in secure equipment rooms. They are wired by fiber or copper to routers, connected on a fiber backbone. The different buildings are linked using T1 connections. Software for network monitoring and management is installed throughout.

The internal networks connect thousands of PCs, Macintoshes and workstations. Tens of servers are installed throughout the facility and used for name-servers, file servers, databases, compute servers, centralized plotting, mail distribution, backup and interactive information retrieval.

Wide Area Network connections with regional and national networks are assured by three T1 links. The site is directly connected to the Texas Higher Education network (THEnet) and ESnet, and has access to Internet and Texas Education network (TEnet). Several workstations are set up as servers for the Word Wide Net. The excellent bandwidth of the connections and the availability of powerful servers, ample mass storage and the High Performance Computer Center make the site very attractive for information storage, interactive retrieval, and 'distance learning'.

F.2.3. Audio-Visual

The SSC laboratory has extensive experience with video teleconferencing. Several complete systems currently support connections with, for example, the National Laboratories, universities in the US, and sites in Italy and Japan. More primitive, multi-party, global video-conferencing between workstations is now possible using Internet.

Sophisticated video production capabilities include pre-production planning, script writing, professional camera teams, videotaping and post-production editing. They are used for documentation, instruction, information, training, public awareness and educational purposes.

The SSC has professional still-camera equipment and photo lab equipment with a throughput of up to 360 prints per hour. High resolution color scanners are used for digitization. Software is installed for digital image treatment. Part of the photographic collection is accessible via Internet.

An integrated publishing system allows for the conversion of various word processing standards and computer assisted translation. Document control systems are accessible via the network. A complete publishing department can handle document preparation and high throughput printing.

F.3. Mechanical shops

Most of the mechanical shop capabilities are located at the Central Facility. The shops have the personnel and equipment to manufacture hardware and instrumentation for a wide range of applications. Shop capabilities include machining, forming, fabrication, welding and assembly processes and specialized techniques for the production of a wide variety of prototype components, systems and experiments.

CAD/CAM program systems provide the capability to take ideas from concept through drawing directly into the proper machine language for the individual machines with Computer Numerical Control (CNC).

F.3.1. Machining Capabilities

Most conventional equipment has the ability to attain a tolerance level of 0.025 mm (0.001"), while some of the more sophisticated CNC units reach 0.002 mm (0.0002"). Most machine tools have the capability of reading in metric or English units.

The shops contain over 150 major pieces of equipment. Machining capabilities include: lathes with working envelopes of 24" swing and 60" length, fully programmable milling machines, a planer that can handle work pieces of up to 144" length, and a 6" by 18" grinder which can satisfy exceptional surface finish requirements. In addition, there is a CNC turning/milling center that swings a maximum diameter of 18". It has a 16 position automatic tool changing magazine, all tool position are live and can operate in the horizontal or vertical position. Parts of up to 39" length can be machined. All function are controlled by microprocessor to within 0.001 degree.

F.3.2. Welding Capability

The welding shop capability includes the equipment to perform a complete range of welding procedures and techniques i.e. Gas Tungsten Arc Welding (TIG), Gas Metal Arc Welding (MIG), Shielded Metal Arc Welding (SMAW). The shop fabricates complex structural and tubing configurations in a variety of materials. It also has the capability to perform soldering, brazing and cutting with oxy-acetylene and plasma systems.

TIG machines are used for the complex and delicate welding of thin wall 0.005" thick stainless steel bellows. Welders are certified to perform vacuum tight and pressure welds to level 3 standards. The scope of the welding capabilities is expanded to provide for the welding of dissimilar materials.

F.3.3. Quality Control

Testing and inspection capabilities cover a wide assortment of precision measurements. The QA group has sophisticated equipment, such as: CNC optical comparators, CNC coordinate measuring machines, a dead weight tester, a vacuum gauge calibration system, a super-micrometer and a laser alignment system.

F.4. Cryogenics

The cryogenics facility is located at the N15 site east from I35. It houses the world's largest cryogenic capability. Three helium refrigerators each provide 4000 W cooling at 4.5° Kelvin and 37 g/s liquefaction. A smaller refrigerator cools 500W at 4° K. Large 40,000 liter dewars intrinsically handle sudden, major load upsets.

The facility is designed to provide maximum flexibility and to handle the requirements of multiple large or small-scale loads. Automatic control is implemented to improve system efficiency and quick turnaround. The large cooling power provides a unique opportunity to create a world-class 1.8K super-fluid helium facility. It can also be used for testing at intermediate temperatures.

F.5. Magnet Fabrication

The magnet development and test laboratories at the N15 site are dedicated to the advancement of superconducting devices and the associated manufacturing technologies. They are equipped to design and produce

superconducting and resistive dipoles and more complex magnets. Magnets of up to 16 meters in length can be built and tested in-house. The capabilities of staff and facilities have been demonstrated by the successful manufacturing of the world's premier superconducting magnets.

The site has 47, 000 square feet of mechanical shops, served by two 25 Ton cranes. The buildings provide a quasi clean room environment for the specialized equipment used for magnet construction, such as fully automated cablers, cable wrappers and wedge wrappers; gantry style coil winders for coils of 2-16 meter length; and curing and collaring presses with up to 300 Tons per foot capacity. A 16 meter long shell welding press allows for fully automated TIG welding.

The magnet laboratories also provide CAD/CAM, factory simulation software, sophisticated general purpose machining equipment and Quality Control inspection. Cryogenic and a warm test stand are used for precision magnetic measurements.

F.6. Electronics

Ten specialized laboratories at the SSC are equipped for research, development and production of electronics and data acquisition systems. All have excellent connectivity to the network. Some of the shops have special high power provisions, while others are RF shielded for ultra-sensitive measurements. The electronics shops can handle analog and digital design, surface mount, programmable logic, RF and high power.

F.6.1. VLSI design and testing

Computer Aided Design software is available for design of analog and digital chips. Simulation at chip level is done using HSpice, for analog electronics, and VERILOG, VHDL for digital, behavioral simulation. A 100-channel 100 MHz pin-by-pin digital chip tester is used for IC verification. Combined with analog digital test & measurement equipment it can be used for the evaluation of mixed analog/digital designs.

F.6.2. Board level systems

Electronics capabilities meet a wide range of requirements in the areas of low noise, low power, radiation hardness, digital signal processing, VME, VXI, and system design. Alternative CAD software is available for design, simulation, layout and production of board level systems of varying complexity and functionality. E-size plotters and copiers are available for

documentation. State-of-the-art programmers are available for PALs, FPGAs, EPROMs and ROM.

Prototype fabrication and small scale production are possible using through-hole mounting and infra-red refold surface mount soldering systems with automated component placement, cleaning and Quality Control. A sheet metal workshop is used for the production of chassis and rack assemblies.

F.6.3. RF capabilities

Extensive capability has been developed in the area of Radio Frequency design and testing. A 5300 square feet facility specializes in testing of high power RF equipment. It has a separate 3-phase, 1000 kVA power feeds that provide 16-20 kV DC output power. Low conductivity cooling water is available at more than 1000 gallons/minute.

A second 5000 square feet RF shielded room specializes in low level RF testing. Capability also exists for high precision impedance testing of RF structures.

F.6.4. Test & Measurement

All laboratories are well equipped with up-to-date measurement equipment, such as network analyzers, spectrum analyzers, oscilloscopes, sweepers, synthesizers and state analyzers. Extensive capability exists for measurements beyond 1 GHz and in the 430 MHz and 60 MHz ranges. Much of the equipment is computer controlled via GPIB, VME or VXI.

Electronics Quality Assurance is provided by the metrology/calibration laboratory that serves as a standard reference traceable to NIST. The laboratory is designed to perform incoming inspection, periodic calibration and repairs of the electronic equipment used at the SSC.

F.7. Data Acquisition

Extensive capability and expertise are available in the area of data acquisition, readout and control. Numerous real-time multi-processor systems have been developed, based on VME and VXI. Large setups are normally controlled by UNIX workstations, while agile small scale readout systems are based on Macs or PCs running LabView. Expertise is available with real-time UNIX operating systems like VxWorks and Lynx.

Specialized evaluation and test equipment exists for network and for high bandwidth connection studies. Experience with measurement, control, readout and digital signal processing allows for the design of small or high bandwidth systems with throughputs of up to 40 GB/s.

A large pool of commercial modular NIM, CAMAC, GPIB, VME and VXI test and measurement equipment is available to tackle the most difficult control and readout problems.

Appendix G R&D Market Survey Results

PLEASE REFER TO ATTACHED DOCUMENT

Appendix H R&D Market Survey Information Requests

In responding to the R&D Market Survey, the following individuals expressed an interest in being contacted regarding future uses of the SSC assets:

- David Alexander, President, S-Tel Corporation, Mineral Wells, TX
- Ralph G. Beil, Marshall, TX
- Dr. Gregory A. Benesh, Associate Professor of Physics, Baylor University, Waco, TX
- P. R. Brooks, Chemistry Department, Rice University, Houston, TX
- John Gostroot, President, EGC Corporation, Houston, TX
- D. M. Dalton, Sr., President, Dalton Tool Inc., Austin, TX
- Albert L. Ford, Professor of Physics, Texas A&M University, College Station, TX
- Harold Garner, McDermott Center, University of Texas Southwest Medical Center, Dallas, TX
- Edwin C. Hodges, President, Q-Systems International, Inc., Arlington, TX
- G. W. Hoffmann, Professor of Physics, University of Texas at Austin, Austin, TX
- Michael Isichenko, Research Fellow, Fusion Research Center, University of Texas at Austin, Austin, TX
- Joe Loya, Academic Budget Officer, University of Texas at San Antonio, San Antonio, TX
- George Mallard, Linguistic Products, The Woodlands, TX
- Dr. William H. Marlow, Texas A&M University, College Station, TX
- Dr. Hans-Jocken Trost, Department of Physics, Texas A&M University, College Station, TX
- Larry Milligan, Director of Engineering, AVO International, Multi-Amp Division, Dallas, TX
- Dr. Chau Nguyen, SBC Consulting, Houston, TX
- Dr. B. Paul Padley, Rice University, Houston, TX
- Mark G. Raizen, Assistant Professor, Department of Physics, University of Texas at Austin, Austin, TX

- Dr. A.K. Ray, Professor of Physics, University of Texas at Arlington, Arlington, TX
- Herbert Ruek, Senior Member of Technical Staff, NEC America, Inc., Irving, TX
- Michael Schermer, President, Consulting Partners, Inc., Dallas, TX
- Charles F. Squire, Houston, TX
- Dr. James Stevenson, Concordia Lutheran College, Austin, TX
- Dr. Jon Hamilton, Concordia Lutheran College, Austin, TX
- P. C. Sundt, Metrix Instrument Co., Houston, TX
- Dr. John Taboado, President, Taboada Research Instruments, San Antonio, TX
- Dr. Richard Wigmans, Professor of Physics, Texas Tech University, Lubbock, TX
- B.H. Wildenthal, University of Texas at Dallas, Richardson, TX
- Liqiu Yang, Department of Chemistry, University of Houston, Houston, TX

Appendix I Electronics Equipment Anticipated to be Available

To provide electronics services the following equipment is requested to be available:

- SSC-SYS-S033: Electronics Test and Measurement System. Test and measurement equipment and specialized test personnel are often underutilized in academic groups and small businesses. This system allows provision of test services in a cost effective way, while optimizing the use of these SSC assets.
- SSC-SYS-S059: Low level RF (Global) Crate and Modules System. This equipment is well fit to serve as loan equipment.
- SSC-SYS-S067: Metrology/Calibration Laboratory. Only about one third of the equipment in this system is needed to provide a state of the art Metrology and Quality Assurance service to academic users and small businesses. This is another example of a capability that small groups can not afford to set up themselves. JTF can provide such services in a cost effective way while optimizing use of this SSC asset.
- SSC-SYS-S085: Test Beam Tracking R&D Equipment. This is a fully configured data acquisition, ideal for short term detector tests that are typically done by small academic groups.
- SSC-SYS-S097: Muon R&D Equipment. This system mainly consists of modular test and measurement equipment typically used in physics research.
- SSC-SYS-S111: Physics Department Electronics R&D Laboratory. This system provides full capability for electronics prototype production.
- UNIX software licensed to the SSC for Board and Chip design and simulation.

Current replacement value of this equipment is on the order $2M.

Appendix J Machine Shop Equipment Anticipated to be Available

Equipment requested to be transferred from the Central Facility to complete the machine shop capabilities at N15.

Item	Usage	Comments
ATLANTIC 1/2" SHEER	METAL CUTTING LARGE CAPACITY.	TO REPLACE THE BETEN 1/4" MACHINE NOW MDL.
ATLANTIC DIES	SPARE DIES FOR ATLANTIC PRESS	
ATLANTIC BRAKE	BRAKE FOR MATERIAL BENDING	
ROTEX PUNCH	METAL PUNCH	
ROTEX PUNCH	METAL PUNCH	
MILLER 350	WELDER	
MILLER 350	WELDER	
ULTRA AIR	FUME COLLECTOR	
ULTRA AIR	FUME COLLECTOR	
MILLER 451	MIG WELDING	MEDIUM DUTY MIG WELDER
THERMAL DYNAMICS CUTTER	PLASMA CUTTER	MEDIUM DUTY PLASMA CUTTER
KELLENBURGER GRINDER	GRINDER	ID-OD GRINDER
BRIDGEPORT	MILLING MACHINE	SERIES I MILLING MACHINE
BRIDGEPORT	MILLING MACHINE	SERIES I MILLING MACHINE
BRIDGEPORT	MILLING MACHINE	SERIES II VERTICAL MILLING MACHINE WITH CNC
	SANDBLASTER	GLASS BEAD SANDBLASTER
	TUBING CUTTER	
MAZAK	MILLING MACHINE	5-AXIS MAZAK MILL WITH CNC
ROBOFILL 6000	WIRE CUTTING	CNC WIRE CUTTER TO CUT METAL LAMINATIONS
MILLER 200	WELDER	PORTABLE WELDERS
MILLER 300	WELDER	PORTABLE WELDERS
	SPOT WELDER	
	ROD OVENS	TO REMOVE MOISTURE FROM WELDING RODS
	POSITIONER	USED FOR HOLDING WORK PIECES
LEBLOND 15"	LATHE	LATHE WITH LARGE CENTER HOLE CLEARANCE
STOCK	WIRE AND ROD STOCK	CONSUMABLE WELDING ROD AND WELDING WIRE STOCK
OPTICAL	OPTICAL COMPARATOR	FOR INSPECTION
ALCATEL	LEAK CHECKER	VACUUM LEAK CHECKING
ALCATEL	LEAK CHECKER	VACUUM LEAK CHECKING
CECOR	OIL CLEANER	

MAKINO	MILLING MACHINE CENTER	MILL FOR MAKING PROTOTYPE CORRECTOR COILS.

Appendix K R&D Infrastructure Workshop Agenda

TEXAS JOINT FACILITY PROJECT

R&D INFRASTRUCTURE SUPPORT WORKSHOP

Tuesday, August 30, 1994

Auditorium, SSC Central Facility

AGENDA

1:00 p.m.	WELCOME & REVIEW OF SSC SETTLEMENT PROCESS
	Dr. Peter Rosen, Dean of Science, UT Arlington
1:20 p.m.	OVERVIEW OF JOINT FACILITY STUDY (UTA/SMU)
	FYI on activities included in proposal
	•market research progress
	Dr. Vigdor Teplitz, Physics Dept. Head, SMU
1:30 p.m.	OPPORTUNITIES FOR COLLABORATION/OTHER STUDIES
	--Regional Medical Technology Ctr.
	Ben Prichard
	--Applied SuperConductivity & Cryogenics Ctr.
	G.T. Mulholland
	--Manufacturing Technology Deployment Ctr.
	Mike Huddleston, TEEX
	--Inland Regional Industrial Technology Ctr.
	Phil Gray, Waco TSTC
	--Southwest Ctr. for Computing, Information & Learning
	Dave Gurd, TNRLC
2:00 p.m.	TOUR OF FACILITIES

2:45 P.M.	BREAK	
3:00 p.m.	WORKSHOP BREAKOUT SESSIONS	

A• *Auditorium* — *Mike Lockerd, VP at TI*

How do we determine what ***specialized equipment and expertise*** (not available at home institutions) are necessary at such a common research facility?

B• *Lapostolle Room* — *Jheroen Dorenbosch, SSC*

What ***potential price levels*** would stimulate sustainable usage? How do other shared use facilities generate revenue?

C• *Meson Room* — *Jane Armstrong*

How do we assess the ***availability/demand for trained technicians*** to support R&D at universities? to support on-site technical programs? corporate R&D labs?

4:00 p.m.	SESSION REPORTS/FEEDBACK & DISCUSSION	*Auditorium*
4:30 p.m.	PRIORITIES & OPPORTUNITIES	*Auditorium*

evolution of action plan

Appendix L HARC-C: Image Compression Software

A breakthrough in Compression Performance and Quality

Non confidential Summary

L.1. The challenge

A new industry is emerging to provide Information-on Demand. This information consists of customized news, weather, sports, and entertainment programming, as well as educational, financial, medical and employment services, Information-on Demand requires the rapid search, sort, storage, transfer and display of information. The delivery of large amounts of time-critical information drives the continuing demand for automated digital processes and for compression software appropriate for image, text, sound and motion. This arena defines the Houston Advanced Research Center (HARC) Information Technologies Initiative.

L.2. The current situation

While text files can be compressed to a high level and yet comply with quality standards, picture files often suffer from such compression methods. A number of solutions to image compression are currently implemented with impressive results, but require a hardware implementation. The remarkable thing about HARC-C is that it matches or exceeds these impressive results -- but in software.

L.3. HARC-C Compression

HARC is enabling the "information highway" through its timely research in wavelet image compression -- a technique that permits very large compression ratios while maintaining excellent image quality standards. The new software have the effect of increasing picture traffic on the information highway.

The compressed images reduce the bandwidth requirements for interactive use of both still and motion pictures. The Houston Advanced Research Center is ready to release its new compression software under the name of HARC-C. Our digital future will be filled with pictures as well as with text because of HARC-C.

HARC-C Compression:

- exceeds JPEG and MPEG (II) standards in both performance and quality for both still and motion pictures.
- achieves a minimum ratio of 30:1 in still image without visible artifacts or visible loss.
- exceeds MPEG standards in video compression on an R3000 processor with 24 bit, real-time expansion at a rate of 30 frames per second (frame compression at 10:1).
- achieves 100:1 compression ratios for black and white (no gray scale) images with minimum loss.

Areas to benefit significantly from HARC-C software include

- image archives for cultural, educational, scientific, medical, financial and military applications
- image transmission, interactive communications, publishing and "on-demand" programming.
- image capture, scanning, duplication and synthetic image generation.

App. M PowerKids' Power OS

Power OS is the operating system developed to manage and control several learning CPUs. Power OS includes bar code log on technology, curriculum control and maintenance, systems networking, participant time and advancement monitoring.

Power OS was developed by and is the property of VerCom Systems, Inc. Designed to allow the use of off the shelf educational software as well as specially developed and integrated software, Power OS is the operations shell in which other programs will be allowed to run. This will allow teachers to control and monitor curriculums for each child on an individual basis regardless of the computer on which the child is working.

Power OS collects data on each session as a child uses the computer. This information includes how long the child was on the computer, the software used by the child, the time spent using each software, and the number of levels advanced in particular programs.

Power OS logon technology is based on bar code readers. Each student receives a bar code sticker which can be placed on a notebook, etc. When the child is ready to log on they will run a bar code reader over their bar code. Thus, the computer will recognize who is logging on and will bring up a personal information screen, containing a picture of the child, other personal information and a personal mail information box.

From this personal information screen, students are able to enter into the mail mode to send or read mail, or to enter their individualized curriculum/software availability screen. The curriculum screen indicates what levels the student has completed in each software program available, as well as what new areas or software are available to the child. From the curriculum screen each student is able to self direct his/her personal area of study during a session.

App. N Letter of Support from Globe Project

See attached document

DISCLAIMER