LEGISLATIVE RESEARCH COMMISSION

COLLEGE SCIENCE EQUIPMENT

REPORT TO THE 1983 GENERAL ASSEMBLY OF NORTH CAROLINA

LEGISLATIVE RESEARCH COMMISSION

COLLEGE SCIENCE EQUIPMENT

REPORT TO THE 1983 GENERAL ASSEMBLY OF NORTH CAROLINA

A LIMITED NUMBER OF COPIES OF THIS REPORT IS AVAILABLE FOR DISTRIBUTION THROUGH THE LEGISLATIVE LIBRARY.

ROOM 2126, 2226
STATE LEGISLATIVE BUILDING
RALEIGH, NC 27611
TELEPHONE: (919) 733-7778

OR

ROOM 500
LEGISLATIVE OFFICE BUILDING
RALEIGH, NC 27611
TELEPHONE: (919) 733-9390

TABLE OF CONTENTS

	Page
Letter of Transmittal	III
Preface	1
Background	3
Committee Proceedings	7
Findings and Recommendations	10
1. A joint resolution requesting the College Science Equipment Study be continued.	12

APPENDICES

A.	Legislative Research Commission Membership List	A-1
	Committee Membership List	A-2
B.	Authorizing Legislation	
	Resolution 61	B-1
	House Joint Resolution 1314	B-6
C.	Persons Appearing Before the Committee	C-1
D.	Presentations made to the Committee	D-1
E.	Board of Science and Technology's Background	E-1
F.	Board of Science and Technology's Report	F-1

STATE OF NORTH CAROLINA

LEGISLATIVE RESEARCH COMMISSION

STATE LEGISLATIVE BUILDING

RALEIGH 27611

December 15, 1982

TO THE MEMBERS OF THE 1983 GENERAL ASSEMBLY:

The report of the Legislative Research Commission's Committee on College Science Equipment made pursuant to Resolution 61 of the 1981 Session is attached.

The Legislative Research Commission adopts, approves and recommends to the 1983 Regular Session of the General Assembly the recommendations and Resolutions contained in this report.

Respectfully submitted,

Liston B. Ramsey

Liston B. Ramsey

W. Craig Lawing

W. Craig Lawing

Cochairmen

PREFACE

The Legislative Research Commission, authorized by Article 6B of Chapter 120 of the General Statutes, is a general purpose study group. The Commission is cochaired by the Speaker of the House and the President Pro Tempore of the Senate and has ten additional members, five appointed from each house of the General Assembly. Among the Commission's duties is that of making or causing to be made, upon the direction of the General Assembly, such studies of and investigation into governmental agencies and institutions and matters of public policy as will aid the General Assembly in performing its duties in the most effective manner" (G.S. 120-30.17(1).)

At the direction of the 1981 General Assembly, the Legislative Research Commission has undertaken studies of numerous subjects. These studies were grouped into broad categories, and each member of the Commission was given responsibility for one category of study. The Cochairmen of the Legislative Research Commission, under the authority of General Statutes 120-30.10(b) and (c), appointed committees consisting of members of the General Assembly and the public to conduct the studies. Cochairmen, one from each house of the General Assembly, were designated for each committee.

The study of College Science Equipment in North Carolina was authorized by Resolution 61 of the 1981 Session Laws.

The Legislative Research Commission grouped this study in its education area under the direction of Representative Lura Tally. The Cochairmen of the study committee established by the Research Commission are Senator William D. Mills and Representative Jeff H. Enloe, Jr. A membership list of the Legislative Research Commission and a membership list of the Study Committee may be found in Appendix A of this report. Resolution 61 authorizing the study and House Joint Resolution 1314 which the committee was authorized to consider in determining the scope of the study are attached as Appendix B.

Resolution 61 states that the Research Commission may, for any study topic listed in the resolution, make an interim report to the 1982 Session of the 1981 General Assembly or a final report to the 1983 General Assembly, or both. The Research Commission did not make an interim report on the College Science Equipment of this State to the 1982 Session of the 1981 General Assembly. This report, therefore, contains all the recommendations concerning College Science Equipment made by the Research Commission.

BACKGROUND TO COMMITTEE STUDY

The Committee is grateful to the Board of Science and Technology for supplying the paper that has been extrapolated for this background study (Appendix E). More than any other field of academic endeavor, the vitality of training and research programs in science and technology depends on the quality of the tools, the equipment and instrumentation, that programs can offer. Technical training revolves around the mastery of a specialized set of tools or equipment. The undergraduate participates in the process of scientific inquiry through hands-on experience with scientific instrumentation in the laboratory. Engineering graduates must be familiar with the sophisticated equipment of their discipline or they will fall far short of employers' expectations. In the research laboratory, access to advanced scientific instrumentation often determines whether the university can operate on the cutting edge of scientific advance.

Yet there is mounting evidence that the quality of instrumentation in U. S. institutions of higher education is deteriorating. Most of the studies come from premier research universities; if the problems are severe there, how much more serious they must be at the two- and four-year level, where federal research grant monies are not available to help foot the bill! When it begins to impede the teaching and research missions of colleges, community colleges, and universities, outmoded equipment can begin to have harmful effects on economic productivity and growth.

The View From the National Level

The problem of inadequate and obsolete scientific equipment is now so widespread and well-recognized that a National Academy of Sciences panel meeting on the subject this spring began its deliberations by agreeing not to waste any of its time further

proving the problem's existence. Earlier in the year, the Deputy Director of the National Science Foundation, in Congressional testimony, had placed the cost of revitalizing laboratories in research universities only at between $1 billion and $4 billion. Some other pieces of evidence include:

- A 1979 Department of Health, Education, and Welfare survey of nine universities, which concluded that there was an unmet need for instruments and facilities of $225 million in those institutions alone.

- A National Science Foundation study which projects a catch-up need of $420 million, over the next five years, in the physical sciences alone.

- An independent university study that suggests that American universities are less well-equipped than their foreign counterparts.

- An Association of American Universities (AAU) study comparing laboratories in sixteen universities to two leading commercial laboratories, which found that the median age of university equipment was twice that of the commercial laboratories instrumentation.

- A study of research instrumentation needs which revealed that in five important scientific disciplines the costs of scientific instruments priced above $5000 rose at an average annual rate of 20 percent between 1970 and 1978.

In sum, then, the situation is serious now and is likely to get worse as researchers attempt to replace old equipment with

newer models at today's inflated prices.

The various studies cite numerous reasons for the decline in instrumentation, including restrictive Federal research grant policies, insufficient Federal research support, and rising costs due to the increasing sophisitication of research equipment. Some reports have also questioned whether universities have directed funds toward maintaining research staffs at the expense of purchasing and maintaining equipment. The studies also note numerous corollary costs in addition to the initial basic cost of equipment, including operation and maintenance costs (estimated at 7-8 percent of the new cost per year), instrument repairs (with service calls now running at $85-$100 per hour), support equipment needed to test or calibrate the equipment, and appropriate facilities to house new equipment.

Federal agencies are likely to remain the major source of support for research instrumentation for the foreseeable future. They financed two-thirds of all research equipment purchases in 1980, and several federal programs have been mounted specifically to address the equipment problem at the federal level. Perhaps the most widely touted was the tax break for corporations donating certain types of equipment to universities which was part of the 1981 Reagan tax package. Many observers, however, seem skeptical that the tax measure will have much impact -- congressional estimates put the total savings to industry resulting from the provision at less than $5 million annually. The NSF plans to increase support for major equipment within its existing research grant programs to 95.3 million in FY83. (Major requests for research and instructional equipment programs were stricken from the NSF's budgets by two successive administrations in FY80 and FY81.) The Foundation is also continuing a small ($2 million) program to support the acquisition of research equipment at two- and four-year colleges. The Department of Defense has recently announced a $30 million

initiative to build up the university research equipment base for disciplines related to its research programs. Nevertheless, these programs, even taken together, are but a drop in the bucket compared to the overall need, and none of them includes any funding for instructional equipment. Furthermore, substantial additional Federal support, in this era of budgetary belt-tightening, is unlikely.

North Carolina Activities

North Carolina's policymakers have also become concerned about the equipment problem in recent years. Three years ago, the Department of Community Colleges conducted a campus-by-campus analysis of training equipment currently in use. That study led to the system's request to the General Assembly for $33 million to repair and replace obsolete equipment. The General Assembly subsequently allocated $5 million of that amount, leaving a need of approximately $28 million (non-inflated dollars) still be met. Corraborating the DCC's analysis is a depreciation schedule for state-owned equipment recently developed by the Department of Administration which shows that the major pieces of equipment in the Community College system are worth only a third of their cost; i.e., that the equipment is old and outdated. Finally, in two major studies conducted by the DCC in 1981, vocational and technical graduates and their employers cited the lack of up-to-date training equipment as a serious handicap to the system's ability to train. The latter is perhaps the most serious charge of all, because of its direct impact on the state's capacity for economic growth. The Community College system has identified equipment as its number one priority in this year's budget, and is requesting $30 million from the General Assembly to alleviate the problem.

The UNC system has also been concerned with the problem of scientific instrumentation. In FY79-80, the General Assembly made a special allocation for research and instructional equipment

for the sciences and engineering to four UNC institutions, distributed as follows: North Carolina State University - $750,000; North Carolina A&T - $300,000; UNC-Chapel Hill - $500,000; and UNC-Charlotte - $300,000. The language of the legislation recognized the special responsibility of those four institutions for scientific and technological education and research in the biological and physical sciences and engineering. The legislation cited as special concerns the shortage of engineers, the rate of technological change and its effect on equipment obsolescence, and inflationary impacts on equipment costs. Because these allocations were built into the institutions' base budgets, the institutions received the same allocation again in 1980-81. In FY81-82, additional allocations of the same amounts were made to the same institutions, and again became part of the base budgets for 1982-83.

This year, the UNC system is requesting $4,049,022 in expansion money to remedy deficiencies in engineering and some related sciences. This would be a general allocation to improve research and teaching in engineering and the sciences, but some portion of it would certainly be budgeted for equipment.

Scientific equipment has also been a longstanding interest of the Board of Science and Technology. In 1979 and 1980, the Board provided $350,000-400,000 for the purchase of scientific and engineering equipment in North Carolina's colleges and universities. The grantees obtained 3-5 times that amount in matching funds from other sources, thereby leveraging a relatively small state investment into almost $2 million for equipment purchases.

In 1980, the Board undertook an initial study of scientific equipment in two science and engineering departments at each of ten North Carolina colleges and universities (a total of 20 departments). The study was published in August, 1981. Amont the Board's findings were the following:

- With few exceptions, the departments have problems in purchasing and maintaining the equipment necessary to conduct their training programs

- To meet the five highest-priority equipment needs of the 20 departments would require a total of $4-5 million, excluding maintenance costs. The costs of obtaining and maintaining such equipment are likely to increase at a rate greater than the general level of inflation.

- New mechanisms for the purchase, maintenance, and use of equipment will be necessary to meet future equipment needs. Substantial new infusions of Federal funds are unlikely.

During the 1981 session, the General Assembly called upon the Legislative Research Commission to study the scientific and technical equipment needs of the state's institutions of higher education, articulating its belief that "it is in the interest of the citizens and the state of North Carolina that our institutions of higher education offer a level of scientific training sufficient to assure that North Carolinians will be able to assume jobs in work settings that require high levels of skill." (H.J.R. 1314, 1981 General Assembly)

COMMITTEE PROCEEDINGS

The Committee on College Science Equipment met three times, on December 10, 1981, June 2, 1982, and November 16, 1982. The Committee heard from Dr. Larry Blake, President of the Community College System, Dr. E. Walton Jones, Vice President for Research and Public Service Programs, General Administration, the University of North Carolina, and from John Henley, a committee member, President of the Association of Private and Independent Colleges, and from many others. (See Appendix C for list of witnesses)

All the speakers testified to the crying need for better, more up-to-date scientific and technical equipment, and for better maintenance programs. Jack Talmadge, Executive Director of the Inter-Agency Working Group on University Research Instrumentation, spoke to the problem on the national level, and to what the National Science Foundation, the Defense Department and the Congress were trying to do about this problem. Even in a year of disappearing finances, most leaders recognized that nationally the equipment shortage is really a potential national defense problem as well as a national industrial one. (See Appendix D)

A number of creative ways to handle the equipment problem were raised such as industry donation, university-industry equipment sharing, others sharing, equipment management systems and creative financing. (Appendix D,E,) State corporate tax incentives for sharing and donating are probably insufficient as the sole incentive pattern.

The committee also received testimony that an essential preliminary to any creative discussion of solutions to the problems of eliminating obsolete, inferior equipment and replacing it with equipment suitable for training the technicians and researchers had to be an inventory of what equipment all the institutions of higher education had, be they constituent institutions of the University of North Carolina, Community Colleges or technical schools, or private and independent colleges and universities.

The committee requested staff counsel to meet with representatives from the University of North Carolina, the community college system, the private colleges and universities and the Board of Science and Technology to generate a methodology sufficient to result in a proper, meaningful inventory, one that would designate not only the kind of equipment, what department and what institution was using it, but what the purchase date was. Staff was also requested to develop a questionnaire on what each pertinent department of each institution considered its highest priority needs.

As the methodology developed, and became increasingly sophisticated, it became evident that a central processing agency was essential to process the vast and various incoming data into a meaningful document. The committee agreed and recommended that the Board of Science and Technology be appointed as that agency and that the Legislative Research Commission allocate $10,000 to the Board to pay for computer program time and staff input time. The Legislative Research Commission made that allocation.

At the committee's last meeting, the Board of Science and Technology presented its methodology (Appendix E) and its reporting schedule. The full, multi-volume inventory document, needs analysis and policy statement is to be presented to staff on December 10 for transmittal to the December 15th meeting of the Legislative Research Commission. (See Appendix F ; Legislative Library.)

The committee approved the Board's work wholeheartedly and with great thanks. It expressed its desire to continue working with the Board, if the committee is continued, and especially with the Board's committee on Research and Higher Education.

The committee ended its study by unanimously making the recommendation that the study be continued, and that the resolution defining the study address certain specific issues such as the feasibility of basing the inventory data in the Division of Purchase and Contract of the Department of Administration, to

permit the Division to function as a sophisticated center for sharing requests as well as a central information bank on what is available and where. Other specific areas of study are to include the feasibility of establishing an information link between industry and a central inventory agency. The continued committee will need to watch developing federal law and incentive programs, in order to be able to consider adopting suitable ideas into North Carolina law. The continued committee will also continue to monitor the inventory, to refine it even further so that it will eventually be able to generate cost replacement data.

The committee acknowledged that, with the completion of the massive inventory and needs analysis, it had still only laid the groundwork for a study of how to solve the equipment problems which generated its study, but that this groundwork was indeed well laid. Many people had testified that the inventory project was impossible of completion; all testified to its essentiality. The committee adjourned, satisfied with its work so far, but aware that its work really was just begun.

FINDINGS AND RECOMMENDATIONS

Finding 1. The committee found that scientific and technical training and research equipment being used by the University of North Carolina, the Community Colleges and technical school systems and the private and independent colleges and universities is far too often obsolete, is far too often makeshift, is far too often generally inadequate, to guarantee that scientific and technical students are being trained sufficiently to compete in an increasingly sophisticated scientific and technical work market. The committee further found that this equipment deficiency is a major problem not only in North Carolina but also throughout the nation and that the ability of the nation to compete in the world's market and to maintain its ability to defend itself against foreign aggression is detrimentally affected.

Finding 2. The committee found that creative methods of financing equipment needs, such as sharing and industry-university donating, needed to be examined but that no such study could be fruitful until data were available on what equipment all departments of all institutions had and how old it was, and on what each department needed most. The committee requested staff to develop such an inventory and needs analysis and appointed the Board of Science and Technology to be its processing agent. (See Recommendation 1.)

Finding 3. The committee, having completed its inventory and needs analysis, found that it was now ready to begin a satisfactory and well-founded study of how to solve the problem of equipment deficiency, and found that its study must be continued into the next interim. No other state, it found, had got as far as North Carolina has in generating an inventory of all pertinent equipment on hand. No other state, therefore, can pursue as satisfactory a creative financing study as can North Carolina. (See Recommendation 2.)

Recommendation 1. The committee recommends that the Legislative Research Commission receive the inventory, needs analysis and policy document generated from data requested of all pertinent departments of all institutions of higher education of North Carolina and processed by the Board of Science and Technology. The committee further recommends that the Board of Science and Technology be commended for its work as processing agent and that the University of North Carolina, the Community Colleges and technical schools and the private and independent colleges and universities be thanked for the great cooperation they gave the committee in its inventory work.

Recommendation 2. The committee recommends that the Legislative Research Commission continue its study of College Science Equipment and that the study be specifically directed to the issues of creative financing methods of making up the real deficiencies, including the feasibility of setting up a central agency to manipulate the inventory data, and continuing to refine it, in order to act as a central information center as well as a central screening agent for budget, sharing and donating requests, and the feasibility of establishing an industry-higher education equipment information and facilitation link. The study must also carefully track what the federal government is doing to eliminate equipment deficiency and what other states that are attempting to address the problem in a systematic way, such as Iowa, are doing , and should also continue to work with all the institutions of higher education and with the Board of Science and Technology in particular with its committee on Research and Higher Education. It is essential that this study be continued. The data now exists to ensure that this study is truly meaningful. (See Resolution 1.)

A JOINT RESOLUTION REQUESTING THAT THE LEGISLATIVE RESEARCH COMMISSION CONTINUE ITS STUDY OF COLLEGE SCIENCE EQUIPMENT.

Whereas, the 1981 Legislative Research Commission Study Committee on College Science Equipment, chaired by Senator William D. Mills and Representative Jeff H. Enloe, Jr., has completed the first phase of its study of college science equipment, the production of a comprehensive inventory and needs analysis of significant scientific, technical and research equipment of all the departments of all the institutions of higher education in the State, whether they be of the University of North Carolina, the Community Colleges and technical schools or the private and independent colleges and universitites; and

Whereas, the Committee found that the problem of deficient scientific and technical equipment in institutions of higher education was one of the greatest problems facing higher education, and, potentially, facing the nation's economy and security; and

Whereas, the Committee now possesses the refined and processed data necessary to provide a proper and sound base for a study of ways to solve the massive problem of deficient scientific and technical research and training equipment in this State's institutions of higher education; and

Whereas, the Committee has, in generating the inventory and needs analysis, with the commendable help of the Board of Science and Technology, its inventory and needs analysis processing agent, of the University of North Carolina, of the Community Colleges and technical schools, of the private and indpenedent colleges and universities, and of other state and national groups, such as the National Science Foundation, developed the expertise to proceed in phase two of the study;

Now, therefore, be it resolved by the House of Representatives, the Senate concurring:

Section 1. The Legislative Research Commission may continue its study of College Science Equipment. The Committee making this study may make an interim report to the 1983 General Assembly, Second Session, 1984, and may make a final report to the 1985 General Assembly.

This study shall be based on the data generated from the inventory and needs analysis produced by the 1981 Legislative Research Commission Study Committee on College Science Equipment and processed by the Board of Science and Technology, with the vital cooperation of the University of North Carolina, the Community Colleges and technical schools and the private and independent colleges and universities.

This study shall be specifically directed to the issues of creative financing methods of making up the known equipment deficiencies, including:

(1) The feasibility of setting up a central agency to manipulate the inventory and needs analysis data, in order to act as a central information center as well as a central screening agent for budget, sharing and donating requests;

(2) The feasibility of establishing an industry-higher education equipment information and facilitation link;

(3) The tracking of national and other state efforts to eliminate equipment deficiencies, especially with regards to creative tax and other incentives to donate or share equipment; and

(4) The continuance of cooperation with all the institutions of higher education in the State, and with the Board of Science and Technology, in particular with its Committee on Research and Higher Education.

Sec. 2. Copies of this resolution shall be sent to Quentin Lindsey, Executive Director of the Board of Science and Technology, to William Friday, President of the University of

North Carolina, to Larry Blake, President of the Department of Community Colleges, and to John Henley, President of the North Carolina Association of Private and Independent Colleges and Universities.

Sec. 3. This resolution is effective upon ratification.

APPENDIX A

STATE OF NORTH CAROLINA
LEGISLATIVE RESEARCH COMMISSION
STATE LEGISLATIVE BUILDING
RALEIGH 27611

MEMBERSHIP

1981-1983

House Speaker Liston B. Ramsey	Senate President Pro Tempore
Cochairman	W. Craig Lawing, Cochairman
Representative Chris S. Barker, Jr.	Senator Henson P. Barnes
Representative John T. Church	Senator Carolyn Mathis
Representative Gordon H. Greenwood	Senator William D. Mills
Representative John J. Hunt	Senator Russell Walker
Representative Lura S. Tally	Senator Robert W. Wynne

LEGISLATIVE RESEARCH COMMISSION'S COMMITTEE ON
COLLEGE SCIENTIFIC AND TECHNICAL TRAINING EQUIPMENT

	TELEPHONE NUMBERS
Senator William D Mills, Cochairman 406 W. Corbett Ave., Box 1238 Swansboro, N. C. 28584	919-326-2177
Senator Cary D. Allred Box 2303 Burlington, N. C. 27215	919-226-1091
The Honorable John T. Henley 216 Lakeshore Drive Hope Mills, N. C. 28348	919-832-5817
Mr. Claude Hunter Route 10, Back Creek Road Charlotte, N. C. 28213	704-596-2859
Rep. Jeff H. Enloe, Jr., Cochairman Route 1, Box 28 Franklin, N. C. 28734	704-524-2632
Rep. Roger W. Bone 3620 Manfield Drive Rocky Mount, N. C. 27801	919-446-1141
Rep. George W. Brannan 309 Maplewood Drive Smithfield, N. C. 27577	919-934-8877
Rep. G. Malcolm Fulcher, Jr. Box 538 Atlantic Beach, N. C. 28512	919-726-7854
Rep. Lura Tally (LRC Member) 3100 Tallywood Drive Fayetteville, N. C. 28303	919-484-4868

APPENDIX B

RATIFIED BILL

RESOLUTION 61

HOUSE JOINT RESOLUTION 1292

A JOINT RESOLUTION AUTHORIZING STUDIES BY THE LEGISLATIVE RESEARCH COMMISSION.

Be it resolved by the House of Representatives, the Senate concurring:

Section 1. The Legislative Research Commission may study the topics listed below. Listed with each topic is the 1981 bill or resolution that originally proposed the study and the name of the sponsor. The Commission may consider the original bill or resolution in determining the nature, scope and aspects of the study. The topics are:

(1) Continuation of study of revenue laws (H.J.R. 15 -- Lilley).

(2) Continuation of study on problems of aging (H.J.R. 48 -- Messer/S.J.R. 37 -- Gray).

(3) Day care (H.J.R. 223 -- Brennan).

(4) Civil rights compliance of non-State institutions receiving State funds (H.J.R. 344 -- Spaulding).

(5) Social services and public assistance (H.B. 393 -- P. Hunt).

(6) The need for new health occupational licensing boards (H.B. 477 -- Lancaster/S.B. 285 -- Jenkins).

(7) Matters related to public education, including:

a. The feasibility of making the 12th grade optional in the public schools (H.J.R. 890 -- Tally).

b. Continue study of public school food service (H.J.R. 948 -- Brennan).

c. The teacher tenure law (S.J.R. 621 -- Royall).

d. Providing teachers with duty-free periods (S.J.R. 697 -- Speed).

e. Continuation of study regarding purchase of buses in lieu of contract transportation, and other school bus transportation matters (no 1981 resolution).

(8) Campaign financing and reporting (H.J.R. 975 -- D. Clark).

(9) State's interests in railroad companies and railroad operations (H.B. 1069 -- J. Hunt).

(10) Matters related to insurance, including:

a. Insurance regulation (H.B. 1071 as amended -- Seymour), including the feasibility of establishing within the Department of Insurance a risk and rate equity board.

b. How the State should cover risks of liability for personal injury and property damage (H.J.R. 1198 -- Seymour).

c. Credit insurance (H.J.R. 1328 -- Barnes).

(11) Matters related to public property, including:

a. Development of a policy on State office building construction (H.J.R. 1090 -- Nye).

b. The potential uses and benefits of arbitration to resolve disputes under State construction and procurement contracts (H.J.R. 1292 -- Adams).

c. The bonding requirements on small contractors bidding on governmental projects (H.J.R. 1301 -- Nye).

d. Continue study of the design, construction and inspection of public facilities (S.J.R. 143 -- Clarke).

e. Whether the leasing of State land should be by competitive bidding (S.J.R. 178 -- Swain).

(12) Allocation formula for State funding of public library systems (H.J.R. 1166 -- Burnley).

(13) Economic, social and legal problems and needs of women (H.R. 1238 -- Adams).

(14) Beverage container regulation (H.J.R. 1298 -- Diamont).

(15) Scientific and technical training equipment needs in institutions of higher education (H.J.R. 1314 -- Fulcher).

(16) Role of the State with respect to migrant farmworkers (H.J.R. 1315 -- Fulcher).

(17) Existing State and local programs for the inspection of milk and milk products (H.J.R. 1353 -- James).

(18) Laws authorizing towing, removing or storage of motor vehicles (H.J.R. 1360 -- Lancaster).

(19) Annexation laws (S.J.R. 4 -- Lawing).

(20) Laws concerning obscenity (House Committee Substitute for S.B. 295).

(21) The feasibility of consolidating the State computer systems (S.J.R. 349 -- Alford/H.J.R. 524 -- Plyler).

(22) Laws pertaining to the taxation of alcoholic beverages and the designation of revenues for alcoholism

education, rehabilitation and research (S.J.R. 497 -- Gray).

(23) Regional offices operated by State agencies (S.J.R. 519 -- Noble).

(24) Continue study of laws of evidence (S.J.R. 698 -- Barnes).

(25) Continue study of ownership of land in North Carolina by aliens and alien corporations (S.J.R. 714 -- White).

(26) Rules and regulations pertaining to the Coastal Area Management Act (S.J.R. 724 -- Daniels).

(27) Transfer of Forestry and Soil and Water from Department of Natural Resources and Community Development to Department of Agriculture (H.B. 1237 -- Taylor).

(28) Continue sports arena study (H.J.R. 1334 -- Barbee).

(29) State investment and maximum earning productivity of all public funds (H.J.R. 1375 -- Beard).

Sec. 2. For each of the topics the Legislative Research Commission decides to study, the Commission may report its findings, together with any recommended legislation, to the 1982 Session of the General Assembly or to the 1983 General Assembly, or the Commission may make an interim report to the 1982 Session and a final report to the 1983 General Assembly.

Sec. 3. The Legislative Research Commission or any study committee thereof, in the discharge of its study of insurance regulation under Section 1(10)a. of this act, may secure information and data under the provisions of G.S. 120-19. The powers contained in the provisions of G.S. 120-19.1 through

G.S. 120-19.4 shall apply to the proceedings of the Commission or any study committee thereof in the discharge of said study. The Commission or any study committee thereof, while in the discharge of said study, is authorized to hold executive sessions in accordance with G.S. 143-318.11(b) as though it were a committee of the General Assembly.

Sec. 4. This resolution is effective upon ratification.

In the General Assembly read three times and ratified, this the 10th day of July, 1981.

JAMES C. GREEN

James C. Green

President of the Senate

LISTON B. RAMSEY

Liston B. Ramsey

Speaker of the House of Representatives

GENERAL ASSEMBLY OF NORTH CAROLINA
SESSION 1981

H

I

HOUSE JOINT RESOLUTION 1314

Sponsors: Representative Fulcher.

Referred to: Appropriations.

June 25, 1981

A JOINT RESOLUTION AUTHORIZING THE LEGISLATIVE RESEARCH COMMISSION TO STUDY SCIENTIFIC AND TECHNICAL TRAINING EQUIPMENT NEEDS IN NORTH CAROLINA INSTITUTIONS OF HIGHER EDUCATION.

Whereas, it is in the interest of the citizens and the State of North Carolina that our institutions of higher education offer a level of technical and scientific training sufficient to assure that North Carolinians will be able to assume jobs in work settings that require high levels of skill; and

Whereas, the training of a skilled work force will enhance the ability of the State to attract scientific and industrial development that can contribute to the economic well-being of the citizens of the State; and

Whereas, the lack of opportunities for sufficient training will condemn the citizens of North Carolina to jobs offering little chance for advancement; and

Whereas, the lack of a properly trained work force within the State will require scientific and industrial concerns choosing to locate in North Carolina to hire skilled personnel from outside the State; and

Whereas, the growing cost to institutions of higher learning to purchase and service up-to-date scientific and technical equipment necessary for the adequate training of North Carolina citizens has become a burden greater than these institutions can bear under the present systems for purchase and maintenance of equipment; and

Whereas, the lack of up-to-date, properly serviced training equipment may result in a lowering of the quality of education for the citizens of the State with a subsequent lowering of their ability to compete in the job market with persons from outside the State;

Now, therefore, be it resolved by the House of Representatives, the Senate concurring:

Section 1. The Legislative Research Commission shall determine what scientific and technical training equipment is needed by North Carolina institutions of higher education in order to train citizens of North Carolina to assume jobs in work settings that require high levels of skill.

Sec. 2. The Commission shall determine the present cost and estimate future costs for purchase and service of needed scientific and technical training equipment by North Carolina institutions of higher education.

Sec. 3. The Commission shall review present levels and methods for funding the purchase and service of scientific and technical training equipment by North Carolina community colleges, colleges, and universities.

Sec. 4. The Commission shall examine new approaches to

the purchase and maintenance of highly costly scientific and technical training equipment to determine which of these approaches, if any, might serve the needs of the State more efficiently than do the present approaches.

Sec. 5. The Commission shall determine the feasibility of cooperative efforts among the State and federal governments, institutions of higher education, and private industry to meet future training equipment needs in North Carolina.

Sec. 6. The Commission may call upon any State department or agency to provide the Commission with information pertinent to its inquiry. In addition, the Commission may invite representatives of private industry as well as university, college, and community college personnel to offer pertinent testimony.

Sec. 7. The Commission shall file a report with the Governor and the General Assembly no later than May 1, 1982. The report shall set forth the Study Commission's findings, conclusions, recommendations, and proposed legislation, if recommended.

Sec. 8. The Legislative Services Commission shall provide professional and other staff assistance upon the request of the Commission.

Sec. 9. This resolution shall become effective July 1, 1981.

APPENDIX C

LRC - College Scientific & Technical Training Equipment - December 10, 1981
Name of Committee Date

VISITORS: Please sign below and return to secretary.

NAME	FIRM OR STATE AGENCY AND ADDRESS
Paul C Dain	Tech College of Alamance, Haw River
Colin Pitt	Board Science & Technology
Mike Walker	" "
Don Phillips	Board of Science & Technology
Sherry Johnson	The News & Observer
Ralph Millwee	UNC Bd of Govs.
Dan Bishop	State Budget Office
Kaye Barker	Dept. Comm. Colleges
Larry Burke	" " "
Henry E. Smith	N.C. State Univ.
Walter Jones	UNC-CH

Attachment I

College Science
Name of Committee

June 2, 1982
Date

VISITORS: Please sign below and return to secretary.

NAME	FIRM OR STATE AGENCY AND ADDRESS
Doug Carter	Fiscal Res. Div.
Charles L. Lineberger	The University of North Carolina Chapel Hill
Eugene Hunter	NC Dept of Community Colleges, Raleigh
Walter Jones	UNC-GA
H. Gilbert Wilson	Office of State Budget
Quentin W. Lindsey	Governor's Office
[illegible]	[illegible]
[illegible]	Ed Sci + Tech.
Bill H. Higgins	Bd Sci + Tech.
[illegible]	Board of Science + Technology

College Science — November 16, 1982
Name of Committee — Date

VISITORS: Please sign below and return to secretary.

NAME	FIRM OR STATE AGENCY AND ADDRESS
R. E. Grissom Jr	Board of Science and Tech
Don Phillips	" " " " "
[illegible]	" " " " "
Paul C'Connor	Press
Eugene Hueston	Dept. of Community Colleges
Charles L. Wheeler	University of North Carolina, Gen Adm

APPENDIX D

Presentation to Legislative Research Committee
Study Committee of College Science Equipment
N.C. COMMUNITY COLLEGE SYSTEM
December 10, 1981

Members of the Committee, Ladies and Gentlemen,

Please accept my appreciation and that of the State Board of Community Colleges for allowing us to present to you our concerns about the status of equipment for science and technology training in North Carolina community and technical colleges.

In accepting responsibilities for the governance of the North Carolina community college system last January, the new State Board of Community Colleges reaffirmed its commitment to the basic mission and purpose of the system as described in the General Statutes (115D) and the policies of the former governing Board, the State Board of Education. These goals require the system to be a comprehensive, community-based, adult education system for the citizens of the state, offering vocational, technical, adult basic, general education, college transfer, and general interest programs. The strong emphasis is upon vocational, technical, and basic education programs.

This emphasis has been shown in the past by the enrollment patterns of the system. Currently, 73 percent of the FTE of the system is in technical and vocational education; 7 percent, in adult literacy programs; 7 percent, in college transfer; and the remaining portion, representing the other programs of the system. In looking to maintain and improve upon the appropriate role of community and technical colleges, the new State Board immediately recognized that the highest funding priority should be that of addressing the serious shortcomings of equipment for training and educational programs of the system.

The Board recognized that the continued quality of the training programs would be totally dependent upon overcoming problems of obsolescence of equipment, shortages of equipment, and shortages of types of equipment currently in use in industry where rapid changes in technology create obsolescence in shorter periods of time.

The State Board has reviewed past practices in funding for equipment, allocating equipment budgets, and maintaining title of equipment and has found them to be appropriate in procedures but not nearly adequate in appropriations. Currently, equipment needs of the system are determined by the State Board through entitlement formula and needs assessment. Funds are then requested from the General Assembly through the general fund, and allocations are made to the individual institutions on the basis of entitlement and demonstrated need. The title to equipment remains with the State Board of Community Colleges.

Recognizing that employment-related training equipment needs were a top priority, the State Board of Education in 1980 directed that a carefully documented study of need be undertaken by the Department of Community Colleges. In this study, verification of need was certified by local business and industry leaders serving on advisory committees as well as on responsible local governing boards. This resulted in a verified reliable estimate that $33.7 million would be necessary just to bring to an adequate level the equipment required for existing programs--not to add new programs--just to adequately equip those already in existence. It was interesting to note that this figure coincided closely with that determined by the State Board's existing entitlement formula which showed a shortfall of equipment funding in the amount of $35.0 million.

Both the State Board of Education and, subsequently, the State Board of Community Colleges endorsed this request and forwarded it to the Governor and the Advisory Budget Commission. During the short session of the General Assembly in June, 1980, $0.5 million was appropriated toward this request reducing the required amount to $33.2 million. An additional $5.0 million was recommended by the Advisory Budget Commission in November, 1980, and was subsequently approved by the 1981 General Assembly. (A continuation equipment allocation of $7.6 million was also granted.) Therefore, with only $5.0 million new money received for equipment in 1981, there exists a current requirement of $28.2 million (non-inflated dollars) still to be satisfied.

Although the Board, the Department, and the system had hoped the full amount would be allocated during the 1981-83 biennium, it is now the opinion of the State Board that if this total amount, adjusted for inflation, is not allocated within the two biennium period of 1981-83 and 1983-85, the quality of the training programs offered by the community and technical colleges in North Carolina will be seriously damaged to the point that critically needed training programs will have to be discontinued because of antiquated equipment or lack of equipment.

The preceding information is of no surprise to you, I am certain, inasmuch as you have heard it from the State Board, the Department, representatives of business and industry, and your local trustees and administrators for some time. It has been included in this presentation to insure a proper perspective of the total need for scientific and technical equipment in higher education in the state.

In addition to the critical need of training equipment, it is known that there are shortcomings in the adequacy, condition, and quantity of science equipment in our institutions. The shortage is in courses offered in related instruction for vocational and technical programs as well as in the

...ntation to LRC Study Commission
...of College Science Equipment
...
...ember 10, 1981

...lege transfer science programs. This would include equipment for ...istry, biology, and physics laboratories in the 58 community and ...hnical colleges and, in particular, in the 23 community colleges.

To our knowledge, a specific survey of the equipment needs for this area not been undertaken. Therefore, we would strongly recommend that such a ...vey be undertaken before your Committee completes its evaluations in ...er to complete a total picture of the requirements for science and tech... ...ogy equipment in higher education in the state. The Department of Com... ...ity Colleges would be most happy to assist in such a survey, if re... ...ted.

The final issue which we would like to present is that of a reasonable ...gram of replacement and repair. In the past, the community college sys... has attempted to maintain a very conservative replacement schedule of 12 ... or 8 percent per year. The inability to maintain this replacement ...dule has caused the current crisis in the condition of the training ...pment within the system. In analyzing current and future realities, ... ultra conservative schedule can no longer be maintained. More ...opriately, an eight-year replacement schedule is realistic while a ten... replacement schedule might be barely adequate. Given the current ...ntory of approximately $65 million, a ten-year replacement schedule ...d require $6.5 million per year, while an eight-year replacement ...dule would require $7.5 million per year, in addition to equipment re... ...ed for new programs.

I hope that the above explanation of the scientific and technical equip... requirements of the community college system has adequately presented ...ntroductory view of our concerns. Again, I look forward to working with ... Committee in finalizing an accurate picture of these requirements.

...scw

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Science serves its readers as a forum for the presentation and discussion of important issues related to the advancement of science, including the presentation of minority or conflicting points of view, rather than by publishing only material on which a consensus has been reached. Accordingly, all articles published in *Science*—including editorials, news and comment, and book reviews—are signed and reflect the individual views of the authors and not official points of view adopted by the AAAS or the institutions with which the authors are affiliated.

Editorial Board

1982: WILLIAM ESTES, CLEMENT L. MARKERT, JOHN R. PIERCE, BRYANT W. ROSSITER, VERA C. RUBIN, MAXINE F. SINGER, PAUL E. WAGGONER, ALEXANDER ZUCKER

1983: FREDERICK R. BLATTNER, BERNARD F. BURKE, CHARLES L. DRAKE, ARTHUR P. FINDEIS, E. PETER GEIDUSCHEK, GLENN ISAAC, MILTON RUSSELL, WILLIAM P. SLICHTER, JOHN WOOD

Publisher
WILLIAM D. CAREY
Associate Publisher: ROBERT V. ORMES

Editor
PHILIP H. ABELSON

Editorial Staff

Assistant Managing Editor: JOHN E. RINGLE
Production Editor: ELLEN E. MURPHY
Business Manager: HANS NUSSBAUM
News Editor: BARBARA J. CULLITON
News and Comment: COLIN NORMAN (deputy editor), WILLIAM J. BROAD, LUTHER J. CARTER, CONSTANCE HOLDEN, ELIOT MARSHALL, R. JEFFREY SMITH, MARJORIE SUN, JOHN WALSH
Research News: ROGER LEWIN (deputy editor), RICHARD A. KERR, GINA KOLATA, JEAN L. MARX, THOMAS H. MAUGH II, ARTHUR L. ROBINSON, M. MITCHELL WALDROP
Administrative Assistant, News: SCHERRAINE MACK; *Editorial Assistants, News:* FANNIE GROOM, CASSANDRA WATTS
Senior Editors: ELEANORE BUTZ, MARY DORFMAN, RUTH KULSTAD
Associate Editors: SYLVIA EBERHART, CAITILIN GORDON, LOIS SCHMITT
Assistant Editors: MARTHA COLLINS, STEPHEN KEPPLE, EDITH MEYERS
Book Reviews: KATHERINE LIVINGSTON, *Editor*; LINDA HEISERMAN, JANET KEGG
Letters: CHRISTINE GILBERT
Copy Editor: ISABELLA BOULDIN
Production: NANCY HARTNAGEL, JOHN BAKER, ROSE LOWERY, HOLLY BISHOP, ELEANOR WARNER, JEAN ROCKWOOD, LEAH RYAN, SHARON RYAN, ROBIN WHYTE
Covers, Reprints, and Permissions: GRAYCE FINGER, *Editor*; GERALDINE CRUMP, CORRINE HARRIS
Guide to Scientific Instruments: RICHARD G. SOMMER
Assistants to the Editors: SUSAN ELLIOTT, DIANE HOLLAND
Membership Recruitment: GWENDOLYN HUDDLE
Member and Subscription Records: ANN RAGLAND

EDITORIAL CORRESPONDENCE: 1515 Massachusetts Ave., NW, Washington, D.C. 20005. Area code 202. General Editorial Office, 467-4350; Book Reviews, 467-4367; Guide to Scientific Instruments, 467-4480; News and Comment, 467-4430; Reprints and Permissions, 467-4483; Research News, 467-4321. Cable: Advancesci, Washington. For "Information for Contributors," write to the editorial office or see page xi, *Science*, 18 December 1981.

BUSINESS CORRESPONDENCE: Area Code 202. Membership and Subscriptions: 467-4417.

Advertising Representatives

Director: EARL J. SCHERAGO
Production Manager: GINA REILLY
Advertising Sales Manager: RICHARD L. CHARLES
Marketing Manager: HERBERT L. BURKLUND

Sales: New York, N.Y. 10036: Steve Hamburger, 1515 Broadway (212-730-1050); Scotch Plains, N.J. 07076: C. Richard Callis, 12 Unami Lane (201-889-4873); Chicago, Ill. 60611: Jack Ryan, Room 2107, 919 N. Michigan Ave. (312 337 4973); Beverly Hills, Calif. 90211: Winn Nance, 111 N. La Cienega Blvd. (213-657-2772); Dorset, Vt. 05251: Fred W. Diefenbach, Kent Hill Rd. (802 867-5581).

ADVERTISING CORRESPONDENCE: Tenth floor, 1515 Broadway, New York, N.Y. 10036. Phone 212-730-1050.

Scientific Instrumentation

Prior to 1965, owing to generous support, university research laboratories were well equipped. But with the growing pressure on available funds that began at that time, a pattern of postponing equipment purchases emerged. By 1970, a problem was widely recognized: university scientists were working with obsolescent equipment.

A National Research Council report commissioned by the National Science Board in the early 1970's gave the cost of updating the laboratories as $200 million at that time. With the inflation of the ensuing decade, compounded by the growing complexity and sophistication of instrumentation, that figure has grown to a conservatively estimated $1 billion.

At a recent meeting of an ad hoc Working Group on Scientific Instrumentation convened by the National Research Council, one participant observed: "The problem of instrumentation in our research universities has implications for the whole country. . . . [W]e are educating a generation of scientists who, when they leave the university, suffer the disadvantages that many people from less developed countries feel when they come to work in a technologically advanced country. This hurts us in a broad range of our activities, both in the defense establishment and in our industrial establishment." He went on to point out that existing scientific and engineering manpower in the universities has outstripped the dollars available for equipment.

But it would not be realistic to try to solve the problem solely by a large infusion of federal funds. The Working Group therefore turned its attention to ways of promoting more effective use of existing resources. A number of leaders of corporate research laboratories participating in the group outlined their procedures for ensuring a balance between manpower and capital expenditures. This stimulated a reassessment by academic participants of institutional arrangements that promote similar rational planning in the academic environment, such as organizing experimental scientists in closely allied areas into research groups with block funding.

The Working Group recommended that several tutorial workshops be organized on a regional level under the auspices of the National Research Council. These workshops would have two objectives: (i) to achieve a more balanced emphasis on provision of modern research instrumentation by revising the policies, mechanisms, and procedures of research support, management, and financing, and (ii) to reduce the current deficit of modern research equipment. Efforts in this direction will be more productive if the research-producing system shows determination to use its resources more effectively. The work of the Interagency Task Force on Instrumentation led by the National Science Foundation, highlighted by the $30-million initiative from the Department of Defense, was enthusiastically supported. Nevertheless, whatever improvements are accomplished in the management of research, there will still be a substantial backlog of need that can only be addressed by the federal government.

The overall purpose of the workshops, then, would be to inform the university community (researchers, administrators, and trustees) of new approaches to providing and using instrumentation. An exchange of practical experience would be sought, with the hope that the universities could respond to the problem with new initiatives and practices. The regional workshops would form the basis for preparing a policy statement and a call to action that could provide some stability for a decade or longer.

Our country's scientific enterprise is a unique combination of individuals from universities, industrial research laboratories, and government research laboratories. The meeting adjourned with a clear sense that discussions among these three elements of the U.S. scientific enterprise could work to the mutual benefit of all three sectors in the solution of this fundamental problem in experimental science.—WILLIAM A. FOWLER *and* DONALD C. SHAPERO, *Office of Physical Sciences, National Research Council, Washington, D.C. 20418*

Attachment III

STATEMENT OF
DR. DONALD N. LANGENBERG
DEPUTY DIRECTOR, NATIONAL SCIENCE FOUNDATION

BEFORE THE

SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
MARCH 4, 1982

MR. CHAIRMAN AND MEMBERS OF THE COMMITTEE.

AS DR. SLAUGHTER MENTIONED IN HIS TESTIMONY LAST WEEK, WHILE ASSESSING OUR PRIORITIES AND NEEDS IN THE PREPARATION OF THE FY 1983 BUDGET REQUEST, WE TOOK A CLOSE LOOK AT RESEARCH INSTRUMENTATION AND FACILITIES NEEDS RELATIVE TO OTHER RESEARCH OPPORTUNITIES.

AS THE MEMBERS OF THIS COMMITTEE KNOW, OVER THE LAST FEW YEARS THE FOUNDATION HAS PLACED A VERY HIGH PRIORITY ON UPGRADING THE SCIENTIFIC AND ENGINEERING INSTRUMENTATION AVAILABLE IN THE NATION'S COLLEGES AND UNIVERSITIES FOR CONDUCTING FOREFRONT RESEARCH IN A VARIETY OF DISCIPLINES. THIS YEAR IS NO EXCEPTION. I WOULD LIKE TO TAKE A FEW MOMENTS TO CHARACTERIZE THE GENERAL NATURE OF THE PROBLEM AND DESCRIBE FOR YOU WHAT THE ADMINISTRATION IS PROPOSING IN THE FOUNDATION'S FY 1983 BUDGET.

There is an emerging consensus in universities, the Federal government and private industry that there is a critical and growing need to replace obsolete and worn-out research apparatus and laboratory facilities in the Nation's research universities.

Although its precise dimensions are not known, there is strong, qualitative evidence that the problem is pervasive and large in scope. A rough, but reasonable, estimate of the lower level of the deficit is $1.0 billion. Upper boundaries of the problem have been placed in the $3.0-$4.0 billion range.

If the general assessment of the scope and nature of the problem is a correct one, and we believe that it is, it means that the productivity and efficiency of the Nation's academic research enterprise has already declined and will continue to decline. Most of modern science and engineering research is instrument-dependent. Capital investment in advanced instrumentation and facilities is necessary if we are to maintain our national position at the forefront of a wide variety of disciplines and to obtain maximum productivity in the future from our investment in research.

Currently, the Foundation is exploring the development of a system of indicators on the status of university research laboratories and equipment to give us a better picture of the scope of the problem. Preliminary data obtained in the fall of 1981 in a sample of 38 institutions suggest that about half of all equipment

HOLDINGS WERE ACQUIRED 6-10 YEARS AGO AND THAT SHARED USE OF INSTRUMENTS AMONG RESEARCHERS AND DEPARTMENTS IS VERY COMMON.

EVEN THOUGH CONSIDERABLE WORK REMAINS TO BE DONE TO DEVELOP BETTER QUANTITATIVE INFORMATION, SOME IMMEDIATE ACTION CAN BE TAKEN. I WOULD LIKE TO DISCUSS SEVERAL THINGS THAT HAVE BEEN DONE IN THE PAST YEAR, AND COMMENT ON HOW NSF'S CURRENT BUDGET REQUEST ADDRESSES THE SITUATION.

EFFORTS TO UPGRADE OUR RESEARCH "HARDWARE" ARE CLEARLY NECESSARY; YET, THE NATION FACES ECONOMIC PROBLEMS AND BUDGETARY CONSTRAINTS. ANY SOLUTION MUST ENCOMPASS NOT ONLY THE FOUNDATION, BUT OTHER FEDERAL AGENCIES, ACADEMIC INSTITUTIONS THEMSELVES, STATE GOVERNMENTS AND INDUSTRY.

LAST AUGUST, WITH THE SUPPORT OF THE DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY, THE FOUNDATION CONVENED AN INTERAGENCY WORKING GROUP ON UNIVERSITY RESEARCH INSTRUMENTATION TO BEGIN REVIEWING THE NATURE AND EXTENT OF THE PROBLEM AND TO EXPLORE SEVERAL SCHEMES FOR A POSSIBLE FEDERAL RESPONSE TO IT. REPRESENTATIVES OUTSIDE NSF CAME FROM THE DEPARTMENT OF AGRICULTURE, DEPARTMENT OF DEFENSE, DEPARTMENT OF ENERGY, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, AND THE NATIONAL INSTITUTES OF HEALTH.

THE WORKING GROUP CONCLUDED THAT INADEQUATE UNIVERSITY RESEARCH INSTRUMENTATION WAS INDEED A PERVASIVE AND ENDEMIC PROBLEM, AND THAT THE NATION WOULD BENEFIT FROM ITS ALLEVIATION.

Because of the diversity of mission responsibilities, an approach involving interagency coordination rather than a single integrated program was thought to be preferable. Such a strategy facilitates matching individual agency priorities, assessing the relation to other research requirments, and enabling a better response to special needs of different scientific areas.

Following this plan, in FY 1983:

- The Department of Defense is proposing a $30 million initiative to build the university research base for disciplines related to its scientific programs;
- NASA is having its program officers give special attention to project-related instrumentation requests;
- NIH plans to increase its current instrumentation programs slightly;
- The Department of Energy plans to instruct its program officers to protect budgets for instrumentation in its research awards;
- NSF research programs are increasing their support for major equipment and other instrumentation by 11.5 percent over FY 1982 to a total of $95.3 million; and
- The interagency working group will continue to monitor, coordinate and heighten awareness of the problem.

WITHIN THE NSF TOTAL, EACH SCIENTIFIC AREA IN THE FOUNDATION IS RESPONDING TO THE NEEDS OF ITS DISCIPLINE. OVERALL INCREASES IN EQUIPMENT AND INSTRUMENTATION SUPPORT RELATIVE TO FY 1982 RANGE FROM 4.8 PERCENT FOR THE U.S. ANTARCTIC PROGRAM TO 23.5 PERCENT FOR ENGINEERING.

SOME PROGRAMS HAVE INCREASED THEIR SUPPORT TO INVESTIGATORS ON THEIR RESEARCH GRANTS; SOME ARE PROVIDING INSTRUMENTATION FOR SHARED USE; SOME PROVIDE RESEARCH INSTRUMENTATION AND FACILITIES THAT ARE TOO SPECIALIZED AND EXPENSIVE TO WARRANT DUPLICATION.

WITHIN THE MATHEMATICAL AND PHYSICAL SCIENCE ACTIVITY, FOR EXAMPLE, PREVIOUS EMPHASIS ON EXPERIMENTAL COMPUTER RESEARCH WILL CONTINUE THE MULTI-USER REGIONAL INSTRUMENTATION FACILITY.

THE PHYSICS PROGRAM WILL PROVIDE SUPPORT FOR CONSTRUCTING A COOLER RING AT THE INDIANA UNIVERSITY CYCLOTRON AND FOR IMPROVING THE DETECTOR AND STORAGE RING AT THE CORNELL ELECTRON STORAGE RING.

IN THE BIOLOGICAL, BEHAVIORAL AND SOCIAL SCIENCE ACTIVITY PARTICULAR ATTENTION IS BEING GIVEN TO UPGRADING INSTRUMENTATION AT MARINE BIOLOGICAL STATIONS, STRENGTHENING ARCHEOMETRIC DATING FACILITIES, AND IN GENERAL PROVIDING ADEQUATE INSTRUMENTATION IN RESEARCH PROJECT AWARDS.

THE ENGINEERING PROGRAM PLANS TO SUPPORT THE INITIAL PHASE OF A FLUIDIZED BED RESEARCH FACILITY.

AS PART OF THE THRUST IN EARTH SCIENCES, IN THE ASTRONOMICAL, ATMOSPHERIC, EARTH AND OCEAN SCIENCES ACTIVITY, SUPPORT OF EQUIPMENT IS BEING ENHANCED ON INDIVIDUAL GRANTS FOR GEOCHEMICAL AND GEOPHYSICAL RESEARCH.

FUNDING FOR RESEARCH INSTRUMENTATION FOR FACULTY AT TWO-AND FOUR-YEAR COLLEGES WILL CONTINUE IN FY 1983. THIS PROGRAM APPEARS TO HAVE BEEN EXTREMELY SUCCESSFUL IN SUPPORTING SMALL RESEARCH EQUIPMENT ACQUISITION AT THESE INSTITUTIONS, THUS UPGRADING SIGNIFICANTLY THE RESEARCH CAPABILITIES OF THEIR FACULTIES. INSTEAD OF PROVIDING A SEPARATELY IDENTIFIED BUDGET LINE FOR THE PROGRAM, SUPPORT WILL BE PROVIDED BY THE RELEVANT RESEARCH DIRECTORATES IN ORDER TO MAINTAIN A CLOSE COUPLING TO THE SCIENCE DISCIPLINES.

IN CONCLUSION, WHILE THE FOREGOING ACTIVITIES WILL CERTAINLY NOT ELIMINATE THE NEED FOR MAJOR RENOVATION OF ADVANCED SCIENTIFIC AND ENGINEERING INSTRUMENTATION THEY DO REPRESENT A REALISTIC AND MEANINGFUL APPROACH AT A TIME WHEN OVERALL ECONOMIC RECOVERY IS A MAJOR NATIONAL CONCERN. WHAT HAS BEEN DONE BY THE FOUNDATION IN FY 1982, AND IS PROPOSED FOR FY 1983, CALLS ATTENTION TO THE NEED FOR CONTINUING EFFORT IN THIS AREA; PROVIDES FOR A BALANCE ACROSS AREAS OF SCIENCE; MEETS THE MOST CRITICAL CURRENT RESEARCH NEEDS WITHIN A

CONSTRAINED BUDGET, AND ALLOWS FOR THE EXPLORATION OF NEW WAYS OF PROVIDING THE INSTRUMENTATION ESSENTIAL TO FULL UTILIZATION OF THE NATION'S SCIENTIFIC AND ENGINEERING MANPOWER POOL, E.G., STIMULATING INDUSTRY TO CONSIDER DONATING INSTRUMENTATION TO A UNIVERSITY IN COORDINATION WITH THE AWARD OF AN NSF GRANT.

I WOULD BE PLEASED TO ANSWER ANY QUESTIONS THAT YOU MAY HAVE.

EXCERPT FROM THE CHAIRMAN'S REPORT TO
THE NSB May 21, 1982

Facilities and Equipment.

One measure of the health of American science is the availability of equipment and research facilities without which leading-edge work cannot be accomplished at all. We began the two-year period with the dedication of the Very Large Array radio telescope in New Mexico. This is the crowning achievement of the efforts of a great many astronomers and engineers and represents an effort by the Board and Foundation continuing over many years. Unhappily, it is the last of the major observational facilities being built by the Foundation that represent major extensions of capability into the unknown, with the single exception of our ocean drilling program. It is a terrible disappointment that we have not been able to do as well by the optical astronomers in the exciting field of millimeter wave research.

The ocean drilling program, on the other hand, has been carefully and adroitly managed through a series of difficult transitions and has emerged scientifically stronger, with a shorter schedule, lower risk, and lower cost than we started out with several years ago. Credit for this substantial achievement, assuming we receive the expected support from the Congress, should go to both the Board's special committee in this area and, importantly, to the Director and his staff who have worked on the problem.

We must all share our disappointment, however, that we have been unable to make any substantial headway against the equipment obsolescence problem that pervades the laboratories of our grantees and has its impact on many activities from engineering education to the exploratory forefront in mathematics, chemistry, and life sciences. This equipment problem has been accepted as real and appropriately has been addressed by federal research investments. Dr. Keyworth shares our concern, as do many of the other agencies with whom our Deputy Director has worked closely.

I hope the Foundation will be able to allocate still greater fractions of its resources in the equipment area, because of the vital importance of having every funded scientist able to do his research in the most efficient way possible. However, I believe we are close to the end of the road on the prior practice of allowing the imbalance between equipment support and labor cost to worsen steadily over time, until finally it becomes intolerable and a special NSF equipment program is generated.

The Board must consider very carefully whether or not the Foundation can manage its grants in such a fashion as to motivate the proposers of research to make adequate provision for modernizing their equipment and for carrying out the research in the most efficacious way. We need to decentralize the trade-off between labor and equipment back to the investigator and the home institution. If we keep more people in research than can properly be afforded by the available funds, we simply deceive ourselves at the expense of quality science.

4. RESEARCH INSTRUMENTATION

Committee View

The Committee recognizes that current budgetary stress does not permit a level of funding commensurate with the magnitude of the research instrumentation problem. Indeed, by any standards, the approximate 6 percent increase over FY 1981 funding for research instrumentation is quite inadequate. However, the Foundation initiation of a study of existing facilities, as well as its organization of an Interagency Working Group, does reflect an attempt to come to grips with the problem.

The Committee would like to express once again its desire to obtain some "benchmark" estimates against which to evaluate the magnitude of the instrumentation shortfall. The analysis underlying such estimates should be clearly visible. Although it is quite clear than any evaluation of this kind will contain inaccuracies, it is necessary to illuminate the complex issues which underly the development of this problem.

It is the Committee's view that, in the absence of any further information, the Foundation commitment of $95.3 million in FY 1983 is reasonably appropriate. Nevertheless, to insure that these funds are not inadvertently rebudgeted for other purposes, the Committee directs that no less than 10 percent of the funds for the Mathematical and Physical Sciences; Engineering; and Astronomical, Atmospheric, Earth, and Ocean Sciences Directorates be targeted for research instrumentation.

Discussion

As in previous years, the shortage of research instrumentation in the nation's universities was singled out as a matter for particular concern. Progress in modern science is dependent on the availability of state-of-the-art instrumentation. In his opening remarks, the Committee Chairman pointed out that the problem was recognized as being serious in an NSF report released in1972. In the ten years since that time, matters have become progressively worse. Absent a directed and substantial effort to remedy the situation, only further deterioration can be expected.

Neither the Foundation spokesman nor the outside witnesses denied the gravity of the situation. Dr. Donald N. Langenberg, Deputy Director of the National Science Foundation, cited in his testimony a shortfall of $1 to $1 billion. Although this number was not seriously challenged, there was no explanation of how it was obtained. Consequently, the Committee has no means of judging the degree to which the Foundation commitment of $95.3 million meets existing needs. Furthermore, there is not one instrumentation problem, but several. Needs for the upgrading of national resources must be distinguished from the availability of research equipment in individual laboratories. The budget document provides only lignited information on this point. Finally, it is clear that NSF cannot and should not be considered the only source of support for instrumentation within the Federal funding agencies. Some active coordination with other agencies is underway, but the fruits of this effort are not apparent.

During a period of fiscal stringency, a problem of this magnitude cannot be solved overnight. A program to approach a solution is required. The NSF, as custodians of the basic research effort in this country, has the responsibility to provide such a program. The patchwork, ad hoc funding mechanisms within NSF, and the meager coordination between Federal agencies, do not inspire confidence that progress is being made. Given that the problem has been visible for so many years, the Committee wishes to express its concern that no such program has been forthcoming.

Finally, the Committee would like to be assured that funds allocated in individual grants for instrumentation are expended in a manner consistent with the intent of the award. Although some flexibility in the disposition of funds is necessary, limited post-award monitoring leaves open the possibility of an applicant repeatedly demonstrating a need for equipment, and diverting the funds to other, grant-related, purposes. If Congress is going to be asked to approve a budget which includes money earmarked for instrumentation, it seems reasonable that some mechanism be established to assure that the funds are used for that purpose. In particular, it is necessary to focus attention on renewal proposal procedures in monitoring such expenditures.

Calendar No. 475

97TH CONGRESS
2d Session

SENATE

REPORT
No. 97-330

DEPARTMENT OF DEFENSE AUTHORIZATION FOR APPROPRIATIONS FOR FISCAL YEAR 1983 AND SUPPLEMENTAL AUTHORIZATION FOR APPROPRIATIONS FOR FISCAL YEAR 1982

REPORT

[To accompany S. 2248]

ON

AUTHORIZING APPROPRIATIONS FOR FISCAL YEAR 1983 FOR PROCUREMENT, FOR RESEARCH, DEVELOPMENT, TEST, AND EVALUATION, AND FOR OPERATION AND MAINTENANCE FOR THE ARMED FORCES, TO PRESCRIBE PERSONNEL STRENGTHS FOR THE ARMED FORCES AND FOR CIVILIAN PERSONNEL OF THE DEPARTMENT OF DEFENSE, AND FOR OTHER PURPOSES

together with

ADDITIONAL VIEWS

COMMITTEE ON ARMED SERVICES
UNITED STATES SENATE

APRIL 13, 1982—Ordered to be printed

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON: 1982

91-801 O

DEFENSE AGENCIES RESEARCH AND DEVELOPMENT

Recommended for Approval as Requested

Defense Department University Research Support

The committee has examined the recent report of the Defense Science Board Task Force on University Responsiveness to National Security Requirements and other evidence documenting the deteriorating health of the Nation's research universities. The committee is concerned that our leading research universities are suffering from a severe erosion in their capacity to conduct competitive research and advanced education programs in such key fields as science and engineering. Manifestations of such erosion may be found in the fact that many laboratories and much research equipment is seriously outdated. Moreover, insufficient numbers of talented students and researchers are being attracted to careers in fields of science and engineering essential to the Nation's future security. In short, the university research base in the United States is being dramatically weakened with grave implications for the national security.

Consequently, the committee fully supports the proposed expansion of the Department's university research programs, the new research instrumentation program, the graduate fellowship program and other related steps planned by the Department, which have been incorporated in the fiscal year 1983 budget request. The committee urges the Department further to strengthen these important programs in its submission of the fiscal year 1984 authorization request.

The committee also requests that the Department of Defense provide an assessment of the degree to which the national defense requires a vigorous program for providing education and training in foreign languages and area studies. This assessment should include recommendations as to measures, and their costs, which could be implemented to rectify the deficiencies that currently exist in these fields.

Summary of Conclusions and Recommendations

National Commission on Research

A rapidly developing equipment inadequacy exists.

The Commission recommends that the Federal agencies and the universities adopt funding mechanisms and improve priority-setting strategies to solve the growing problem of research equipment obsolescence.

Smith and Karlesky

The scale, vigor and creativity of American science are outstanding but the signs of trouble for the future are unmistakable. Deterioration may well proceed long before the matter becomes a public issue, and a downward spiral, were it to develop, might be difficult to reverse.

Association of American Universities

The quality of research instrumentation in university laboratories has seriously eroded. Attributed to the relative decrease in instrumentation support, are inflexibility within the project system and insufficient support for maintenance.

Consequences include: diminished research productivity; reduced training capacity; and decline in international competitive status.

Recommendations are to:

- strengthen instrumentation funding in the project system;
- expand special instrumentation programs;
- create in the National Science Foundation a new supplemental formula grant program to meet diverse institutional needs.

Sloan Commission

A new competitive program of Research Facilities Grants should provide $50 million annually for laboratory facilities and equipment.

U.S. House of Representatives

The scientific instrumentation and physical resource base at research institutions is aging and may no longer be state-of-the-art.

General Accounting Office

OMB should establish (1) minimum requirements for colleges and universities to follow to assure that equipment purchases are necessary and (2) procedures for reviewing grantees' compliance with the requirements.

American Council on Education/HEP Report #44

More than one-fourth of the surveyed institutions have established systems specifically designed to facilitate equipment sharing, and an additional 18 percent were planning to do so in the near future.

American Council on Education/HEP Report #47

During FY 1978, approximately $250 million was expended at Ph.D.-granting institutions for the purchase of scientific research equipment. The breakdown is estimated as follows:

- Fifty percent financed for the life sciences; 19 percent for engineering; 16 percent for the physical sciences;
- Sixty-five percent financed by the Federal Government;
- Nine percent of research equipment expenditures from current funds were for items costing $50,000 or more;
- Expenditures for separately budgeted scientific research equipment from current funds comprised about 6 percent of all research and development expenditures at doctorate-granting institutions during FY 1978.

PRE-PUBLICATION RELEASE

SCIENCE RESOURCES STUDIES HIGHLIGHTS

AL SCIENCE FOUNDATION WASHINGTON, D.C. 20550 MAY , 1982 NSF 82-

Attachment VIII

Sharing of University Equipment Prevalent; Substantial Replacement Requirements Foreseen During Early Eighties

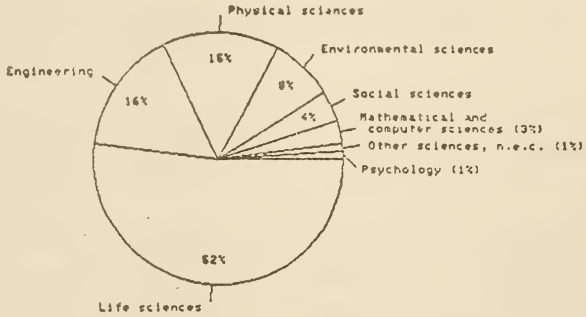
This report is based upon recent NSF efforts to collect information on research instrumentation located in universities and colleges. One of these sources, the NSF Survey of Scientific and Engineering Expenditures at Universities and Colleges, includes national estimates of the research equipment expenditures at higher education institutions in fiscal year 1980. A second effort was initiated primarily to test the feasibility of collecting more detailed information on the status of active research instrumentation. This study produced sample data as of 1981 that are representative of the 38 institutions and the four science and engineering (S/E) subfields surveyed -- organic chemistry, cell biology, solid state physics, and electrical engineering. All references to equipment in the sample pertain to items costing $5,000 or more and having a useful life of at least one year. Excluded from the study were major equipment items such as accelerators, radio-telescopes, research ships, aircraft, and the like.

Highlights

o Universities and colleges spent between $350 and $400 million for separately budgeted research equipment in FY 1980, representing approximately 6 percent of all separately budgeted R&D expenditures.1/ This proportion ranged from 8 percent of the total academic R&D expenditures in the physical sciences to 4 percent in the social sciences. Federal agencies financed two-thirds of these 1980 research equipment purchases with the Federal share differing significantly by field (chart 1 and table 1).

The following findings are based on data covering only four science and engineering (S/E) subfields in 38 institutions -- organic chemistry, cell biology, solid state physics, and electrical engineering. Data were provided by departmental chairpersons and three senior investigators in each department. Unless otherwise noted, all data are expressed in terms of equipment items located in investigators' own laboratories.

Chart 1. Research equipment expenditures at universities and colleges by field: FY 1980



NOTE: Data reflect separately budgeted expenditures from current funds only.

SOURCE: National Science Foundation

Table 1.Research equipment expenditures at universities and colleges by field and source: FY 1980

(Dollars in millions)

Field	Total	Federal	Federal as percent of total
Total	$363	$241	66%
Engineering	57	36	63
Physical sciences	54	45	82
Environmental sciences	29	20	68
Mathematical and computer sciences	10	5	47
Life sciences	187	122	65
Psychology	5	4	76
Social sciences	13	6	50
Other sciences, n.e.c.	7	3	49

NOTE: Data reflect separately budgeted expenditures from current funds only. Detail may not add to totals because of rounding.

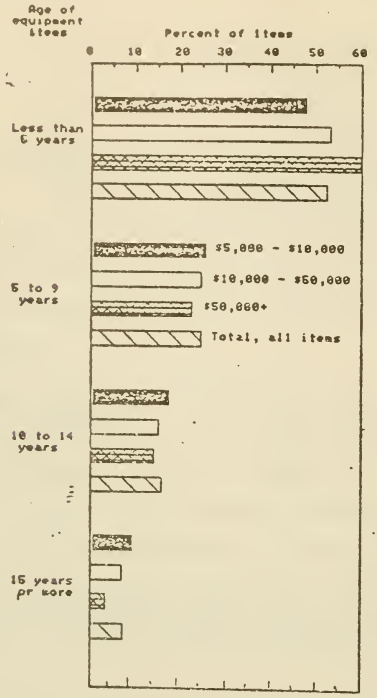
SOURCE: National Science Foundation's Survey of Scientific and Engineering Expenditures at Universities and Colleges, FY 1980.

o Departmental chairpersons reported the following condition of equipment located in large central pools: About 10 percent to 12 percent of the equipment was described in "poor" condition; 20 percent to 25 percent in "fair" condition; 30 percent to 40 percent to "good" condition, and 28 percent to 33 percent in "excellent" condition.

o Research instruments costing at least $50,000 (e.g., mass spectrometers, electron microscopes, etc.) accounted for more than 70 percent of the aggregate value of equipment items with a purchase cost of at least $5,000 ; these instruments tended to be located primarily in shared facilities. Items in shared facilities represented 60 percent of the total cost of all reported research instruments.

o More than three-fifths of research equipment purchases in the sample were wholly financed with Federal funds; one-fifth were purchased solely with institutional funds; and one-tenth were funded from other sources. In addition, about one-tenth of purchases were "jointly-funded" (i.e., by a combination of funding sources). Joint-funding accounted for about 20 percent of the purchases in the $50,000 or more category.

equipment items in sampled departments as of 1981 by cost category a/



a/Subfields sampled include cell biology, organic chemistry, solid state physics, and electrical engineering.

SOURCE: National Science Foundation

o About one-fourth of research equipment in the four subfields combined was at least 10 years old; one-fourth was five to nine years old; and one-half was less than five years old (chart 2). This pattern did not change significantly among the subfields with the exception of electrical engineering, where two-thirds of research instruments were less than five years old.

o In all four subfields sampled, academic research instrumentation is highly shared. "Big ticket" items in investigators' laboratories tended to have more users (7 to 10 users) than the average reported for all equipment items (4 to 6 users). Because of the greater demand placed on these items, investigators reported a higher level of difficulty in gaining access to the more expensive equipment. Research investigators also reported that 90 percent these more expensive equipment items underwent less than 20 percent "downtime" because of equipment failure.

o In the next 5 years researchers plan to replace a substantial share of their equipment -- averaging about one-fifth of all the items in the four subfields surveyed. The planned replacement rate is even higher (36 percent) for items costing $50,000 or more. In describing the characteristics of future equipment replacements in all cost categories, research investigators reported that about

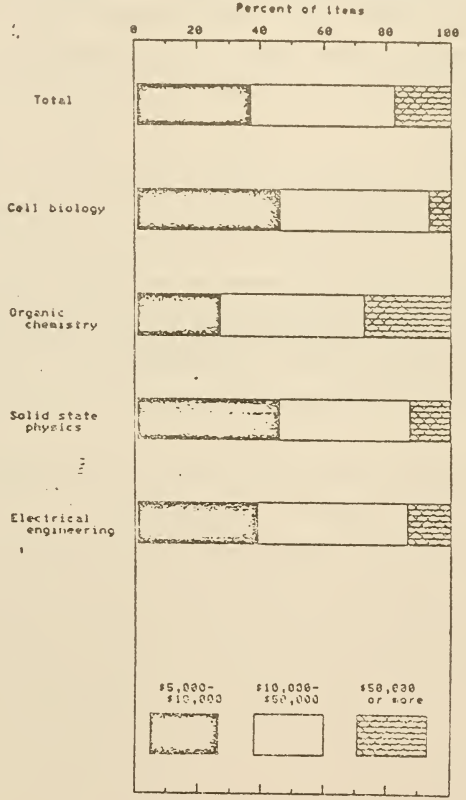
four-fifths of planned new items would be purchased for their improved technical capacities and/or capabilities.

Instrumentation Inventory

This study produced data on the cost, age, and source of funds of the inventory of equipment items located in the four S/E subfields at sampled institutions. As expected, the cost distribution of equipment items differed according to the magnitude of the institutions' research performance. The largest research performers, defined in terms of their annual R&D expenditures, had the largest portion (22 percent) of equipment items costing at least $50,000. In contrast, smaller R&D performers reported only 7 percent of their inventory items in the $50,000 plus category. Although accounting for 18 percent of total instrument items in all sampled strata, the "big ticket" apparatus accounted for most of the aggregate value of the inventory in sampled departments, which was estimated to be about $70 million.

The cost distribution of equipment differed among subdisciplines. Investigators in organic chemistry departments reported the largest portion of "big ticket" items, 27 percent compared to the 18 percent average for all four subfields. Investigators in cell biology reported the smallest share, 7 percent (chart 3).

Chart 3. Cost distribution of research equipment items in sampled departments and subdisciplines as of 1981



SOURCE: National Science Foundation

An examination of the age distribution indicated that about 50 percent of research equipment items were more than five years old. This distribution was generally similar across cost categories and three of the four subfields. In electrical engineering, about two-thirds of the equipment had been purchased during the preceding five years.

About 7 percent of all equipment items were locally assembled, with this proportion being about the same across all cost categories and subfields, with the exception of solid state physics, where 15 percent of the items were locally assembled. When asked why they had built their own equipment, researchers most often reported that no commercial equivalent could be purchased.

Although Federal dollars were used exclusively for nearly two-thirds of equipment items in investigators' laboratories, the need for investigators to use multiple funding sources increased in proportion to equipment costs (table 2). While such joint-funding accounted for 7 percent of all equipment items in investigators' own laboratories, joint-funding was most common among items costing $50,000 or

Distribution of research equipment items in investigators' own laboratories as of 1981 by source and cost category a/

Source	Total	Equipment cost categories		
		$5,000 to $10,000	$10,000 to $50,000	$50,000 +
Total.....	100%	100%	100%	100%
Federal.....	62	61	64	51
Institutional.....	19	21	19	9
Other.....	12	13	9	21
Multiple sources.....	7	5	8	19

a/ Excludes equipment located outside of investigators' laboratories in departmental or other centralized university equipment facilities. Subfields sampled include cell biology, organic chemistry, solid state physics, and electrical engineering.

SOURCE: National Science Foundation

more, accounting for 19 percent of equipment in this category. This proportion may understate the degree of combination funding within these subdisciplines, since departmental or other university facilities for which detailed data were not requested tend to have a higher ratio of "big ticket" items than in investigators' own laboratories, as noted in the discussion of shared usage.

Utilization/Sharing

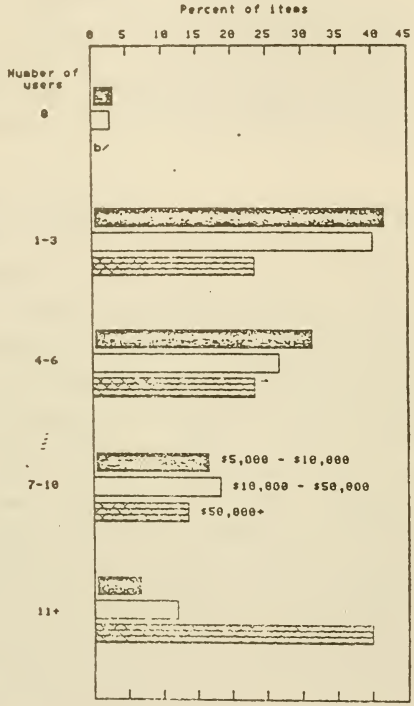
The following data are intended to indicate the degree to which research equipment in sampled departments was utilized. The feasibility study did not attempt to produce data on time-in-use. The study did find however, that more than 90 percent of the equipment items in the sample were in active use on research projects. This portion did not differ significantly among the four subfields studied, although the more expensive items costing at least $50,000 had a 95-percent "in-use" rate. When asked about the status of the 7 percent of inactive equipment items, investigators indicated that nearly one-half of these items were "temporarily" not in use in the particular experiment currently in progress, while the other half required "too much maintenance and repair."

In most institutions, common facilities exist in which significant amounts of research equipment are located. Among the larger research performers surveyed, 87 percent of the departments sampled reported such facilities. The more expensive items tended to be located in these facilities where sharing could be most beneficial.

Even for items in investigator-controlled laboratories, academic research equipment is seldom used by only a single investigator. In addition to being used by several researchers in the investigator's research group, most are also shared with users from outside. Almost all investigators reported multiple users of equipment. The median number of users per equipment item in investigators' own research group was lowest in solid state physics, averaging one to three people. In contrast, four to six users were reported in organic chemistry, cell biology, and electrical engineering. The median number of users per equipment item in investigators' laboratories increased with cost. An average of about four users each was reported for all equipment items compared to about seven users for items costing $50,000 or more (chart 4).

When asked to comment on the problems of accessibility to equipment in other laboratories, investigators responded that nearly 40 percent of items were readily accessible, although more expensive items tended to have greater problems of access because

Chart 4. Distribution of research equipment items located in investigators' own laboratories as of 1981 by number of users and cost category a/



a/ Subfields sampled included cell biology, organic chemistry, solid state physics, and electrical engineering.

b/ Less than 0.5 percent.

SOURCE: National Science Foundation

of demand. For example, about 67 percent of "big ticket" items, which tended to be located outside of the investigators' own research laboratories, had some access difficulties. "Too much competition" (from other researchers) was cited for 36 percent of all equipment (47 percent of "big ticket" items), followed by "too frequently inoperable", 19 percent, and "inconvenient location", 6 percent.

Obsolescence

S/E instruments can suffer from both chronological and technological obsolescence. The former is related to problems of age and wear while the latter is generally related to an investigator's access to state-of-the-art equipment needed for "frontier" research. This feasibility study yielded little data on technological obsolescence. Future NSF studies will be designed to capture data related to this phenomenon. Data obtained from the sample did indicate, however, that investigators planned to replace nearly 20 percent of their equipment inventory items during the next five years. Improved technical capabilities are available for most of the new equipment needs.

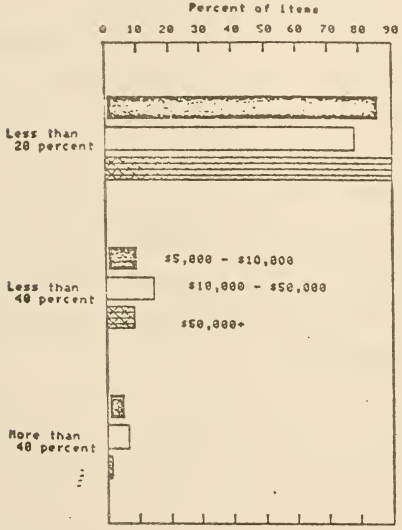
Five-sixths of research instruments in investigators' own laboratories experienced less than 20-percent "downtime" because of equipment failures, compared with the equipment costing $50,000 or more, where 90 percent of items experienced less than

"downtime" (chart 5). During interviews, investigators reported that available maintenance and repair resources were primarily devoted to these key items. Also, high-cost equipment items were more likely to have maintenance contracts. About two-thirds of investigators in the four subfields surveyed spent less than 5 percent of their research budget on maintenance and repair; another one-fifth spent between 5 percent and 10 percent, and about 1 in 10 spent 10 percent or more.

* * * * * * *

A full-scale survey covering more extensive data elements will be conducted by NSF during FY 1983 to acquire equipment data representative of the entire academic sector. It will cover enginering and the computer and physical sciences. Other S/E fields will be covered during FY 1984.

Failure of items located in investigators' own laboratories as of 1981 by cost category[a]



[a] Subfields sampled include cell biology, organic chemistry, solid state physics, and electrical engineering.

SOURCE: National Science Foundation

Footnotes

1/ Data are based on results from the NSF Survey of Scientific and Engineering Expenditures at Universities and Colleges, FY 1980. The imputed or estimated rate for nonresponse to this item on the survey represented approximately 40 percent of total equipment expenditures and is based on actual reported data from 214 institutions. The reader should be aware that these data reflect separately budgeted equipment expenditures from current funds only. Not included is research equipment purchased from plant (capital) funds, such as newly constructed laboratories stocked with scientific apparatus.

APPENDIX E

laboratories, which found that the median age of university equip-
ment was twice that of the commercial laboratories instrumentation.[6]

A study of research instrumentation needs which revealed that in five important scientific disciplines the costs of scientific instruments priced above $5000, rose at an average annual rate of 20 percent between 1970 and 1978.[7]

In sum, then, the situation is serious now and is likely to get worse as rchers attempt to replace old equipment with newer models at today's ted prices.

The various studies cite numerous reasons for the decline in instrumenta- including restrictive Federal research grant policies, insufficient al research support, and rising costs due to the increasing sophistica- of research equipment. Some reports have also questioned whether univer- s have directed funds toward maintaining research staffs at the expense irchasing and maintaining equipment. The studies also note numerous lary costs in addition to the initial basic cost of equipment, including tion and maintenance costs (estimated at 7-8 percent of the new cost per [8], instrument repairs (with service calls now running at $85-$100 per [9], support equipment needed to test or calibrate the equipment, and priate facilities to house new equipment.

Federal agencies are likely to remain the major source of support for irch instrumentation for the foreseeable future. They financed two-thirds ll research equipment purchases in 1980[10], and several federal programs been mounted specifically to address the equipment problem at the federal l. Perhaps the most widely touted was the tax break for corporations ing certain types of equipment to universities which was part of the 1981 an tax package. Many observers, however, seem skeptical that the tax ire will have much impact -- congressional estimates put the total savings ndustry resulting from the provision at less than $5 million annually.[11] NSF plans to increase support for major equipment within its existing arch grant programs to 95.3 million in FY83. (Major requests for research instructional equipment programs were stricken from the NSF's budgets by successive administrations in FY80 and FY81.) The Foundation is also inuing a small ($2 million) program to support the acquisition of research pment at two- and four-year colleges. The Department of Defense has ntly announced a $30 million initiative to build up the university re-[12] ch equipment base for disciplines related to its research programs. rtheless, these programs, even taken together, are but a drop in the et compared to the overall need, and none of them includes any funding for ructional equipment. Furthermore, substantial additional Federal support, his era of budgetary belt-tightening, is unlikely.

h Carolina Activities

North Carolina's policymakers have also become concerned about the pment problem in recent years. Three years ago, the Department of Com- ty Colleges conducted a campus-by-campus analysis of training equipment ently in use. That study led to the system's request to the General mbly for $33 million to repair and replace obsolete equipment. The ral Assembly subsequently allocated $5 million of that amount, leaving a

SCIENTIFIC EQUIPMENT

More than in any other field of academic endeavor, the vitality of training and research programs in science and technology depends on the quality of the tools -- the equipment and instrumentation -- the programs can offer. In technical education, training almost always revolves around the mastery of a specialized set of tools or equipment. In the undergraduate science courses, the student is allowed to participate in the process of scientific inquiry through hands-on experience with scientific instrumentation in the laboratory. In engineering, young graduates must be familiar with the sophisticated equipment of the discipline or they will fall short of employers' expectations. And in the research laboratory, access to advanced scientific instrumentation often determines whether the university can operate at the cutting edge of scientific advance.

Yet there is mounting evidence that the quality of instrumentation in U.S. institutions of higher education is deteriorating. Most of the studies come from premier research universities; if the problems are severe there, how much more serious they must be at the two- and four-year level, where federal research grant monies are not available to help foot the bill! When it begins to impede the teaching and research missions of colleges, community colleges, and universities, outmoded equipment can begin to have harmful effects on economic productivity and growth. This paper will attempt to lay out some of the background at the national level, discuss North Carolina's present status, and preview some of the issues that will confront the committee as it begins its deliberations.

The View From the National Level

The problem of inadequate and obsolete scientific equipment is now so widespread and well-recognized that a National Academy of Sciences panel meeting on the subject this spring began its deliberations by agreeing not to waste any of its time further proving the problem's existence.[1] Earlier in the year, the Deputy Director of the National Science Foundation, in Congressional testimony, had placed the cost of revitalizing laboratories in research universities only at between $1 billion and $4 billion.[2] Some other pieces of evidence include:

- A 1979 Department of Health, Education, and Welfare survey of nine universities, which concluded that there was an unmet need for instruments and facilities of $225 million in those institutions alone.[3]

- A National Science Foundation study which projects a catch-up need of $420 million, over the next five years, in the physical sciences alone.[4]

- An independent university study that suggests that American universities are less well-equipped than their foreign counterparts.[5]

- An Association of American Universities (AAU) study comparing laboratories in sixteen universities to two leading commercial

need of approximately $28 million (non-inflated dollars) still be met. Corraborating the DCC's analysis is a depreciation schedule for state-owned equipment recently developed by the Department of Administration which shows that the major pieces of equipment in the Community College system are worth only a third of their cost; i.e., that the equipment is old and outdated. Finally, in two major studies conducted by the DCC in 1981, vocational and technical graduates and their employers cited the lack of up-to-date training equipment as a serious handicap to the system's ability to train.[13] The latter is perhaps the most serious charge of all, because of its direct impact on the state's capacity for economic growth. The Community College system has identified equipment as its number one priority in this year's budget, and is requesting $30 million from the General Assembly to alleviate the problem.[14]

The UNC system has also been concerned with the problem of scientific instrumentation. In FY79-80, the General Assembly made a special allocation for research and instructional equipment in the sciences and engineering to four UNC institutions, distributed as follows: North Carolina State University - $750,000; North Carolina A&T - $300,000; UNC-Chapel Hill - $500,000; and UNC-Charlotte - $200,000. The language of the legislation recognized the special responsibility of those four institutions for scientific and technological education and research in the biological and physical sciences and engineering. The legislation cited as special concerns the shortage of engineers, the rate of technological change and its effect on equipment obsolescence, and inflationary impacts on equipment costs. Because these allocations were built into the institutions' base budgets, the institutions received the same allocation again in 1980-81. In FY81-82, additional allocations of the same amounts were made to the same institutions, and again became part of the base budgets for 1982-83.

This year, the UNC system is requesting $4,049,022 in expansion money to remedy deficiencies in engineering and some related sciences. This would be a general allocation to improve research and teaching in engineering and the sciences, but some portion of it would certainly be budgeted for equipment.[15]

Scientific equipment has also been a longstanding interest of the Board of Science and Technology. In 1979 and 1980, the Board provided $350,000-400,000 for the purchase of scientific and engineering equipment in North Carolina's colleges and universities. The grantees obtained 3-5 times that amount in matching funds from other sources, thereby leveraging a relatively small state investment into almost $2 million for equipment purchases.[16]

In 1980, the Board undertook an initial study of scientific equipment in two science and engineering departments at each of ten North Carolina colleges and universities (a total of 20 departments). The study was published in August, 1981 and a copy is enclosed. Among the Board's findings were the following:[17]

- With few exceptions, the departments have problems in purchasing and maintaining the equipment necessary to conduct their training programs

- To meet the five highest-priority equipment needs of the 20 departments would require a total of $4-5 million, excluding maintenance costs. The costs of obtaining and maintaining such equipment are

likely to increase at a rate greater than the general level of inflation.

- New mechanisms for the purchase, maintenance, and use of equipment will be necessary to meet future equipment needs. Substantial new infusions of Federal funds are unlikely.

During the 1981 session, the General Assembly called upon the Legislative Research Commission to study the scientific and technical equipment needs of the state's institutions of higher education, articulating its belief that "it is in the interest of the citizens and the state of North Carolina that our institutions of higher education offer a level of scientific training sufficient to assure that North Carolinians will be able to assume jobs in work settings that require high levels of skill."[18] With the Commission's support, the Board is now conducting an exhaustive survey of existing equipment and equipment needs in all the community colleges, colleges, and universities in the state (survey instruments attached).

By December 1, the Board will present to the Commission a two-part factual analysis of its comprehensive scientific equipment study. The first part will be a compilation of inventory data, presented in a format similar to that of the preliminary inventory. The second portion will list, by institution and department, the five highest-priority equipment needs identified by the respondents. Both the inventory and needs sections will be divided into five categories: public Ph.D. institutions, private Ph.D. institutions, public non-Ph.D. institutions, private non-Ph.D. institutions, and the community college system. The factual analysis will be accompanied by an Executive Summary which will summarize the needs and inventory data by type of institution, type of academic department and geographical location.

After December first, the Board will conduct an in-depth assessment of the inventory and needs data and make recommendations aimed at alleviating equipment shortage and obsolescence problems in North Carolina's institutions of higher education. The Committee on Research and Higher Education may want to be particularly involved in this final phase of the Board's work.

Creative Solutions

In the past, equipment purchases have been financed almost entirely from Federal grants and contracts or from the institutions' own funds. Both of those sources are now facing serious financial pressures, just at the time that the need for more and better instrumentation is becoming severe. Therefore, many observers are calling for new mechanisms to address the equipment problem. Although the Committee will want to consider carefully which mechanisms might be appropriate for North Carolina and its institutions, a sampler of the options includes:

Industry Donations and University-Industry Equipment Sharing.

Because the private sector is the ultimate beneficiary of the trained manpower coming out of our systems of higher education, business and industry have a substantial stake in the quality of training and research programs. The public sector can encourage industry to share, lease or donate its equipment through a number of

mechanisms ranging from persuasion to tax credits. Nevertheless, private sector assistance does have its limitations. Specifically, industry contributions may fluctuate with the business cycle, and therefore not provide the stable base needed by colleges and universities, and the extent of private sector assistance may vary across scientific and technical disciplines, helping some departments or institutions and not others.[19]

Sharing Arrangements

As the price of sophisticated instrumentation skyrockets, the old system of providing each professor with his or her "own" equipment will become increasingly untenable. Some predict that intra-department, inter-department, and inter-university sharing arrangements (including regional instrumentation centers, like the Microelectronics Center) will become the order of the day. Still there are some questions as to how much further sharing arrangements can go in solving the problems of research and training equipment. Equipment sharing already is more widespread than is commonly believed: a recent NSF study of 38 institutions revealed that items in shared facilities accounted for 60 percent of the total cost of all research equipment with a purchase cost of $5000 or more.[20] Investigators in that study reported that they found "too much competition" for the use of 36 percent of all the pieces of shared research equipment.[21] Federal research grant policies are another barrier to greater equipment sharing, since they make it difficult for researchers to purchase equipment jointly, especially when their research projects are funded by different agencies.

Equipment Management Systems

Some institutions and multi-campus systems have begun new management programs to ensure more efficient utilization of scientific and technical equipment. These include sophisticated inventories, better scheduling of both courses and equipment use, and centralized "brokering" systems to facilitate intra- and inter-campus sharing. (Iowa State University's Research Equipment Assistance Program is an example of the latter.)

Creative Financing[22]

Colorado State University has recently pioneered the use of debt financing to purchase scientific instrumentation. Debt financing can be accomplished through tax-exempt revenue bonds, industrial development bonds, municipal bonds, tax-exempt commercial borrowing, municipal leases, or revolving lines of credit. The equipment itself generally serves as security, and the debt can be retired through user changes.

Debt financing allows for more immediate acquisition of instruments since time is not lost while looking for matching funds to cover the price of costly equipment. However, researchers may find that to generate enough user charges to repay the debt they must allocate a large amount of instrument time to other users, which may jeopardize

their own research efforts. Also, universities can become locked into debt financing projects and later be unable to commit funds to new lines of research. Some universities have also used limited partnerships to provide funds for university research. This form of financing has become more attractive because of recent changes in the law that provide tax advantages for such arrangements. Typically, the university and private investors join forces to provide equipment and expenditure funds for research projects with the university acting as a general partner and the investors as limited partners. Limited partners are allowed tax deductions on costs up to the amount invested. Should the project show a profit, limited partners earn a percentage of that profit and pay capital gains taxes on that amount. Obviously, limited partnerships are most attractive in scientific areas that promise quick, high returns on investment, for example, biotechnology. They are somewhat less suitable as vehicles for funding basic research.

Issues for the Committee's Consideration

- Most of the available information on scientific equipment concerns research instrumentation at research universities. How do the problems and proposed solutions differ for instructional equipment? For non-research institutions?

- How can the state address fairly the different yet equally pressing needs of:
  1. the public and private institutions?
  2. the Ph.D., non-Ph.D. and two year institutions?

- To what extent is state-of-the-art equipment necessary in educational programs? Where should the line be drawn between the educational institution's responsibility and the employer's responsibility for training scientists, engineers, and technicians on the use of specialized equipment?

- The magnitude of need for scientific equipment is obviously too great to enable every institution to acquire every piece of equipment it wants. Who should set the priorities? How can the state assist in a way that balances the state's interests (to avoid waste and duplication, for example) with institutional autonomy?

- New Mexico has proposed issuing severance tax bonds to cover the cost of scientific equipment in its colleges and universities. The Federal government is providing tax credits to corporations willing to donate certain types of equipment to universities. How can North Carolina best generate the resources needed to address the scientific and technical equipment problem?

FOOTNOTES

1. National Academy of Sciences, "Revitalizing Laboratory Equipment," National Academy Press (Washington, DC: 1982), p.2.

2. "Statement of Dr. Donald Langenburg, National Science Foundation, before the Subcommittee on Science, Research, and Technology," March 4, 1982.

3. National Science Foundation (NSF), "Emerging Issues on Science and Technology, 1981," June, 1982, p. 50.

4. Ibid

5. Ibid

6. Association of American Universities (AAU), "Scientific Instrumentation Needs of Research Universities," June, 1982, Executive Summary.

7. NSF, "Emerging Issues," op cit, p. 50.

8. Ibid

9. Maugh, Thomas H. II, "At $100 per Hour, Service Is a Big Concern," Science, Vol 212, April 10, 1981, p. 153.

10. National Science Foundation (NSF), "Science Resources Studies Highlights," May, 1982, p. 2.

11. NSF, "Emerging Issues," op cit, p. 53.

12. Conversation with Jack Talmadge, NSF Staff, October 15, 1982.

13. Community College information taken from letter from Judy O'Neal, Department of Community Colleges, to Beverly Wiggins, People Panel Staff of N.C. 2000 Project, dated October 12, 1982.

14. Conversation with Thomas King, Department of Community Colleges, October 21, 1982.

15. Conversation with Charles Wheeler, UNC General Administration, October 22, 1982.

16. Board of Science and Technology scientific equipment file.

17. North Carolina Board of Science and Technology, "Inventory of Scientific Equipment in North Carolina," August, 1981, preface.

18. General Assembly of North Carolina, Session 1981, House Joint Resolution 1314.

19. NSF, "Emerging Issues," op cit, pp. 53-54.

20. "Sharing of University Equipment Prevalent; Substantial Replacement Requirements Foreseen During Early Eighties," Science Resources Studies Highlights, National Science Foundation, May 1982, p. 3.

21. Ibid, p.4.

22. NSF, "Emerging Issues," op cit, p. 54.

SAMPLE

High Priority Needs Questionnaire

Name of Institution Department or Program

1. Please list the 3-5 highest priority needs for teaching and/or research equipment (with approximate purchase price) in your program or department. Include brief (1-2 sentence) explanations of these needs.

2. Which, if any, of these above-mentioned needs are now on order?

3. Although you must of necessity both purchase new equipment and maintain existing equipment, do you regard purchasing or maintaining of higher priority?

4. What equipment would benefit you the most if donated to you or shared with you?

5. What equipment would you be willing to sell, donate or share?

6. What conditions would you need to impose on any sharing, selling, or donating arrangement? Why?

EQUIPMENT PROFILE
Sophisticated Scientific Equipment

Name _____

Department _____

Institution _____

Directions: Please list the significant* equipment items in your department (using the nomenclature in the Equipment Category Code List where possible) and characteristics for each. Round purchase price and cost parameters to the nearest dollar (omitting dollar signs and decimals). For your information, the State Commodity Classification Code is shown (in the Code List) for those items included in the current state inventory system.

For Staff Use	REQUIRED						OPTIONAL		
Code	Equipment Item	No. of Items	Year Purchased	Manufacturer	Model #	Purchase Price	Replacement Cost	Operating Status (Good; Fair; Poor)	Annual Maint Costs

* Significant equipment is defined to include all items costing at least $10,000 plus other less expensive items that are essential for the operation of your laboratory.

**NOTE TO RESEARCH AND HIGHER EDUCATION COMMITTEE: The $10,000 limit proved unworkable for some institutions; therefore the Board has been flexible in defining what constitutes "significant" equipment based on the institutions' own assessments.

EQUIPMENT CATEGORY CODE LIST

CATEGORY	COLLEGE SCIENTIFIC EQUIPMENT CODE*	STATE CODE
ABRASION TEST EQUIP		
ACID SAMPLING EQUIP		
ACOUSTIC RADAR		220-48
" "		220-51-75
ACTINOMETER		
ACUCUT LAB EQUIP		
AIR COMPRESSOR		025
AIR CONDITIONING EQUIP		030
AIR SAMPLING EQUIP		493-02
AMPEROMETRIC CONTROLLER		220
ANALYSIS SYST		493-02
" "		730-05
ANALYZER, ACID		
, AEROSOL		
, AIR		493-02-02
, AMINO ACID		493-02-04
, AUTO		493-02-06
, C-H-N-O		493-02
, CHEMI-LUM		
, COAL		
, CRYSTAL		
, ELECTROLYTIC		
, GAS		493-02-32
, ION		
, MAGNET		
, MERCURY		
, MOISTURE		493-02-52
, MULTICHANNEL		493-02-55
, NOISE		493-02-57
, OZONE		
, PORE VOLUME		
, POTENTIODYNE		
, PULSED HEIGHT		493-02-62
, REAL TIME		730-05-65
, SCALES		
, SO2/NITRIC OXIDE		
, SPECTRUM		493-02-72
, "		730-05-75
, SULFUR		
, THERMAL		493-02-80
, TRACE METAL		
, TRACER		
, UNSPECIFIED		493-02
, WATER VAPOR		493-02-92

*Once the inventory of scientific equipment is complete, a code classification system will be developed to facilitate computerization of all the data.

CATEGORY	COLLEGE SCIENTIFIC EQUIPMENT CODE	STATE CODE
ANECHOIC CHAMBER		
ANENOMELIN SYST EQUIP		220-87
ANNIHILATION FACILITY AND EQUIP		
ANIMAL CHAMBER		495-10
ANIMAL VOCAL ANALY SYST		495-05-07
ANNULUS SYST EQUIP		
ATMOSPHERIC FUME CHAMBER		493-36
AUDIO EQUIP		480-60
AUTOCLAVE		465-06
"		465-08
BALANCE		493-06
"		175-08
BIOLOGICAL CABINET		495-20-10
BIOREACTOR UNITS		
BLOOD FLOW EQUIP		493-41-12
BOATS (AND ACCESSORIES)		120
CALIBRATOR		730-30-20
CALORIMETER		493-10
CATHODO-LUMINOSCOPE		
CELL SORTER		
CENTRIFUGE		493-12
CHANNELIZER		
CHART READER		480-52
CHLORIDOMETER		
CHROMATOGRAPH, GAS		493-14-32
, LIQ		493-14-52
, OTHER		493-14
CHROMATOGRAPHY ACCESSORIES		493-14
CIRCULATOR		030-65-20
"		720-12-15
CLOCK		195
COAL GASIFICATION PILOT PLANT		
COLLECTOR		
COLORIMETER		493-20
COMBUSTION EQUIP		493-16
COMPUTERS (AND ACCESSORIES)		250-15
CONDUCTIVITY ANALY EQUIP		220-09
CONVERTOR		
CORRELATOR		
CORROSION RATE ANALY EQUIP		
COUNTER: BACT, PARTICLE, ETC		493-22
COUNTER: RADIATION		493-22
CRYOGENIC SYST EQUIP		
CRYOSTAT		493-24-36
CURVE TRACER		
CYTOFLUOROGRAPH		
CYTOGRAPH		
DATA PROCESS SUBSYST AND EQUIP		250

CATEGORY	COLLEGE SCIENTIFIC EQUIPMENT CODE	STATE CODE
DEIONIZER		
DENSITOMETER		493-28
DESALINATION FACILITY AND EQUIP		
DETECTOR		345-16
DIALYSIS EQUIP		465-55
DIAMOND KNIFE		
DIFFRACTOMETER		900-20
DIGESTION EQUIP		
DISC GEL UNIT		
DISINTEGRATOR		
DISTILLATION EQUIP		493-30
DRILLING EQUIP		445-06-20
" "		445-26
" "		465-67-20
" "		545-13
" "		545-15
" "		545-57
" "		765-14
" "		765-24
" "		765-26
" "		765-27
" "		890-70-20
DRYER		655-55-20
"		740-59-20
DYNAMOMETER		075-21
EKG SYST EQUIP		465-29
ELEC CIRC TEST EQUIP		285-61
" " " "		285-80
" " " "		730
ELECTRON BEAM GUN		
ELECTRON MOBILITY SYST		
ELECTROMETER		175-27-20
ELECTROPHORESIS SYST EQUIP		493-33
ELECTROSCOPE		
ENGINE		060-27
"		120-35
ENVIRONMENTAL CHAMBER		493-35
EVAPORATOR		493-29
EXHAUST SAMPLING EQUIP		
EXTRACTION/FILTRATION EQUIP		175-29
" " "		500-20
FADEOMETER		
FERMENTER		493-37
FIBROGRAPH		
FINISHING RANGE		
FLAMMABILITY TEST EQUIP		
FLOW METER		493-41
" "		495-70-26
FLUID MODELING SYST EQUIP		
FLUID POWER SYST EQUIP		

CATEGORY	COLLEGE SCIENTIFIC EQUIPMENT CODE	STATE CODE
FLUORIDE METER		175-27
FRACTIONATOR		
FRACTION COLLECTOR		493-42
FREEZE DRYER		493-31
FREEZE ETCH APP		
FUME HOOD		493-36
FURNACE		175-36
"		450-13-25
FURNITURE LAB EQUIP		415
GAUSSMETER		
GENERATING EQUIP		285-37
" "		730-20
GLOSSMETER SYST EQUIP		
GOLD COATER		
GONIOMETER		
GRAVITY METER		220-24
GROWTH CHAMBER		493-35-06
HEATING EQUIP		493-44
" "		495-36
HELIUM LIQUIFIER		
HOMOGENIZER		
HOT PRESS		
HYDROCARBON SAMPLING EQUIP		
HYDROGENATION EQUIP		
HYDROLAB EQUIP		
IMPACT TEST EQUIP		
INCINERATOR		450-46
INCUBATOR		493-50
"		410-36
INHALATION FACILITY AND EQUIP		
INJECTION MOLDING EQUIP		665-66-35
INTEGRATOR		
INTERFEROMETER		
ION SOURCE		493-51
KINETICS SYST EQUIP		
KNIFE MAKER		
LASER		493-52
"		493-89-30
LEAF AREA METER		
LEAF PRESS		
LIGHT SOURCE		493-53
" "		285-50
LYOPHILIZER		
MACHINERY AND HEAVY EQUIP		545
MAGNETIC EQUIP		493-32-50
" "		493-32-52
MANOMETER		493-56
MCA-PHA SYST		
MECHANICAL TEST EQUIP		
METALLOGRAPH		
MICROCOULOMETER		

CATEGORY	COLLEGE SCIENTIFIC EQUIPMENT CODE	STATE CODE
MICROMANIPULATOR		493-60-35
MICROMETER		845-50
"		845-54
"		845-55
MICROSCOPE, ELECTRON		493-60-20
" "		493-60-70
" OPTICAL		493-60
MICROTOME		493-24-56
"		493-62
MICROWAVE EQUIP		725-36
" "		730-40
MILLING EQUIP		545-45-55
MIXER		
MONITOR		465-14-50
"		840-60-40
"		840-60-55
MONOCHROMATOR		
NEPHELOMETER		
NEUROL COUNTING DEVICE		
NEUTRON ACTIVAT ANALY EQUIP		
NEURON METER		
OEDOMETER		
OIL PRETREAT EQUIP		
OLFACTOMETER		
OSCILLOGRAPH		220-36
OSCILLOSCOPE		730-05-55
OSMOMETER		493-67
OVEN		493-69
OXIDIZER		
OXIMETER		
PARTICLE SIZING EQUIP		493-02-60
PARTICULATE MEASURING EQUIP		
PERCEPTOSCOPE		
PH METER		493-71
PHOTOGRAPHIC EQUIP		655
" "		700-28
" "		840-70
PHOTOLYSIS EQUIP		
PHOTOMETER		493-73
PHOTOTYPESETTER		705-90
PHYSIOGRAPH		465-14-60
PHYTOTRON		
PIPETTE, AUTOMATIC		493-74
PLANT-MOBILE		
PLASMA UNIT		
PLETHYSMOGRAPH		
PLOTTER		493-75
POCKELS SYST EQUIP		
POLARIMETER		493-72
POLAROGRAPH		493-02-63
POLYGRAPH		680-68

CATEGORY	COLLEGE SCIENTIFIC EQUIPMENT CODE	STATE CODE
PORTABLE SAMPLER		493-80
POTENTIOSTAT		
POWER SYST LAB EQUIP		730-65
POWER UNIT		
PRECIPITATION EQUIP		495-70-65
PROBE		
PROTEIN SEQUENCER		
PSYCHROMETER		465-03-65
PUMP		493-77
"		720
"		
PURIFIER		
PYRANOMETER		
PYRHELIOMETER		220-72-65
PYROMETER		
RADIATION POLYMER PILOT PLANT		
RADIATION SOURCE		493-78
RADIOMETER		
RECORDER, CUMULATIVE		
, DIGITAL		
, TEMP/HUMIDITY		
, INTEGRATOR		
, LINEAR		
, MULTICHANNEL		
, OSCILLOGRAM		
, PHYSIOLOGICAL		
, POTENTIOMETRIC		
, REPORTING		
, SPECTROPHOTOMETER		
, STRIP CHART		220-54
, UNSPECIFIED		
, UV		
, WAVE		
, WEATHER		
, X-Y		493-81
REFRACTOMETER		740
REFRIGERATION EQUIP		
RESPIROMETER		
RESPONSE MONITORING EQUIP		
RHEOMETER		
RHOUGHOMETER		493-02-68
SALINOMETER		
SCALE READER		465-84
SCANNER		
SCINTILLOMETER		
SEISMOGRAPHIC EQUIP		
SEMICONDUCTOR FABRICAT EQUIP		493-85
SEPARATOR		
SEQUENCER		
SERVA BENCH		
SHAKER		

CATEGORY	COLLEGE SCIENTIFIC EQUIPMENT CODE	STATE CODE
SIGNAL GENERATOR		
SIMULATOR		
SMOG CHAMBER		
SMOKE DENSITY CHAMBER		
SOIL TEST EQUIP		845-81
SOLAR IRRADIANCE EQUIP		
SOLVENT DELIVERY SYST EQUIP		
SONAGRAPH		
SONICATOR		
SOUND ANALY EQUIP		
SOURCE ASSESS SAMPL SYST		250-35-75
SPECIFIC-ION METER		715-27-35
SPECTROGRAPH		
SPECTROMETER ACCESSORIES		493-89-60
SPECTROMETER, ALPHA		
, ATOM ABS		493-89-06
, DIGITAL		
, ELECTRON		
, ESR		493-89-18
, EMISSION		
, ESCA		
, FLAME		
, FLUOROMETER		493-89-22
, GAS CORRELATION		
, INFRARED		493-89-34
, ION CYCLE RES		
, MASS		493-89-54
, MOSSBAUER		
, NMR		493-89-56
, NUC QUAD RES		
, OPTICAL ARRAY		
, ORD-CD		
, PHOSPHOR		
, PHOTOACOUSTIC		
, PLASMA EMISSION		
, PULSE		
, RAMAN		493-89-30
, STOP FLOW		
, UV/VIS		493-89-84
, UNSPECIFIED		493-89
, X-RAY		493-89-96
SPECTROSCOPE		
SPEED COUNTER		
SPIROMETER		
SPUTTERING SYST EQUIP		
STAR CHART		
STEAMER		
STRAIN GAUGING EQUIP		
STRANDIZATION EQUIP		

CATEGORY	COLLEGE SCIENTIFIC EQUIPMENT CODE	STATE CODE
SUSCEPTIBILITY SYST EQUIP		
TELESCOPE		625-91
TEMPERATURE CHAMBER		
THERMOMETER		493-92
TISSUE PROCESSOR		493-95
TITRATOR/TITRIMETER		493-97
TRANSFORMER		285-84
"		285-86
TRANSMISSOMETER		
TURBIDOMETER		
VACUUM SYST EQUIP		
VAN DE GRAF ACCELERATOR		
VELOMETER		
VIBRATION EQUIP		220-84
" "		493-02-82
" "		493-99
VIDEO EQUIP		840
VISCOMETER		493-02-84
WATER BATH		175-93
WATER MANAGEMENT EQUIP		
WEATHEROMETER		
WELDER		895
WIND TUNNEL		845-09-90
WIND UTILIZATION EQUIP		
X-RAY ANALY EQUIP		
ZETA METER		

APPENDIX F

F1

STATE OF NORTH CAROLINA
OFFICE OF THE GOVERNOR
RALEIGH 27611

JAMES B. HUNT, JR.
GOVERNOR

December 10, 1982

The Honorable Liston B. Ramsey
The Honorable W. Craig Lawing
Co-Chairmen
Legislative Research Commission
North Carolina General Assembly
State Legislative Building
Raleigh, North Carolina 27611

Dear Senator Lawing and Representative Ramsey:

The North Carolina Board of Science and Technology herein submits its initial report to the Legislative Research Commission on the status of scientific and technical equipment in the institutions of higher education in the state. This is in accord with the agreement set forth in your letter September 15, 1982 directing the Board to create an inventory and analysis of scientific equipment in cooperation with the LRC Study Committee on College Science Equipment.

As requested, the Board is providing you with the following material:

1. A summary of the findings of the Board.

2. A compilation of 3-5 priority equipment needs of each department in the responding institutions.

3. An inventory of equipment items, by department, from the responding institutions.

4. An inventory of equipment by item from each of the responding institutions.

The material collected and presented to you is an important first step in an analysis of the status of scientific and technical equipment at the institutions. It enables you to examine, in a comprehensive manner, the quantity and quality of the equipment within individual institutions and departments, within certain geographical regions, and statewide.

It must be noted that certain qualifications are necessary before any final conclusions can be drawn from examining the data. The data are useful for determining where certain shortages exist, and what types of equipment are needed to upgrade the level of teaching or research at some institutions. However, because the response to the survey was not 100 percent, and because

institutions did not indicate the degree of severity of their equipment needs, the data do not represent a complete picture as to why certain situations exist. The Board, therefore, will continue its examination of the equipment issue in cooperation with the colleges and universities which participated in the survey in order to develop a comprehensive analysis of the issue and identify potential solutions to the problem. We anticipate an opportunity to work with members and staff of the General Assembly in determining appropriate steps to increase the quantity and upgrade the quality of equipment in the institutions.

The data do reveal some significant findings which should be highlighted, and which merit your particular attention:

1. Meeting just the three to five highest priority equipment needs of the 374 responding departments at all levels (public and private colleges and universities as well as the community colleges) would require more than $35 million. In the UNC system alone (11 responding institutions, 137 responding departments), meeting no more than 5 of the highest priority needs per department would require in excess of $23 million. The 185 departments in 53 responding community colleges have equipment needs (3-5 priority items) which require more than $6.7 million. It must be noted that this represents only a fraction of the priority needs of the institutions. Meeting all of their equipment needs at a reasonable level would require millions of additional dollars.

2. Very few of the high priority equipment items are currently on order, most likely due to inadequate funds to purchase new scientific equipment. For example, only about 2% of the high priority items needed by the community colleges are on order, according to the survey. If this situation is not altered--that is if the institutions are unable to obtain new equipment to upgrade their laboratories--the quality of research and education at North Carolina's colleges and universities will be adversely affected.

3. The mean age of all scientific and technical equipment in the institutions surveyed is 8.3 years. This is 1.3 years higher than the average age of equipment at 16 public and private research universities nationwide surveyed by the National Science Foundation. Significantly, the mean age of equipment at UNC-Chapel Hill, Duke, and N.C. State University--three of the state's premier research institutions--is 8.8 years. This indicates that, in the aggregate, North Carolina's prominent research institutions may be facing increased obsolescence with their equipment to a greater degree than similar institutions across the country. If the state is to maintain pre-eminence in scientific and technological advance, it must develop suitable methods for making state-of-the-art equipment and facilities accessible to its education and research institutions.

4. The data indicate that the greatest percentage of items of equipment were less than five years old (40% of all equipment). However, 94% of that equipment cost less than $5,000. Less than 1 percent of all equipment less than five years old cost greater than $50,000. (Note-51% of all equipment costing greater than $50,000 is less than 5 years of age). While colleges and universities frequently purchase new equipment, they appear to be unable to make frequent purchases of the more expensive equipment items. Laboratories which rely heavily on smaller, less expensive items may not, therefore, be

facing obsolescence to the same degree as laboratories which require the more expensive, more sophisticated items.

5. The engineering disciplines indicated that approximately 11 percent of their equipment is more than 20 years of age, which is a much higher percentage than the other disciplines. The mean age of equipment in the engineering disciplines is also highest among all the disciplines.

6. As might be anticipated, nearly 85 percent of all equipment items are located in institutions in the Northwestern Piedmont and the Northeastern Piedmont. A number of factors contribute to the large concentration of equipment items in these regions, all of which should be taken into account in any analysis. The Board urges caution in reaching any conclusions based on these data.

7. For all institutions, the purchase of new equipment was rated a higher priority than the maintenance of existing equipment. More than half of the departments of public institutions, it should be noted, rated purchase and maintenance of equal priority. On the whole, while institutions indicated that the maintenance of existing equipment was a serious ongoing problem, an even greater priority was placed on the purchase of new equipment.

8. Many institutions indicated a willingness to sell, share, or donate some of their equipment. Most institutions indicated that certain conditions would have to be met in order for such transactions to be satisfactory. For example, institutions indicated that their own staff and students must have first priority on the equipment, and that there must be assurances that the shared equipment would be used by properly trained personnel. Any maintenance problems that arise while the equipment is being shared would have to be promptly repaired at the user's expense, and any materials and supplies used would have to be paid for by the user. Donated equipment would have to be picked up by the receiving party, and all donated equipment being received would have to be functional.

A problem facing institutions of higher education in North Carolina and throughout the United States is chronological and technological obsolescence of scientific equipment used in teaching and/or research. Chronological obsolescence is related to age and wear, while technological obsolescence is related to the state-of-the-art of the equipment. Chronological obsolescence can occur when parts are no longer available, when cost of repair becomes prohibitive, or when the frequency of repair becomes unacceptably high. A point will eventually be reached where it is no longer worthwhile to repair the piece of equipment.

Technological obsolescence is more difficult to define. Estimates of the age at which point technological obsolescence occurs range from 5 to 10 years. Technological obsolescence can occur when equipment is developed that has greater sensitivity and/or speed of operations. Some newly developed instruments have a 10,000-fold increase in speed and a 100-fold increase in sensitivity of measurement over similar instruments produced 10 years ago. Not all instruments, however, have had such a dramatic increase in sensitivity and speed of measurements, although this is the general trend in scientific

equipment development. Increased sensitivity and speed of measurement produce more accurate results from a smaller sample in a shorter time period as compared to results produced using equipment 5-10 years old. The older equipment, therefore, can be considered as technologically obsolete.

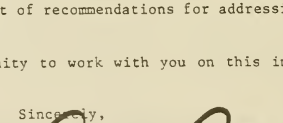
The problem faced by the North Carolina institutions is a lack of access to the most recently developed equipment. Technological innovation has resulted in a much greater variety of equipment today than was available even 5 years ago. This equipment is essential to state-of-the-art research. The absence of this type of equipment may force researchers to produce data of marginal value. Some areas of research, such as surface chemistry, are not pursued in many institutions because the instrumentation required is not available at these campuses.

It is therefore clear that many of North Carolina's institutions possess equipment which may properly be labeled obsolete--by either of the above classifications. The data indicate that failure to take appropriate steps toward increasing the access of the state's institutions to more and better quality equipment will result in further exacerbation of the equipment problem. The data in this report provide a comprehensive contour "map" of the status of scientific equipment in the state, and should serve as a point of reference in fully analyzing the equipment problem.

The Board of Science and Technology will continue its study of the equipment needs of the state's institutions of higher education. The Board would appreciate an opportunity to pursue this effort in cooperation with the General Assembly. A great deal more analysis will be required to fully understand the nature of the problem and the types of solutions which might be recommended. The Board will move rigorously during the next several months to continue this effort, and will do so in conjunction with officials representing those institutions participating in this study. We would be pleased to prepare for you, at a later date, and in cooperation with your staffs, a more comprehensive analysis as well as a set of recommendations for addressing this issue.

We are grateful for the opportunity to work with you on this important effort.

Sincerely,



Quentin W. Lindsey
Executive Director
N.C. Board of Science and Technology

THE STATUS OF SCIENTIFIC AND TECHNICAL EQUIPMENT IN NORTH CAROLINA'S INSTITUTIONS OF HIGHER EDUCATION:

A Preliminary Report to

The Legislative Research Commission

VOLUME I

The North Carolina Board of Science and Technology

Office of the Governor
Raleigh, North Carolina
December, 1982

TABLE OF CONTENTS

VOLUME I

	Page
EXECUTIVE SUMMARY (Correspondence with co-chairmen of the LRC)..	i
TABLE OF CONTENTS.....	vi
ACKNOWLEDGEMENTS.....	vii
INTRODUCTION.....	1
BACKGROUND.....	1
METHODS.....	5
FOOTNOTES.....	7
APPENDICES.....	8

APPENDIX A - High Priority Needs and Equipment Profile Questionnaires

APPENDIX B - Institutions of Higher Education that Responded to the Scientific Equipment Survey

APPENDIX C - Definitions and Classification of Institutions of Higher Education

APPENDIX D - Map of the Geographical Distribution of Institutions of Higher Education in North Carolina

APPENDIX E - Disciplines and Departments used in the Scientific Equipment Survey

APPENDIX F - Scientific Equipment Available for Sale, Trade or Donation

APPENDIX G - Tables

APPENDIX H - Members, Board of Science and Technology

UNDER SEPARATE COVER

VOLUME II - AN INVENTORY OF EQUIPMENT NEEDS

VOLUME III - AN INVENTORY OF EQUIPMENT ITEMS BY INSTITUTIONS

VOLUME IV - AN INVENTORY OF EQUIPMENT ITEMS, BY CLASSIFICATION OF ITEM

ACKNOWLEDGEMENTS

This report was prepared by the North Carolina Board of Science and Technology, with the cooperation of UNC-General Administration, the N.C. Association of Independent Colleges and Universities, the Department of Community Colleges and the many participating public and private institutions. Funds for this report were provided by the Board and by the North Carolina Legislative Research Commission.

The Board wishes to gratefully acknowledge the assistance of several persons, including Joy Johnson and Diana Haywood from the UNC General Administration, for their efforts in organizing and computerizing the data from the sixteen constituent institutions in the UNC system. The Board also wishes to thank Shirley Tabon from the North Carolina Science and Technology Research Center for keypunching the data collected from the Community College System and the private institutions. Finally, the Board wishes to thank Jack Lineback and Larry Leis for their assistance in preparing the computer programs essential for this project.

The Board is especially grateful to Dr. Raymond Grissom, Jr., who coordinated the preparation of this report, and to Cathy Peeler and Brenda Pennington who typed the manuscript and the tables.

HIGH PRIORITY SCIENTIFIC AND TECHNICAL EQUIPMENT NEEDS IN THE INSTITUTIONS OF HIGHER EDUCATION IN NORTH CAROLINA

VOLUME II

Compiled by the

NORTH CAROLINA BOARD OF SCIENCE TECHNOLOGY

December, 1982

Office of the Governor
Administration Building
Raleigh, North Carolina 27611

INTRODUCTION

Selected institutions of higher education in North Carolina were requested to list the highest priority scientific and technical equipment needs required to improve their teaching and/or research programs.[1] The information contained in this volume represents the data compiled by the North Carolina Board of Science and Technology.

It is important to note that the information in this volume does not necessarily represent the official priority needs of the administrators of the institutions sampled.

The information provided in this report is intended to give interested parties estimates of the types of scientific and technological equipment needed to upgrade teaching and/or research in the institution of higher education in North Carolina and an estimate of the cost required to achieve this goal.

---

[1] Two surveys were mailed. One, sent by the Board, asked the departments to list their 3-5 highest priority needs. The other, sent by the UNC General Administration to its 16 constituent institutions, asked the departments to list their highest priority needs -- with no limit on the number of items. In the event that departments listed more than 5 items, we have listed here only 5 items as a representative sample of that department's needs.

F10

TABLE OF CONTENTS

	Page
INTRODUCTION	iii
TABLE OF CONTENTS	v
SENIOR PUBLIC INSTITUTIONS	1
Appalachian State University	3
East Carolina University	4
Favetteville State University	10
N.C. A&T State University	10
N.C. State University	12
Pembroke State University	22
UNC-Chapel Hill	23
UNC-Charlotte	31
UNC-Greensboro	35
UNC-Wilmington	37
Western Carolina University	38
SENIOR PRIVATE INSTITUTIONS	41
Duke University	43
Wake Forest University	46
Belmont Abbey College	48
Campbell College	48
Catawba College	49
Davidson College	50
Elon College	50
Greensboro College	51
Guilford College	51
High Point College	52
Johnson C. Smith University	52
Lenoir-Rhyne College	52
Livingstone College	53
Mars Hill College	53
Meredith College	54
Methodist College	54
N.C. Wesleyan College	54
Queens College	55
St. Andrews Presbyterian College	55
St. Augustine's College	55
Salem College	56
Wingate College	56

TABLE OF CONTENTS (Continued)

	Page
COMMUNITY COLLEGE SYSTEM	59
Anson Technical College	61
Asheville-Buncombe Technical College	61
Beaufort County Community College	62
Blue Ridge Technical College	64
Brunswick Technical College	64
Caldwell Community College	64
Cape Fear Technical Institute	65
Carteret Technical College	67
Catawba Valley Technical College	68
Central Carolina Technical College	69
Central Piedmont Community College	71
Cleveland Technical College	72
Coastal Carolina Community College	73
College of the Albemarle	75
Craven Community College	75
Davidson County Community College	76
Durham Technical Institute	77
Edgecombe Technical College	77
Fayetteville Technical Institute	78
Forsyth Technical Institute	78
Gaston College	78
Guilford Technical Institute	80
Halifax Community College	80
Haywood Technical Institute	81
Isothermal Community College	82
James Sprunt Technical College	82
Johnson Technical College	83
Lenoir Community College	84
Martin Community College	85
Mayland Technical College	86
McDowell Technical Institute	86
Mitchell Community College	87
Montgomery Technical Institute	87
Nash Technical College	88
Pamlico Technical College	89
Piedmont Technical College	89
Pitt Community College	90
Randolph Technical College	91
Richmond Technical College	92
Roanoke-Chowan Technical College	93
Rockingham Community College	93
Rowan Technical College	94
Sampson Technical College	94

Page

COMMUNITY COLLEGE SYSTEM (Continued)

Sandhills Community College 95
Southeastern Community College 97
Southwestern Technical College 98
Stanly Technical College 99
Technical College of Alamance 100
Tri-County Community College 100
Vance-Granville Community College 101
Wake Technical College 102
Wayne Community College 102
Western Piedmont Community College 103
Wilkes Community College 104
Wilson County Technical Institute 104

The full, multi-volume inventory and needs analysis report of the Board of Science and Technology is on file in the Legislative Library. A duplicate set of the computer data that generated the report document is stored in the computer banks of the Department of Administration.