REPORT OF THE

STATE COUNCIL OF HIGHER EDUCATION FOR VIRGINIA

ON THE NEED FOR GRADUATE INSTRUCTION

AND CONTINUING EDUCATION IN ENGINEERING IN THE

RICHMOND AREA AND NORTHERN VIRGINIA

TO

THE GOVERNOR

AND

THE GENERAL ASSEMBLY OF VIRGINIA

HOUSE DOCUMENT NO. 23

COMMONWEALTH OF VIRGINIA
Richmond, Virginia
1981

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PREFACE

IT IS WIDELY HELD TODAY THAT THE FUTURE OF THIS COUNTRY IS LINKED TO THE SUCCESSFUL DEVELOPMENT OF NEW FORMS OF TECHNOLOGY TO MEET SOCIETY'S INCREASINGLY COMPLEX AND DIFFICULT PROBLEMS. ENGINEERING IS WHERE THEORY AND APPLICATION ENCOUNTER EACH OTHER TO YIELD TECHNOLOGICAL PROGRESS. THE VITAL INTERESTS OF THE COUNTRY AND THE COMMONWEALTH ARE BEST SERVED, THEN, IF EDUCATIONAL OPPORTUNITIES IN ENGINEERING AND RELATED FIELDS ARE MADE AVAILABLE TO ALLOW THE FULL POTENTIAL OF CREATIVE ENDEAVOR IN THESE AREAS TO BE REALIZED.

THE COMMONWEALTH IS FORTUNATELY WELL ENDOWED WITH EDUCATIONAL RESOURCES IN THE FIELD OF ENGINEERING. OLD DOMINION UNIVERSITY, THE UNIVERSITY OF VIRGINIA, VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY, AND VIRGINIA MILITARY INSTITUTE OFFER HIGHLY REGARDED PROGRAMS IN ENGINEERING. OF THESE, ONLY THE FIRST THREE OFFER GRADUATE LEVEL INSTRUCTION, AND WITH THE EXCEPTION OF OLD DOMINION UNIVERSITY, THESE PROGRAMS ARE NOT LOCATED IN CENTERS OF POPULATION. THEREFORE A SIZABLE NUMBER OF VIRGINIANS, ESPECIALLY IN RICHMOND AND NORTHERN VIRGINIA, HAVE NO DIRECT ACCESS TO STATE-SUPPORTED ENGINEERING PROGRAMS.

IN RECOGNITION OF THIS LACK OF OPPORTUNITIES FOR ADVANCED STUDY IN ENGINEERING AND THE NEED FOR PRACTICING ENGINEERS TO KEEP ABREAST OF THEIR SPECIALTIES, THE 1980 GENERAL ASSEMBLY ADOPTED HOUSE BILL 419, WHICH REQUESTS THE COUNCIL OF HIGHER EDUCATION TO STUDY THE NEED FOR GRADUATE AND CONTINUING EDUCATION IN ENGINEERING IN VIRGINIA'S URBAN CORRIDOR. AS WILL BE SEEN IN THE REPORT OF THE CONSULTANTS, UNDERGRADUATE AND GRADUATE EDUCATION ARE NOT WHOLLY SEPARABLE, BUT THE FOCUS OF THE STUDY HAS REMAINED IN GRADUATE AND CONTINUING EDUCATION. IN PARTICULAR, THE STUDY ADDRESSES THE POSSIBILITIES OF COOPERATIVE VENTURES TO SATISFY THE NEED WHICH HAS BEEN IDENTIFIED.

THE NEEDS OF HIGH TECHNOLOGY INDUSTRIES IN VIRGINIA MAY GO BEYOND WHAT IS THOUGHT OF AS PURE ENGINEERING. AS THE CONSULTANTS NOTE, HIGH TECHNOLOGY AND COMPUTERS ARE ALMOST IDENTICAL TODAY, CO-EXISTING IN AN AREA WHICH CROSSES THE BOUNDARIES OF CLASSICAL ELECTRICAL AND MECHANICAL ENGINEERING. IN VIEW OF THIS FACT, THE COUNCIL WILL MAKE IN THIS REPORT AN IMPORTANT RECOMMENDATION CONCERNING PROGRAMS IN THE COMPUTER SCIENCE AREA.

THE COUNCIL OF HIGHER EDUCATION AND ITS STAFF ARE DEEPLY GRATEFUL TO DR. LINTON E. GRINTER AND DR. JOHN C. HANCOCK WHO SERVED AS CONSULTANTS AND PERFORMED THE BULK OF THE BACKGROUND WORK OF THIS STUDY. THE COUNCIL IS ALSO GRATEFUL TO THE DEANS OF VIRGINIA'S ENGINEERING SCHOOLS FOR THEIR COOPERATION, AND TO THE GENERAL ASSEMBLY FOR PROVIDING FUNDS FOR THE STUDY. OUR GREATEST THANKS, HOWEVER, GOES TO THE PRACTICING ENGINEERS ON THE STUDY

ADVISORY COMMITTEE, REPRESENTING THE VIRGINIA SOCIETY OF PROFESSIONAL ENGINEERS, THE CONSULTING ENGINEERS, AND THE ENGINEERING INDUSTRY. THE HELP AND ADVICE OF THESE MEMBERS OF THE PRIVATE SECTOR HAVE BEEN INVALUABLE IN THE COURSE OF THE STUDY. AND THEIR PARTICIPATION EXEMPLIFIES THE COOPERATION BETWEEN GOVERNMENT AND INDUSTRY WHICH IS SO VITAL TO THE COMMONWEALTH. IT IS TO FURTHER SUCH MUTUALLY BENEFICAL UNDERTAKINGS THAT THIS STUDY IS OFFERED.

HOUSE BILL 419

AN ACT TO REQUIRE THE STATE COUNCIL OF HIGHER EDUCATION TO CONDUCT A STUDY CONCERNING GRADUATE AND CONTINUING EDUCATION IN ENGINEERING; AND TO APPROPRIATE FUNDS.

APPROVED APRIL 4, 1980

WHEREAS, THE COMMONWEALTH HAS A NEED FOR INCREASED ENGINEERING AND TECHNOLOGICAL SKILLS IN ITS WORKFORCE TO EXPAND ITS ECONOMY AND ENHANCE INDUSTRIAL DEVELOPMENT; AND

WHEREAS, THERE ARE INDICATIONS OF AN INCREASING NEED FOR GRADUATE INSTRUCTION AND CONTINUING EDUCATION IN ENGINEERING IN VIRGINIA'S URBAN CORRIDOR; AND

WHEREAS, THERE ALREADY EXISTS IN TIDEWATER AN ENGINEERING SCHOOL OF HIGH QUALITY AT OLD DOMINION UNIVERSITY; AND

WHEREAS, IT MAY BE POSSIBLE TO EMPLOY THIS RESOURCE IN MEETING ENGINEERING EDUCATION NEEDS IN THE RICHMOND AREA AND IN NORTHERN VIRGINIA; AND

WHEREAS, THE MISSIONS OF OLD DOMINION UNIVERSITY, VIRGINIA COMMONWEALTH UNIVERSITY, AND GEORGE MASON UNIVERSITY ARE TO MEET THE EDUCATIONAL NEEDS OF THEIR REGIONS; AND

WHEREAS, THESE THREE URBAN UNIVERSITIES HAVE AGREED TO WORK TOGETHER IN EXPLORING THE EXTENT OF ENGINEERING EDUCATION NEEDS AND THE POTENTIAL FOR SHARING THEIR RESOURCES IN MEETING THEM; AND

WHEREAS, IT WOULD BE IN THE BEST INTEREST OF THE COMMONWEALTH TO FOSTER COOPERATION AMONG INSTITUTIONS TO MEET SUCH NEEDS RATHER THAN ESTABLISH NEW SCHOOLS OR COLLEGES; AND

WHEREAS, THE STATE COUNCIL OF HIGHER EDUCATION FOR VIRGINIA IS RESPONSIBLE FOR PROMOTING COOPERATION AMONG THE INSTITUTIONS OF HIGHER EDUCATION AND FOR STUDYING THE COMMONWEALTH'S NEEDS IN HIGHER EDUCATION; NOW, THEREFORE,

BE IT ENACTED BY THE GENERAL ASSEMBLY OF VIRGINIA:

1. SECTION 1. THE STATE COUNCIL OF HIGHER EDUCATION SHALL STUDY THE NEED FOR GRADUATE INSTRUCTION AND CONTINUING EDUCATION IN ENGINEERING IN THE RICHMOND AREA AND NORTHERN VIRGINIA AND THE POTENTIAL FOR A COOPERATIVE PROGRAM TO MEET SUCH A NEED IF ONE IS DETERMINED TO EXIST. IN CONDUCTING THE STUDY THE COUNCIL SHALL CONSULT, AS IT DEEMS NECESSARY, WITH REPRESENTATIVES OF APPROPRIATE INSTITUTIONS OF HIGHER EDUCATION AND THE VIRGINIA SOCIETY OF PROFESSIONAL ENGINEERS. THE COUNCIL SHALL REPORT ITS FINDINGS AND RECOMMENDATIONS TO THE GOVERNOR AND GENERAL ASSEMBLY NO LATER THAN DECEMBER ONE, NINETEEN HUNDRED EIGHTY.

2. THAT THERE IS HEREBY APPROPRIATED TO THE STATE COUNCIL OF HIGHER EDUCATION FOR THE PURPOSES OF THIS STUDY FROM THE GENERAL FUND OF THE STATE TREASURY THE SUM OF TWENTY-FIVE THOUSAND DOLLARS.

I. INTRODUCTION

THE STUDY OF THE "NEED FOR GRADUATE INSTRUCTION AND CONTINUING EDUCATION IN ENGINEERING IN THE RICHMOND AREA AND NORTHERN VIRGINIA" HAS PROVEN TO BE AN EXTREMELY CHALLENGING AND REWARDING ENDEAVOR FOR THE COUNCIL OF HIGHER EDUCATION AND THE INSTITUTIONS OF HIGHER EDUCATION WHICH PARTICIPATED IN THE STUDY. THIS STUDY HAD TO DEAL WITH THE NEEDS OF TWO DRAMATICALLY DIFFERENT REGIONS, NORTHERN VIRGINIA AND RICHMOND-PETERSBURG. THE KINDS OF INDUSTRY ESTABLISHED AND DEVELOPING, THE SOCIO-ECONOMIC PROFILES, THE EXTENT OF INDUSTRIAL AND PROFESSIONAL SOCIETY INVOLVEMENT IN HIGHER EDUCATION PLANNING, AND EXISTING OPPORTUNITIES FOR GRADUATE INSTRUCTION AND CONTINUING EDUCATION IN ENGINEERING AND RELATED DISCIPLINES, ARE QUITE DIFFERENT IN THE TWO REGIONS.

THE DIFFERENCES BETWEEN THE TWO REGIONS ARE REFLECTED THROUGHOUT THIS REPORT IN THE TYPES AND MAGNITUDE OF EDUCATIONAL NEEDS IDENTIFIED, THE RECOMMENDED RESPONSES TO THE NEEDS, AND THE TYPE AND EXTENT OF INVOLVEMENT SUGGESTED FOR THE HIGHER EDUCATION INSTITUTIONS IN EACH REGION. BECAUSE OF THE SIGNIFICANCE OF THESE REGIONAL DIFFERENCES, IT IS APPROPRIATE TO DESCRIBE BRIEFLY THE TWO REGIONS STUDIED.

NORTHERN VIRGINIA. THE REGION STUDIED CONSISTED OF PLANNING DISTRICT EIGHT, WHICH CONSISTS OF THE CITIES OF ALEXANDRIA, FAIRFAX, FALLS CHURCH, MANASSAS, AND MANASSAS PARK, AND THE COUNTIES OF ARLINGTON, FAIRFAX, LOUDOUN, AND PRINCE WILLIAM. IT IS IMPOSSIBLE TO STUDY NORTHERN VIRGINIA WITHOUT ALSO CONSIDERING THE REMAINDER OF THE METROPOLITAN WASHINGTON D.C. AREA. NORTHERN VIRGINIA WAS PREVIOUSLY A "BEDROOM" SUBURB OF WASHINGTON, BUT IN THE LAST TWENTY YEARS HAS DEVELOPED AN EXTENSIVE ECONOMIC BASE OF ITS OWN. THE PRIMARY INDUSTRY IN THE METROPOLITAN AREA IS THE FEDERAL GOVERNMENT AND MOST OF THE SECONDARY INDUSTRIES THAT HAVE DEVELOPED ARE DIRECTLY OR INDIRECTLY RELATED TO THE CIVILIAN AND MILITARY AGENCIES OF THE FEDERAL GOVERNMENT.

IN RESPONSE TO THE DEMANDS OF THE REGION, THERE HAS DEVELOPED A HIGH CONCENTRATION OF "HIGH TECHNOLOGY" INDUSTRIES AND FIRMS WHICH DEPEND HEAVILY ON THE AVAILABLILITY OF HIGHLY EDUCATED AND SKILLED INDIVIDUALS IN THE DISCIPLINES OF ENGINEERING, MATHEMATICS, PHYSICAL SCIENCES, AND COMPUTER SCIENCE. WHILE MOST OF THE LARGER FIRMS AND AGENCIES RECRUIT NATIONALLY FOR THEIR STAFFS AND DESIRE INDIVIDUALS ALREADY POSSESSING ADVANCED DEGREES, THEIR PRESENCE INFLUENCES THE EDUCATIONAL DEMANDS OF THE REGION. TABLE I-1 PROVIDES A PROFILE OF THE INDUSTRIES IN THE REGION AND THE NUMBER OF EMPLOYEES IN EACH INDUSTRY SECTOR.

TABLE I-1
PLANNING DISTRICT EIGHT PROFILE

ESTIMATED LABOR FORCE COMPONENTS*
Northern Virginia
(Planning District 8)

Subject	Total** Employment Sept. 1980	Percent of Total
LABOR FORCE DATA (Place or Residence)		
Civilian Labor Force	567,900	100.0
Employment	548,000	96.5
Unemployment	19,900	3.5
Percent of Labor Force	3.5	-
State Rate (%)	5.4	-
National Rate (%)	7.1	-
ESTABLISHMENT DATA (Place of Work)		
Nonagricultural Wage & Salary Employment	432,300	100.0
Manufacturing	17,100	4.0
Durable Goods	10,100	59.1
Stone, Clay & Glass Prod.	1,100	10.9
Fabricated Metal Prod.	1,100	10.9
Machinery (ex. Electrical)	600	5.9
Electrical Equipment & Supplies	5,300	52.9
Other Durable Goods	2,000	19.8
Nondurable Goods	7,000	40.9
Food & Kindred Prod.	1,100	15.7
Printing and Publishing	4,500	64.3
Other Nondurable Goods	1,400	20.0
Nonmanufacturing	415,200	96.0
Construction	28,000	6.7
Transp., Comm., & Pub. Util.	29,400	7.1
Wholesale and Retail Trade	97,800	23.6
Finance, Ins., & Real Estate	27,300	6.6
Services and Mining	113,700	27.3
Government	119,000	28.7
Federal	67,100	56.4
State & Local	51,900	43.6

* Source: Labor Market Trends, Virginia Employment Commission, Volume 36, Number 10.

** By comparing the "Place of Residence" data with the "Place of Work" data, the difference is an approximation of those people who do not work in the same area as they live.

THE POPULATION OF NORTHERN VIRGINIA IS CONSIDERABLY LARGER THAN THAT OF THE RICHMOND-PETERSBURG AREA. IN ADDITION TO BEING LARGER, THE POPULATION IS MORE MOBILE, MORE AFFLUENT, AND HAS A HIGHER LEVEL OF OVERALL EDUCATION.

THE REGION IS SERVED BY AN IMPRESSIVE RANGE OF HIGHER EDUCATION INSTITUTIONS AS DESCRIBED IN TABLE I-2. BECAUSE OF THE NATURE OF THE METROPOLITAN AREA, WITH ITS SOPHISTICATED SYSTEM OF ROADS AND DEVELOPING MASS TRANSIT SYSTEM, COMMUTING TIME TO INSTITUTIONS IN THE DISTRICT OF COLUMBIA OR MARYLAND MIGHT BE NO GREATER THAN THAT TO GEORGE MASON UNIVERSITY OR THE VIRGINIA POLYTECHIC INSTITUTE CENTER AT DULLES.

TABLE I-2
METROPOLITAN AREA COLLEGES AND UNIVERSITITES

Political Jurisdiction / Institutions	Accreditation	Has Accredited Engineering Programs
District of Columbia		
American University	Middle States Association	-
Campus-Free College	Middle States Association (candidate)	-
Catholic University of America	Middle States Association	X
Dominican House of Studies	Middle States Association	-
Gallaudet College	Middle States Association	-
Georgetown University	Middle States Association	-
George Washington University	Middle States Association	X
Howard University	Middle States Association	X
Mount Vernon College	Middle States Association	-
Oblate College	Middle States Association	-
Southeastern University	Middle States Association	-
Strayer University	Middle States Association (candidate)	-
Trinity College	Middle States Association	-
University of the District of Columbia	Middle States Association	X
Washington International College	Middle States Association (candidate)	-
Wesley Theological Seminary	Middle States Association	-
Maryland		
The University of Maryland	Middle States Association	X
Virginia		
George Mason University	Southern Association	-
Marymount College of Virginia	Middle States Association	-
University of Virginia (Falls Church Center)	Middle States Association	X[1]
Virginia Polytechnic Institute and State University (Dulles Center)	Middle States Association	X[1]
Northern Virginia Community College	Middle States Association	X[2]

1 Both UVA and VPI and SU offer engineering courses and programs in Northern Virginia.
2 Approved to offer Associate degrees in Pre-Engineering and Engineering Technologies.

ACCREDITED UNDERGRADUATE AND GRADUATE ENGINEERING PROGRAMS ARE AVAILABLE AT CATHOLIC UNIVERSITY, GEORGE WASHINGTON UNIVERSITY, HOWARD UNIVERSITY, AND THE UNIVERSITY OF MARYLAND. THE UNIVERSITY OF THE DISTRICT OF COLUMBIA ALSO HAS ACCREDITED UNDERGRADUATE ENGINEERING PROGRAMS. FURTHER DETAILS ABOUT EXISTING ENGINEERING PROGRAMS ARE PROVIDED IN SECTION V.

RICHMOND-PETERSBURG AREA. THE AREA CONSIDERED IN THE STUDY CONSISTED OF PLANNING DISTRICT 15, WHICH INCLUDES THE CITY OF RICHMOND AND THE COUNTIES OF CHARLES CITY, CHESTERFIELD, GOOCHLAND, HANOVER, HENRICO, NEW KENT, AND POWHATAN. THE STUDY WAS EXPANDED TO CONSIDER THE NORTHERN PORTION OF PLANNING DISTRICT 19 WHICH INCLUDES THE CITIES OF PETERSBURG, HOPEWELL, AND COLONIAL HEIGHTS, AND THE COUNTIES OF PRINCE GEORGE AND DINWIDDIE. ALTHOUGH IT IS THE STATE CAPITAL, THE INDUSTRY IN THE RICHMOND-PETERSBURG AREA IS MUCH LESS DOMINATED BY GOVERNMENTAL AGENCIES AND GOVERNMENTAL SUPPORT INDUSTRIES THAN IS NORTHERN VIRGINIA. THERE IS A LARGER INVOLVEMENT IN MANUFACTURING AND AGRICULTURE WHICH IS REFLECTED IN THE EDUCATIONAL NEEDS IDENTIFIED IN THE SUBSEQUENT SECTIONS OF THIS REPORT. THE INDUSTRY PROFILE OF THE RICHMOND-PETERSBURG AREA IS PROVIDED IN TABLE I-3.

TABLE I-3
RICHMOND-PETERSBURG PROFILE

ESTIMATED LABOR FORCE COMPONENTS*
Richmond-Petersburg Profile
(Planning District 15 and Northern Portion of Planning District 19)

Subject	Total** Employment Sept. 1980	Percent of Total
LABOR FORCE DATA (Place of Residence)		
Civilian Labor Force	393,990	100.0
Employment	376,730	95.6
Unemployment	17,260	4.4
Percent of Labor Force	4.4	-
State Rate (%)	5.4	-
National Rate (%)	7.1	-
ESTABLISHMENT DATA (Place of Work)		
Nonagricultural Wage & Salary Employment	373,670	100.0
Manufacturing	66,870	17.9
Durable Goods	20,540	30.7
Lumber, Wood Prod., & Furniture	4,240	20.6
Stone, Clay & Glass Prod.	1,540	7.5
Fabricated Metal Prod.	2,650	12.9
Machinery (Ex. Electrical)	2,100	10.3
Other Durable Goods	10,010	48.7
Nondurable Goods	46,330	69.3
Food & Kindred Prod.	4,550	9.8
Tobacco Manufacturers	12,000	25.9
Textiles and Apparel	3,320	7.3
Paper and Allied Prod.	4,100	8.8
Printing and Publishing	5,200	11.2
Chemicals and Chem. Prod.	11,120	24.0
Other Nondurable Goods	6,040	13.0
Nonmanufacturing	306,800	82.1
Construction	20,140	6.6
Transportion and Pub. Uuil.	21,320	6.6
Wholesale and Retail Trade	80,690	26.4
Finance, Ins., & Real Estate	28,020	9.1
Services and Mining	66,660	21.7
Government	89,970	29.3
Federal	13,270	14.7
State & Local	76,700	85.3

* Source: Labor Market Trends, Virginia Employment Commission, Volume 36, Number 10.
** By comparing the "Place of Residence" data with the "Place of Work" data, the difference is an approximation of those people who do not work in the same area as they live.

THE POPULATION OF THE RICHMOND-PETERSBURG AREA IS SMALLER, LESS MOBILE, LESS AFFLUENT, AND IT IS NOT AS HIGHLY EDUCATED AS THAT OF NORTHERN VIRGINA.

THE AREA IS WELL SERVED BY A NUMBER OF STATE-SUPPORTED AND INDEPENDENT INSTITUTIONS OF HIGHER EDUCATION, BUT DOES NOT HAVE RESOURCES SUCH AS THOSE IN THE DISTRICT OF COLUMBIA AND MARYLAND UPON WHICH IT CAN DRAW. IN ENGINEERING, ONLY THE NEW BACHELOR OF SCIENCE IN ENGINEERING TECHNOLOGY AT VIRGINIA STATE UNIVERSITY IS AVAILABLE IN THE REGION.

TABLE I-4
RICHMOND-PETERSBURG EDUCATIONAL INSTITUTIONS

RICHMOND-PETERSBURG EDUCATIONAL INSTITUTIONS

Institutions	Accreditation	Has Accredited Engineering Programs
J. Sargeant Reynolds Community College	Southern Association	X[1]
John Tyler Community College	Southern Association	X[2]
Old Dominion University	Southern Association	X[3]
Presbyterian School of Christian Education	Southern Association	-
Randolph-Macon College	Southern Association	-
Richard Bland College	Southern Association	-
Union Theological Seminary in Virginia	Southern Association	-
University of Richmond	Southern Association	-
University of Virginia (Richmond Center)	Southern Association	X[3]
Virginia Commonwealth University	Southern Association	-
Virginia Polytechnic Institute and State University (Richmond Center)	Southern Association	X[3]
Virginia State University	Southern Association	X[4]
Virginia Union University	Southern Association	-

1 Approved to offer Associate degrees in Pre-Engineering and Engineering Technologies.

2 Approved to offer Associate degrees in Engineering Technologies.

3 UVA, VPI & SU, and ODU offer engineering courses and programs in the Richmond-Petersburg area.

4 Approved to offer B.S. in Engineering Technology in Fall, 1980.

II. STATUS OF ENGINEERING EDUCATION

THE CURRENT STATUS OF ENGINEERING EDUCATION, AS WELL AS THAT OF OTHER HIGH-TECHNOLOGY DISCIPLINES, HAS BEEN THE SUBJECT OF MUCH NATIONAL CONCERN. ENROLLMENTS IN ENGINEERING HAVE EXHIBITED CYCLIC CHANGES OVER THE LAST THIRTY YEARS. IN 1948, POST-WORLD WAR II ENGINEERING ENROLLMENTS WERE APPROXIMATELY 220,000. THEY DECLINED RAPIDLY TO 165,000 BY 1951. THE TREND REVERSED QUICKLY AND BY 1957, APPROXIMATELY 295,000 STUDENTS WERE ENROLLED IN ENGINEERING PROGRAMS. DECLINES WERE AGAIN OBSERVED BUT QUICKLY REVERSED IN THE POST-SPUTNIK ERA, RESULTING IN A PEAK OF 315,000 ENROLLMENTS IN 1969. BY 1973 THE CONTRACTIONS IN THE AEROSPACE INDUSTRY HAD REDUCED ENROLLMENTS BY 55,000; ENROLLMENTS OF 275,000 IN 1974 EQUALLED THOSE OF TWENTY YEARS EARLIER. THE TREND HAS NOW REVERSED ONCE MORE, AND CURRENT ENROLLMENTS ARE APPROACHING 400,000. THE NUMBER OF UNDERGRADUATE ENGINEEING DEGREES IN 1950-51 WAS APPROXIMATELY 50,000 AND IS ESTIMATED TO EXCEED 60,000 IN 1980 (NATIONAL CENTER FOR EDUCATIONAL STATISTICS).

EXAMINATION OF THE ENROLLMENT STATISTICS INDICATES THAT THE CYCLIC PATTERN HAS A TEN YEAR PERIOD BUT THAT THE GENERAL TREND HAS BEEN CONSTANTLY UPWARD. THE CYCLES HAVE LAGGED BEHIND ECONOMIC SHIFTS BY TWO TO THREE YEARS, REFLECTING THE FACT THAT UNDERGRADUATE DEGREE PROGRAMS TAKE FOUR TO FIVE YEARS TO COMPLETE.

ENROLLMENT IN GRADUATE DEGREE PROGRAMS HAS BEEN MORE STABLE IN THE LAST TEN YEARS. THE FACT THAT GRADUATE ENROLLMENT HAS NOT EXPANDED PROPORTIONATELY WITH THE UNDERGRADUATE ENROLLMENT, ESPECIALLY IN DOCTORAL DEGREE PROGRAMS, IS A MATTER OF CONCERN BECAUSE TODAY'S GRADUATE STUDENTS ARE THE SOURCE OF FUTURE FACULTY AND HIGHER LEVEL ENGINEERS FOR CONSULTING AND HIGH-TECHNOLOGY INDUSTRIES.

A RECENT STUDY RELEASED BY THE SOUTHERN REGIONAL EDUCATION BOARD HIGHLIGHTS THE NATIONAL AND REGIONAL PROBLEM BY DEALING WITH ALL OF THE HIGH-TECHNOLOGY DISCIPLINES RATHER THAN JUST ENGINEERING. TABLE I-5 SHOWS THAT NATIONALLY AND IN THE SOUTH THE HIGH-TECHNOLOGY DISCIPLINES OF COMPUTER SCIENCE, MATHEMATICS, ENGINEERING, AND THE PHYSICAL SCIENCES HAVE DECLINED AS A PERCENT OF TOTAL DEGREES AWARDED. THE MAJOR DECLINES HAVE OCCURED IN MATHEMATICS AND THE PHYSICAL SCIENCES, BUT ENGINEERING HAS ALSO DECLINED. THIS DECLINE HAS RESULTED IN AN IMBALANCE BETWEEN THE SUPPLY OF HIGH-TECHNOLOGY GRADUATES, BOTH UNDERGRADUATE AND GRADUATE, AND THE DEMAND FOR THEM BY INDUSTRY AND HIGHER EDUCATION (AS FACULTY AND GRADUATE STUDENTS). ENGINEERING AND COMPUTER SCIENCE GRADUATES HAVE NO DIFFICULTY FINDING EMPLOYMENT, AND STARTING SALARIES OFFERED CONTINUE TO INCREASE AS THE COMPETITION INCREASES.

Proportion of Total Baccalaureate Degrees in High Technology Fields Selected Years

	1963-64		1970-71		1976-77		1977-78	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
South								
Computer Science	—	—	596	0.3%	1,676	0.7%	1,931	0.8%
Mathematics	5,450	4.6%	6,723	3.1	3,656	1.5	3,215	1.3
Engineering	8,238	6.9	11,646	5.4	12,197	4.9	14,551	5.8
Physical Sciences	4,251	3.6	4,989	2.3	5,987	2.4	6,271	2.5
United States								
Computer Science	—	—	2,388	0.2	6,426	0.8	7,224	0.8
Mathematics	18,649	4.1	24,912	2.9	14,295	1.5	12,701	1.4
Engineering	35,354	7.7	50,357	5.9	49,667	5.4	56,009	6.0
Physical Sciences	17,507	3.8	21,548	2.5	22,609	2.4	23,175	2.4

Source: *Degree Output* reports, based on HEGIS data, Southern Regional Education Board. The "engineering" field, as reported by the HEGIS system, includes engineering technology baccalaureates and is not comparable to the "engineering" category as reported by the American Association of Engineering Societies.

III. STRUCTURE OF THE STUDY

THE STUDY PLAN THAT EVOLVED PURSUANT TO HOUSE BILL 419 DREW UPON SEVERAL PREVIOUS AND CURRENT STUDIES. IN 1978 GEORGE MASON UNIVERSITY ASKED THE COUNCIL OF HIGHER EDUCATION TO APPROVE SEVERAL UNDERGRADUATE ENGINEERING PROGRAMS TO BE STARTED DURING THE 1980-82 BIENNIUM. SOME USEFUL INFORMATION ABOUT THE DEMAND FOR UNDERGRADUATE ENGINEERING EDUCATION WAS PROVIDED BY THE UNIVERSITY IN ITS PROPOSAL. DURING 1979-80 THREE STUDIES WERE CONDUCTED PERTAINING TO ENGINEERING. ONE WAS DONE BY VIRGINIA COMMONWEALTH UNIVERSITY AND FOCUSED ON THE RICHMOND-PETERSBURG AREA. THE SECOND WAS DONE BY GEORGE MASON UNIVERSITY, OLD DOMINION UNIVERSITY, AND VIRGINIA COMMONWEALTH UNIVERSITY AND EXPLORED THE POSSIBILITY OF ESTABLISHING A COOPERATIVE UNDERGRADUATE ENGINEERING PROGRAM IN NORTHERN VIRGINIA AND RICHMOND-PETERSBURG, BUILDING UPON THE EXISTING DEGREE PROGRAM AT OLD DOMINION. THIS STUDY BY THE URBAN UNIVERSITIES HAD BEEN SUGGESTED BY THE COUNCIL OF HIGHER EDUCATION. WHILE IT WAS GOING ON, GEORGE MASON UNIVERSITY WAS CONDUCTING AN EXTENSIVE STUDY OF THE CONTINUING EDUCATION NEEDS OF ENGINEERS AND PHYSICISTS IN THE METROPOLITAN WASHINGTON AREA UNDER A GRANT FROM THE NATIONAL SCIENCE FOUNDATION (NSF).

THE COUNCIL OF HIGHER EDUCATION FORMED AN ADVISORY COMMITTEE CONSISTING OF REPRESENTATIVES FROM THE EXISTING SCHOOLS OF ENGINEERING AT OLD DOMINION UNIVERSITY, THE UNIVERSITY OF VIRGINIA, AND VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY, AS WELL AS REPRESENTATIVES OF VIRGINIA STATE UNIVERSITY, GEORGE MASON UNIVERSITY, VIRGINIA COMMONWEALTH UNIVERSITY, AND THE VIRGINIA COMMUNITY COLLEGE SYSTEM. IN ADDITION, THE VIRGINIA SOCIETY OF PROFESSIONAL ENGINEERS AND THE ASSOCIATION OF CONSULTING ENGINEERS WERE REPRESENTED. THE ROLE OF THE COMMITTEE WAS TO ADVISE COUNCIL STAFF ON THE DESIGN OF THE STUDY, THE POSSIBLE CONSULTANTS, AND THE PROPOSED PLANS OF THE STUDY SUBMITTED BY CONSULTANTS. THE COMMITTEE ALSO REVIEWED CONSULTANT REPORTS AND THIS REPORT.

ON THE BASIS OF PRELIMINARY INFORMATION AVAILABLE ABOUT THE NATURE OF THE EDUCATIONAL NEEDS IN NORTHERN VIRGINIA, IT WAS DECIDED TO HIRE TWO CONSULTANTS, ONE TO BE RESPONSIBLE FOR THE GENERAL CONDUCT OF THE STUDY AND ONE TO FOCUS SPECIFICALLY ON THE ELECTRICAL ENGINEERING REQUIREMENTS OF THE NORTHERN VIRGINIA AREA. THE TWO CONSULTANTS EMPLOYED WERE DR. LINTON E. GRINTER AND DR. JOHN C. HANCOCK. BRIEF BIOGRAPHICAL SKETCHES FOLLOW:

DR. LINTON E. GRINTER
DEAN EMERITUS, UNIVERSITY OF FLORIDA

TEACHING AND RESEARCH. PROFESSOR OF CIVIL ENGINEERING, TEXAS A AND M UNIVERSITY AND ILLINOIS INSTITUTE OF TECHNOLOGY. AUTHOR OF TECHNICAL BOOKS PUBLISHED BY MACMILLIAN COMPANY. AUTHOR OF ARTICLES AND PAPERS ON TECHNICAL AND EDUCATIONAL SUBJECTS.

ADMINISTRATION. DEAN OF THE GRADUATE SCHOOL AND EXECUTIVE VICE PRESIDENT AT ILLINOIS INSTITUTE OF TECHNOLOGY AND THE UNIVERSITY OF FLORIDA.

PLANNING AND CONSULTING. COORDINATED THE PLANNING ACTIVITY AND DEVELOPED A 10-YEAR PLAN FOR THE UNIVERSITY OF FLORDIA, 1970-73. CONSULTANT TO THE EDITOR OF ENCYCLOPEDIA BRITANNICA AND TO A NUMBER OF OTHER GOVERNMENTAL, REGIONAL, AND INSTITUTIONAL GROUPS.

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TEACHING AND RESEARCH. PROFESSOR OF ELECTRICAL ENGINEERING, PURDUE UNIVERSITY AND AUTHOR OF MORE THAN 30 PRESENTATIONS AND PAPERS ON TECHNICAL AND EDUCATIONAL SUBJECTS.

ADMINISTRATION. DEAN, SCHOOLS OF ENGINEERING, PURDUE UNIVERSITY.

PLANNING AND CONSULTING. A RECOGNIZED LEADER IN COMMUNICATIONS SYSTEMS AND CONTRIBUTOR TO A NUMBER OF INDUSTRIES, INCLUDING THE NEW SIGNAL SYSTEM TECHNIQUE APPLIED TO RADAR AND A SATELLITE-TO-EARTH TRANSMITTING SYSTEM.

CONSULTANT ACTIVITIES.

THE CONSULTANTS VISITED THE EXISTING SCHOOLS OF ENGINEERING IN VIRGINIA, THE DISTRICT OF COLUMBIA, AND THE UNIVERSITY OF MARYLAND; THEY INTERVIEWED REPRESENTATIVES OF SELECTED FIRMS IN NORTHERN VIRGINIA AND RICHMOND-PETERSBURG; THEY MET WITH GROUPS OF SMALLER FIRMS TO DISCUSS THEIR SPECIFIC REQUIREMENTS IN NORTHERN VIRGINIA, AND THEY MET WITH THE STAFF OF GEORGE MASON UNIVERSITY REGARDING THE NSF STUDY, THE CURRENT OFFERINGS IN ENGINEERING AND ASSOCIATED DISCIPLINES, AND FUTURE PLANS. THE CONSULTANTS HAVE ATTEMPTED TO IDENTIFY THE TYPE AND MAGNITUDE OF DEMAND FOR GRADUATE INSTRUCTION AND CONTINUING EDUCATION IN BOTH NORTHERN VIRGINIA AND RICHMOND-PETERSBURG AND HAVE RECOMMENDED TO THE COUNCIL SEVERAL WAYS TO REPOND TO THE IDENTIFIED NEEDS.

THE RESULTS OF THE NSF STUDY CONDUCTED BY GEORGE MASON UNIVERSITY FACULTY WERE CONSIDERED BY THE CONSULTANTS IN THEIR REPORT. THEY WERE ALSO CONSIDERED BY THE COUNCIL IN FORMULATING THE CONCLUSIONS AND RECOMMENDATIONS PRESENTED IN THE FINAL SECTION OF THIS DOCUMENT. THE MOST SIGNIFICANT RESULT OF THE GEORGE MASON UNIVERSITY NSF STUDY IS THE INDICATION THAT THE PRIMARY DEMAND FOR GRADUATE INSTRUCTION IN NORTHERN VIRGINIA IS IN THE AREAS OF COMPUTER SCIENCE, INFORMATION SYSTEMS, COMMUNICATION SYSTEMS, AND OPERATIONS RESEARCH RATHER THAN IN THE TRADITIONAL ENGINEERING DISCIPLINES. THIS STUDY THUS SUPPORTS THE CONTENTION THAT THE INDUSTRIAL DEVELOPMENT OF NORTHERN VIRGINIA IS, IN FACT, UNIQUE AND REPRESENTS THE EVOLUTION OF NEW TECHNOLOGIES FOR WHICH THERE ARE AT PRESENT NO CORRESPONDING

HIGHER EDUCATION DEGREE PROGRAMS OR RESEARCH DISCIPLINES. THESE TECHNOLOGIES CAN BE MASTERED BY THE BEST GRADUATES OF CONVENTIONAL ENGINEERING PROGRAMS, BUT AN ALTERNATIVE IS TO EXPERIMENT WITH THE DEVELOPMENT OF HIGHER EDUCATION PROGRAMS AND RESEARCH DISCIPLINES THAT REFLECT MORE PRECISELY THE TECHNOLOGIES WHICH ARE EVOLVING.

IV. UNIVERSITY OF MARYLAND TELEVISION PROGRAM

ONE OF THE MANY INTERESTING DEVELOPMENTS IDENTIFED BY THE CONSULTANTS WAS THE EXISTENCE OF A SOPHISTICATED TELEVISION INSTRUCTION SYSTEM DEVELOPED BY THE UNIVERSITY OF MARYLAND. THE SYSTEM, WHICH HAS TWO-WAY VOICE COMMUNICATION CAPACITY AND ONE-WAY VIDEO CAPACITY, IS ALREADY DELIVERING GRADUATE INSTRUCTION IN ENGINEERING AT SEVERAL LOCATIONS IN MARYLAND AND THE DISTRICT OF COLUMBIA.

THE SYSTEM CONSISTS OF TWO STUDIO CLASSROOMS AT THE COLLEGE PARK CAMPUS, AN ORIGINATING BROADCAST TOWER ON THE CAMPUS, A PRIMARY BROADCAST TOWER AT WDON-TV, AND VARIOUS REMOTE CLASSROOM LOCATIONS. THE ACTIVITIES IN THE STUDIO CLASSROOMS ARE COVERED BY THREE REMOTE CONTROL CAMERAS AND MICROPHONES FOR THE INSTRUCTOR AND EACH OF THE 45 STUDENT STATIONS. AUDIO RESPONSE FROM THE REMOTE SITES IS PROVIDED VIA DEDICATED TELEPHONE LINES.

THIS SYSTEM DIFFERS FROM PREVIOUS TELEVISION INSTRUCTION SYSTEMS IN THAT IT ALLOWS THE REMOTE STUDENTS TO PARTICIPATE DURING THE CLASS SESSION. THE EVALUATION OF INTERACTIVE TELEVISION INSTRUCTION (ITV) SYSTEMS IS STILL GOING ON, BUT THE PRELIMINARY RESULTS INDICATE SIGNIFICANT INCREASES IN PARTICIPANT SATISFACTION OVER THE PREVIOUS PASSIVE VIEWER SYSTEMS.

THE UNIVERSITY OF MARYLAND CHOSE THE ITV SYSTEM BECAUSE OF THE EXPERIENCE OF OTHER INSTITUTIONS THAT HAVE USED IT. ACCORDING TO THE UNIVERSITY OF MARYLAND STUDY ON THE ITV SYSTEM, THE DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, SUMMARIZING THE RESULTS OF 350 RESEARCH STUDIES, HAS REPORTED "THE VAST MAJORITY OF THESE STUDENTS HAS REVEALED NO SIGNIFICANT DIFFERENCE IN THE MEASURED PERFORMANCE BETWEEN STUDENTS WHO WERE INSTRUCTED VIA TELEVISION AND THOSE WHO WERE TAUGHT DIRECTLY ..."

THE EXISTENCE OF THIS SYSTEM PERMITS THE POSSIBLE CONSIDERATION AND TESTING OF A NON-TRADITIONAL MEANS OF PROVIDING GRADUATE INSTRUCTION THAT WOULD DRAW UPON THE EXISTING RESOURCES IN THE VIRGINIA AND MARYLAND SCHOOLS OF ENGINEERING AND AVOID A CONSIDERABLE CAPITAL INVESTMENT BY THE COMMONWEALTH. THIS OPTION IS ATTRACTIVE IN VIEW OF THE TERMS UNDER WHICH THE VIRGINIA-MARYLAND REGIONAL SCHOOL OF VETERINARY MEDICINE HAS BEEN OPENED AT VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY IN BLACKSBURG. THE MAJORITY OF CAPITAL INVESTMENT FOR THE VETERINARY SCHOOL WILL BE MADE BY VIRGINIA, SINCE THE FACILITIES WILL BE LOCATED HERE. IN MEETING SOME OF THE ENGINEERING NEEDS OF NORTHERN VIRGINIA, IT MIGHT BE POSSIBLE TO TAKE ADVANTAGE OF A CAPITAL INVESTMENT ALREADY MADE BY MARYLAND BY SEEKING A COOPERATIVE AGREEMENT BETWEEN THE UNIVERSITY OF MARYLAND AND GEORGE MASON UNIVERSITY TO MAKE INSTRUCTION AVAILABLE IN VIRGINIA.

V. CONCLUSIONS

THE FOLLOWING CONCLUSIONS ARE DRAWN FROM THE CONSULTANTS' REPORT, THE GEORGE MASON UNIVERSITY NSF STUDY, ADDITIONAL INFORMATION PROVIDED BY THE CONSULTANTS BUT NOT INCLUDED IN THEIR REPORT, AND STAFF DISCUSSIONS WITH ADVISORY COMMITTEE MEMBERS.

A. NORTHERN VIRGINIA AREA

1. THE NEEDS OF NORTHERN VIRGINIA DIFFER CONSIDERABLY FROM THOSE OF RICHMOND-PETERSBURG AND REFLECT THE CONCENTRATION OF "HIGH-TECHNOLOGY" INDUSTRIES THERE. THE PRIMARY DEMANDS FOR GRADUATE INSTRUCTION ARE IN THEORETICAL AREAS PERTAINING TO COMPUTER HARDWARE AND SOFTWARE DESIGN, OPERATIONS RESEARCH, HIGH SPEED DATA TRANSMISSION, INFORMATION SYSTEMS, AND THE CONNECTION BETWEEN HIGHLY COMPLEX DEVICES AND THEIR USERS.
2. THE RELATIONSHIP BETWEEN UNDERGRADUATE AND GRADUATE ENGINEERING PROGRAMS IS SUCH THAT THE UNDERGRADUATE OFFERINGS TRADITIONALLY FORM THE BASIS FOR GRADUATE OFFERINGS. WHILE IT IS POSSIBLE TO HAVE AN UNDERGRADUATE SCHOOL WITHOUT GRADUATE OFFERINGS, IT IS PROBABLY NOT FEASIBLE TO CONSIDER THE DEVELOPMENT OF A GRADUATE SCHOOL OF ENGINEERING BY ITSELF.
3. THERE IS A NEED IN NORTHERN VIRGINIA FOR GRADUATE INSTRUCTION IN THE TRADITIONAL ENGINEERING FIELDS.
4. THERE IS A SIGNIFICANT NEED FOR NON-CREDIT AND SHORT COURSES IN ENGINEERING.
5. THERE IS DEMAND FOR UNDERGRADUATE ENGINEERING BY INDIVIDUALS WHO ARE UNABLE TO RELOCATE TO THE EXISTING VIRGINIA SCHOOLS OF ENGINEERING OR BEAR THE FINANCIAL BURDEN OF ATTENDING THE EXISTING INSTITUTIONS IN THE DISTRICT OF COLUMBIA METROPOLITAN AREA. THE CONSULTANTS WERE ADVISED BY THE EXISTING SCHOOLS OF ENGINEERING IN THE DISTRICT OF COLUMBIA OF THEIR DESIRE TO ENROLL MORE UNDERGRADUATE STUDENTS.

B. RICHMOND-PETERSBURG

1. THE NEEDS OF RICHMOND-PETERSBURG REFLECT THE HIGHER CONCENTRATION OF MANUFACTURING INDUSTRIES THERE. THE PRIMARY DEMANDS FOR GRADUATE INSTRUCTION ARE IN MECHANICAL AND ELECTRICAL ENGINEERING.
2. THE RELATIONSHIP BETWEEN UNDERGRADUATE AND GRADUATE ENGINEERING EDUCATION IS SUCH THAT THE UNDERGRADUATE OFFERINGS TRADITIONALLY FORM THE BASIS FOR GRADUATE OFFERINGS. WHILE IT IS POSSIBLE TO HAVE AN UNDERGRADUATE SCHOOL WITHOUT GRADUATE OFFERINGS, IT IS PROBABLY NOT FEASIBLE TO CONSIDER THE DEVELOPMENT OF A GRADUATE SCHOOL OF ENGINEERING BY ITSELF.

3. THE NEED FOR GRADUATE INSTRUCTION IS NOT WELL DOCUMENTED IN THE RICHMOND-PETERSBURG AREA AT THIS TIME.
4. THERE IS A NEED FOR NON-CREDIT AND SHORT COURSES IN ENGINEERING.
5. THERE IS A DEMAND FOR UNDERGRADUATE ENGINEERING INSTRUCTION. INDUSTRY SEEMS RECEPTIVE TO THE CONCEPT OF A CO-OP PROGRAM COMBINING ALTERNATIVE PERIODS OF WORK AND STUDY.

VI. RECOMMENDATIONS

THESE RECOMMENDATIONS ARE PRESENTED BY REGION REFLECTING THE DIFFERENT KINDS OF INDUSTRY, DIFFERENT COLLEGES AND UNIVERSITIES, AND DIFFERENT SIZES OF POPULATION.

1. NORTHERN VIRGINIA

A. COUNCIL APPROVE SEVERAL GEORGE MASON PROGRAMS IN COMPUTER SCIENCE, OPERATIONS RESEARCH, INFORMATION SYSTEMS, COMPUTER ELECTRONICS AND DESIGN TO MEET NEED FOR GRADUATE HIGH TECHNOLOGY. THESE SHOULD BE OFFERED COOPERATIVELY WITH OLD DOMINION, AND WITH THE UNIVERSITY OF VIRGINIA AND VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY AS APPROPRIATE.

B. THREE GRADUATE ENGINEERING SCHOOLS (ODU, UVA, VPI&SU) CONTINUE OR INCREASE OFF-CAMPUS OFFERINGS IN TRADITIONAL ENGINEERING IN NORTHERN VIRGINIA. OFF-CAMPUS ENGINEERING SHOULD BE FUNDED AT ON-CAMPUS LEVELS.

C. GEORGE MASON SEEK AN AGREEMENT WITH THE UNIVERSITY OF MARYLAND UNDER WHICH MARYLAND'S TELEVISION AND TWO-WAY VOICE CAPACITY CAN BE USED TO OFFER GRADUATE ENGINEERING IN NORTHERN VIRGINIA ON A TRIAL BASIS FOR ONE YEAR. FUNDS NECESSARY FOR SUCH AN AGREEMENT SHOULD BE APPROPRIATED AS A SEPARATE LINE ITEM EITHER TO GMU OR TO THE COUNCIL OF HIGHER EDUCATION FOR SUBSEQUENT TRANSFER TO GMU. IF SUCCESSFUL, VIRGINIA SHOULD CONSIDER EQUIPPING ITS GRADUATE ENGINEERING SCHOOLS TO OFFER SIMILAR PROGRAMS ACROSS THE STATE.

D. THE COUNCIL OF HIGHER EDUCATION, ACTING ON BEHALF OF THE COMMONWEALTH, SHOULD SEEK CONTRACTS FOR SPACES IN THE FIVE UNDERGRADUATE ENGINEERING PROGRAMS IN THE METROPOLITAN WASHINGTON AREA (MARYLAND, GEORGE WASHINGTON, CATHOLIC, UNIVERSITY OF THE DISTRICT OF COLUMBIA AND HOWARD).

2. RICHMOND-PETERSBURG

A. THREE GRADUATE ENGINEERING SCHOOLS (ODU, UVA, VPI&SU) CONTINUE OR INCREASE OFF-CAMPUS OFFERINGS

IN TRADITIONAL ENGINEERING IN RICHMOND-PETERSBURG. OFF-CAMPUS ENGINEERING SHOULD BE FUNDED AT ON-CAMPUS LEVELS.

B. VIRGINIA STATE AND VIRGINIA COMMONWEALTH DEVELOP COOPERATIVE ENGINEERING PROGRAMS FOR UNDERGRADUATES, CONSISTING OF TWO OR THREE YEARS AT VSU OR VCU; WORK EXPERIENCE IN RICHMOND-PETERSBURG INDUSTRY; TRANSFER TO ODU. VPI&SU OR UVA WITH FORMAL EDUCATION AND WORK EXPERIENCE ALTERNATED OVER THREE YEARS UNTIL THE DEGREE IS EARNED. THIS CLASSIC "COOPERATIVE EDUCATION" PATTERN HAS BEEN USED FOR YEARS BY NORTHEASTERN UNIVERSITY, BOSTON, MASSACHUSETTS.

C. VIRGINIA STATE CONTINUE TO DEVELOP ITS ENGINEERING TECHNOLOGY PROGRAMS.

3. <u>STATEWIDE</u>

A. VIRGINIA'S INSTITUTIONS OFFERING ENGINEERING, AND AS WELL AS VIRGINIA COMMONWEALTH UNIVERSITY, VIRGINIA STATE UNIVERSITY AND GEORGE MASON UNIVERSITY, SHOULD FORM AN ENGINEERING EDUCATION PLANNING GROUP TO PERFORM THE FOLLOWING TASKS:

1. COORDINATE OFF-CAMPUS ENGINEERING PROGRAM OFFERINGS, AND DRAW THE COUNCIL'S ATTENTION TO ANY LOGISTICAL OR FUNDING PROBLEMS THAT ARISE;

2. MONITOR THE TRIAL USE OF CLOSED CIRCUIT TELEVISION AS A MEANS OF PROVIDING INSTRUCTION. AND REPORT TO THE COUNCIL WITH RECOMMENDATIONS;

3. DEVELOP THE AGREEMENTS NECESSARY TO BEGIN COOPERATIVE UNDERGRADUATE ENGINEERING PROGRAMS IN THE RICHMOND-PETERSBURG AREA; AND

4. ASSIST VSU IN DEVELOPING TRANSFER AGREEMENTS WITH TWO-YEAR INSTITUTIONS TO ENABLE THEIR STUDENTS TO CONTINUE WORK TOWARD BACHELOR'S DEGREES IN ENGINEERING TECHNOLOGY.

B. THE ENGINEERING EDUCATION PLANNING GROUP SHOULD ELECT A PERSON REPRESENTING ONE OF THE INSTITUTIONS AS ITS CONVENING OFFICER, AND SHOULD MAKE A REPORT ON ITS ACTIVITIES TO THE COUNCIL OF HIGHER EDUCATION IN THE FALL OF EACH YEAR AT A MINIMUM. THE COUNCIL SHOULD ASSIST THE PLANNING GROUP IN ITS

ACTIVITIES, AND A MEMBER OF THE COUNCIL STAFF SHOULD BE A MEMBER EX OFFICIO OF THE GROUP.

ALTERNATIVE RESPONSE. THE FOLLOWING OPTIONS WERE CONSIDERED, BUT NOT RECOMMENDED BY STAFF, SINCE:

(A) IN NORTHERN VIRGINIA, INDICATIONS THAT MOST INDUSTRIAL DEMAND IS ACTUALLY FOR PERSONS TRAINED IN COMPUTER-RELATED SKILLS RATHER THAN THE FULL ARRAY OF TRADITIONAL ENGINEERING DISCIPLINES;
(B) HIGH COSTS;
(C) EXPECTED SHARP DECLINE IN 18-21 YEAR OLD STUDENTS BY 1985;
(D) HISTORIC PATTERN OF CYCLIC INDUSTRIAL DEMAND FOR ENGINEERS; (E) VIRGINIA NOW PRODUCES ENGINEERS AT BETTER THAN THE NATIONAL RATE PER 100,000 POPULATION; (F) LACK OF PH.D. ENGINEERS WILL MAKE STAFFING NEW SCHOOLS EXTREMELY DIFFICULT; AND (G) EXPRESSED INTEREST IN HB419 IN FINDING WAYS IN WHICH NEEDS CAN BE MET BY COOPERATION BETWEEN EXISTING ENGINEERING SCHOOLS AND URBAN UNIVERSITIES.

1. NORTHERN VIRGINIA

A. COUNCIL APPROVE SEVERAL GEORGE MASON PROGRAMS IN COMPUTER SCIENCE, OPERATIONS RESEARCH, INFORMATION SYSTEMS, COMPUTER ELECTRONICS AND DESIGN TO MEET NEED FOR GRADUATE HIGH TECHNOLOGY. THESE SHOULD BE OFFERED COOPERATIVELY WITH OLD DOMINION, AND WITH THE UNIVERSITY OF VIRGINIA AND VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY AS APPROPRIATE.

B. COUNCIL AUTHORIZE GEORGE MASON TO BUILD, EQUIP AND STAFF A SCHOOL OF ENGINEERING, WITH PROGRAMS EVENTUALLY OFFERED AT THE GRADUATE AND UNDERGRADUATE LEVELS. THE COST OF STARTING (NOT OPERATING) A SCHOOL WOULD BE IN EXCESS OF TEN MILLION DOLLARS.

2. RICHMOND-PETERSBURG

A. COUNCIL AUTHORIZE VIRGINIA STATE UNIVERSITY TO BUILD, EQUIP AND STAFF A SCHOOL OF ENGINEERING, WITH PROGRAMS EVENTUALLY OFFERED AT THE GRADUATE AND UNDERGRADUATE LEVELS.

B. THREE GRADUATE ENGINEERING SCHOOLS (ODU, UVA, VPI&SU) CONTINUE OR INCREASE OFF-CAMPUS OFFERINGS IN TRADITIONAL ENGINEERING IN RICHMOND-PETERSBURG. OFF-CAMPUS ENGINEERING SHOULD BE FUNDED AT ON-CAMPUS LEVELS.

C. VIRGINIA STATE CONTINUE TO DEVELOP ITS ENGINEERING TECHNOLOGY PROGRAMS.

VII. CONSULTANTS' REPORT

REPORT ON GRADUATE AND CONTINUING EDUCATION FOR ENGINEERS IN THE URBAN CORRIDOR OF VIRGINIA

JANUARY 6, 1981

ENGINEERING EDUCATIONAL STUDY

BY

LINTON E. GRINTER

AND

JOHN C. HANCOCK

CONSULTANTS TO THE COUNCIL FOR HIGHER EDUCATION

RICHMOND, VIRGINIA

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*SEE "CRITERIA FOR EVALUATING OFF-CAMPUS GRADUATE PROGRAMS", PUBLISHED JANUARY, 1980 BY THE CONFERENCE OF SOUTHERN GRADUATE SCHOOLS.

PREMISES BASIC TO THE STUDY OF GRADUATE AND CONTINUING ENGINEERING EDUCATION

1. AS TECHNOLOGY INCREASES IN COMPLEXITY, THE PERCENTAGE OF ENGINEERS WITH ADVANCED DEGREES WOULD BE EXPECTED TO GROW. INSTEAD, RECENT GROWTH HAS BEEN IN BACCALAUREATE DEGREES WITH MASTER'S ENROLLMENTS BEING RATHER STATIC AND THE DOCTORATES DECREASING SIGNIFICANTLY.

2. WITH SOME FORTY PERCENT OF THE DOCTORATES BEING AWARDED TO FOREIGN STUDENTS THERE IS A SERIOUS QUESTION AS TO THE SOURCES OF NEW FACULTY THROUGH THE NINETEEN EIGHTIES.

3. AS AN AID TO IMPROVING THE IMBALANCES MENTIONED ABOVE IT IS EVIDENT THAT THERE SHOULD BE INCREASED ATTENTION TO PART-TIME AND EVENING CLASSES OR PROGRAMS FOR EMPLOYED ENGINEERS.

4. TO ATTRACT EMPLOYED ENGINEERS INTO PART-TIME PROGRAMS THE PLANNING SHOULD BE SUFFICIENTLY DEFINITE SO THAT THE POTENTIAL STUDENT CAN FEEL ASSURANCE OF COMPLETION WHICH IN SOME CASES WOULD RESULT IN AN ADVANCED DEGREE.

5. BECAUSE COURSES PLANNED FOR THE NEEDS OF ADVANCED STUDENTS ATTRACT LARGELY EMPLOYED ENGINEERS, A CLOSE RELATIONSHIP WITH ENGINEER EMPLOYING INDUSTRY AT THE LOCAL LEVEL IS ESSENTIAL.

6. THE GROWING IMPORTANCE OF AVAILABILITY OF ADVANCED ENGINEERING PROGRAMS ON A PART-TIME BASIS LEADS TO CONSIDERATION OF REASONABLE AND ASSURED FUNDING OF SUCH PROGRAMS WHICH IN THE PAST HAVE OPERATED ON TUITION OR WITHOUT SEPARATE BUDGETING.

7. SINCE THE ACADEMIC RESOURCES OF THE COMMONWEALTH OF VIRGINIA ARE AT FIXED LOCATIONS WHILE THE NEED FOR PART-TIME ENGINEERING EDUCATIONAL PROGRAMS FOR EMPLOYED ENGINEERS DOES NOT NEATLY COINCIDE. SOME ORGANIZATIONAL ARRANGEMENT THAT MAKES COOPERATION BETWEEN INSTITUTIONS EASIER SHOULD BE STUDIED.

8. AMONG OTHER PROBLEMS IT IS CLEAR THAT TRANSFER OF CREDITS. AWARD OF DEGREES. ORGANIZED COUNSELING AND COST REIMBURSEMENT MUST ALL BE SOLVED IF A SUCCESSFUL OFF-CAMPUS ENGINEERING PROGRAM IS TO DEVELOP.

JANUARY 6.1981

1. PREFACE RELATING THIS STUDY TO THE VCU STUDY OF EARLY 1980. AS OF MAY 1980 THE FIRST CONSULTANT COMPLETED A STUDY OF THE INDUSTRIAL NEED FOR ENGINEERS IN THE RICHMOND METROPOLITAN AREA VERSUS THE SUPPLY OF NEW GRADUATE ENGINEERS. AFTER AN INITIAL MEETING WITH INDUSTRIAL AND GOVERNMENTAL REPRESENTATIVES FROM RICHMOND, A DOZEN OR MORE INDUSTRIES WERE VISITED FOR DISCUSSIONS WITH ADMINISTRATORS AND COMPANY RECRUITERS CONCERNING THE MUCH PUBLICIZED SHORTAGE OF ENGINEERS. MOST OF THESE DISCUSSIONS WERE ATTENDED BY SEVERAL INDIVIDUALS REPRESENTING BOTH CENTRAL AND DIVISIONAL RESPONSIBILITIES. ALSO, THE FOUR ENGINEERING SCHOOLS IN VIRGINIA WERE VISITED TO SENSE THE ATTITUDES OF ACADEMIC ADMINISTRATORS TOWARD OFF-CAMPUS INSTRUCTION IN ENGINEERING.

IT WAS SOON APPARENT THAT RICHMOND INDUSTRIES WERE LARGELY INVOLVED IN PRODUCT MANUFACTURE, MOST OFTEN A MECHANICAL ENGINEERING NATURE. HOWEVER, THERE IS AN INCREASING USE OF ELECTRICAL ENGINEERS AND COMPUTER SPECIALISTS FOR THE PURPOSE OF AUTOMATION. THERE IS LITTLE RESEARCH ACTIVITY, THE MAIN INTEREST BEING IN ADAPTING KNOWN TECHNOLOGY TO REDUCING THE COST OF PRODUCT. IT WAS ALSO MADE CLEAR TO THE CONSULTANT THAT NO GREAT SHORTAGE OF ENGINEERS EXISTED IN RICHMOND, CERTAINLY NOT OF A CRITICAL NATURE. TO RECHECK THIS VIEW, TWO LARGE CORPORATIONS HAVING THEIR CENTRAL OFFICES IN RICHMOND WERE REVISITED IN THE FALL OF 1980. THESE DISCUSSIONS CONFIRMED THE IMPRESSION OF SIX MONTHS EARLIER THAT ENGINEERING NEEDS ARE BEING FULFILLED.

THE VCU REPORT COVERED SEVERAL OTHER MATTERS OF IMPORTANCE RELATIVE TO GRADUATE AND CONTINUING EDUCATION OF ENGINEERS IN THE RICHMOND AREA. HOWEVER, SINCE THERE ARE GREAT CONTRASTS BETWEEN ENGINEERING AS PRACTICED IN RICHMOND AND IN NORTHERN VIRGINIA IT SEEMED DESIRABLE TO COVER ALL OTHER POINTS OF THE VCU REPORT IN THE APPROPRIATE SECTIONS OF THIS DOCUMENT WHERE EMPHASIS CAN BE PLACED UPON THE CRITICAL DIFFERENCES BETWEEN THE GEOGRAPHICAL AREAS STUDIED.

2. UNDERGRADUATE AND GRADUATE ENGINEERING EDUCATION. THE CHARGE FROM THE VIRGINIA LEGISLATURE TO SCHEV WAS TO STUDY AND REPORT ON THE PROVISION FOR GRADUATE AND CONTINUING EDUCATION FOR ENGINEERS IN THE URBAN CORRIDOR. IT WAS CLEARLY THE EXPRESSED HOPE OF THE RESOLUTION THAT BY COOPERATION BETWEEN GEORGE MASON UNIVERSITY, VIRGINIA COMMONWEALTH UNVERSITY, AND OLD DOMINION UNIVERSITY ANY PROJECTED NEED FOR ENGINEERING EDUCATION FROM NORTHERN VIRGINIA TO RICHMOND COULD BE MET BY COOPERATION BETWEEN THE EXISTING ENGINEERING SCHOOLS OF THE COMMONWEALTH, AND WITHOUT SIGNIFICANT ADDITIONS THERETO (APPENDIX A).

THE OMISSION OF REFERENCE TO UNDERGRADUATE ENGINEERING EDUCATION AND THE EMPHASIS UPON GRADUATE AND CONTINUING EDUCATION IN THE LEGISLATURE'S RESOLUTION OVERLOOKS THE ESSENTIAL RELATION BETWEEN THEM. THE CHARACTER OF ON-CAMPUS GRADUATE EDUCATION IS CONTROLLED TO A LARGE DEGREE BY THE CONTENT OF RELATED

UNDERGRADUATE CURRICULA. GRADUATE EDUCATION ON CAMPUS IS DESIGNED FOR FULL-TIME STUDENTS WHOSE INITIAL OBJECTIVE COMMONLY IS A MASTER'S DEGREE, AFTER WHICH A SMALL PERCENTAGE MAY COMPLETE A DOCTORATE. OFF-CAMPUS GRADUATE COURSES USUALLY OFFERED IN THE EVENING ARE A PART OF CONTINUING EDUCATION. SUCH COURSES ARE USED PRIMARILY BY EMPLOYED ENGINEERS ON A PART-TIME BASIS. ONLY A SMALL FRACTION OF GRADUATE LEVEL COURSES COMPLETED BY EMPLOYED ENGINEERS ARE EVENTUALLY USED AS CREDITS FOR AWARD OF AN ADVANCED DEGREE. THEIR PURPOSE HAS BEEN ACHIEVED MUCH EARLIER IN MODERNIZING OR UPGRADING THEIR ENGINEERING ENROLLEES. THE CONSULTANTS HEARD TESTIMONY FROM MORE THAN ONE INDUSTRY ADMINISTRATIVE ENGINEER THAT HE HAD PERSONALLY COMPLETED SEVERAL EVENING COURSES TO FILL OUT HIS EDUCATIONAL BACKGROUND AND TO UPDATE HIS SPECIALTY DURING A PROFESSIONAL AND LATER AN ADMINISTRATIVE CAREER.

3. INDUSTRY IN THE RICHMOND AND NORTHERN VIRGINIA AREAS. THE FIRST CONSULTANT HAD VISITED A DOZEN INDUSTRIES IN THE SPRING OF 1980 WITHIN THE RICHMOND METROPOLITAN AREA FOR DISCUSSIONS ON THE HIRING AND UTILIZATION OF ENGINEERS. IN THE FALL OF 1980 VISITS WERE CONDUCTED BY BOTH CONSULTANTS WITH SEVERAL LARGE INDUSTRIES LOCATED IN NORTHERN VIRGINIA, SOUTH AND WEST OF WASHINGTON, D.C. A MEETING OF SOME TEN INDUSTRY REPRESENTATIVES FROM NORTHERN VIRGINIA WAS ARRANGED BY GEORGE MASON UNIVERSITY TO PROVIDE THE TWO CONSULTANTS WITH THE VIEWS OF SMALL TO MEDUIM SIZE COMPANIES EMPLOYING FROM TEN TO A FEW HUNDRED ENGINEERS. TWO LARGE FEDERAL AGENCY HEADQUARTERS WERE ALSO VISITED FOR DISCUSSIONS ON PROBLEMS IN RECRUITING, UPGRADING AND RETAINING ENGINEERS. OF COURSE, ANY INDUSTRIAL AREA OF LARGE MAGNITUDE, SUCH AS THAT OF RICHMOND OR THAT OF NORTHERN VIRGINIA, WILL PRESENT A MIX OF HARDWARE AND SOFTWARE USAGE RELATED TO THE PROCESSING OF MATERIALS. SOME ENGINEERS IN THESE PLANTS MANAGE REPETITIVE OUTPUT, OTHERS PROVIDE UNIQUE PLANS, MODELS AND CONCEPTS. NEVERTHELESS, IT WAS READILY OBSERVABLE THAT RICHMOND INDUSTRY IS PREDOMINANTLY HARDWARE, MATERIALS AND MARKETABLE PRODUCT ORIENTED. IN CONTRAST, THE INDUSTRY OF NORTHERN VIRGINIA IS HEAVILY WEIGHTED TOWARD THE PROVISION OF SPECIAL TECHNOLOGICAL SERVICES THROUGH CONTRACTS WITH MANY AGENCIES OF THE FEDERAL GOVERNMENT, OR INDIRECTLY THROUGH SUBCONTRACTS WITH GIANT SUPPLIERS. SUCH SPECIAL SERVICES CAN INVOLVE USE OF HIGH TECHNOLOGY HARDWARE, BUT THE DELIVERABLE OUTPUT IS USUALLY THAT OF A REPORT PROVIDING CONCEPTS, PLANS AND MODELS OR PROJECTIONS.

4. RICHMOND INDUSTRY'S USE OF BACCALAUREATE ENGINEERS. IT IS CLEARLY OBSERVABLE THAT THE RECRUITMENT OF ENGINEERS IS RELATED TO THE TYPE OF INDUSTRY. WHILE CIVIL ENGINEERS ARE EMPLOYED BY TRANSPORTATION AND WATER RESOURCE AGENCIES, AND MECHANICAL ENGINEERS BY HEAVY INDUSTRY, HIGH TECHNOLOGY COMPANIES CURRENTLY SEEK ELECTRONIC ENGINEERS AND COMPUTER ORIENTED SPECIALISTS. AS TO LEVEL OF PROFESSIONAL EDUCATION, THE GREAT MAJORITY OF RICHMOND COMPANIES EXPRESSED SATISFACTION WITH BACHELOR DEGREE ENGINEERS BUT DESIRED AVAILABILITY OF MASTER'S LEVEL COURSES AND PROGRAMS. ALTHOUGH SOME PROFESSIONAL RECOGNITION IS OFFERED TO

MASTER'S DEGREE ENGINEERS. MOST RICHMOND COMPANIES EXPRESSED THE VIEW THAT THEIR IN-PLANT TRAINING. INVOLVING WORK EXPERIENCE. WAS THE PRIMARY QUALIFICATION FOR ADVANCEMENT. THE PURPOSE OF CONTINUING EDUCATION COURSES. AS CONTRASTED TO HIGHLY APPLIED SHORT COURSES. SEEMED TO BE LARGELY FOR THE SATISFACTION OF ENGINEERING EMPLOYEES. IN DISCUSSIONS WITH REPRESENTATIVES OF ENGINEERING CONSULTANTS. AND WITH FIRMS OF PRACTICING ENGINEERS. THE POINT WAS MADE BOTH IN RICHMOND AND IN THE GROUP MEETING AT GMU THAT THESE RELATIVELY SMALL COMPANIES WOULD RECOMMEND SOME REDUCTION IN NON-ENGINEERING COURSES AND OF THEORY COURSES TO MAKE ROOM IN UNDERGRADUATE CURRICULA FOR MORE EMPHASIS UPON ENGINEERING ART AND PRACTICE. THE CONSULTANTS WOULD CALL ATTENTION TO THE FACT THAT SUCH A CHANGE WOULD INCREASE THE DIFFICULTY OF DISTINGUISHING THE ENGINEER FROM THE ENGINEERING TECHNOLOGIST.

5. NORTHERN VIRGINIA INDUSTRY'S USE OF ENGINEERS.* HAVING CLARIFIED THAT THE PROFESSIONAL ENGINEERING FIRMS AND MANUFACTURING COMPANIES OF SMALL SIZE. WHEREVER LOCATED. WOULD PREFER TO EMPLOY NEW BACCALAUREATE ENGINEERS WITH A MORE PRACTICAL ORIENTATION THAN THOSE OF 1980. WE CAN SEPARATE OUT THE LARGE THINK-TANK INDUSTRIES OF NORTHERN VIRGINIA FOR SPECIAL ANALYSIS. TWO VERY LARGE SPECIAL SERVICE COMPANIES OF THEORETICAL ORIENTATION WERE VISITED ALONG WITH A BRANCH OF GIANT SUPPLIER OF THE CHEMICAL INDUSTRY AND ONE OF COMPUTERS INVOLVING ALL OF THEIR APPLICATIONS. IT WAS IMMEDIATELY CLEAR THAT THE SO-CALLED "THINK-TANK" INDUSTRIES. FINANCIALLY DEPENDENT UPON THE FEDERAL GOVERNMENT FOR CONTINUING CONTRACTS FOR INNOVATIVE CONCEPTS. PLANS. MODELS AND PROJECTIONS. NEEDED DIFFERENTLY TRAINED ENGINEERS THAN THE PRODUCT ORIENTED INDUSTRIES OF RICHMOND AND ALSO OF NORFOLK. IN THE FIRST PLACE A MUCH HIGHER PRIORITY WAS BEING ASSIGNED BY THESE INNOVATIVE COMPANIES TO ADVANCED DEGREES OF ENGINEERING EMPLOYEES. AN ADDED VALUE WAS ATTACHED TO ACADEMIC RESEARCH EXPERIENCE OFTEN ASSOCIATED WITH THE PH.D. DEGREE. THE TYPICAL NEW ENGINEERING EMPLOYEE OF THESE COMPANIES HAS TWO TO FIVE YEARS OF PREVIOUS EXPERIENCE. ALTHOUGH SOME NEW BACCALAUREATES ARE ALSO HIRED.

BEYOND THESE CONSIDERATIONS THE LARGE BELTWAY COMPANIES REQUIRE ENGINEERS COMPETENT TO WORK AT THE LEVEL OF HIGH TECHNOLOGY AND TO CONTRIBUTE TO GROUP SOLUTION OF PEPPLEXING PROBLEMS. TODAY ADVANCED TECHNOLOGY IS ALMOST SYNONYMOUS WITH ADVANCED USE OF COMPUTERS IN THE AREA OF ARTIFICIAL INTELLIGENCE. HENCE. ELECTRONIC ENGINEERS WHO HAVE EXPERIENCE WITH COMPUTER DESIGN CARRY A HIGH PRIORITY FOR EMPLOYMENT. GRADUATES OF COMPUTER SCIENCE PROGRAMS ARE ALSO IN STRONG DEMAND. HOWEVER. THE FUTURE OF THE WASHINGTON THINK TANKS WILL DEPEND HEAVILY UPON THEIR SUCCESS IN RECRUITING INNOVATIVE ENGINEERS. FOR THE NEXT SEVERAL YEARS THERE WILL BE STONG COMPETITION FOR THE LIMITED

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*A GMU-NSF SURVEY AND REPORT ON USE AND NEED FOR ENGINEERS IN THE WASHINGTON METROPOLITAN AREA IS AVAILABLE.

NUMBER OF HIGH LEVEL INNOVATIVE ENGINEERS WHO HAVE BEEN PRODUCED THROUGH ADVANCED EDUCATION FROM THE SMALL BACCALAUREATE CLASSES OF THE YEARS 1970-75.

6. QUESTION OF A NEW SCHOOL OF ENGINEERING IN VIRGINIA. IT IS IMPORTANT TO REPEAT THAT THE REQUEST OF THE VIRGINIA LEGISLATURE WAS FOR A STUDY OF "GRADUATE AND CONTINUING ENGINEERING EDUCATION". THE CONSULTANTS RECOGNIZE THAT GRADUATE AND UNDERGRADUATE ENGINEERING EDUCATION CAN NOT BE SEPARATED ENTIRELY BECAUSE ONE BUILDS UPON THE OTHER. ALSO, AS OF 1980 THE OUTPUT OF THE U.S. ENGINEERING SCHOOLS IN TERMS OF BACHELOR DEGREES IS STILL RISING FROM AN ALL-TIME HIGH, ROUGHLY TWICE THE ANNUAL NUMBER OF BACCALAUREATES PRODUCED LESS THAN TEN YEARS AGO. THE FOUR PUBLICLY SUPPORTED ENGINEERING SCHOOLS IN VIRGINIA HAVE GROWN IN STEP WITH THE NATIONAL OUTPUT, AWARDING SOME 1500 BACCALAUREATE AND ADVANCED DEGREES IN 1979 (APPENDIX E).

IN A PREVIOUS REPORT, PREPARED AT THE REQUEST OF VCU, THE FIRST CONSULTANT HAS POINTED OUT THAT THE 600,000 RESIDENTS OF THE RICHMOND METROPOLITAN AREA ARE FAR SHORT OF THE POPULATION BASE OF ONE MILLION WHICH IS THE AVERAGE PER ACCREDITED ENGINEERING SCHOOL IN THE USA. IN CONTRAST, THE POPULATION BASE IN NORTHERN VIRGINIA IS MORE THAN ADEQUATE. IF IT WAS ASSURED THAT THE FEDERAL EXPENDITURES BEYOND SAY 1985 WOULD BE AT A VERY HIGH LEVEL INVOLVING MUCH ENHANCED DEFENSE AND SYNTHETIC FUEL COMMERCIALIZATION ALONG WITH GROWTH OF SUPPORTING FACILITIES, THE COMMONWEALTH OF VIRGINIA COULD AT THAT TIME CONSIDER THE ESTABLISHMENT OF A NEW UNDERGRADUATE AND MASTER'S LEVEL SCHOOL OF ENGINEERING IN NORTHERN VIRGINIA TO HELP MEET THE NATIONS TECHNOLOGICAL MANPOWER NEEDS. A RECOMMENDATION IN THIS REGARD WILL NOT BE MADE FOR THE FOLLOWING REASONS:

1) THE CONSULTANT'S CHARGE WAS CLEARLY STATED TO BE A STUDY OF "GRADUATE AND CONTINUING EDUCATION" (APPENDIX A).

2) THE EXTREMELY RAPID RATE OF GROWTH OF POPULATION IN NORTHERN VIRGINIA HAS SLOWED SIGNIFICANTLY IN THE PAST SEVERAL YEARS (APPENDIX K).

3) BECAUSE THE OUTPUT OF BACCALAUREATE ENGINEERS IS AT AN ALL TIME HIGH, AND STILL GROWING, IT IS TIME TO EMPHASIZE QUALITY OVER GREATER QUANTITY IN UNDERGRADUATE ENGINEERING EDUCATION. (APPENDIX E)

THE CONSULTANTS THEREFORE SUGGEST THAT A LOWER PRIORITY SHOULD BE GIVEN TO FURTHER GROWTH OF BACCALAUREATE OUTPUT OF ENGINEERS IN VIRGINIA VERSUS UPGRADING BOTH PRESENT AND FURTURE EMPLOYED ENGINEERS. AT LEAST UNTIL GREATER EVIDENCE DEVELOPS THAT THE U.S. WILL UNDERTAKE CRASH PROGRAMS FOR DEFENSE AND ENERGY INDEPENDENCE.

7. NATIONAL NEED AND AVAILABILITY OF BACCALAUREATE ENGINEERS. IT SEEMS QUITE WELL UNDERSTOOD THAT THE ANNUAL

NUMBER OF B.S. GRADUATES FROM OUR COLLEGES OF ENGINEERING HAS VARIED RATHER WIDELY IN THE GENERAL FORM OF A SINE CURVE. FROM 1950-1978 THE EXTREME OUTPUT RANGED FROM 25,000 TO 50,000 NEW BACCALAUREATE ENGINEERS ANNUALLY. THE B.S. GRADUATES OF 1979 REACHED 52,598 AND FOR 1980 THE TOTAL JUST ANNOUNCED BY THE ENGINEERING MANPOWER COMMISSION IS 58,742 FIRST TIME GRADUATES. APPLICATION OF SIMPLE EXTRAPOLATION BASED UPON PRESENT AND PAST CLASS SIZES OF FRESHMEN, SOPHOMORES, JUNIORS AND SENIORS INDICATE FURTHER GROWTH OF ENGINEERING GRADUATES THROUGH 1985, PROBABLY REACHING 65,000. THEREAFTER, THE INFLUENCE OF THE LOW BIRTH RATE OF THE 1960-80 PERIOD WILL REDUCE THE POOL OF THE 18-24 YEAR YOUTH WITH RESULTING REDUCTION OF THE NUMBERS OF B.S. GRADUATES.

ONE MIGHT ANTICIPATE THAT SUCH GYRATIONS IN PRODUCTION OF B.S. ENGINEERS WOULD RESULT IN SERIOUS UNEMPLOYMENT DURING PERIODS OF HIGH BACCALAUREATE OUTPUT, BUT THIS HAS NOT OCCURRED. INDUSTRY SEEMS TO HAVE A BUILT-IN CAPACITY FOR EXPANDING AND CONTRACTING ITS ENGINEERING CADRE SUCH THAT ITS DESIRED USE VERSUS ITS MINIMAL NEED FOR ENGINEERS CAN BE ADJUSTED TO THE ENGINEERING MARKET PLACE. WHEN ENGINEERS ARE IN SHORT SUPPLY MOST NEW GRADUATES ARE RECRUITED INTO ENGINEERING DESIGN DEPARTMENTS. ALTERNATIVELY, WHEN THE COLLEGE OUTPUT OF ENGINEERS IS RELATIVELY LARGE, EMPLOYMENT OF B.S. ENGINEERS MAY ALSO OCCUR IN DEPARTMENTS WHERE USE WILL BE MADE OF THE ENGINEER AS A PRACTICAL ANALYST WITH FUTURE MANAGEMENT CAPABILITY RATHER THAN A DESIGNER.

ENGINEERING EMPLOYMENT IS SO DIVERSE THAT FEW ENGINEERS REMAIN IN THE AREA OF PRODUCT DESIGN THROUGH A LIFETIME. MANAGEMENT EVENTUALLY CLAIMS A LARGE FRACTION OF ENGINEERS AND ENTREPENEURSHIP ALSO SHORTENS PROFESSIONAL LIFETIMES. EVEN WHEN THE ENGINEER'S EDUCATION IS LIMITED TO THE B.S. DEGREE HE USUALLY OFFERS INDUSTRY QUALITIES OF MIND AND ACTION THAT HAVE STRONG VALUE FOR EMPLOYMENT. IN LOOKING FORWARD BEYOND 1985 TO EMPLOYMENT OF ENGINEERS, IT IS ESSENTIAL TO TAKE INTO ACCOUNT THE CHANGING PERCENTAGE OF WHITE MALES WHO ARE ALSO U.S. CITIZENS IN THE OVERALL NATIONAL ENGINEERING CADRE. FOR 1980 THE PERCENTAGE OF WOMEN BACCALAUREATE GRADUATES APPROACHED TEN PERCENT, MINORITIES TEN PERCENT AND FOREIGN NATIONALS TEN PERCENT. THESE PERCENTAGES ARE EXPECTED TO INCREASE WHICH MAY BE THE KEY TO MAINTAINING LARGE GRADUATING CLASSES OF ENGINEERS BEYOND 1985.

8. NATIONAL NEED FOR ENGINEERS WITH ADVANCED DEGREES OR EXPERIENCE. THE PRODUCTION OF MASTER'S DEGREE ENGINEERS HAS BEEN STALLED FOR SEVERAL YEARS AT SOMEWHERE BELOW 20,000 GRADUATES PER YEAR. THE EXACT NUMBERS ARE 16,036 FOR 1979 AND 17,243 FOR 1980 (APPENDIX E). IF ONE COMPARES THE NUMBERS OF M.S. DEGREES AWARDED 10 YEARS EARLIER, THEY ARE ROUGHLY THE SAME. HENCE, WHILE B.S. GRADUATES IN

ENGINEERING INCREASED BY 30 TO 50 PERCENT FOR DIFFERENT CURRICULA FROM 1970 TO 1980 THE NUMBER OF M.S. GRADUATES REMAINED RELATIVELY STATIC.

THE PREPONDERANCE OF THE VIEWS REACHING THE CONSULTANTS WAS SIMPLY THAT INDUSTRY, FACED WITH THE NEED TO MODERNIZE PRODUCTION METHODS, HAS REACHED FOR THE MOST AVAILABLE ENGINEERING TALENT, THE GRADUATING BACCALAUREATE ENGINEERS. THROUGH INCREASED RECRUITMENT AND FINANCIAL ATTRACTIONS INDUSTRY HAS REDUCED TO A CRITICAL LEVEL THE NUMBER AND QUALITY OF B.S. GRADUATES WHO WILL CONTINUE FULL TIME AS GRADUATE STUDENTS FOR AN ADVANCED DEGREE. THERE IS SOME EVIDENCE THAT BOTH INDUSTRY AND GOVERNMENT NOW UNDERSTAND THAT A CONTINUATION OF "EATING OUR SEED CORN" WILL INCREASE THE SHORTAGE OF M.S. ENGINEERING GRADUATES INTO A REAL CRISIS. THESE ADVANCED STUDENTS ARE ALSO THE PROFESSOR'S "HANDS" FOR HIS BASIC RESEARCH. AND OFTEN HIS TEACHING ASSISTANTS AS WELL. THE GROWING SHORTAGE OF ENGINEERING PH.D.'S ENHANCES THE PROBLEM.

IN THE MANY INTERVIEWS THAT THE CONSULTANTS HAD WITH INDUSTRY EXECUTIVES THERE WAS A SOMEWHAT DISAPPOINTING REACTION REGARDING THE VALUE OF THE MASTER'S DEGREE. IT APPEARED THAT MECHANICAL AND CIVIL TYPE INDUSTRIES OF SLOWLY CHANGING CHARACTER PLACED GREATER WEIGHT UPON EXPERIENCE THAN UPON EQUAL YEARS DEVOTED TO EITHER FULL-TIME OR PART-TIME CONTINUING EDUCATION. SUCH INDUSTRIES CONDUCT LITTLE RESEARCH. THEY SEEM NOT TO HAVE FOUND A SOLUTION TO THE ENGINEER SHORTAGE THROUGH UPGRADING THEIR PRESENT ENGINEERS EXCEPT BY INTERNAL METHODS NOT RELATED TO ACQUISITION OF THE MASTER'S DEGREE.

A CONTRASTING TYPE OF INDUSTRY VISITED WAS THE LARGE ELECTRONIC AND COMPUTER INVOLVED COMPANIES. THEY WERE ALSO LARGE IN TERMS OF THE NUMBER OF ENGINEERS EMPLOYED. THEY HAVE TENDED TO PLACE EMPHASIS UPON EMPLOYMENT OF YOUNG ENGINEERS AFTER 2 TO 5 YEARS OF EXPERIENCE INCLUDING THOSE WITH THE PH.D. DEGREE SINCE MUCH OF THEIR ENGINEERING WORK IS OF A RESEARCH CHARACTER. CLEARLY, EXPERIENCED ENGINEERS WILL BE DIFFICULT TO EMPLOY BECAUSE THEY COME FROM SMALLER GRADUATING CLASSES THAN THE CLASS OF 1980.

9. <u>DILEMMA OF TIME AND FUNDS TO EXPAND GRADUATE EDUCATION.</u> THE CONSULTANTS SEE A GREAT FUTURE PROBLEM IN FILLING THE NEED OF HIGH TECHNOLOGY INDUSTRY FOR INNOVATIVE ENGINEERS. ALTHOUGH ALL INNOVATIVE ENGINEERS WILL NOT HOLD THE PH.D. DEGREE, OR EVEN A MASTERS DEGREE, THE GREAT MAJORITY WILL. THE TEN-YEAR ZERO GROWTH OF NEW MASTER'S DEGREE ENGINEERS HAS BEEN ACCOMPANIED BY A 24 PERCENT REDUCTION IN THE AWARD OF PH.D. DEGREES IN ENGINEERING, I.E., FROM 3620 IN 1970 TO 2751 IN 1980. WHEN ONE REALIZES THAT SOME 40 PERCENT OF THESE PH.D. DEGREES ARE EARNED BY FOREIGN NATIONALS AND ALL THE REST WOULD BE NEEDED FOR THE NEXT SEVERAL YEARS TO

REFILL THE GROWING VACANCIES ON ENGINEERING FACULTIES. INDUSTRY'S OPPORTUNITY TO FILL ITS INCREASING NEED FOR INNOVATIVE ENGINEERS SEEMS SLIM INDEED. IT WILL HAVE TO JOIN IN SUPPORT OF EXPANDED PH.D. PROGRAMS.

EVEN THOUGH THE GROWING SHORTAGE OF INNOVATIVE OR PH.D. ENGINEERS IS NOW FULLY RECOGNIZED, AND WHEN FUNDS ARE PROVIDED FOR CORRECTION, A NEAR DECADE WILL STILL BE REQUIRED TO OVERCOME THE NEGLECT OF THE 1970'S. THE TRANSFER OF INNOVATIVE ENGINEERS FROM INDUSTRY TO UNIVERSITY AND VICE VERSA DOES NOT INCREASE THE OVERALL POOL. FROM FRESHMAN TO PH.D. IS FULLY SEVEN YEARS, OFTEN TEN. WE NEED TO BEGIN INDOCTRINATING THE MOST PROMISING YOUNG STUDENTS IN THE REWARDS OF RESEARCH AND OF TEACHING TO IMPROVE OUR FACULTIES OF 1990. ALL INDUSTRY NEEDS TO TAKE FAR MORE SERIOUSLY ITS RESPONSIBILITY, COMPANY BY COMPANY, TO ASSIST IN EVERY REASONABLE WAY TO INCREASE THE EFFECTIVENESS OF ENGINEERING FACULTIES. ONLY BY JOINT EFFORT OF STATE AND FEDERAL GOVERNMENTS IN PARTNERSHIP WITH INDUSTRY CAN THE SCHOOLS OF ENGINEERING HOPE TO TRAIN AN ADEQUATE CADRE OF ADVANCED DEGREE ENGINEERS. MORE R AND D ENGINEERS WILL BE ESSENTIAL NOT ONLY TO STIMULATE HIGH TECHNOLOGY INDUSTRY BUT ALSO TO STRENGTHEN AND MODERNIZE THE ENGINEERING SCHOOLS THEMSELVES.

THE CONSULTANTS URGE THE GRADUATE SCHOOLS OF ENGINEERING IN VIRGINIA JOINTLY TO REQUEST FUNDS TO INCREASE SHARPLY THE OUTPUT OF PH.D. ENGINEERS. CONSIDERING THE HIGH SALARY OFFERS BY INDUSTRY FOR THE TOP B.S. ENGINEERS, FELLOWSHIPS AND ASSISTANTSHIPS AT 10,000 DOLLARS PER YEAR ABOVE WITHHOLDING SEEM REQUIRED. ALSO, A MODERNIZING OF LABORATORY EQUIPMENT AND A MAJOR INCREASE IN TECHNICIANS TO ASSIST OVERLOADED FACULTIES WILL BE NEEDED. WITH SUCH AIDS, DEDICATED FACULTIES WILL REMAIN RESEARCH PRODUCTIVE OVER THE PERIOD CLEARLY VISIBLE AHEAD WHEN THE ALTERNATE CHOICE WILL BE TO FILL FACULTY VACANCIES WITH MEDIOCRE SCHOLARS WHO WILL BE MISFITS WHEN THE DEVELOPING SHORTAGE OF ENGINEERS IS OVERCOME.

10. PLANNING OFF-CAMPUS PROGRAMS TO UPGRADE VIRGINIA ENGINEERS. THERE ARE THREE MAJOR AGENCIES THAT PROVIDE CONTINUING EDUCATION FOR ENGINEERS. THE MOST IMPORTANT FOR THIS STUDY ARE UNIVERSITIES. HOWEVER, IT IS RECOGNIZED THAT NEARLY ALL TECHNICAL SOCIETIES, SUCH AS ASCE, ASME, IEEE AND AICHE, PROVIDE SHORT COURSES AND SEMINARS DESIGNED TO HELP ENGINEERS UPDATE THEIR TECHNOLOGICAL BACKGROUNDS (APPENDIX I). ATTENDANCE AT THESE SHORT COURSES MAY BE FORMALIZED BY AWARD OF NON-ACADEMIC CREDITS. SOME CONSIDERATION HAS BEEN GIVEN TO REQUIRING AN ACCUMULATION OF SUCH CREDITS FOR RETENTION OF EACH ENGINEER'S LEGAL REGISTRATION, BUT THE ADOPTION OF SUCH A REQUIREMENT SEEMS UNLIKELY IN MOST STATES. THE OTHER MAJOR SOURCE OF CONTINUING EDUCATION FOR ENGINEERS IS INDUSTRY ITSELF. USUALLY A COMPANY'S IN-HOUSE

EFFORT AT CONTINUING EDUCATION IS LIMITED TO SPECIAL TRAINING FOR PROSPECTIVE MANAGERS. OR SHORT COURSES DESIGNED TO INCREASE KNOWLEDGE OF A SPECIALIZATION IMPORTANT TO THE COMPANY'S IMMEDIATE FUTURE. THE INSTRUCTORS MAY BE COMPANY EMPLOYEES. OR COURSES MAY BE PUT ON BY OUTSIDE CONTRACTORS OR CONSULTANTS.

THE REMAINDER OF THIS SECTION WILL DEAL ONLY WITH UNIVERSITY SPONSORED PROGRAMS OF CONTINUING EDUCATION FOR ENGINEERS. INDIVIDUAL COURSES AND SOME PROGRAMS HAVE BEEN OFFERED BY VPI, UVA AND ODU IN RICHMOND AND ALSO IN NORTHERN VIRGINIA. THE D.C. UNIVERSITIES, MAINLY GEORGE WASHINGTON AND CATHOLIC UNIVERSITY, ALONG WITH THE UNIVERSITY OF MARYLAND. HAVE AT TIMES HAD RATHER EXTENSIVE COURSE OFFERINGS IN NORTHERN VIRGINIA. BUT FEW OF THESE APPEAR TO HAVE BEEN "PLANNED PROGRAMS" IN CONTRAST TO COURSES GIVEN IN RESPONSE TO A PERCEIVED NEED EXPRESSED IN TERMS OF AVAILABLE ENROLLEES OR TUITION INCOME.

IF THE NEED FOR CONTINUING ENGINEERING EDUCATION IN RICHMOND AND IN NORTHERN VIRGINIA HAD BEEN MET, A STUDY WOULD NOT HAVE BEEN NEEDED. THE CONSULTANTS BELIEVE THAT AN OMITTED FACTOR HAS BEEN THE PLANNING AND CORRELATION OF EFFORT BY THE UNIVERSITIES INVOLVED ALONG WITH INDUSTRY AND THE ORGANIZED TECHNICAL GROUPS OF ENGINEERS. EMPLOYED B.S. ENGINEERS WHO HAVE THE OBJECTIVE OF OBTAINING A MASTER'S DEGREE THROUGH PART-TIME STUDY NEED A DEFINITE ANNOUNCEMENT OF COURSES TWO TO THREE YEARS AHEAD IN ORDER TO PLAN A DEGREE PROGRAM. EVEN THOUGH WE RECOGNIZE THAT ONLY A FRACTION OF SUCH PLANNED PROGRAMS WILL BE CARRIED TO COMPLETION. THE CHALLENGE TO PROSPECTIVE STUDENTS TO BE ENROLLED IN A DEFINITE DEGREE PROGRAM OF GRADUATE LEVEL IS A MAJOR ATTRACTION. SINGLE COURSES OF DOUBTFUL OR UNDEFINED GRADUATE CREDIT CARRY NO OVERALL OBJECTIVE. SUCH ENROLLMENTS ARE SUBJECT TO NEGLECT BY DROP-IN, DROP-OUT STUDENTS. WHICH APPEARS TO BE THE CURRENT STATUS OF CONTINUING ENDINEERING EDUCATION IN VIRGINIA.

11. <u>TELEVISION--A TECHNOLOGY FOR SPREADING GRADUATE EDUCATION OFF-CAMPUS.</u> AS ONE STUDIES THE DIVERSE INDUSTRIES OF NORTHERN VIRGINIA AND THE MANY AND EVEN MORE DIVERSE INTERESTS OF THE EMPLOYED ENGINEERS, THE CONCLUSION IS INEVITABLY REACHED THAT MUCH OF THE LACK OF SUCCESS OF THE UNIVERSITIES IN MEETING THE CONTINUING EDUCATION NEEDS OF NORTHERN VIRGINIA'S ENGINEERS IS INHERENT IN THE GEOGRAPHY, TRAFFIC CONGESTION AND SOCIAL STRUCTURE OF THE AREA. DESPITE SMALL DISTANCES THERE SEEM TO BE NO ENCLAVES. INSTEAD OF SMALL GROUP MEETINGS, INTERCHANGE AND COMMUNICATION IS SAID TO BE DIRECTED TO AND FROM WASHINGTON, D.C. HENCE THERE IS NO DISTINCTIVE CENTER OR FOCAL POINT OUTSIDE OF D.C. FROM WHICH CONTINUING EDUCATION MIGHT GROW AND PROSPER.

THE SITUATION DESCRIBED REQUIRES NUMEROUS LOCATIONS WHERE CLASSES CAN BE OFFERED TO VERY SMALL GROUPS WITH ACCOMPANYING HIGH COST OF INSTRUCTION PER STUDENT. FORTUNATELY, BOTH OF THE CONSULTANTS HAVE HAD EXTENSIVE EXPERIENCE WITH GRADUATE AND CONTINUING EDUCATION OF ENGINEERS THROUGH INSTRUCTIONAL TELEVISION. THEY HAVE FOUND IT TO BE A SUCCESSFUL MEDIUM FOR SPREADING GRADUATE EDUCATION OFF CAMPUS. THE COURSES IN SOME INSTANCES MAY BE DESIGNED AS CONTINUING EDUCATION, BUT IT IS MORE USUAL TO BROADCAST CAMPUS CLASSES OF AN ADVANCED UNDERGRADUATE AND GRADUATE LEVEL. THUS, TV MAY PROVIDE A STABLE BASE OF COURSES REQUIRED FOR DEGREE PROGRAMS. COMMONLY ONE-WAY VIDEO AND TWO-WAY AUDIO IS PROVIDED FOR OFF-CAMPUS STUDENTS TO PARTICIPATE. IN ADDITION TO THE CENTRAL BROADCASTING STATION, WHICH REQUIRES A MAJOR INVESTMENT, RECEIVING STATIONS MAY BE SET UP AT REASONABLE COST OF SOME 10,000 DOLLARS PER LOCATION. SOME RECEIVING STATIONS MAY BE OPEN TO PUBLIC ENROLLMENT AND OTHERS MAY BE FOR THE EXCLUSIVE USE OF EMPLOYEES OF A SINGLE COMPANY. THE NUMBER OF OFF-CAMPUS ENROLLEES IS ESSENTIALLY UNLIMITED. THEY ADD TO THE PROFESSOR'S INFLUENCE AND MAY REDUCE THE COST OF EDUCATION PER STUDENT.

THE CONSULTANTS VISITED TWO OPERATING STATIONS FOR INSTRUCTIONAL TELEVISION. THE FIRST WAS THE BROADCASTING OF SOME 30 ADVANCED AND GRADUATE CLASSES FOR ENGINEERS BY THE UNIVERSITY OF MARYLAND (APPENDIX G). THIS OPERATION STEMMING FROM COLLEGE PARK SHOULD BE VISITED BY ANYONE WHO QUESTIONS OR WISHES MORE INFORMATION ABOUT THE TECHNOLOGY INVOLVED, INCLUDING CLASSROOM ARRANGEMENTS, ETC. THE SECOND INSTALLATION VISITED WAS AT THE CENTER FOR EXCELLENCE IN WILLIAMSBURG. IT IS A TWO-WAY VIDEO AND TWO-WAY AUDIO SET-UP THAT GIVES SPECIAL INSTRUCTION FOR GROUPS OF PUBLIC SCHOOL TEACHERS. IT COULD BE ADAPTED TO BRING ODU ENGINEERING CLASSES OF A GRADUATE AND CONTINUING EDUCATION NATURE TO RICHMOND. THE UNIVERSITY OF MARYLAND'S BROADCAST OF 25 MILES COVERS MUCH OF NORTHERN VIRGINIA INCLUDING THE CONTINUING EDUCATION CENTER OF VPI AT DULLES AIRPORT.

TO GIVE ALL OF THE ARGUMENTS FOR AND AGAINST RELIANCE UPON INSTRUCTIONAL TELEVISION FOR SOLVING MANY AND PERHAPS MOST OF NORTHERN VIRGINIA'S PROBLEMS OF GRADUATE AND CONTINUING EDUCATION IN ENGINEERING WOULD BE TO COVER A WELL TRAVELED PATH FIRST OPENED BEFORE 1970 IN FLORIDA AND NOW USED IN A NUMBER OF LOCATIONS. FORTUNATELY, IT IS NOT NECESSARY FOR THE COMMONWEALTH OF VIRGINIA TO DECIDE WHETHER OR NOT IT SHOULD INVEST ABOUT A MILLION DOLLARS TO BRING UVA GRADUATE ENGINEERING CLASSES TO NORTHERN VIRGINIA AS CURRENTLY BEING STUDIED. INSTEAD, AT REASONABLE COST TWO OR THREE EXPERIMENTAL STATIONS MIGHT BE INSTALLED TO RECEIVED THE ENGINEERING CLASSROOM BROADCASTS OF THE UNIVERSITY OF MARYLAND. THE CONSULTANTS HAVE NO HESITANCY IN RECOMMENDING A DETAILED STUDY OF THIS PATH FOR DEVELOPING AN ESSENTIALLY

FULL-SCALE EXPERIMENT OF SOME 30 TELEVISED CLASSES. THUS THE ACADEMIC AND INDUSTRIAL REACTIONS AND VIEWPOINTS COULD BE DETERMINED AT REASONABLE COST BEFORE COMMITMENT OF FUNDS TO EXTEND THE ENGINEERING EDUCATIONAL SERVICES OF UVA, ODU, AND IN DUE TIME VPI, OVER A LARGE FRACTION OF THE COMMONWEALTH.

12. BOARD TO COORDINATE PROGRAMS, STANDARDS AND CREDIT TRANSFER. THE HISTORY OF COURSES TAUGHT BY OR UNDER THE AEGIS OF A HALF DOZEN UNIVERSITIES FROM VIRGINIA, D.C. AND MARYLAND IS NOT NOW AND IS UNLIKELY TO APPEAR IN THE FUTURE AS A COORDINATED VENTURE. UNLESS THE FUTURE INCLUDES A UNIFIED EFFORT AT COORDINATION OF COURSES, DEGREE PROGRAMS, STANDARDS, AND TRANSFER OF DEGREE CREDIT, THE CONSULTANTS DOUBT THAT IMPROVEMENT IN PLANNING STUDENT PROGRAMS WILL OCCUR. THE POSSIBLE AVAILABILITY OF TELEVISED INSTRUCTION IS ANOTHER FACTOR REQUIRING ACCEPTANCE AND AGREEMENT OF THE INSTITUTIONS INVOLVED.

THERE ARE MANY ORGANIZATIONAL CONCEPTS FOR THE CONTROL OF STANDARDS AND FOR THE TRANSFER OF CREDIT BETWEEN INSTITUTIONS THAT SEEM TO WORK REASONABLY WELL. THE ADDITION OF INTERINSTITUTIONAL PREPLANNING OF STUDENTS' PROGRAMS, INCLUDING THE POSSIBLE OBJECTIVE OF AN OFF-CAMPUS DEGREE, INCREASES THE NECESSARY LEVEL OF COOPERATION. THE CONSULTANTS HAVE ACCEPTED THE FOLLOWING WORDING FROM THE ACT OF THE GENERAL ASSEMBLY OF VIRGINIA ESTABLISHING THIS STUDY AS A REQUEST FOR WHATEVER LEVEL OF COOPERATION AND OF COORDINATION IS NECESSARY. THE OBJECTIVE IS TO PROVIDE "GRADUATE INSTRUCTION AND CONTINUING EDUCATION IN ENGINEERING IN VIRGINIA'S URBAN CORRIDOR".

"THE STATE COUNCIL OF HIGHER EDUCATION SHALL STUDY THE NEED FOR GRADUATE INSTRUCTION AND CONTINUING EDUCATION IN ENGINEERING IN THE RICHMOND AREA AND IN NORTHERN VIRGINIA AND THE POTENTIAL FOR A COOPERATIVE PROGRAM TO MEET SUCH A NEED IF ONE IS DETERMINED TO EXIST."

THE CONSULTANTS HAVE FOUND A NEED FOR SUCH ENGINEERING EDUCATIONAL PROGRAMS AND ALSO A NEED FOR MUCH BETTER COORDINATION OF INSTITUTIONAL OFFERINGS TO ENCOURAGE DEGREE OBJECTIVES. THE NECESSARY LEVEL OF COOPERATION AMOUNTS TO THE ACCEPTANCE OF COORDINATION THROUGH AN INTER-INSTITUTIONAL BOARD OF SUCH ACADEMIC DECISIONS AS CREDIT-TRANSFER, STANDARDS OF QUALITY FOR GRADUATE COURSES, AND PREPLANNING OF STUDENT PROGRAMS. TO ENCOURAGE THE ESSENTIAL LEVEL OF COOPERATION THE INSTITUTIONS INVOLVED SHOULD BE REPRESENTED ON THE INTER-INSTITUTIONAL BOARD (IIB) BY THEIR DEANS OF ENGINEERING. A MAJORITY OF THE BOARD SHOULD BE ENGINEERS. SUGGESTIONS FOR IMPLEMENTATION INCLUDING THE EFFECT OF THE BUDGETING PROCEDURE UPON INSTITUTIONAL, COLLEGE AND DEPARTMENTAL COOPERATION WILL BE COVERED IN FOLLOWING SECTIONS.

13. RELATIONSHIP OF BUDGETING PROCEDURES TO OFF-CAMPUS SERVICE. THE PROBLEM OF ACHIEVING PRE-PLANNED OFF-CAMPUS GRADUATE AND CONTINUING EDUCATION FOR ENGINEERS IS OFTEN EXACERBATED BY A UDGETING SYSTEM THAT ALLOCATES ALL COSTS ON THE BASIS OF A ESIRABLE CAMPUS MODEL RATHER THAN AN OFF-CAMPUS MODEL. FACED WITH SHORTAGE OF FACULTY AND WITH AN OVERLOAD OF UNDERGRADUATE STUDENTS THE ENGINEERING DEAN IS PREDICTABLY UNWILLING TO NEGLECT THE NEEDS OF FULL-TIME CAMPUS STUDENTS TO PROVIDE CONTINUING EDUCATION CLASSES FOR PART-TIME OFF-CAMPUS PARTICIPANTS. DEPARTMENTAL CHAIRMEN ARE EVEN MORE NEGATIVE IN THIS REGARD WHEN THEIR BUDGETS DO NOT SEEM TO INCLUDE THE FULL COSTS OF OFF-CAMPUS INSTRUCTION. THE DEPARTMENT CHAIRMAN ALSO MUST ASSIGN BOTH CAMPUS AND OFF-CAMPUS TEACHING LOADS KNOWING THAT THE STRAIN OF COMMUTING TO TEACH OFF CAMPUS IS SELDOM ACCEPTED BY CHOICE BY RESIDENT PROFESSORS.

TO SOLVE IN PART THE DIFFICULT PROBLEM OF STAFFING AN OFF-CAMPUS PROGRAM, FULL COSTS SHOULD BE RETURNED TO THE ACADEMIC DEPARTMENT INVOLVED. OTHERWISE THE END RESULT WILL BE A GRADUAL LOSS OF FACULTY INTEREST AND A DRYING UP OF THE OUTPUT OF CONTINUING EDUCATION CENTERS OR PROGRAMS. IT IS ESSENTIAL TO AVOID MIXING THE COSTS OF OFF-CAMPUS INSTRUCTION WITH THE ANNUAL DEPARTMENTAL BUDGETS. A CLEAN-CUT SEPARATION IS THE MOST DESIRABLE PROCEDURE. IF THE CONCEPT OF AN INTER-INSTITUTIONAL BOARD TO ASSIGN RESPONSIBILITY FOR EACH PARTICULAR SEGMENT OF CONTINUING EDUCATION IS ACCEPTED, THE BOARD SHOULD THEN AUTHORIZE PAYMENT TO EACH INSTITUTION TO MEET THE FULL COST OF PROVIDING THE DESIRED OFF-CAMPUS SERVICE. ANY BENEFIT FROM SUCH RETURNED UNDS SHOULD ACCRUE MAINLY TO THE TEACHING DEPARTMENTS THAT ROVIDED THE SERVICE.

14. OPPORTUNITY FOR VCU TO COORDINATE AN ENGINEERING CO-OP PROGRAM. THE SUBJECT OF UNDERGRADUATE ENGINEERING EDUCATION IS NOT CENTRAL TO THIS STUDY. IN A PREVIOUS STUDY AND REPORT DATED MAY 1, 1980 THE FIRST CONSULTANT REPORTED THAT UNDERGRADUATE ENGINEERING ENROLLMENT IN THE FOUR ACCREDITED COLLEGES OF ENGINEERING IN VIRGINIA IS AT LEAST AVERAGE FOR A STATE OF SOME FIVE MILLION POPULATION (APPENDIX D). AFTER CONSIDERATION OF THE TWO AREAS SUGGESTED AS POSSIBLE LOCATIONS FOR NEW UNDERGRADUATE AND MASTER'S LEVEL COLLEGES OF ENGINEERING THE CONSULTANT NOTED IN THE MAY 1980 REPORT THAT RICHMOND'S 600,000 POPULATION IS ONLY 60 PERCENT OF THE POPULATION BASE NEEDED TO FULLY SUPPORT AN AVERAGE SIZE COLLEGE OF ENGINEERING. THE POPULATION BASE OF 1,200,000 IN NORTHERN VIRGINIA WOULD PROVIDE ADEQUATE POPULATION SUPPORT IF A NEW ENGINEERING SCHOOL WERE GREATLY NEEDED. HOWEVER, VISITS TO FOUR ACCREDITED ENGINEERING SCHOOLS IN WASHINGTON, D.C. ESTABLISHED THE FACT THAT ALL FOUR WERE UNDERENROLLED AND WERE SEEKING ADDITIONAL STUDENTS. HENCE, WITHIN A CIRCLE OF 25 MILES RADIUS FROM DOWNTOWN D.C. IT WOULD BE EXTREMELY DIFFICULT TO JUSTIFY ESTABLISHING ANOTHER COLLEGE OF ENGINEERING. EVEN IN THE COMPETITIVE MATTER OF COST TWO OF THE FOUR D.C. SCHOOLS OF ENGINEERING HAVE EITHER MEDIUM OR LOW TUITION (APPENDIX J).

WHILE INVESTIGATING THE NEEDS OF RICHMOND INDUSTRY FOR ENGINEERS, IT BECAME EVIDENT TO THE CONSULTANTS THAT ONE RESOURCE NOT BEING WELL UTILIZED IS THE RESIDENTIAL POPULATION OF RICHMOND. THIS POPULATION IS HEAVILY BLACK AND IF FINANCIALLY ABLE TO PAY THE COST OF AN ENGINEERING OR TECHNOLOGY 4-YEAR EDUCATION, ITS YOUTH WOULD THEN BE RECRUITED ACTIVELY BY LOCAL INDUSTRY. THE CONSULTANT ALSO FOUND THAT RICHMOND INDUSTRY (IN CONTRAST TO THE INDUSTRY OF NORTHERN VIRGINIA) HAD EXPERIENCED SUCCESS IN THE HIRING, USE AND RETENTION OF CO-OP STUDENTS AND WOULD GLADLY EMPLOY MORE WHEN AVAILABLE. THESE TWO BITS OF INFORMATION HAVE BEEN COMBINED INTO THE FOLLOWING RECOMMENDATION TO VCU.

BECAUSE OF ITS DOWNTOWN RICHMOND LOCATION AND ITS BACKGROUND OF SUCCESSFUL ENROLLMENT OF MINORITY STUDENTS, VCU COULD INITIATE A CO-OP ENGINEERING PROGRAM OR PROGRAMS BASED ENTIRELY UPON LOCAL INDUSTRY FOR STUDENT EMPLOYMENT IN ALTERNATING TERMS. IT WOULD BE UNNECESSARY FOR VCU TO TEACH ADVANCED ENGINEERING CLASSES AND IT SHOULD NOT DO DO. THE STUDENTS' HALF TIME EMPLOYMENT INCOME, COMBINED WITH THE LOW COST OF LIVING AT HOME WHILE EMPLOYED LOCALLY, WOULD PROVIDE ALL OR MOST OF THE COST OF TUITION PLUS BOARD AND ROOM FOR THE JUNIOR AND SENIOR YEARS AT VPI, ODU OR UVA. THE STUDENTS COULD COMPLETE THE FRESHMAN AND SOPHOMORE YEARS AS VCU CO-OP STUDENTS OR BY INCLUDING FULL TIME ENROLLMENT FOR ONE YEAR TO SHORTEN THE DEGREE PROGRAM. THE EMPHASIS SHOULD BE PLACED ON LOCAL EDUCATION FOR THE FIRST TWO YEARS, LOCAL HALF-TIME CO-OP EMPLOYMENT AND, UPON GRADUATION, LOCAL EMPLOYMENT FULL-TIME IN A KNOWN AND DESIRED ENVIRONMENT.

TO PRODUCE A SUCCESSFUL CO-OP ENGINEERING PROGRAM VCU WOULD NEED TO SET UP AN ADMINISTRATIVE OFFICE. IT SHOULD EMPLOY AN ENGINEER WITH PROMOTIONAL QUALITIES WHO WOULD GIVE HIS ENTIRE ATTENTION TO THE TASK OF FORMING CONTACTS WITH LOCAL INDUSTRY, WITH THE EDUCATIONAL INSTITUTIONS AND WITH HIS CO-OP STUDENTS. CONSIDERING THE VIEWS EXPRESSED BY LOCAL RICHMOND INDUSTRY, THE CONSULTANT SUGGESTS THAT THE FIRST EFFORT SHOULD BE TO ACHIEVE AN ACTIVE, CO-OP MECHANICAL ENGINEERING PROGRAM TO BE FOLLOWED LATER BY CO-OP ELECTRICAL ENGINEERING. NO SIMILAR RECOMMENDATION CAN BE MADE TO GMU BECAUSE ITS LOCAL POPULATION AND THE INDUSTRY OF NORTHERN VIRGINIA SHOW DISTINCTIVELY DIFFERENT CHARACTERISTICS THAN RICHMOND. INSTEAD, THE GMU BACCALAUREATE AND PROPOSED MASTER'S PROGRAMS IN COMPUTER SCIENCE APPEAR DESIRABLY FITTED TO THE INDUSTRY OF NORTHERN VIRGINIA.

15. VCU SITUATED TO COORDINATE PROGRAMS FOR UPGRADING RICHMOND ENGINEERS. THE USUAL SITUATION WHERE OFF-CAMPUS CLASSES ARE OFFERED NEAR THE CENTER OF A METROPOLITAN AREA IS FOR THE STRONGEST ENGINEERING COLLEGE PARTICIPANT TO DOMINATE THE PROGRAM AND TO PROVIDE MINIMALLY NECESSARY COORDINATION. THIS MODEL DOES NOT EXIST EITHER IN RICHMOND OR IN NORTHERN VIRGINIA, NOR DOES IT SEEM LIKELY TO DEVELOP. HOWEVER, THE CONSULTANTS FIND NO SERIOUS OBSTACLE TO A LOCAL NON-ENGINEERING UNIVERSITY OF ESTABLISHED GRADUATE STANDARDS BEING ASSIGNED THE FUNCTION OF LOCAL

COORDINATION OF A CONTINUING ENGINEERING EDUCATIONAL PROGRAM. SINCE VCU IS CONVENIENTLY LOCATED IN THE CENTER OF RICHMOND, IT COULD SERVE THE FUNCTION OF COORDINATOR WHILE BEING CONTROLLED BY THE INTER-INSTITUTIONAL BOARD FOR ENGINEERING. THIS CONCEPT FOR COORDINATION SHOULD DRAW THE SUPPORT OF ALL ENGINEERING EDUCATIONAL INTERESTS BECAUSE (1) ALL THE ACCREDITED ENGINEERING SCHOOLS IN VIRGINIA ARE OVERLOADED, AND (2) EACH HAS HAD A LESS THAN AUSPICIOUS EXPERIENCE IN PROVIDING CONTINUING EDUCATION IN RICHMOND FOR ENGINEERS.

THE DETAILS OF ESTABLISHING AN ADMINISTRATIVE OFFICE AT VCU FOR ENGINEERING CAN BE LEFT TO LOCAL PROCEDURES AND TO VCU'S KNOWLEDGE AND EXPERIENCE. CLEARLY THE DIRECTOR SHOULD BE AN ENGINEER. HE SHOULD REPORT JOINTLY TO THE APPROPRIATE VCU ADMINISTRATOR AND TO THE INTER-INSTITUTIONAL BOARD FOR ENGINEERING EDUCATIONAL COORDINATION. ONE BOARD AND A SINGLE ADMINISTRATIVE OFFICE COULD OPERATE BOTH THE SUGGESTED CO-OP ENGINEERING PROGRAMS OF VCU AND THE COORDINATION FUNCTION IN RICHMOND FOR GRADUATE AND CONTINUING EDUCATION IN ENGINEERING. THE CONSULTANTS' BELIEF THAT THE COORDINATION FUNCTION CONDUCTED THROUGH VCU-IIB WOULD PROVE SUCCESSFUL IS BASED UPON THE FOLLOWING: (1) THERE IS LITTLE EVIDENCE OF PREVIOUS ATTEMPTS AT COOPERATION OR COORDINATION OF PROGRAMS, (2) RICHMOND'S SATISFACTION WITH THE PRESENT AVAILABILITY OF NEW B.S. ENGINEERS WILL DISSIPATE AS THE SHORTAGE DEVELOPES TOWARD 1985, (3) THROUGH COORDINATION, STUDENTS WILL BE ASSURED OF OPPORTUNITY FOR COMPLETION OF A PLANNED PROGRAM, AND THIS INFORMATION WILL DRAW POTENTIAL STUDENTS INTO THE PROGRAM. DOUBTLESS, ACTIVE RECRUITMENT WILL BE NECESSARY AT FIRST, BUT AS INFORMATION OF BOTH OFFERINGS AND DEGREE OBJECTIVES, AS WELL AS LESS AMBITIOUS PLANS ARE DISSEMINATED, THE PROGRAM SHOULD BECOME SELF GENERATING YEAR AFTER YEAR.

16. <u>GMU SITUATED TO COORDINATE ACTIONS TO UPGRADE NORTHERN VIRGINIA ENGINEERS.</u> THE LOCATION OF GMU, SOME 15-20 MILES SOUTHWEST OF DOWNTOWN WASHINGTON, D.C., PLACES IT WELL WITHIN THE SO-CALLED BELTWAY DEVELOPMENT OF THE INDUSTRY OF NORTHERN VIRGINIA. WITH NO ACCREDITED ENGINEERING SCHOOL OF VIRGINIA WITHIN COMMUTING DISTANCE, GMU IS THE COMMONWEALTH'S LOGICAL AGENCY FOR COORDINATING THE EFFORTS OF ALL VIRGINIA ENGINEERING SCHOOLS TO PROVIDE GRADUATE AND CONTINUING ENGINEERING EDUCATION IN NORTHERN VIRGINIA. THIS EFFORT SHOULD NOT BE A SIDELINE ACTIVITY OF THE PRE-ENGINEERING FACULTY OF GMU. IT SHOULD BE A SEPARATE ADMINISTRATIVE UNIT (GMU-IIB) HEADED BY AN ENGINEER REPORTING TO THE INTER-INSTITUTIONAL BOARD FOR ENGINEERING IN REGARD TO ITS ACTIVITIES OF COORDINATION AND INSTITUTIONAL COOPERATION.

THE SCHEV CONSULTANTS ARE RECOMMENDING THAT THE COMMONWEALTH INVESTIGATE THE POSSIBILITY OF A CONTRACT WITH THE UNIVERSITY OF MARYLAND TO PROVIDE CLASSROOM TELEVISION FOR GRADUATE AND CONTINUING ENGINEERING EDUCATION IN NORTHERN VIRGINIA. IT WOULD BE THE RESPONSIBILITY OF GMU-IIB TO ARRANGE FOR ONE OR MORE

(PROBABLY THREE) VIEWING STATIONS SOUTH OF WASHINGTON WHERE ENROLLED STUDENTS COULD PARTICIPATE THROUGH ONE-WAY VIDEO AND TWO-WAY AUDIO IN STANDARD GRADUATE OR OTHER ADVANCED ENGINEERING CLASSES. THIS FULL SCALE EXPERIMENT WITH CLASSROOM TELEVISION FOR THE PURPOSE OF MODERNIZING THE BACKGROUNDS OF BELTWAY ENGINEERS SHOULD BE MONITORED FOR THE INTER-INSTITUTIONAL BOARD FOR ENGINEERING BY THE DIRECTOR OF THE NORTHERN VIRGINIA OR GMU-IIB OFFICE. AT THE END OF ONE TO TWO YEARS, THE GMU-IIB OFFICE SHOULD HAVE ACCUMULATED SUFFICIENT DATA ON ENROLLMENTS AND COMPLETIONS OF THE TELEVISION STUDENTS FOR THE DIRECTOR TO RECOMMEND EITHER CONTINUATION, EXTENSION, IMPROVEMENT OR TERMINATION OF THE TV EXPERIMENT.

AN IMPORTANT PART OF THE DUTIES OF THE GMU-IIB DIRECTOR SHOULD BE TO SEEK COOPERATION OF THE D.C. UNIVERSITIES THAT PROVIDE CONTINUING EDUCATION CLASSES IN NORTHERN VIRGINIA. THE MAJORITY OF THIS ACTIVITY APPEARS TO BE THAT OF GEORGE WASHINGTON UNIVERSITY. IF ONE CENTER OF INFORMATION, THAT IS, THE GMU-IIB OFFICE, CAN PROVIDE INFORMATION ON CONTINUING EDUCATION CLASSES TO BE TAUGHT SEMESTER BY SEMESTER, THE DESIRES OF STUDENTS TO PLAN PROGRAMS OF MORE THAN ONE TERM DURATION SHOULD ENCOURAGE A WILLINGNESS OF ALL THE COOPERATING ENGINEERING SCHOOLS TO ANNOUNCE OFFERINGS A YEAR OR MORE IN ADVANCE. AND SUCH ANNOUNCEMENTS SHOULD BE MADE ONLY AFTER UNNECESSARY DUPLICATIONS HAD BEEN ELIMINATED AND COURSES ADDED TO SATISFY NEEDS EXPOSED BY SURVEYS AND OTHER ACCUMULATED DATA FROM THE GMU-IIB OFFICE. THE CONSULTANTS SEE THIS COORDINATING SERVICE AS THE CRITICAL FACTOR NEEDED TO ASSURE AN ON-GOING PROGRAM OF GRADUATE AND CONTINUING EDUCATION FOR NORTHERN VIRGINIA.

17. IMPORTANCE OF NON-CREDIT COURSES FOR TECHNOLOGICAL MODERNIZATION. THE CENTRAL THRUST OF THIS STUDY HAS BEEN TO DETERMINE HOW THE VIRGINIA COLLEGES OF ENGINEERING CAN BEST PROVIDE OFF-CAMPUS GRADUATE AND CONTINUING EDUCATION IN RICHMOND AND NORTHERN VIRGINIA. THERE ARE OTHER INDUSTRIAL ENCLAVES OF SMALLER SIZE THAT CANNOT JUSTIFY EQUIVALENT SERVICE. THE PRESENTATION OF NON-CREDIT COURSES SPECIFICALLY DESIGNED FOR THE ENGINEERING EMPLOYEES OF AN INDIVIDUAL COMPANY ALSO SERVE A SOMEWHAT SIMILAR PURPOSE. THEY MAY BE GIVEN BY A UNIVERSITY PROFESSOR OR BY AN INDUSTRY SPECIALIST. THE USE OF ADJUNCT INSTRUCTORS FROM INDUSTRY TO TEACH HIGHLY SPECIALIZED INFORMATION HAS A LONG HISTORY OF EFFECTIVENESS.

THE NON-CREDIT COURSE MAY BE DESIGNED OF ANY LENGTH AND IT MAY BE CONCENTRATED INTO A FEW DAYS OR WEEKS IN CONTRAST TO ACADEMIC SEMESTERS. AN INDUSTRIAL INSTRUCTOR MAY BE BETTER INFORMED ABOUT THE STATE OF THE ART INVOLVED THAN A UNIVERSITY PROFESSOR. THEORY MAY BE MINIMIZED AND MOST OF THE CLASSROOM TIME DEVOTED TO DISCUSSIONS OF SUCCESSFUL TECHNOLOGY RATHER THAN THE BACKGROUND SCIENCE INVOLVED. THERE IS A PLACE AND A USE FOR BOTH ACADEMIC COURSES OF GRADUATE LEVEL AND NON-CREDIT COURSES WHOLLY UNRELATED TO GRADUATE STUDY IN ENGINEERING. AS THE GMU-NSF* STUDY INDICATES, NORTHERN VIRGINIA MAY WELL NEED AS MUCH OR MORE

ATTENTION TO UPGRADING ENGINEERS THROUGH SPECIALIZED NON-CREDIT COURSES AS BY EXTENDING THE CAMPUS UMBRELLA OVER THESE INDUSTRIAL AREAS. IT SHOULD BE AN OBJECTIVE OF THE INTER-INSTITUTIONAL CARD FOR ENGINEERING TO EXTEND THE COORDINATING SERVICES OF ITS MU-IIB OFFICE AND ITS VCU-IIB OFFICE TO NON-CREDIT COURSES AS WELL AS GRADUATE CREDIT PROGRAMS.

18. CONCLUSIONS AND RECOMMENDATIONS OF THE CONSULTANTS. THE CONSULTANTS' CONCLUSIONS AND RECOMMENDATIONS ARE INHERENT IN THE TEXT OF THE REPORT. HOWEVER, THEY ARE ASSEMBLED HERE FOR EMPHASIS AND CONVENIENT REFERENCE. THE RECOMMENDATIONS ARE ALSO PLACED IN ORDER OF PRIORITY ACCORDING TO THE CONSULTANTS' VIEWS CONCERNING THE NEEDS OF INDUSTRY IN VIRGINIA'S URBAN CORRIDOR.

1) APPOINT AN INTER-INSTITUTIONAL BOARD TO COORDINATE OFF-CAMPUS COURSES AND PROGRAMS OF GRADUATE AND CONTINUING EDUCATION FOR ENGINEERS EMPLOYED IN THE URBAN CORRIDOR FROM NORTHERN VIRGINIA TO TIDEWATER. THE VIRGINIA ENGINEERING DEANS SHOULD BE MEMBERS AND THE MAJORITY OF MEMBERS SHOULD BE ENGINEERS. GIVE THE BOARD SUFFICIENT BUDGETARY RESPONSIBILITY SO THAT EACH ENGINEERING SCHOOL COOPERATING IN SUCH EDUCATIONAL SERVICE IS FULLY COMPENSATED FOR COSTS INCURRED. OTHER RESPONSIBILITIES ARE PLANNING FOR STUDENT DEGREE PROGRAMS EXTENDING BEYOND ONE YEAR, MAINTAINING CONTINUING CONTACTS WITH THE INDUSTRIES OF NORTHERN VIRGINIA AND RICHMOND, AND PROMOTING THE VALUES OF GRADUATE AND CONTINUING EDUCATION FOR ENGINEERS OF ALL AGE LEVELS.

2) INVESTIGATE THE DESIRABILITY OF AN AGREEMENT WITH THE UNIVERSITY OF MARYLAND TO SET UP A FULL-SCALE EXPERIMENT FOR ONE YEAR IN THE TELEVISING OF GRADUATE AND CONTINUING EDUCATION CLASSES FROM COLLEGE PARK, MARYLAND, INTO NORTHERN VIRGINIA. THERE SHOULD BE TWO OR MORE TALK-BACK STATIONS IN CONVENIENT VIRGINIA LOCATIONS FOR ENROLLED STUDENTS. WITHHOLD DECISIONS ON BRINGING TELEVISED CLASSROOM INSTRUCTION FROM UVA TO NORTHERN VIRGINIA, OR FROM ODU TO RICHMOND, UNTIL A YEAR OF OPERATION OF THE MARYLAND-VIRGINIA EXPERIMENT HAS BEEN COMPLETED AND ANALYZED FULLY AS TO COST AND EFFECTIVENESS.

3) INVESTIGATE THROUGH THE INTER-INSTITUTIONAL BOARD THE DESIRABILITY OF ASSIGNING TO GMU THE ESTABLISHMENT OF A CAMPUS OFFICE TO SERVE AS THE HANDS OF THE IIB FOR NORTHERN VIRGINIA. THE OFFICE SHOULD BE ADMINISTERED BY A DIRECTOR WHO SHOULD BE AN ENGINEER AND WHO WOULD BE THE COORDINATOR OF GRADUATE AND CONTINUING EDUCATION FOR THE ENGINEERING

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*GMU-NSF SURVEY AND REPORT ON USE AND NEED FOR ENGINEERS IN THE WASHINGTON METROPOLITAN AREA IS AVAILABLE.

SCHOOLS OPERATING PROGRAMS IN NORTHERN VIRGINIA. A NEW LEVEL OF COOPERATION AND COORDINATION WILL BE NEEDED TO INTER-RELATE CREDITS EARNED THROUGH REGULAR CLASSROOM ATTENDANCE WITH OTHERS FROM TELEVISED CLASSES. A MAJOR ACTIVITY OF THE DIRECTOR SHOULD BE TO DEVELOP CORDIAL AND EFFECTIVE WORKING RELATIONSHIP WITH THE SEVERAL TYPES OF INDUSTRY SERVED IN NORTHERN VIRGINIA BY THE SCHOOLS OF ENGINEERING INVOLVED.

4) INVESTIGATE THROUGH THE INTER-INSTITUTIONAL BOARD THE DESIRE OR WILLINGNESS OF VCU TO ESTABLISH A CAMPUS OFFICE TO SERVE AS THE HANDS OF IIB FOR THE RICHMOND METROPOLITAN AREA. EXCEPT FOR THE EXPERIMENT IN CLASSROOM TELEVISION, THE VCU-IIB DIRECTOR WOULD HAVE THE SAME RESPONSIBILITY OF COORDINATION AS THE GMU-IIB DIRECTOR UNDER RECOMMENDATION 3 AND SECTIONS 12 AND 15.

5) INVESTIGATE, THROUGH THE INTER-INSTITUTIONAL BOARD, THE WILLINGNESS OF VCU TO UNDERTAKE DEVELOPMENT OF A HIGHLY LOCALIZED CO-OP ENGINEERING B.S. PROGRAM DESIGNED WHOLLY TO MEET THE NEEDS OF STUDENTS AND OF INDUSTRY IN THE RICHMOND METROPOLITAN AREA. ABOUT ONE-HALF OF THE FIVE-YEAR PROGRAM WOULD BE COMPLETED BY THE STUDENTS AT VCU, THE UPPER YEARS BEING COMPLETED AT VPI&SU, ODU, OR UVA WHEREVER THE APPROPRIATE CO-OP PROGRAM WAS OPERATING. VCU WOULD NOT NEED TO AND SHOULD NOT DEVELOP UPPER DIVISION ENGINEERING COURSES WHICH ALREADY EXIST AT ACCREDITED ENGINEERING SCHOOLS IN VIRGINIA. RICHMOND STUDENTS COULD LIVE AT HOME THE FIRST TWO YEARS, AND ONE-HALF TIME THE LAST THREE YEARS. HALF TIME EMPLOYMENT INCOME SUPPLEMENTED BY LIMITED BORROWING SHOULD MEET FINANCIAL PROBLEMS PARTICULARLY FOR MINORITY STUDENTS. THE DIRECTOR OF THE VCU-IIB COORDINATION OFFICE SHOULD SERVE ALSO AS THE DIRECTOR OF THE VCU CO-OP PROGRAM BECAUSE BOTH PROGRAMS REQUIRE REGULAR CONTACTS WITH RICHMOND INDUSTRY AND WITH THE COOPERATING SCHOOLS OF ENGINEERING.

15. <u>SUGGESTIONS FOR IMPLEMENTING THE CONSULTANTS' RECOMMENDATIONS.</u> THE FIRST STEP SHOULD BE TO DEVELOP COOPERATIVE PLANNING AND ACTION BETWEEN THE ENGINEERING SCHOOLS INVOLVED. THIS WILL REQUIRE ESTABLISHMENT OF A JOINT COMMITTEE, HERE TERMED THE INTER-INSTITUTIONAL BOARD. TO MAKE THE BOARD EFFECTIVE IT SHOULD INCLUDE THE VIRGINIA DEANS OF ENGINEERING, OFFICIAL REPRESENTATIVES FROM VCU AND GMU AND REPRESENTATIVES OF ENGINEERING ORGANIZATIONS AND INDUSTRY. TO BE RESPECTED THE BOARD SHOULD HAVE DECISION MAKING POWER WITHIN THE AREAS OF NEED AND PROVISION FOR CONTINUING EDUCATION COURSES. AND MORE IMPORTANTLY PROGRAMS OF COURSES WHERE DEGREES, WHICH MUST REMAIN UNDER UNIVERSITY CONTROL, MAY BE INVOLVED. THUS A HIGH DEGREE OF COOPERATION WILL BE REQUIRED.

THE BOARD SHOULD BE FINANCED FOR OPERATION OF TWO OFFICES HEADED BY ENGINEERING DIRECTORS, ONE PREFERABLY AT GMU FOR NORTHERN VIRGINIA AND ANOTHER IN RICHMOND PREFERABLY ON THE VCU

CAMPUS. THE OTHER IMPORTANT BUDGETARY FUNCTION OF THE BOARD WOULD BE TO APPROVE REIMBURSEMENT OF COSTS OF TEACHING CONTINUING EDUCATION COURSES TO EACH ENGINEERING SCHOOL PARTICIPATING. THE DETAILS INCLUDING THE QUESTION OF REIMBURSEMENT OF OVERHEAD WOULD REQUIRE EARLY ATTENTION.

THE CAPABILITY AT THE UNIVERSITY OF MARYLAND TO COVER MOST OF NORTHERN VIRGINIA BY ITS CURRENT BROADCASTS OF SOME 30 CLASSES FOR ENGINEERS PROVIDES A MOST FORTUNATE OPPORTUNITY TO VIRGINIA FOR LOW-COST TV EXPERIMENTATION.

AFTER ESTABLISHING THE GENERAL ACCEPTABILITY OF THE TV TRANSMISSION, THE BOARD SHOULD NEGOTIATE FOR TWO OR THREE VIEWING STATIONS TO BE SET UP IN NORTHERN VIRGINIA. THE QUALITY OF DAILY RECEPTION, THE USE OF THE TALK-BACK FEATURE, THE WILLINGNESS OF INDUSTRY TO PROVIDE COMPANY VIEWING STATIONS, THE ADJUSTMENT OF WORK HOURS BY THE ENGINEER'S EMPLOYER TO PERMIT WORK-DAY ENROLLMENT, AND OTHER FEATURES, INCLUDING ATTITUDES OF BOTH EMPLOYER AND EMPLOYEE TOWARD THE VALUE OF THE TELEVISION CLASSROOM, CAN ALL BE TESTED BEFORE A LARGE STATE INVESTMENT WOULD NEED BE COMMITTED. HAVING DETERMINED THAT THE COLLEGE OF ENGINEERING OF THE UNIVERSITY OF MARYLAND WOULD LOOK FAVORABLY UPON THE SUGGESTED COOPERATIVE EXPERIMENT, THE CONSULTANTS RECOMMEND AND URGE STEPS TOWARD IMMEDIATE IMPLEMENTATION.

VIII. APPENDICES

Appendix A

An Act to require the State Council of Higher Education to conduct a study concerning graduate and continuing education in engineering; and to appropriate funds.

Approved APR 4 . 1980

Whereas, the Commonwealth has a need for increased engineering and technological skills in its workforce to expand its economy and enhance industrial development; and

Whereas, there are indications of an increasing need for graduate instruction and continuing education in engineering in Virginia's urban corridor; and

Whereas, there already exists in Tidewater an engineering school of high quality at Old Dominion University; and

Whereas, it may be possible to employ this resource in meeting engineering education needs in the Richmond area and in Northern Virginia; and

Whereas, the missions of Old Dominion University, Virginia Commonwealth University, and George Mason University are to meet the educational needs of their regions; and

Whereas, these three urban universities have agreed to work together in exploring the extent of engineering education needs and the potential for sharing their resources in meeting them; and

Whereas, it would be in the best interest of the Commonwealth to foster cooperation among institutions to meet such needs rather than establish new schools or colleges; and

Whereas, the State Council of Higher Education for Virginia is responsible for promoting cooperation among the institutions of higher education and for studying the Commonwealth's needs in higher education; now, therefore,

Be it enacted by the General Assembly of Virginia:

1. *§ 1. The State Council of Higher Education shall study the need for graduate instruction and continuing education in engineering in the Richmond area and Northern Virginia and the potential for a cooperative program to meet such a need if one is determined to exist. In conducting the study the Council shall consult, as it deems necessary, with representatives of appropriate institutions of higher education and the Virginia Society of Professional Engineers. The Council shall report its findings and recommendations to the Governor and General Assembly no later than December one, nineteen hundred eighty.*

2. That there is hereby appropriated to the State Council of Higher Education for the purposes of this study from the general fund of the State Treasury the sum of twenty-five thousand dollars.

_____

President of the Senate

_____

Speaker of the House of Delegates

Approved:

_____

Governor

Appendix B

STATE COUNCIL OF HIGHER EDUCATION FOR VIRGINIA
ADVISORY COMMITTEE
ON
GRADUATE AND CONTINUING EDUCATION NEEDS
IN ENGINEERING

Dr. Ralph Baxter
Associate Vice President
for Academic Affairs
George Mason University
Fairfax, Virginia 22030

Dr. Murray Black
Coordinator of Engineering
George Mason University
Fairfax, Virginia 22030

Dr. John H. Borgard
Assistant Dean of
Arts and Sciences
Virginia Commonwealth University
Richmond, Virginia 23284

Dr. S.A. Burnette, President
J. Sargeant Reynolds Community
College
1701 E. Parham Road (REBCOR)
P.O. Box 12084
Richmond, Virginia 23241

Dr. John E. Gibson, Dean
Engineering and Applied Science
University of Virginia
Charlottesville, Virginia

Dr. Norton D. Harding, Jr.
Division of Engineering
Northern Virginia Community
College
Annandale Campus
8333 Little River Turnpike
Annandale, Virginia 22003

Dr. Dana B. Hamel, Consultant
Virginia State University
Box C
Petersburg, Virginia 23803

Mr. Alexander B. Sadler
Member of Consulting Engineers
Council of Virginia, Inc.
Austin, Brockenbraugh & Associates
114 East Cary Street
Richmond, Virginia 23219

Mr. Phillips L. Melville, P.E.
6116 Edgewood Terrace
Alexandria, Virginia 22307

Dr. Paul E. Torgersen, Dean
College of Engineering
Virginia Polytechnic Institute
and State University
Blacksburg, Virginia 24061

Dr. John A. Weese, Dean
School of Engineering
Old Dominion University
Norfolk, Virginia 23508

Dr. Marvin E. Wyman, Associate
Vice President for Research
and Sponsored Programs
Old Dominion University
Norfolk, Virginia 23508

Consultants

Dr. L. E. Grinter
Dean Emeritus
2256 N.W. 4th Place
Gainesville, Florida 32603

Dr. John C. Hancock
Dean, Schools of Engineering
Purdue University
Lafayette, Indiana 47907

SCHEV Staff

Mr. J. Michael Mullen
Associate Director
SCHEV Staff

Dr. J. C. Phillips
Coordinator, Academic Programs
and Special Projects
SCHEV Staff

APPENDIX C

Institutions, Businesses, Professional Associations and Societies Interviewed about Engineering Needs In Richmond and Northern Virginia

RICHMOND AND VICINITY*

Name and Title	Company and Location	Date
Mr. Richard Blanchard Vice President for Administration	Ethyl Corporation Richmond	Feb. 12, 1980
Mr. Ted Carron Manager of Management Development and Training, Human Resources Group	Ethyl Corporation Richmond	Feb. 12, 1980
Mr. Rudolph Janis Technical Superintendent	E. I. Dupont DeNemours and Co., Richmond	Feb. 13, 1980
Mr. H. S. Stokes Training Supervisor Spruance Research Laboratory	E. I. Dupont DeNemours and Co., Richmond	Feb. 13, 1980
Mr. Raymond Wynn Staff Assistant to Personnel Supervisor Spruance Fibers Plant	E. I. Dupont DeNemours and Co., Richmond	Feb. 20, 1980
Mr. Bernard Kosakowski Manager, Administrative Services Research Center	Philip Morris Richmond	Feb. 13, 1980
Mr. Robert O'Connor Staff Engineer	Philip Morris Richmond	Feb. 13, 1980
Mr. Arthur Pasquine Vice President for Engineering	Philip Morris Richmond	Feb. 13, 1980
Ms. Susan Satterfield Staff Coordinator, Engineering Department	Philip Morris Richmond	Feb. 13, 1980
Mr. William Stephens Personnel Administrator for the Research Center	Philip Morris Richmond	Feb. 13, 1980
Mr. James McCarron, Jr. Director, Economic Development Office	City of Richmond	Feb. 13, 1980
Mr. Robert Sarver Head, Engineering Department Bureau of Public Works	City of Richmond	Feb. 23, 1980
Mr. L. Y. Parker Executive Manager, Personnel and Security	Virginia Electric Power Co., Richmond	Feb. 12, 1980
Mr. William Stafford Director, Employment and Salary Administration	Virginia Electric Power Co., Richmond	Feb. 12, 1980
Mr. Leslie Pocsik Director of Engineering	Allied Chemical Corporation Hopewell	Feb. 12, 1980
Mr. Thomas Nash	Reynolds Metal Company Richmond	March 10, 1980
Dr. Charles O. Burgess Vice President for Academic Affairs and Provost	Old Dominion University Norfolk	Feb. 20, 1980
Mr. Kenneth H. Murray Assistant Dean, School of Engineering	Old Dominion University Norfolk	Feb. 20, 1980
Dr. Marvin Wyman Associate Provost for Research and Sponsored Programs	Old Dominion University Norfolk	Feb. 20, 1980
Dr. John E. Gibson Dean, School of Engineering	University of Virginia Charlottesville	March 11, 1980
Dr. Bruce Nelson Associate Provost	University of Virginia Charlottesville	March 11, 1980

* The majority of visits to businesses and institutions in the Richmond area were conducted in the spring, 1980, when Dr. Grinter conducted a study for VCU on the engineering needs in the Richmond area.

Name and Title	Company and Location	Date
Dr. James Morgan, Jr. Dean of Faculty	Virginia Military Institute Lexington	March 11, 1980
Dr. Lee Nichols, Sr. Head, Electrical Engineering Curriculum	Virginia Military Institute Lexington	March 11, 1980
Dr. Jay Sculley Head, Civil Engineering Curriculum	Virginia Military Institute Lexington	March 11, 1980
Dr. Arthur Taylor, Jr. Head, Mechanical Engineering Curriculum	Virginia Military Institute Lexington	March 11, 1980
Dr. Benjamin Blanchard Director, Engineering Extension	Virginia Polytechnic Institute and State University, Blacksburg	March 12, 1980
Dr. George A. Gray Associate Dean, Engineering School	Virginia Polytechnic Institute and State University, Blacksburg	March 12, 1980
Dr. Paul E. Torgersen Dean, Engineering School	Virginia Polytechnic Institute and State University, Blacksburg	March 12, 1980
Dr. John Wilson Vice President and Provost	Virginia Polytechnic Institute and State University, Blacksburg	March 12, 1980
Mr. J. Michael Mullen Assistant Director, Research and Information Systems	State Council of Higher Education for Virginia, Richmond	March 31, 1980
Dr. J. C. Phillips Coordinator, Continuing Education	State Council of Higher Education for Virginia, Richmond	March 31, 1980
Mr. Robert P. Schultze Assistant Director, Finance and Facilities	State Council of Higher Education for Virginia, Richmond	March 31, 1980
Mr. Charles W. Tatum Graduate Engineer Trainee Coordinator	State Department of Highways and Transportation, Richmond	April 1, 1980
Mr. A. H. Paessler	State Water Control Board Richmond	April 1, 1980
Ms. Deborah Yetzer	State Water Control Board Richmond	April 1, 1980

Name and Title	Company and Location	Date
Dr. S. A. Burnette President	J. Sargeant Reynolds Community College, Richmond	April 1, 1980
Mr. Earl W. Cameron Division Chairman, Engineering and Engineering Technology	J. Sargeant Reynolds Community College, Richmond	April 1, 1980
Mr. Fred McConnell Head, Pre-Engineering Program	J. Sargeant Reynolds Community College, Richmond	April 1, 1980
Mr. Allen R. Hammer Director, Bureau of Water Supply Engineering	Department of Health, State Division of Water Programs, Richmond	April 1, 1980
Dr. Walter Elias Dean, School of Science and Technology	Virginia State University Petersburg	April 1, 1980
Dr. Dana Hamel Consultant for Organizing Engineering Technology Program	Virginia State University Petersburg	April 1, 1980
Mr. Ike Ridley Head, Industrial Technology Institute	Virginia State University Petersburg	April 2, 1980
Mr. Robert Watts Chief Executive Officer	A. H. Robbins Richmond	April 2, 1980
Dr. Ralph Baxter Associate Vice President for Academic Affairs	George Mason University Fairfax	Feb. 21, 1980
Dr. Murray Black Director, Pre-Engineering Program	George Mason University Fairfax	Feb. 21, 1980
Dr. Robert Ehrlich Chairman, Department of Physics	George Mason University Fairfax	Feb. 21, 1980
Dr. David Powers Academic Vice President	George Mason University Fairfax	Feb. 21, 1980

NORTHERN VIRGINIA AND VICINITY**

Name and Title	Company and Location	Date
Mr. Kenneth H. Murray Assistant Dean, School of Engineering	Old Dominion University Norfolk	Oct. 17, 1980
Dr. John Weese, Dean School of Engineering	Old Dominion University Norfolk	Oct. 17, 1980
Dr. George E. Dieter Dean, School of Engineering	University of Maryland College Park	Oct. 20, 1980
Dr. Arnold Seigel Director of TV Studio	University of Maryland College Park	Oct. 20, 1980
Mr. Donald Marlowe Executive Director	American Society for Engineering Education, D. C.	Oct. 20, 1980
Dr. Philip Brack Dean of Engineering	University of the District of Columbia	Oct. 21, 1980
Mr. Paul France Assistant Executive Director	National Society of Professional Engineers, D. C.	Oct. 21, 1980
Mr. Don Weinert Executive Director	National Society of Professional Engineers, D. C.	Oct. 21, 1980
Dr. Stephen Harris Assistant Dean, School of Engineering	Howard University District of Columbia	Oct. 21, 1980
Dr. James Fair Associate Dean, Engineering and Applied Science	George Washington University District of Columbia	Oct. 21, 1980
Dr. Harold Liebowitz Dean, Engineering and Applied Science	George Washington University District of Columbia	Oct. 21, 1980
Mr. Ray Robinson Deputy Director of Continuing Education	George Washington University District of Columbia	Oct. 21, 1980
Mr. Roy Abrams Chief of Manpower Section	U. S. Geological Survey Reston	Oct. 22, 1980
Mr. Thomas J. Buchanan Assistant Chief Hydrologist for Operations	U. S. Geological Survey Reston	Oct. 22, 1980
Mr. Bill Gary Director, Industrial Relations	Computer Services Corporation Falls Church	Oct. 22, 1980
Ms. Lorraine Gawkins Manager, Equal Employment Opportunity	Computer Services Corporation Falls Church	Oct. 22, 1980
Mr. Dave Karlgard Technical Manager	Computer Services Corporation Falls Church	Oct. 22, 1980
Ms. Gus Siekierka Director, Industrial Relations	Computer Services Corporation Falls Church	Oct. 22, 1980
Mr. Paul Pederson Manager, Personnel Services	I. B. M. Manassas	Oct. 22, 1980
Mr. Ralph Yost Senior Training Specialist	I. B. M. Manassas	Oct. 22, 1980
Dr. Norton D. Harding Faculty Member (Engineering)	Northern Virginia Community College, Fairfax	Oct. 27, 1980
Mr. Richard Knox Manager, Career Development and Training	Mobil Oil Corporation Fairfax	Oct. 27, 1980
Mr. Courtland D. Perkins President	National Academy of Engineers, D. C.	Oct. 27, 1980
Mr. Earl Williams President	The B. D. M. Corporation McLean	Oct. 28, 1980
Dr. Olsen Berman Director of Research	Naval Research Laboratory District of Columbia	Oct. 28, 1980

** The majority of the visits to businesses and institutions in the Northern Virginia area were conducted in the fall, 1980.

Names and Title	Company and Location	Date
Dr. George E. McDuffie Dean of Engineering and Architecture	Catholic University of America District of Columbia	Oct. 28, 1980
Joint Meeting Held at George Mason University:		
Dr. Roger Barron President	Westgate Research Park	Oct. 27, 1980
Mr. Roland H. Berger	Byrd, Tallamy, MacDonald & Lewis	Oct. 27, 1980
Mr. Hal Demath	ENSCO, Inc.	Oct. 27, 1980
Mr. Raoul E. Drapeau		Oct. 27, 1980
Mr. Steven Gageby President	Advanced Design Corporation	Oct. 27, 1980
Mr. Lewis Guy	Patton, Harris, Rust & Guy	Oct. 27, 1980
Mr. Dominic A. Laiti President	Hadron, Inc.	Oct. 27, 1980
Mrs. Mary Newell Personnel	ENSCO, Inc.	Oct. 27, 1980
Mr. Alan Yorkdale Director of Engineering and Research	Brick Institute of America	Oct. 27, 1980
Mrs. Etyle Lorengo	Melpar, E. Systems	Oct. 27, 1980
Mr. Ted Carron Manager of Management Development and Training	Ethyl Corporation Richmond	Nov. 11, 1980
Mr. Bob O'Connor Staff Engineer	Philip Morris, Inc. Richmond	Nov. 11, 1980
Mr. Harry Kincaid Executive Director	Consulting Engineers' Council of Virginia, Inc., Richmond	Nov. 11, 1980
Mr. Ed Holm Assistant Director	State Division of Industrial Development, Richmond	Nov. 11, 1980
Mr. John Curtis President	Center for Excellence (Centex), Williamsburg	Nov. 12, 1980

Name and Title	Company and Location	Date
Mr. George Wadlin Director	American Society of Civil Engineers (ASCE) New York City	Nov. 20, 1980
Mr. Michael J. Sheridon Executive Director	Engineering Manpower Commission New York City	Nov. 20, 1980
Mr. David Reyes-Guerra Executive Director	Accreditation Board for Engineering Technology (ABET), formerly the Engineers' Council for Professional Development (ECPD) New York City	Nov. 20, 1980
Mr. Eric Herz Executive Director	Institute of Electrical and Electronic Engineers (IEEE) New York City	Nov. 20, 1980
Mr. John Wilhelm Educational Director	Institute of Electrical and Electronic Engineers (IEEE) New York City	Nov. 20, 1980

Appendix D

Engineering Enrollments by School or College - 1979

Virginia

Name of School	Undergraduate Students			Graduate Students		
	Full Time 1st Year	Full Time 4 Years	Part Time 4 Years*	Full Time Masters Degree	Full Time Doctoral Degree	Part Time
VPI and State University	1,259	4,697	46	315	138	-
University of Virginia	416	1,417	29	241	102	128
Old Dominion University	217	618	78	32	5	140
Virginia Military Institute	202	604	-	-	-	-
Virginia - Total	2,094	7,336	153	605	245	268

District of Columbia

Name of School	Undergraduate Students			Graduate Students		
	Full Time 1st Year	Full Time 4 Years	Part Time 4 Years*	Full Time Masters Degree	Full Time Doctoral Degree	Part Time
Catholic	112	400	29	27	10	173
University of D.C.	94	455	-	-	-	-
George Washington	182	678	205	278	49	1,067
Howard	312	675	15	83	15	51
D. C. - Total	700	2,208	249	388	74	1,292

Maryland

Name of School	Undergraduate Students			Graudate Students		
	Full Time 1st Year	Full Time 4 Years	Part Time 4 Years*	Full Time Masters Degree	Full Time Doctoral Degree	Part Time
Annapolis	-	1,294	-	-	-	-
Hopkins	119	335	481	-	95	221
Loyola Bal.	58	140	45	-	-	-
Maryland	1,038	3,189	445	133	78	241
Maryland - Total	1,215	4,958	971	133	173	462

United States Enrollments

U. S. Totals	103,724	340,485	25,811	27,171	13,461	25,768

* The designation "4 years" includes all undergraduates.
Totals may not check exactly with institutional numbers

Appendix D (continued)

Engineering Enrollments in Fall 1979, Compared with Earlier Years.

Engineering Students	Fall 1969	Fall 1970	Fall 1971	Fall 1972	Fall 1973	Fall 1974	Fall 1975	Fall 1976	Fall 1977	Fall 1978	Fall 1979
Freshman Year, Full-Time	74113	71661	58568	52100	51925	63444	75340	82250	98780	95805	103724
Sophomore Year, Full-Time	52972	53419	47948	42272	40519	45935	55891	62003	70325	72150	78594
Junior Year, Full-Time	50039	49855	48543	45874	41673	43007	49333	56825	64271	69816	74928
Senior Year, Full-Time	51738	51583	51377	49895	48366	44533	47070	51692	60119	68250	77823
Fifth Year, Full-Time	4868	4812	4391	4586	4222	4175	3737	4055	5312	5206	5419
TOTAL FULL-TIME UNDERGRADS	233530	231730	210825	194727	186705	201099	231379	257835	289243	311237	340488
Part-Time Undergraduates	20984	18445	18222	14143	15892	16689	17041	19844	20634	22843	25811
Master's Degree, Full-Time *	20814	23218	22405	22877	22588	21999	25004	25516	26878	26060	27923
Doctor's Degree, Full-Time	14298	14802	14100	13489	11904	10828	11281	10963	12359	12521	13461
TOTAL FULL-TIME GRADUATE STUDENTS	34312	38018	36505	36337	34492	32827	37285	36479	39235	38581	41384
Part-Time Grad Students	32845	30892	27302	24940	28114	27572	27173	26842	25065	24133	25768
Number of Schools	280	275	282	283	285	282	291	289	289	276	286

*Includes Engineer (professional) degrees.

Engineering Technology Enrollments by Curriculum and Year, Fall 1979 (all students)

	ASSOCIATE DEGREE						BACHELOR OF TECHNOLOGY PROGRAMS						
ALL SCHOOLS	1ST YEAR	2ND YEAR	OTHER YEARS	TOTAL FULL TIME	TOTAL PART TIME		1ST YEAR	2ND YEAR	3RD YEAR	4TH YEAR	TOTAL FULL TIME	TOTAL POST BACC	ALL PART TIME
AEROSPACE	1708	736	17	2461	572	:	333	254	211	222	1020	-	56
AGRICULTURAL	47	25	-	72	-	:	-	-	-	-	-	-	-
AIR CONDITIONING	936	523	5	1464	1236	:	21	16	-	-	37	-	-
ARCHITECTURAL	2796	1508	14	4318	1688	:	241	98	258	204	801	6	198
AUTOMOTIVE	2598	1301	57	3956	2060	:	178	149	129	128	584	5	61
BIOENGINEERING	84	71	-	155	47	:	34	25	18	20	97	-	31
CERAMIC	13	2	-	15	-	:	-	-	-	-	-	-	-
CHEMICAL	583	370	-	953	379	:	21	13	16	21	71	1	8
CIVIL	2532	1518	12	4062	1478	:	388	274	676	616	1954	1	654
COMPUTER	4045	1669	18	5732	5676	:	445	251	325	277	1298	2	279
CONSTRUCTION	1899	1118	34	3051	1756	:	637	545	709	634	2525	16	439
DRAFTING & DESIGN	3773	1675	29	5477	2473	:	266	257	207	197	927	2	202
ELECTRICAL	5114	3006	2	8122	3638	:	523	498	1137	1074	3224	39	1777
ELECTROMECHANICAL	934	578	3	1515	660	:	36	28	97	77	238	-	111
ELECTRONIC	9992	5223	448	15663	7746	:	1707	1138	1671	1632	6148	21	1839
ENG SCIENCE	742	284	22	1048	253	:	434	7	4	-	445	-	70
ENVIRONMENTAL	369	178	-	547	258	:	89	81	87	134	391	15	63
GENERAL	1187	471	86	1664	1338	:	425	418	668	867	2378	11	672
INDUSTRIAL	1485	738	8	2151	2710	:	1524	1253	1486	1527	5790	113	1115
MANUFACTURING	948	308	21	877	939	:	166	189	249	326	930	28	340
MARINE	126	80	-	206	33	:	265	131	162	178	736	-	19
MATERIALS	-	3	-	3	-	:	-	-	-	-	-	-	-
MECHANICAL	4353	2562	24	6939	4424	:	683	666	1449	1318	4116	26	1891
METALLURGICAL	192	61	5	258	302	:	23	19	40	34	116	-	4
MINING	489	469	-	958	718	:	2	1	76	113	192	-	38
NUCLEAR	37	25	-	62	1	:	-	-	5	19	24	-	-
OTHER	1841	456	11	1508	914	:	199	187	173	162	721	16	205
PETROLEUM	54	38	-	92	9	:	48	57	49	60	206	-	-
SYSTEMS	-	-	-	-	-	:	-	-	-	2	2	-	-
TOTAL U.S.	47517	24988	816	73321	41284	:	8688	6547	9902	9842	34971	294	9982
CURRICULA ACCREDITED BY ECPD	15739	9048	455	25242	11133	:	2363	1937	4458	4312	13070	35	4138
CURRICULA NOT ACCREDITED BY ECPD	31778	15940	361	48079	30151	:	6317	4618	5444	5530	21901	259	5844
SCHOOL NOT ON ECPD LIST	47517	24988	816	73321	41284	:	8688	6547	9902	9842	34971	294	9982

Virginia

Appendix E

Engineering Degrees Awarded in 1979 by Degree Level

Name of School	Degree Level		
	B.S.	M.S.*	Ph.D.
Virginia Polytechinc Institute and State University	669	164	36
University of Virginia	286	158	29
Old Dominion University	76	29	3
Virginia Military Institute	106	-	-
Virginia - Total	1,137	351	68

District of Columbia

Name of School	Degree Level		
	B.S.	M.S.	Ph.D.
Catholic	66	38	5
University of D. C.	30	-	-
George Washington	72	192	12
Howard	85	32	-
D. C. - Total	253	262	17

Maryland

Name of School	Degree Level		
	B.S.	M.S.	Ph.D.
Annapolis	298	-	-
Hopkins	120	47	14
Loyola Bal.	6	-	-
Maryland	359	123	21
Maryland - Total	783	170	35

United States

	Degree Level		
	B.S.	M.S.	Ph.D.
U. S. Total (1969)	39,972	14,980	3,345
U. S. Total (1974)	41,407	15,885	3,362
U. S. Total (1979)	52,598	16,036	2,815
U. S. Total (1980)	58,742	17,243	2,751

* Include other awards below the Ph.D.

APPENDIX F

COURSE OFFERINGS AND ENROLLMENTS FOR CONTINUING ENGINEERING EDUCATION IN VIRGINIA; 1970-1980 and 1975-1980

	No. of Courses Offered Off-Campus Credit	Headcount Enrollment Off-Campus Credit	No. of Courses Offered Non-Credit	Registrations In Non-Credit
1970-1980	516	8,151	1,498	41,266
1975-76	50	718	152	4,004
1976-77	51	720	181	4,887
1977-78	54	652	194	4,830
1978-79	46	631	231	6,010
1979-80	57	880	262	6,609
1975-1980	258	3,601	1,020	26,340
1970-1980:				
Northern Virginia Area	165	2,647	246	6,422
Richmond Area	171	2,640	42	947
Tidewater Area	42	581	715	14,072
Other	138	2,283	495	19,825
1975-76:				
Northern Virginia Area	16	232	18	569
Richmond Area	13	234	2	62
Tidewater Area	3	50	93	1,779
Other	18	202	39	1,594
1976-77:				
Northern Virginia Area	19	262	22	640
Richmond Area	21	279	3	102
Tidewater Area	3	32	95	1,772
Other	8	147	61	2,373
1977-78:				
Northern Virginia Area	20	209	37	867
Richmond Area	18	260	5	99
Tidewater Area	4	33	88	1,720
Other	12	150	64	2,144
1978-79:				
Northern Virginia Area	22	316	39	932
Richmond Area	14	217	5	117
Tidewater Area	1	13	110	2,327
Other	9	85	77	2,634
1979-80:				
Northern Virginia Area	29	478	43	982
Richmond Area	12	193	2	74
Tidewater Area	4	58	140	2,621
Other	12	151	77	2,932
1975-80:				
Northern Virginia Area	106	1,497	159	3,990
Richmond Area	78	1,183	17	454
Tidewater Area	15	186	526	10,219
Other	59	735	318	11,677

Source: State Council of Higher Education for Virginia

(SCHEV/12-9-80/JCP)

6/12/80

APPENDIX G

UNIVERSITY OF MARYLAND

FALL 1980 ITV COURSES

COURSE	TITLE	INSTRUCTOR	TIME
ENAE 371	Aerodynamics I	Anderson	MWF 1
ENAE 640	Flight Mechanics I	Barlow	TuTh 2-3:15
ENAE 788A	Applied Computational Aerodynamics	Anderson	F 2-4:30
ENAE 673	Aerodynamics of Compressible Fluids I	Griffin	TuTh 8-9:15
ENCE/METO 434	Air Pollution	Pitter	TuTh 2-3:15
ENCH 468A	Economics Of Fuel & Energy Related Processes	Schroeder	TuTh 9:30-10:45
ENCH 468C	Introduction To Occupational Health & Safety	Bruckner	F 2-4:30
ENEE 442	Software Engineering	Chu	TuTh 3:30-4:45
ENEE 468B	Microprocessors (TENTATIVE)	Ligomenides	MWF 8
ENEE 480	Fund. of Solid State Electronics	White	MW 5-6:15
ENEE 488A	Computer Aided Design	Zaki	MWF 11
ENEE 610	Electrical Network Theory	Newcomb	MW 2-3:15
ENEE 620	Random Processes In Communication & Control	Krishnaprasad	MW 5-6:15
ENEE 661	NonLinear Control Systems	Blankenship	MW 2-3:15
ENEE 680	Electromagnatic Theory I	Striffler	MW 3:30-4:45
ENME 633	Advanced Classical Thermodynamics	Gatzoulis	TuTh 5:30-6:45
ENME 651	Fundamentals Of Fluid Mechanics I	Buckley	MW 4-5:15
ENME 681	Engineering Acoustics	Tsui	MW 3:30-4:45
ENNU 430	Radioisotope Power Sources	Duffey	M 6:45-9:15
BMGT 434	Operations Research I	Bodin	TuTh 11-12:15
BMGT 503	Accounting & Information Systems	Hamer	TuTh 5-6:15
BMGT 735	Application of Management Science	Fromovitz	Th 7-9:30 P.M.
BMGT 764	Behavioral Factors In Management	Gannon	TuTh 9:30-10:45
BMGT 828	Organizational Theory & Behavior	Hage & Gannon	TuTh 12:30-1:45
CMSC/MAPL 470	Numerical Mathematics: Analysis	Osborn	MWF 1
CMSC 498F	Languages For Artificial Intelligence I	Rieger	TuTh 12:30-1:45
CMSC 498G	Design & Construction Of Personal Micro-Computers	Rieger	Th 7-9:30 P.M.
MATH 463	Complex Variables For Scientists & Engineers	Alexander	TuTh 11-12:15
MATH 464	Transform Methods For Scientists & Engineers	Cooper	MWF 10
PHYS 622	Introduction To Quantum Mechanics I	Redish	M 11-12:45; WF 11

APPENDIX H

SUMMARY OF INDUSTRY VIEWS ON
NEEDS AND USES OF ENGINEERS

LOCATION → / INTEREST ↓	RICHMOND METRO AREA	NORTHERN VIRGINIA
Fresh Baccalaureates	Primary source of Engineers	Greater interest in 2-5 yrs. experience
Masters degree Engineers	Small numbers recruited	Interest by M'g't relatively high
PhD Engineers	No significant interest	Strong interest in "Think-Tank" Co.'s
Opportunities for earning a Master's degree	Opportunities are limited and enrollment is spotty.	Variable offerings but Management's interest is made evident
Interest is employing Co-op engineering students	Strong interest shown by management	Limited interest and in some companies none
Interest in employing BET graduates	Limited experience with BET graduates, but interested	No interest expressed in BET graduates
Interest in upgrading engineers by credit engineering courses as contrasted to short courses and company designed courses	No urgency seems to be felt, but mild encouragement is provided, e.g., tuition paid --- Enrollments have decreased slightly.	Evidence that considerable activity has occurred, 1970-80. Enrollments have increased in continuing education classes for engineers.

APPENDIX I

Continuing Education Calendar - ASME

Fluid Power for Manufacturing and Product Design

Place: Bradley University
Objective: This course is intended for the designer and engineer who design fluid power components for manufacturing and for the original equipment manufacturing (OEM) companies who utilize these components.
Dates: January 12–16
Contact: Dr. D. Albanito, Dean-Continuing Education, Bradley University, Peoria, Ill. 61625. Tel.: (309) 676-7611

Probability and Statistics for Engineers

Place: Milwaukee, Wis.
Objective: Write for details.
Dates: January 12–16
Contact: American Society for Quality Control, Education and Training Institute, 161 W. Wisconsin Ave., Milwaukee, Wis. 53203. Tel.: (414) 272-8575

Data Base Fundamentals

Place: Philadelphia, Pa.
Objective: Course provides a solid foundation in data base concentrating in the areas of benefits, structures and views of data. The course introduces data base design techniques, stressing data aggregates, relationships, program logical views and fundamental procedures.
Dates: January 12–14
Contact: Director, Office of Continuing Education, Drexel University, 32nd and Chestnut St., Philadelphia, Pa. 19104. Tel.: (215) 895-2154

Probability Analysis and Risk Assessment in Geotechnical Engineering

Place: The George Washington University
Objective: Write for details.
Dates: January 19–23
Contact: The George Washington University, School of Engineering and Applied Science, Washington, D.C. 20052. Tel.: (202) 676-6080

Microcomputers: An Overview for Managers and Engineers

Place: Clearwater Beach, Fla.
Objective: Topics include definitions of what microcomputers are and how they are used, fundamental concepts, and software and hardware characteristics.
Dates: December 3–4
Contact: Ms. D. P. Copp, Special Programs Dept., Society of Manufacturing Engineers, One SME Drive, P.O. Box 930, Dearborn, Mich. 48128

Engineer-in-Training Examination Review

Place: The University of Texas at Austin
Objective: Write for details.
Dates: January 22–April 9
Contact: The University of Texas at Austin, Engineering Institutes, P.O. Box 7727, Austin, Tex. 78712. Tel.: (512) 471-3396

Geometric and Positional Tolerancing and Dimensioning

Place: University of Wisconsin-Ext.
Objective: This seminar will be of value to all personnel who prepare, interpret, or work from engineering drawings. A complete and thorough coverage of the fundamentals of geometric tolerancing and true position dimensioning will be presented.
Dates: January 6–9
Contact: J. M. Leaman, Dept. of Engineering, University of Wisconsin-Ext., 929 North Sixth St., Milwaukee, Wis. 53203

Coal-Fired Industrial Boilers Workshop

Place: Raleigh, N.C.
Objective: Workshop is to provide a basic understanding of coal-fired boiler operations to prospective coal users, both for new boiler installations and conversions to coal from other energy sources. Experts from industry will present aspects of coal-fired boiler operation covering the spectrum from coal characterization, preparation, and combustion to emissions control and waste disposal.
Dates: December 10–11
Contact: C. S. Cooper, North Carolina State University, Raleigh, N.C. 27650 Tel.: (919) 737-2356

Passive Solar Heating and Cooling

Place: The Georgia Institute of Technology
Objective: This course will provide a current knowledge of passive solar design, performance, analysis, and economics. Course topics include fundamentals, thermal storage walls, thermal storage roofs, direct gain systems, convection loops, attached greenhouses, and passive solar economics.
Dates: February 18–19
Contact: Dept. Continuing Education, Georgia Institute of Technology, Atlanta, Ga. 30332. Tel.: (404) 894-2400

Synfuel Environmental Impact

Place: Houston, Tex.
Objective: To provide a systematic approach to evaluate environmental, safety and health impacts associated with the synfuel program. Subjects covered include principles of toxicology, recent regulatory developments, risk assessment, and state-of-the-art developments associated with synfuels.
Dates: December 8–9
Contact: Association of Energy Engineers, 4025 Pleasantdale Rd., Suite 340, Atlanta, Ga. 30340. Tel.: (404) 447-6424

Introduction to Polymer Science and Technology

Place: Stevens Institute of Technology
Objective: Write for details.
Dates: December 9–11
Contact: Plastics Institute of America, Inc., at Stevens Institute of Technology, Castle Point Station, Hoboken, N.J. 07030. Tel.: (201) 420-5553

ASME COURSES

The following short courses will be offered at the ASME Energy-sources Technology Conference and Exhibition at the Albert Thomas Convention Center in Houston, Tex., January 18–21, 1981.

- **Minicomputers, and Microprocessors for Non-Electrical Engineers**
  Dates: January 21–23
- **ASME/ANSI B31.1 Piping Design and Analysis**
  Dates: January 22–23
- **Designing and Fabricating Pressure Vessels**
  Dates: January 22–23
- **Numerical Methods in Gas-Particle Flow**
  Dates: January 22

For further program information on the above ASME courses, contact: ASME, Professional Development Program, 345 E. 47th St., New York, N.Y. 10017. Tel.: (212) 644-7743

Gasohol Production Technologies

Place: Georgia Institute of Technology
Objective: This course will present the fundamentals necessary for producing alcohol from various agricultural products including corn, sugar, milo, wood, and waste materials.
Dates: January 26–27, 1981
Contact: Continuing Education Dept., Georgia Institute of Technology, Atlanta, Ga. 30332. Tel.: (404) 894-2400

Finite Elements in Flow Problems

Place: University of Arizona
Objective: To present the theory of and applications of the finite element method for the solution of fluid and thermal flow problems.
Dates: Jauary 12–16
Contact: Special Professional Education, College of Engineering, University of Arizona, Tucson, Ariz. 85721. Tel.: (602) 626-3054

Probabilistic and Statistical Methods in Mechanical and Structural Design

Place: Tucson, Ariz.
Objective: To provide practical information on engineering applications of probabilistic and statistical methods, and design under random vibration environments. Modern methods of structural and mechanical reliability analysis will be presented. Special emphasis will be given to fatigue and fracture reliability.
Dates: January 5–9, 1981
Contact: Dr. P.H. Wirsching, Assoc. Professor of Aerospace and Mechanical Engineering, The University of Arizona, College of Engineering, Tucson, Ariz. 85721. Tel.: (602) 626-3159

Appendix J
Tuition for Selected Virginia Institutions, Selected District of Columbia Institutions and University of Maryland
1980-81

Institution	UNDERGRADUATE			
	Full-Time		Part-Time	
	In-State	Out-of-State	In-State	Out-of-State
George Washington University	$ 3,700/yr.	--	$ 137/sem. hr.	--
Catholic University	4,250/yr.	$ 4,250/yr.	158/sem. hr.	$ 158/sem. hr.
University of Maryland	884/yr.	2,689/yr.	41/sem. hr.	41/sem. hr.
The University of the District of Columbia	136/yr.	1,156/yr.	--	--
Howard University	900/yr.	--	--	--
VA Polytechnic Institute and State University	837/yr.	1,782/yr.	72/qtr. hr.	156/qtr. hr.
George Mason University	636/yr.	1,404/yr.	--	--
University of VA	665/yr.	2,025/yr.	--	--
Old Dominion University	721/yr.	1,417/yr.	--	--

Institution	GRADUATE			
	Full-Time		Part-Time	
	In-State	Out-of-State	In-State	Out-of-State
George Washington University	$ 3,288/yr.	$ 3,288/yr.	$ 137/sem. hr.	$ 137/sem. hr.
Catholic University	4,450/yr.	4,450/yr.	158/sem. hr.	158/sem. hr.
University of Maryland	1,320/yr.	2,400/yr.	55/sem. hr.	100/sem. hr.
The University of the District of Columbia	--	--	--	--
Howard University	--	--	--	--
VA Polytechnic Institute and State University	--	--	--	--
George Mason University	636/yr.	1,404/yr.	--	--
University of VA	665/yr.	2,025/yr.	--	--
Old Dominion University	888/yr.	1,584/yr.	--	--

(SCHEV-12/17/80-JCP)

APPENDIX K

Population Statistics for Northern Virginia; Residents and Engineers.

Northern Virginia, 1,200,000. Total for Virginia, 5,000,000.

Northern Virginia grew at the rate of 4.1 percent per year in the 1960's.

Northern Virginia grew at the rate of 1.7 percent per year from 1970-74.

Northern Virginia grew at the rate of 1.3 percent per year from 1974-78.

Northern Virginia is the residence of 43 percent of Virginia engineers.

Richmond Metro Area is the residence of 11 percent of Virginia engineers.

Larger Urban Area	1960	1970	1974	1978	Annual Percent Change 1960-1970	1970-1974	1974-1978
Virginia Portion of Washington, D.C.-Md.-Va. SMSA	614,331	921,237	986,900	1,038,100	4.1	1.7	1.3
Richmond	461,993	547,542[1]	574,200	611,700	1.7	1.2[1]	1.6[1]
Norfolk-Virginia Beach-Portsmouth	622,482	725,624[2]	757,200[2]	789,500	1.5	1.1	1.0
Newport News-Hampton	254,793	333,140	349,500[3]	361,400	2.7	1.2	0.8
Roanoke	178.875	203,153	212,700	210,800	1.3	1.2	−0.2
Total	2,132,473	2,730,696	2,880,500	3,011,500	2.5	1.3	1.1
State Total	3,966,949	4,651,448	4,909,000	5,148,100	1.6	1.4	1.2
Larger Urban Areas as Percent of State Total	53.8	58.7	58.7	58.5			

[1]Richmond's annual rate of population increase was somewhat more evenly distributed between 1970-1974 and 1974-1978 than shown because the trial Census for Richmond-Henrico-Chesterfield adjusted Chesterfield's population upward by six percent but this adjustment was made only back to 1977.

[2]Population increase shown from 1970-1974 reflects 16,000 decline in military stationed in area.

[3]Population increase shown from 1970-1974 reflects 4,000 decline in military stationed in area.

Sources: U. S. Census of Population and Tayloe Murphy Institute of the University of Virginia

APPENDIX L

Number of ABET/ECPD Accredited Curricula in Engineering

Virginia		Washington, D.C.		Maryland	
University of Virginia	6	Catholic	4	University of Maryland	9
VPI & State University	10	Howard	4		
Virginia Military Institute	2	University of D.C.	2		
Old Dominion University	3	George Washington University	3		
TOTAL Virginia	21	TOTAL Washington D.C.	13	TOTAL D.C. Metro Area	43

(SCHEV/12-9-80/JCP)