

Campaign 2001 Briefing Series

Issue Paper #3

The Commonwealth Information Technology Program Part 1

*A proposal to use distributed techniques for a new
Bachelor's Degree in Information Technology*

By

John Rocovich

September 2001

Foreword

As business becomes more and more dependent upon the computer, it is also clear that those who better understand information technology will be at the leading edge of the next generation of business expansion. Information Technology is no longer some exclusive and strange way of doing business. It is both the "wave of the future" and the "key to the future" and those who grasp it will be ready to lead in tomorrow's business world. Those who remain "in the dark" about this technology will be significantly hindered as they compete in tomorrow's economy whether they work in the private sector, the public sector or the non-profit sector.

John Rocovich, has written an important two-part issue paper for the *Campaign 2001 Briefing Series* published and distributed by the Thomas Jefferson Institute for Public Policy. As a leading attorney in Virginia, a key member of the Board of Visitors at Virginia Tech, and an active member of the Jefferson's Institute Policy Working Group on Higher Education, Mr. Rocovich is a state leader in promoting the use of technology to enhance the capability of higher education. He is also a strong advocate of Virginia taking those actions necessary to make sure that our college students have access to quality education in the field of Information Technology.

Part I of this two-part issue paper focuses on Mr. Rocovich's concept for a Virginia wide Bachelor's Degree in Information Technology. He details the need and the way such a degree can be offered statewide.

Part II of this two-part paper discusses the need for a special scholarship program that would enable more of our college students in Virginia to take advantage of the proposed Bachelor's Degree in Information Technology as well as degrees in other "critical need" areas necessary for the economic development of our state.

This two-part issue paper presents a creative program that our elected leaders, our business leaders and our education leaders should seriously consider as they work together to continue the economic success of Virginia.

The ideas presented in this paper, and the other issue papers that are part of the *Campaign 2001 Briefing Series*, are those of the author and do not necessarily reflect the views of the Thomas Jefferson Institute nor its Board of Directors. Nothing in this paper is meant to influence specific legislation.

Michael W. Thompson
Chairman and President
Thomas Jefferson Institute for Public Policy
September 2001

The Commonwealth Information Technology Program

Part 1

A proposal to use distributed learning techniques for a new Bachelor's Degree in Information Technology.

By: John Rocovich

Introduction - BIT Degree

The past decade created an unprecedented demand for workers with skills in computing, networks, and communications. These three fields have converged to drive the global economy to record levels of productivity, creating a need for a rapidly growing workforce with information technology (IT) skills. Recently, many reports have been written documenting the national need for IT workers. The United States Department of Commerce predicts the creation of 1.5 million new IT jobs by the year 2005. The United States Bureau of Labor Standards projected that over the decade ending 2008 the country will need nearly 1.7 million additional computer engineers, programmers, and analysts. The majority of these jobs will go unfilled unless the United States provides new educational and training programs to supply both experienced workers and young college graduates with the IT skills demanded in the 21st century.

In March of 1998, Virginia Tech's Department of Continuing Education and the Information Technology Association of American (ITAA) reported on the nationwide need for programmers, systems analysts, computer engineers and computer scientists. The study reported nearly 350,000 job vacancies in these core areas of IT. Virginia Tech has responded by nearly tripling enrollments in computer engineering, computer science, management sciences and accounting systems. Sometime ago, the State Council of Higher Education (SCHEV) approved the Master of Information Technology (MIT) degree, which Virginia Tech is currently offering in Northern Virginia and will offer across the State of Virginia using advanced distributed learning technologies, including *net.work.Virginia* and asynchronous Internet video streaming. Although Virginia Tech has responded to this huge need, these efforts alone will not satisfy the large demand for IT workers in the Commonwealth of Virginia.

The Northern Virginia Region alone still has tens of thousands of job openings for IT workers. Two years ago, the office of the Commerce Secretary for the State of California estimated that San Francisco and the Silicon Valley had at least 100,000 job openings for IT workers, and that California could be losing as much as 40 billion dollars worth of business for lack of IT workers.

When you consider the state and local tax revenues generated by that much business revenue and its multiplier effect throughout a state's economy, the cost of providing graduates with the necessary skills is very small. According to the State Council of Higher Education of Virginia (SCHEV), more than 100,000 new technology workers must be added to Virginia's growing workforce in the next five years. Recent Center for Innovative Technology (CIT) studies have not been clear on the levels of IT skills needed in these new positions. It is clear from the studies that many of the jobs could be filled by IT workers with a skill set that is more focused and less theoretical than the IT education provided in the computer engineering and computer science programs currently available at Virginia's universities. Indeed, many IT jobs across the nation are found outside of the IT industry. IT occupations can be established in traditional businesses such as banking, manufacturing, medicine and insurance. Although the skills needed in these occupations are less technical than engineering and science, the IT education and training required is still substantial.

The creation of a new statewide, asynchronously delivered Commonwealth Bachelor of Information Technology (BIT) degree is needed. This BIT degree will provide students with a professional background in information technology that is well matched to the growing needs of the nation's information technology industry and specifically matched to the needs of the Commonwealth of Virginia. This new degree could be offered at one university with accessibility throughout our state and in cooperation with other universities and colleges.

It is also becoming clear that women and minorities are not enrolling in traditional IT programs in nearly the same numbers as their white male counterparts. The United States will never fill the vacant IT jobs without the full participation of the female and minority communities in the IT workforce. (See chart below) Much has been written recently describing the "digital divide" and the "digital opportunity." With this in mind, joint programs with the State's community colleges and other four-year public and private colleges should be implemented. Virginia's government will never meet its obligations to its citizens unless all of the citizens can participate in the economic benefits of the IT Revolution. Because of the need for practical training and financial support for students, this program should be available as a co-op program with at least three semesters of industry internship available for each student.

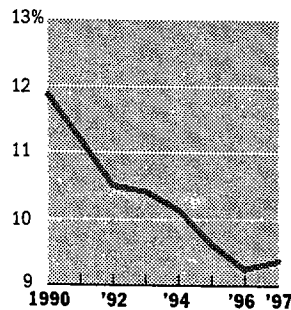
The chart below is from a *Wall Street Journal* article dated July 7, 2000. The article accompanying that chart observes, "That need [nearly 1.7 million additional computer engineers, programmers and analysts] is growing even as the number of American college graduates with high-tech degrees is falling, according to the American Electronics Association. The group estimates that 207,056 high-tech degrees were awarded in 1997, down 2% since 1990. Although the number of minorities with degrees in engineering, math and

computer science has grown in the past decade, the totals remain relatively small.

Have High-Tech Firms Overlooked Minorities?

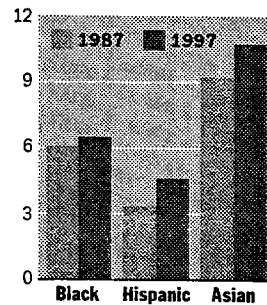
Fewer Tech Degrees¹

Degrees as a percentage of total degrees awarded



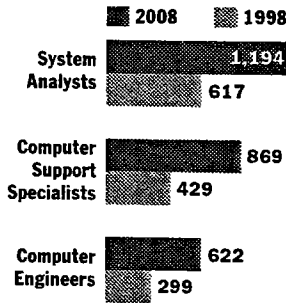
Except for Minorities

Number of high-tech degrees awarded, by race, in thousands²



Shortage Still Looms

Top three job growth categories in the U.S., by number of jobs (in thousands)



¹Engineering, engineering technology, computer science, business information systems, mathematics and physics degrees ranging from associate degrees to Ph.D.s

²Computer science, engineering and mathematics undergraduate degrees

Source: American Electronics Association

The following proposal emphasizes the program on information technology/ biotechnology to prepare students for positions in the growing field of bioinformatics. Many predict that 21st century economies will be driven by advances in molecular biology, biochemistry, and bioinformatics. Virginia Tech expects to play a leading role in the development of these new industries in Virginia. Other Virginia universities and colleges will be involved as well. *Offered statewide, the BIT program would provide this opportunity to all of the other institutions that wished to benefit from it. In this way the investment could be made at Tech with other institutions able to "connect" into this program.*

Program Overview and Features

The Virginia Tech Departments of Electrical and Computer Engineering, Computer Science, Management Sciences, and Information Technology, and Accounting and Information Systems, along with the University of Virginia, Virginia Commonwealth University, Old Dominion University, George Mason University, and the College of William and Mary, in conjunction with the Community College System, should jointly create a consortium (known as Consortium) to offer the Commonwealth Bachelor of Information Technology (BIT) degree.

The new BIT degree would utilize many existing courses. The cost of this program is not so much in course development but rather in converting the courses to distributed learning delivered through *net.work*. Virginia and asynchronous Internet video streaming. The curriculum meets general university

requirements, but unlike its Computer Science and Computer Engineering counterparts, the math, science, and engineering prerequisites have been selected to support the program focus on IT practice rather than a focus on theory and design. The degree will provide students with the necessary background to enter the IT industry or to further their education by enrolling in the Master of Information Technology (MIT) degree program, which could easily be made a part of this program like the Virginia Microelectronics consortium's VMEC combination BS/MS program. (See page 7 for further explanation.)

Students enrolled in the BIT degree program would be required to take a variety of specialized information technology courses that enhance their ability to work with computer and network systems. Course topics include the following: information systems, database management, networks and telecommunications, artificial intelligence and expert systems, client/server systems, object-oriented programming, the Internet, and simulation. Specific programming language skills would include C++, JAVA, COBOL, and Visual Basic.

Where possible, links would be forged to provide *industry certification* in software, databases, and networks for all graduates of the BIT program. Cisco, Microsoft, Novell, Oracle and other such companies would be contacted as soon as possible to explore the necessary partnerships. Certification in these areas is becoming particularly important to the information technology workers.

Teaching and Learning Approaches

This program would be designed to engage a variety of learners with different mental models and different discourse communities who will ultimately work in a world that grows smaller and more interdisciplinary with technology's assistance. To do this, teaching should be offered in a distributed environment. Distributed learning opportunities can engage students as apprentices to learning content assisted by technology, and at the same time offer them more flexibility in the time and place of their learning activities. In the proposed BIT, this relief from place-bound traditional course delivery is the essence and reality of the education process and the students' future employment activities.

Furthermore, collaborative approaches to teaching and learning should be an integral part of the instructional design. Each learner has a certain mental framework based on past experiences. Through collaborative learning activities students can become better acquainted with the limits of their own mental frameworks and can be exposed to others' interpretations of material. Well-designed collaborations can also demonstrate the large differences between the communities that a student encountered before college, the general academic conversation in college, and the world of work that they will enter after college. Such collaborations can provide for the re-acculturation that college demands for many students (especially nontraditional or disadvantaged students), and they are instrumental in helping students to achieve the complex critical thinking they

will need to be productive at work. Collaborative teaching and learning also helps students to understand and master the conventions of a discipline (and the discourse involved in disciplinary communities), as well as the differences in discipline-based expectations when working in an interdisciplinary arena, like information technology and bioinformatics.

Through progressive collaborative teaching and learning activities in a highly distributed environment, the BIT would assist students in the kind of intellectual development required for success in a knowledge economy. The aim is to help students see knowledge as constructed rather than discovered, as contextual and based inevitably on approximations. Faculty should assist in providing the intellectual scaffolding for more complex critical thinking, designing virtual and real discursive exchanges for students with each other, with the corporate world and with faculty themselves. Whether we view these changes as intellectual development or re-acculturation, it is the existential challenge of our times. Since research suggests that students do their most serious rethinking in preparation for and during collaborative sessions, well-designed efforts in this area can provide the social support required to make such mental changes emotionally acceptable for students.

This proposed Bachelor of Information Technology degree will need a set of core requirements to be passed by the student in order to earn this newly designated degree. The proposed Core Requirements are outlined in Appendix A at the end of this study.

In order to facilitate the participation by women and minorities in the BIT degree program, Virginia Tech could initially take the leadership in establishing the Commonwealth Information Technology Program with the five other institutions of higher education: the University of Virginia, George Mason University, Virginia Commonwealth University, Old Dominion University and the College of William and Mary. This Consortium should establish joint programs with the Virginia Community College System and with any other college in the Commonwealth, public or private, that is ready and willing to offer this opportunity to its students.

An additional two years of classes and industry internships should be required to complete the BIT degree at a Consortium member institution. However, all public and private colleges could utilize the distributed learning coursework to supplement their own course availability to offer degrees to their place-bound traditional students or non-traditional students without having the expense of hiring costly faculty or developing expensive courses.

Institutions electing this option likely will have to employ an on-site, qualified teaching associate or adjunct professor to provide direct contact with their students and interaction with the faculty member in charge of the course. Personal contact should continue to play a role in undergraduate teaching. As

with VMEC there could be one statewide program available to all schools without grossly expensive duplication. Students could elect to have a degree from a Consortium member or a degree from whichever other institution they attended.

Northern Virginia Senior Program

Students should be given the opportunity to complete their senior year in Northern Virginia or other regions with demonstrated shortages of IT workers. The students could participate in a less structured university/industry cooperative environment that would include coursework at the Northern Virginia Center (NVC), other Commonwealth facilities located in Northern Virginia, and industry-based certification programs. The year of study could be built around a number of learning modules that would need to be completed over the one-year period. Features of the program could include the following:

- Day and evening classes at participating institutions
- Self-paced learning modules using the Internet
- Industry internships and mentors
- Software and network certification
- Specialized intensive short courses for credit
- Team-oriented capstone projects

Co-op and Internship Programs

This BIT Program could also be available as a co-op program. More than two thousand companies in Virginia hire IT workers. It should be a simple matter to identify a large number of Virginia companies that are willing to participate in BIT's co-op program. Hopefully at least 50% of the enrolled students would select the co-op option. Benefits include:

- financial support for lower income students
- practical on-the-job training in a rapidly moving discipline
- possibility of earning certification and academic credit while employed
- helps keep Virginia graduates employed in Virginia
- establishes stronger ties with Virginia's IT industry

An additional course offering would be an Information Technology Minor (ITM) and that course would include 21 semester units from a required core and elective list.

Every college in Virginia could be offering IT Bachelors and Masters degrees on and off their campuses within two years. Luckily, a similar model, the Virginia Micro-electronics Consortium (VMEC), already is in effect in Virginia. That model demonstrates how cost-effective and learning-effective co-operative distributed learning can be. It seems to me that the best BIT/MIT program would be a cooperative program like VMEC. That program model,

although excellent, has evolved at glacial speed. In order to start the program now, I propose that Virginia Tech initiate the development of the Consortium as rapidly as possible. Set forth below is a review of the VMEC program to familiarize us with it. This proposal is also similar also to Virginia's Satellite TV MBA Program which Virginia Tech has offered statewide since 1989, described later in this paper.

After working with key personnel at Virginia Tech, I have concluded that this entire program could be funded with an annual state commitment of \$10 million to the Consortium that would be offer this new BIT degree to students throughout Virginia.

Background - VMEC

Today the major challenges of Virginia's higher education institutions are excessive labor cost and duplication of effort. Cooperation between institutions and utilization of technology could solve both problems.

The model program is the Virginia Microelectronics Consortium (VMEC). This program utilizes resources and talents by combining high-technology delivery of teaching while simultaneously reducing or eliminating duplicative and overlapping degree programs, facilities, and faculties.

The Commonwealth of Virginia appears to have a public policy of placing an engineering school within walking distance of every Virginian. With regard to engineering education, Virginia has taken the "road less traveled." The premier state-supported engineering education programs, such as those at the University of Illinois and Georgia Tech, concentrate all of their resources in one university. My hope and belief is that the Virginia approach (six engineering schools, with more to come), unique as it is, should yield enormous dividends *if* it is properly utilized. The VMEC program, designed to provide a statewide undergraduate and master's program in microelectronics, should begin to deliver a strong return on Virginia's enormous investment in engineering schools once the VMEC funding is finally secured from Virginia's government.

Virginia already has a massive education infrastructure of buildings, equipment, and faculty. What Virginia needs now is *cutting edge programs*, both in engineering and the other disciplines, to deliver to the citizens of the Commonwealth maximum benefit at minimum costs.

Five of the Commonwealth's engineering schools (the University of Virginia, Virginia Tech, Old Dominion University, George Mason University, and Virginia Commonwealth University), the Applied Science Program at the College of William and Mary, and the Virginia Community College System have joined forces to create a framework for a statewide microelectronics education and research consortium. VMEC seeks to utilize the complementary skills, expertise,

and facilities of the Commonwealth's universities, community colleges, major laboratories, and growing microelectronics industries to deliver both seamless, flexible, high-quality instructional training and research programs in microelectronics and semiconductor technology (with a strong emphasis on fabrication).

Introduction to the Virginia Microelectronics Consortium

In the fall of 1994, Motorola, IBM/Toshiba, and Motorola/Siemens announced their intention to locate multi-billion dollar microelectronic fabrication plants in Virginia. Two of these facilities are now operational and ultimately will employ several thousand engineers and technicians, with many more similarly skilled persons in supporting industries. Recently, Dominion Semiconductor and White Oak Semiconductor announced major expansions of their facilities in Manassas and Richmond. These industries have created a strong demand for enhanced science and engineering education from K-12 through the doctoral degree and a need for industry-academic partnerships.

The Commonwealth committed \$9 million to create a quasi-endowment in support of the semiconductor industry. These funds, together with a subsequent \$1 million pledge from Motorola, are to be administered by the Virginia Semiconductor Educational Endowment (VSEE). At a meeting in June 1998, it was agreed that the funds would be used to endow professorships and student scholarships, and to provide one-time start-up costs for infrastructure.

These and other resources are needed to complement the significant microelectronics, research, and academic degree programs that already exist at the participating Virginia institutions. These activities span the complete spectrum of microelectronics fabrication, from the fundamentals of semiconductor electron transport through device design and manufacturing, packaging, and incorporation (with software) in systems. Strong programs in business, commerce, workforce assessment, and training are also available.

The endowed professors should provide highly visible, talented leadership to implement the collaborative program developed by VMEC over the next two-and-one-half years. *This consortium avoids duplication of expensive facilities across the State and will ensure that institutions work together to provide the workforce needed by the microelectronics industry when it is in full-scale production a few short years from now.* In addition, the graduates produced by this consortium can help fill the current shortage of tens of thousands of high-tech employees in Northern Virginia.

Program Vision

The six universities involved in VMEC employ a combined total of more than fifty faculty spanning the areas of electronic materials, devices, circuits, and

Very Large Scale Integration (VLSI) design, processing, and packaging. The consortium calls upon these faculty to establish the most comprehensive and in-depth undergraduate microelectronics program in the nation and a five-year B.S./M.S. degree for selected students utilizing the specialized expertise and facilities of the member institutions in cooperative joint-degree programs.

The first six semesters of the program at each institution will provide every microelectronics undergraduate student with a similar background and prerequisites. VMEC will sponsor a two-session summer exchange program for students in the summers between their junior and senior years and between the senior and M.S. level. Each institution will offer at least two intensive, senior, summer-electives in its respective areas of specialization. Summer scholarships, internships in the microelectronics industry, and the exchange of industrial and academic personnel will supplement these experiences. This approach provides the highest quality microelectronics undergraduate/master's program in the nation while eliminating costly duplication of faculty positions and facilities at the participating institutions.

The role of the community colleges in the successful implementation of the proposed program will be to prepare well-qualified transfer students for entry into the upper division of the undergraduate curriculum. Currently, seven Virginia community colleges offer the engineering transfer program that is designed to prepare the student for transfer to a senior institution in one of several engineering fields. Introduction of the microelectronics program as an area of specialization will increase the enrollment in community college engineering programs. The community colleges offering the engineering program have circuits and electronics laboratories that will support the new microelectronics program with minimal additional cost. University facilities can be made available to the Community Colleges where appropriate.

The Virginia Community College System also has faculty positions to offer the microelectronics specialization on a regional basis. The seven community colleges currently offering engineering will make mathematics, science, and engineering courses available to students at other community colleges via the Asynchronous Transfer Mode (ATM) network and through the use of the Internet and video streaming.

High-Technology Delivery of Teaching

As part of the program, VMEC schools will develop, in a shared manner, multimedia activities and interactive learning materials that they incorporate into microelectronics-related courses on a state wide basis. These schools may provide such courses to students for home study on their personal computers.

Several years of prior classroom experience indicate that materials such as those described here significantly improve the quality of education delivery

and enhance student understanding of complex concepts. The consortium will pay special attention to creating materials for the community colleges. The proposed materials will be developed in a manner that is consistent with distance learning delivery to remote sites (the community colleges, other universities, and microelectronics industries within the state), via the recently commissioned *net.work.Virginia* and the Internet.

The consortium will make the content available to all VMEC faculty (both from the four-year institutions and from the community colleges), via an on-line (Internet) library. As the program develops, the consortium will encourage the participation of other Virginia schools that do not have a critical mass of faculty in microelectronics, but whose presence will clearly enhance the consortium.

Finally, the VMEC program will create a Faculty Development Institute where faculty will train to incorporate and effectively use these materials in their own courses. A single faculty member at one institution will coordinate the program and will disseminate it throughout the State via the Internet and through the summer Faculty Development Institute.

Potential Future Problems

When starting a new program like VMEC, it is much easier to set the ground rules regarding requirements and funding that will be provided. We are building the program from the ground up. It will be important to monitor the development of the VMEC partners to insure over time the degree to which they remain partners. The tendency will be for some universities to develop their own agendas for future growth that will result in lobbying to get more monies to ultimately move away from the concepts being established at the outset for VMEC.

That result is the reality of Virginia Commonwealth Graduates Engineering Program (the VCGEP), discussed later. The primary purpose for VCGEP was to provide graduate engineering in locations in the Commonwealth where graduate engineering programs did not exist. Two key locations targeted by VCGEP were Northern Virginia and Richmond. Both locations now have onsite, "live" engineering programs in place. Judging from enrollment numbers, GMU appears to have utilized VCGEP very little and, instead, to have developed its own missions in engineering. VCU has built an engineering school with the blessing and funding of the Commonwealth.

Indeed, these two new engineering schools appear to have resulted from the natural evolution of these programs and the localities and the Commonwealth will certainly reap great benefits. Thus, these distance learning programs do not always solve long-term needs, especially if there is insufficient political will and oversight to hold participants to the original plans. In cases such as these two, the local market conditions and maturity of the institutions enabled the

development of full-fledged programs. The high cost of engineering schools and their expensive educational programs mandates that such developments should be carefully planned in order to maximally benefit the Commonwealth.

Summary

As you can see, this program has all the elements to make Virginia's higher education system the world leader in microelectronics. VMEC pulls together all of the schools with meaningful capacity in the microelectronics area and bonds them closer to the community college system. The consortium utilizes traditional teaching, multi-media, asynchronous transfer mode (*net.work.Virginia*), Internet, satellite transmission, wireless communications (through the wireless spectrum that Virginia Tech recently acquired for western Virginia), shared faculties, shared physical facilities, and mutual cooperation. The program also builds on the strengths of each institution to produce maximum return at minimum cost for Virginia and its citizens.

Background - the Graduate Program In Information Technology

A specific program (similar to VMEC), that Virginia could easily develop as a pilot program along the same lines to include all Virginia institutions is the Graduate Program in Informational Technology (GPIT), which Virginia Tech initiated within the last few years. GPIT would be an excellent statewide pilot program that could be initiated immediately and expanded to the undergraduate level incrementally as needed.

The program provides Virginia professionals the opportunity to enter the rapidly expanding information technology arena. GPIT offers a broad focus through three Virginia Tech departments and colleges. This focus reflects the breadth of the disciplines impacting the field of information technology. The program achieves this breadth through a number of parallel tracks (currently six), including wireless communications, computer architecture, software, networking, and two tracks focusing on the business aspects of information technology (business information systems and decision support systems). Modules in computer systems administration and electronic commerce are being developed for future addition to the six initial modules. The program is unique in that three colleges jointly administer it. Thus, the program is interdisciplinary and reflects the multi-faceted nature of the information technology arena.

In addition to offering a master's degree, the program offers certificates to those students completing specific discipline modules. Certificates allow students who do not complete the entire degree program to document specific accomplishments.

The degree program allows students to complete individual modules for continuing education certification in a timely manner. Completion of 3 modules,

along with 6 semester units of preparatory course work and 1.5 semester units of seminar and project work, fulfills the requirements of the Master of Information Technology degree (MIT). The degree is focused on the needs of the working professional; however, graduates from the Master of Information Technology degree program can be admitted to Ph.D. programs subject to satisfactory performance. These students may have to satisfy additional course requirements prior to final admission to the Ph.D. programs.

The rapid convergence of computing, communications, and networking impacts the economy of the U.S. in a positive and profound way. It is responsible for the expansion of business opportunities both nationally and for all of us in Virginia. A workforce with expertise in these disciplines allows industry to take maximum advantage of today's business climate and provides individuals with the tools necessary to profit from the rapid expansion of communications technology and the related infrastructure.

A recent Virginia Tech survey of the high-technology industry identified a vital need for graduate courses and degree programs in information technology, including software, computer networks, communications, and the business aspects of information technology. Currently, tens of thousands of openings in Northern Virginia are unfilled. At least one half of these opportunities are in computer science, computer engineering, system administration, and programming. As a response to these needs, this new graduate program, targeted to the working professional, focuses on workforce needs requiring backgrounds in electrical and computer engineering, computer science, and the business aspects of information technology.

Program

The program consists of 30 semester units that are offered as a sequence of discipline-specific modules. The six modules consist of 6 semester units of course work divided into 2, two-semester-unit segments, each of which has a duration of sixteen weeks. Completion of a module certificate also requires one of the 3 semester foundation courses that provides a broad background, while the other two courses in the module provide more specific material on the particular area.

Students will earn certificates upon completion of any of the 6 semester-unit modules and the associated prerequisite courses. This certificate allows participants in the program to certify their progress and accomplishments in a tangible way. Certification will be very important to those students who may not be able to complete the entire degree program. Many students will enter the program with the primary goal of obtaining more knowledge in the subject area of one or more modules. Obtaining a graduate degree may be a secondary goal or, indeed, may not even be a goal of some of the students entering the program.

The Master of Information Technology program will also contain an additional 12 semester units of required foundation coursework. Students who satisfactorily complete any three modules and the additional 12 semester units of work will qualify for the Master of Information Technology degree.

Student Population

The program is being offered initially to individuals with B.S. degrees in any engineering, science, or business discipline. In this manner, Virginia Tech offers both retraining to a large number of individuals who wish to enter the field of information technology and post-baccalaureate education to those already in the field who wish to expand their knowledge base and skills. Virginia Tech will work with the Virginia Community College System and selected four-year institutions to establish a set of prerequisite courses for those individuals who wish to pursue the certificate or degree options, but have little or no computer or information technology background. After a pilot program has been completed in Northern Virginia, students on the Blacksburg campus will have the opportunity to participate in the program. Two hundred and fifty students currently are enrolled in the program. An enrollment cap has been set because of a lack of resources.

Every college campus--public, community or even private--can offer this program so that all institutions with compatible offerings could award degrees or certificates.

If schools that otherwise might experience economically inefficient low enrollments could offer this program, they could develop a viable degree program, even if it started with only a handful of students.

Delivery Mechanisms

The courses will be offered live, over *net.work.Virginia* and via the Internet. Courses will originate from Virginia Tech's Northern Virginia Center (NVC) and from its Blacksburg Campus. Most courses will be offered live at the NVC because of its location at the heart of Virginia's information technology industry. Virginia Tech will also attempt to offer the courses via *net.work.Virginia* at a number of regional community college sites. The courses are intended to be offered weekday evenings and on Saturdays between 8:00 a.m. and 5:00 p.m. All courses are expected to be offered over the Internet by Fall 2001.

Use of Existing Infrastructure - *net.work.Virginia*

In 1996, Virginia Tech, in cooperation with Bell Atlantic, Sprint, ODU, and the Virginia Community College System, led the implementation of *net.work.Virginia*, a broadband, digital communications network that provides affordable access statewide to the most advanced communications technology

and services available. This network integrates high-capacity voice, data, and video services along with Internet access. The network creates a foundation for unconstrained implementation of new modes of teaching and learning, and it greatly reduces technological and economic limits placed on instructional designers. The network also provides an effective lever for economic development, with level pricing and equitable access guaranteed statewide. Every Virginia institution of higher learning (and public and private secondary schools), can utilize this communication network to provide access to remote sites, to support new distance learning initiatives, and to gain the best possible Internet access. In addition, Virginia Tech recently acquired the wireless spectrum for western Virginia, which will be available for course delivery in the near future.

Advising

An advisor will work with each student who enters the program to develop a course of study that includes the modules of interest to the student. The advisor will specify the prerequisite courses to be completed prior to beginning study in specific modules.

Program Administration

A steering committee consisting of faculty members from the College of Engineering, the College of Arts and Sciences, and the Pamplin College of Business will administer the program. If successful, Virginia Tech could become a world leader in this area. This program could be much more successful if Virginia utilized a VMEC-type structure and delivery system. The University of Virginia is the leader in electronic commerce, and could bring much to the table in that area for a consortium approach.

Proposed Program

This program, similar in nature to the Satellite TV MBA Program and to VMEC, could quickly develop as a statewide program along the same lines to include all Virginia institutions. Detail has been provided in order to demonstrate how carefully thought-out this program is. Some of the larger institutions may decide to provide a GPIT-type program on their own; but, for many of the smaller ones, a Satellite TV MBA or VMEC consortium approach may be the only way to offer these opportunities to their students. Even institutions offering their own on-site, stand-alone programs would benefit from the availability of consortium-provided courses. Why should Virginia Tech develop course work in electronic commerce if UVa. or Old Dominion already has the best? And the same question comes to mind if Virginia Tech has developed such a course that UVA or others could access.

For example, if Norfolk State decides to offer this degree or certificate

program, it may opt to teach one module itself and to utilize additional modules provided by Virginia Tech, or other schools, for the balance of the program. A student at Norfolk State could have the option of receiving the degree or certificate on a Norfolk State diploma or on that of one of the other providers, depending upon which modules were completed and which institutions provided them. This plan affords Norfolk State a more attractive course offering and the opportunity to place more of its students in the high-tech, high-pay workforce, thus offering enhanced economic opportunities to all institutions in our state.

In Virginia, workforce training has been identified as a critical need, witnessed by the creation of three different types of workforce training centers in Norfolk, Abingdon, and Roanoke. Through this program Virginia's higher education institutions could meaningfully impact workforce training with very low cost and very high quality. Every college campus--public, community or even private--can offer this program so that all institutions with compatible offerings could award degrees or certificates.

Other Programs Utilizing Cooperation and Advanced Technology

Virginia Commonwealth Graduate Engineering Program - VCGEP

Since 1983, Virginia Tech and the University of Virginia have televised graduate engineering courses from their respective campuses to various classroom locations in industry, at government installations, and in other academic facilities throughout Virginia. The Virginia Commonwealth Graduate Engineering Program (VCGEP) now represents a consortium of Virginia universities (University of Virginia, Virginia Tech, George Mason University, Old Dominion University, and Virginia Commonwealth University), that provides televised graduate engineering and support courses throughout the Commonwealth of Virginia in the following areas:

- Civil Engineering
- Electrical Engineering
- Industrial Engineering
- Systems Engineering

The Program is conducted under the auspices of SCHEV and in cooperation with the Department of Information Technology.

The primary intent of the program is to provide practicing engineers and other qualified individuals with strong backgrounds in the sciences the opportunity to pursue graduate studies leading to a master's degree in engineering. Many non-degree-seeking students likewise enroll in these graduate course offerings each semester as they seek to improve their workplace skills.

These televised courses provide the ability of existing engineering programs to supplement their offerings with courses from other Commonwealth universities; also, the program provides an opportunity for students in essentially all areas of the Commonwealth to have reasonably convenient access to graduate engineering courses.

All participating universities have downlink sites for receiving courses; in addition, students may take these courses at several other universities, graduate centers, and private/industrial sites around the Commonwealth. Examples of major industries that have installed downlink-access capabilities include AT&T - Richmond, Allied Signal, Union Camp Corporation, and Westvaco. Thousands of engineering and science students derive benefits each academic year through their access to these televised course offerings.

The program was originally provided via microwave connections into limited regions of the Commonwealth. In 1986, a conversion was made to satellite transmission of courses. Skyrocketing costs plus limitations on available satellite time led to a movement of the program to *net.work.Virginia* effective fall 1998. The increased delivery capacity of the new system will allow far more course availability at numerous sites around the Commonwealth.

The Virginia Tech College of Engineering conducted more than 1,700 graduate engineering courses at off-campus locations from 1970 to 1996. Of these, 220 courses have been offered via educational television; the rest have been conducted at classroom sites in Richmond, Northern Virginia, Tidewater, Lynchburg, Roanoke, and other areas throughout the state. This effort has resulted in a total combined enrollment of more than 30,000, with more than 1,000 graduates at the master's degree level.

Satellite TV MBA

Virginia Tech has been involved in a similar program and delivery system for ten years -- the Satellite TV MBA program. With the support and guidance of the Commonwealth, the Pamplin College of Business began offering an MBA Program targeted at full-time professionals in the fall of 1989. This off-campus program has the same academic requirements as the Blacksburg and Northern Virginia campuses. It requires a minimum of 48 semester hours and typically requires a four-year commitment by the student. It prepares students for career advancement in a world that increasingly relies on technology.

The program reaches a significant population of students who otherwise would not be able to pursue a Pamplin MBA. Enrollment in the program increased from 57 in 1989 to over 100 currently. This semester, the program has MBA students enrolled at 11 remote sites, in addition to students attending the origination classroom in Blacksburg.

The technology used to deliver these programs has evolved and improved. Since fall 1998, the remote sites have been connected via *net.work.Virginia*, the high capacity ATM network capable of transmitting data, voice, and video referred to previously. This technology allows for two-way video interaction between the main and remote classrooms. The capacity to transmit information (or bandwidth) varies by the size and use of the remote site. Larger sites possess sufficient bandwidth to receive at least 7 courses simultaneously. This capacity provides opportunities for future expansion of the course offerings at remote sites by Virginia Tech and other institutions and gives students the potential for more opportunities.

Virginia Tech's Distributed Learning Systems opened a newly outfitted classroom on the Blacksburg campus this fall to better support this technology and the MBA program. The classroom is used for the origination of the majority of classes, although professors occasionally deliver classes that originate from remote sites, such as the Roanoke Valley Graduate Center.

For example, Mary Washington has offered this program on its campus for many years. A student attending Mary Washington for the MBA receives a diploma from Virginia Tech. Over the last 10 years Virginia Tech has offered this degree to 320 students at 18 locations with 180 degrees awarded.

As credible a program as I believe Virginia Tech has delivered in the Satellite TV MBA, think how much better it could be if it were a joint effort with the internationally prominent Darden School of the University of Virginia and other Virginia institutions such as William & Mary. Virginia could be a world leader in this field, too.

By joining forces, Virginia institutions can create programs which simultaneously reduce costs and raise existing quality.

Virginia Consortium of Engineering and Science Universities VCES

Another useful example of the benefits of cooperation and high-tech delivery of education is the Virginia Consortium of Engineering and Science Universities. VCES is a resident Ph.D. program on the Peninsula offered by the College of William & Mary, Old Dominion University, the University of Virginia, and Virginia Tech. It offers the following areas of study in engineering:

- Aerospace Engineering
- Materials Science & Engineering
- Engineering Mechanics
- Mechanical Engineering

It offers these areas of study in Applied Science:

- Applied Mathematics
- Atmospheric Science
- Computer Science
- Nondestructive Evaluation
- Physics
- Polymeric Materials

The primary purpose is to increase graduate study and research at the highest technological level and to make this available to the second largest population concentration in Virginia. Fulfillment of this purpose is expected to create new jobs and to provide support for the creation of even more high-technology business in Virginia.

The Consortium offers instruction by traditional classes supplemented by satellite and two-way *net.work*. *Virginia* classes from the College of William & Mary, Old Dominion University, the University of Virginia, and Virginia Tech. Each consortium university provides resident faculty members, plus eminent adjunct faculty from NASA and elsewhere. The course offerings are tailored for students accepted by their respective consortium university graduate schools. Major professors on the faculty of the consortium universities, as well as NASA experts, guide students in their doctoral programs.

Students declare themselves as VCES applicants and go through the standard procedure of being accepted by a chosen university graduate school. The students, their major professors, and the VCES Director determine a course of study. NASA, the member universities, and the Space Grant consortium or other sources may provide support for the applicants' research. Students get full resident credit by attending classes locally, just as on any member university campus. Students can take up to 50% of their courses from VCES universities (other than the one which grants their degree).

The doctoral program presently has 40 students enrolled in both day and evening courses. The M.S. program currently is offered during the afternoon through the Commonwealth Graduate Engineering Program. The M.S. theses may be supervised by VCES faculty by special arrangement.

The distance learning approaches that have been utilized for VCES and VCGEP, and proposed for the VMEC, have been efficient decisions in terms of use of available resources. VCGEP has allowed graduate students to pursue advanced studies in several engineering areas from Commonwealth locations where they never have had the opportunity to do so, due to lack of a local engineering program. Likewise, televised course offerings have permitted the offering of more varied graduate courses through the Northern Virginia Center to supplement courses that were being taught "live" there.

Virginia-Maryland Regional College of Veterinary Medicine-VMRCVM

A further extension of the concept of cooperation that also uses high-tech delivery is the Virginia-Maryland Regional College of Veterinary Medicine. This college originally was planned to include West Virginia, so as to be a Tri-state cooperative program. The original split of an 80-seat class was 50 seats for Virginia, 20 for Maryland and 10 for West Virginia. When West Virginia could not come up with its share of the money, Maryland took over its 10 seats.

Veterinary schools are so expensive that their costs dwarf the instructional costs of other academic subjects. They require specialized buildings, equipment, and hospitals. For a class of 80, the buildings, equipment, and hospital cost over \$40 million (in 1980 dollars), not including the land of great value that was either donated or provided at no additional cost. The upcoming animal parts waste disposal plant will cost at least \$1.6 million. The ratio of professors to students is one to four. Today the total cost probably would be over \$100 million.

VMRCVM uses its own video-conferencing system, so professors in Maryland simultaneously can teach students at the Equine Center in Northern Virginia and in Blacksburg.

The high cost of veterinary education demanded a cooperative effort. Since 1984, when the first class graduated, Maryland and Virginia have continued to improve their working relationship.

Other disciplines could benefit from multi-state consortia and should be encouraged to do so by state policy.

Math Emporium

Indeed, Virginia Tech has already developed the capability to share high quality, interactive math instruction across the Commonwealth through its Math Emporium. This facility, developed by faculty of the Mathematics Department, has 500 dual-platform workstations with interactive programs to teach such basic courses as linear algebra. Open 24 hours a day, the Math Emporium allows students to learn math in their own style and at their own pace. In only one year, the Math Emporium has produced impressive results, including a decrease in the failure rate and an increase in the overall GPA for the same courses taught in the traditional lecture mode.

Last fall, nearly 7,000 students had taken courses in the Emporium, where they can download lectures, work problems interactively, and consult with faculty and graduate students who are always on hand to provide assistance. Over 2,000 middle and high school students already have worked on mathematics in the Emporium. Using interactive digital technology and *net.work.Virginia*, we easily could make the Math Emporium's resources available across the state.

Summary

I have provided an overview of three successful programs, VMEC, GPIT, and the TV MBA. Through cooperation across universities and colleges, and with the integration of technology, Virginia can help eliminate excessive labor costs and duplication of efforts within our education system. I have also proposed several examples of how these concepts could be incorporated into other programs across the state.

Cooperation and high-technology delivery are the best currently available answers to Virginia's needs. Virginia Tech and other schools have been participating in various distance learning through high-technology delivery since 1983. Virginia has been developing and perfecting the methodology for seventeen years. Now we need to capitalize on past successes in order to take our higher education system up to the next level by mandating the consortium approach as a matter of state policy in designated areas.

As each consortium in high-technology areas is developed, I believe that both consortia and high-technology delivery systems will spread to all disciplines, creating a unique environment for higher education in the Commonwealth.

This coin has two sides. I have discussed the distributed learning side. To insure that the Commonwealth of Virginia receives the maximum return on its investment, it must stimulate the demand side of the equation as well as the supply side.

APPENDIX A

Sample Curriculum (Developed by ECE at Virginia Tech)

Information Technology Program (BIT Degree)

FIRST YEAR

First Semester

ENGL 1105: Freshman English	3	(3)
University Core Curriculum Elective (1-3)	3	(3)
Math 2534 Introduction to Discrete Mathematics	3	(3)
CS 1004: Computer Literacy (Optional)	3	(3)
Science Requirement ¹	3	(3)
Credits		(15)

Second Semester

ENGL 1106: Freshman English 3(3)	3	(3)
Math 2534 Introduction to Discrete Mathematics	3	(3)
Science Requirement ¹	3	(3)
CS 1104: Introduction to Computer Science	3	(3)
BIT 1004: Problem Solving with C++	3	(3)

SECOND YEAR

First Semester

ECpE 2504S; Intro to Computer Systems	3	(3)
ECpE 2574: Intro to Data		

¹The Bioinformatics Track requires Bio 1005 & 1006

Structure and Software Engineering	3	(3)
BIT 2004 Fundamentals of Networks and Protocols	3	(3)
ACIS 2004: Survey of Accounting	3	(3)
University Core (Recommended Area 2)	3	(3)
Credits		(15)

Second Semester

Science Requirement	3	(3)
Csxxx: Object Oriented Programming and Java	3	(3)
COMM 1014 Intro to Communications Studies	3	(3)
CS 2604: Data Structures and File Management	3	(3)
University Core (Recommended Area 2)	3	(3)
Credits		(15)

THIRD YEAR

First Semester

BIT Track Elective	3	(3)
MSCI 3544: Management of Information Systems and Technologies	3	(3)
MSCI 5: Network Applications and Security	3	(3)
Science Requirement	3	(3)
ENGL: 3764: Technical Writing	3	(3)
Credits		(15)

Second Semester

BIT Track Elective	3	(3)
MSCI 4554: Networks and Telecommunications in Business	3	(3)
ISE 2014: Engineering		

Economy	3	(3)
CS 3724: Introduction to Human-Computer Interaction	3	(3)
CS 3604; Professionalism in Computing	3	(3)
Credits		(15)

FOURTH YEAR

First Semester

Open	3	(3)
BIT 3004 Artificial Intelligence and Expert Systems	3	(3)
BIT Track Elective	3	(3)
University Core (Recommended Area 3)	3	(3)
University Core (Recommended Area 7)	3	(3)
Credits		(15)

Second Semester

BIT 3014: Digital Images and Graphics	3	(3)
BIT Track Elective	3	(3)
University Core (Recommended Area 3)	3	(3)
BIT 4004: Senior Seminar		
Free Elective	3	(3)
Open	3	(3)
Credits		(15)

Total Credits (120)

About the Author

John G. Rocovich, Jr. is a well-known and well-respected attorney and community leader in Roanoke, his hometown. He is Chairman of the law firm of Moss and Rocovich.

Long active in the Southern Baptist Convention, Rocovich served as a member of that organization's Education Commission. He has served as Chairman of the Endowment Steering Committee and the National Development Council of the Foreign Mission Board. He currently serves on the Board of Visitors of Southeastern Baptist Theological Seminary.

John Rocovich graduated from Virginia Polytechnic Institute and State University with honors and received his law degree from the University of Richmond, and his LL.M in Taxation from New York University. Since graduating from Virginia Tech, he has remained active in support of that institution. He currently serves on the Board of Visitors and is Chairman of the Finance, Budget, and Audit Committee. Rocovich is the former President of the Virginia Tech Foundation, past President of the Virginia Tech Alumni Association, Chairman of the Major Gifts Committee for the Capital Campaign from 1993-1998, as well as being active in several other university activities.

He also serves as the current Chairman of the Harvey W. Peters Research Center for the Study of Parkinsons Disease and the Via-Bradley College of Engineering Foundation. He is a current member of the Board of Trustees for Mary Baldwin College in Staunton, is a current Director of the Virginia College Fund, is a former two-term Director and President of the University of Richmond Law School Association, and serves on the Development Council of Roanoke College.

He was formerly Chairman of the Virginia Museum of Natural History and is currently President of the Smith Mountain Lake 4-H Educational and Conference Center.

His interest in education was the reason John Rocovich was appointed to the Governor's Commission on Champion Schools that worked on the Standards of Learning currently being implemented in the K-12 public schools in Virginia. He served as a member of the Governor's Blue Ribbon Commission on Higher Education, the Governor's Distance Learning Steering Committee, and currently serves on the Thomas Jefferson Institute's *Policy Working Group on Higher Education*.