2005

Ab initio : a new concept in engineering education, a history of the design, creation and implementation of a new School of Engineering in Richmond, Virginia (1990-2000)

Henry A. McGee Jr.
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A New Concept in Engineering Education

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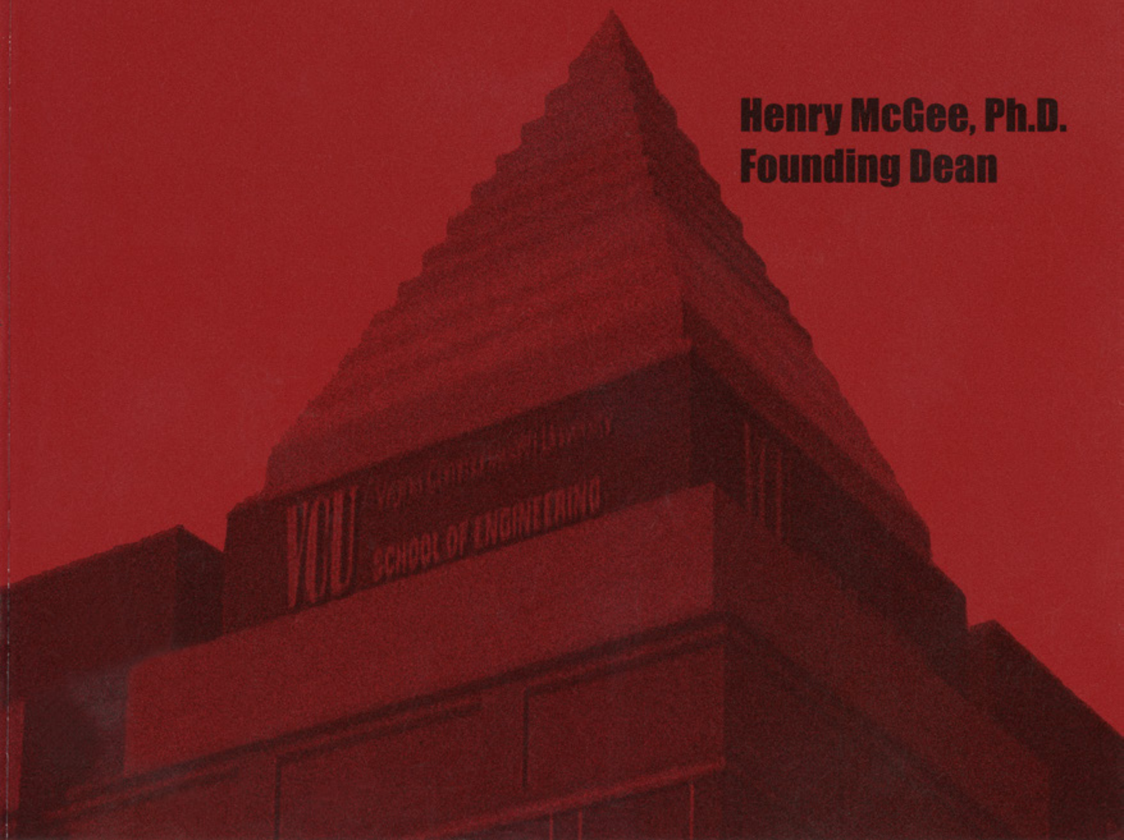
Founding Dean



AB INITIO
A NEW CONCEPT IN ENGINEERING EDUCATION

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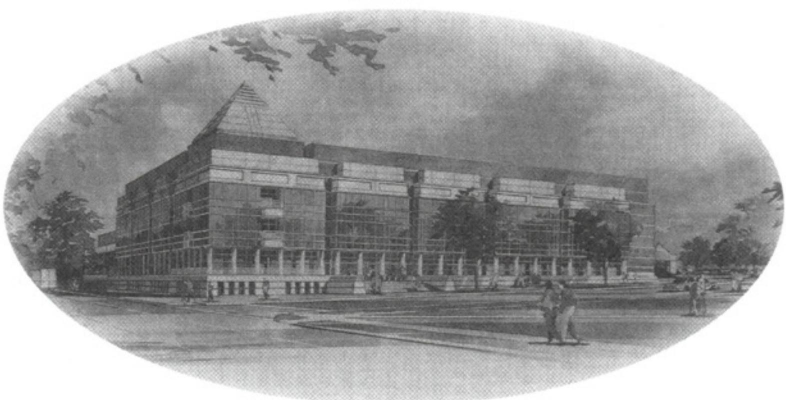

By

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A New Concept in Engineering Education

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PREFACE

The lead-in to the title of this book will be obscure to many readers. Not so for those who have studied Quantum Mechanics (Modern Physics) where an **ab initio** calculation is fundamental, free of the baggage of prior approximation*. This was the mind-set of the designers of this School.

The design of a new school of engineering from a blank piece of paper has been at the same time thrilling and daunting. It was a once in a lifetime opportunity, and I shall be forever indebted to Dr. Eugene P. Trani, President of VCU, and to Dr. Paul E. Torgersen, President of Virginia Tech, for the confidence they placed in me.

This discussion of the design and subsequent implementation of the school — physically, intellectually, and financially — has been aided by Mr. Peter Wyeth, Vice President for Advancement; by my Chairs and Associate Deans; by Mr. David van Blaricom, our project manager for the building from the Richmond office of Trammel Crow Company; and by many others. I express to them all my sincere thanks for all they did to make our new school a reality. This book is a history of outstanding work by many individuals from my

* **ab initio,** adv.[latin]: from the beginning: at the outset. *Webster's Third New International Dictionary.*

appointment in January of 1994 until my retirement from the position of Founding Dean in June of 1999. Many colleagues helped in the writing of this account, special thanks to them all, but any errors that remain herein are mine alone.

A quote from President Theodore Roosevelt in 1910 encapsulates well the leap of faith made by all faculty and students who would have the adventuresome spirit to join the the fledgling school of engineering at VCU, a struggling and underfunded school with absolutely no reputation.

"It is not the critic who counts, not the one who points out how the strong man stumbled or how the doer of deeds might have done them better. The credit belongs to the man who is actually in the arena, who face is marred with dust and sweat and blood; who strives valiantly; who errs and comes short again and again; who knows the great enthusiasms, the great devotions, and spends himself in a worthy cause; who, if he wins, knows the triumph of high achievement; and who, if he fails, at least fails while daring greatly, so that his place shall never be among those cold and timid souls who know neither victory nor defeat."

This quote is on a plaque in the second-floor study room used by all students. The prominent location of this thought was the idea of Mr. Wyeth, who is himself also a taker of risks. Clearly the men and women associated with our school — whether students, faculty, or staff — have chosen to enter the arena.

Taking advantage of being new and then having no prior "baggage", we designed a school with a distinctly non-traditional character. Programs would be close to industrial practice, i.e. there was to be no "ivory tower". There would be useful exposure to business related issues of marketing, finance, project management, and economics. There would be a strong devotion to entrepreneurship. There would be throughout a spirit of innovation and synthesis to balance the current overwhelming devotion to analysis alone.

Programs would be interdisciplinary both within engineering and with other programs of the university, most particularly with Medicine. Consequently, dual degrees would be commonplace. Communication skills and teamwork would be emphasized. Although it sounds a bit pretentious, we thought of these seven characteristics as defining the Renaissance engineer.

In addition to these intellectual and pedagogical components, our physical facility was privately designed and financed, which required an unrestricted endowment. None of the students or faculty or programs described herein, no matter how attractive, would have been possible without the financial generosity of many individuals, companies, foundations, and political entities.

On my birthday in 1998, my office staff, Susan Younce, Assistant Dean for Administration and Finance, and Steve Davidson, Building Engineer, coaxed me out to the parking lot with some sort of ruse where on a pole they had mounted a permanent sign that said "Reserved, Founding Dean." It was decorated with a big red ribbon and bow. The faculty has also established a Distinguished Visiting Lectureship in Engineering that is named in my honor. I retired from the position of Founding Dean on July 1, 1999. The following September, I was 70 years old, my Chairs and Deans and their wives gave me a surprise birthday party and dinner at a local restaurant. They presented a most appropriate gift under the circumstances, a rocking chair. Perhaps these were microcosms of the respect and camaraderie that our leadership team felt for each other. While there was great pride in what we had accomplished together, there was also clear recognition that we had only scratched the surface, and the tasks ahead were even more challenging.

This operation, like all new ventures, is fragile, it will require the continued best efforts of outstanding people if it is to survive and grow and reach its enormous potential – a

potential largely built upon the maintenance and expansion of its non-traditional character. In its letter approving the creation of our School, the State Council of Higher Education for Virginia recommended the establishment of an outside committee of oversight to help ensure the continuation of our defining non-traditional character. Professional excellence of our people is essential. It is this fragility, however, that makes the camaraderie and mutual respect and morale that is so important in any organization so absolutely necessary and critical to this fledgling School of Engineering. Without it, the dream vanishes like early morning fog as the sun comes up. A development as complex as designing and creating a school of engineering is not, and cannot be, on the face of it, the work of any one person. I have been fortunate to have enjoyed the leadership of each of the Chairs and Deans who succumbed to my wily persuasion to leave outstanding positions at other major universities and companies to join a new School that was little more than a dream at the time. It is their insights that are portrayed in this book and "in the flesh" at the corner of Main and Belvidere Streets and in the ambitions of already hundreds of students.

Finally, I believe the design methodologies that are described here to be generally applicable. To be sure, the details of this discussion are situated at a particular time and in a particular place. But the overall philosophy and processes are universal and can also well-serve as a template for any subsequent pioneers who might have the opportunity and the audacity to design a new academic venture in any field of intellectual inquiry.

Henry A. McGee, Jr.
Richmond, Virginia

April 2005

To Bettey Rose. I continue to enjoy the support of my 'trophy' wife of only 53 years. She makes it all worthwhile. I also acknowledge and thank Professor Gary Huvard and his student consultants in ChemEngine who covered the cost of printing this book from the profits of over $200, 000 in contracts in 2004. Cover by Artley Design, Inc. of Arlington, Virginia.

CHAPTER 1 : EARLY PLANNING

More than 300 institutions in the United States offer engineering education at the undergraduate and/or graduate levels. Five accredited schools in Virginia – all of them very fine, serve students who aspire to become engineers or who realize that an engineering degree opens doors to careers in medicine or law or business as can no other background. Virginia ranked 12th in population and 11th in production of B.S. graduates in engineering in 1992. It is natural, then to wonder why the legislators of the Virginia General Assembly would authorize the establishment, in 1996, of another engineering school at Virginia Commonwealth University.

To better understand the rationale behind the concept of the VCU School of Engineering, it is useful to dip briefly into the history of an institution, some parts of which are 166 years old, that has always been somewhat unconventional. To establish any kind of school in a crowded field, a penchant for innovation is a major requirement.

Virginia Commonwealth University: A History of New Ideas

In 1966 Virginia Governor Mills E. Godwin appointed a commission led by Edward A. Wayne, head of the Federal

Reserve Bank in Richmond at the time, to study the needs of the Richmond region and how a new institution at the university level could fulfill them. The Wayne Commission proposed that two local institutions, the Medical College of Virginia (MCV), founded in 1838 as the medical department of Hampden-Sydney College, and the Richmond Professional Institute (RPI), founded in 1917 as the Richmond School of Social Work, be merged to form a university that would place MCV within a broader university structure and would fulfill the growing demand for undergraduate, graduate and professional education in the metro area. By an act of the Virginia General Assembly, Virginia Commonwealth University was created through a merger of these two institutions, and the new university was officially open for business on July 1, 1968.

MCV, now the VCU Medical Center, unlike most schools in the South, did not close during the War Between the States. Its few buildings even escaped the great fire when Richmond was destroyed as the Confederates retreated south towards Petersburg. MCV grew and flourished during the presidency of Dr. William T. Sanger (1925-1956) with more buildings, more faculty, and more students than ever before. Dr. Sanger's tenure ended at the time of the Russian sputnik, an event that initiated a revolution in American higher education in science and math and in medicine. There were massive influxes of federal dollars for research, and research became the centerpiece at MCV just as it did at most universities. In principle, such an emphasis upon research could diminish the other two legs of the academic career of teaching and service. But in my 40 years of academic experience at five first-class universities, it has never occurred. If anything, the exact opposite occurs, and all three legs are strengthened.

The history and programs of RPI were very different from the high level graduate programs in all branches of medicine and health related fields at MCV. Dr. Henry H. Hibbs came to

Richmond in 1917 to take charge of the newly created Richmond School of Social Work. The school added programs in art and other subjects, and became a branch campus of the College of William and Mary in 1925, which lasted until 1962 . . . almost 40 years . . . when the state made RPI an independent institution. It was a college without a conventional campus, a college with one of the largest evening programs in the country, a college of large numbers of commuter and part-time students, and a large and highly regarded School of the Arts.

Some of these "arty" students voiced their free spirits with unconventional dress, or dying their hair purple, or placing rings through various body parts, or the like. Very much unlike the student physicians and dentists and pharmacists and nurses at MCV.

The marriage of these unlikely and highly dissimilar entities formed Virginia Commonwealth University. A sophisticated and highly regarded academic unit was married to a distinctly unconventional institution.[1] It was not a marriage of equals.

The merger was controversial from the start. Some administrators, faculty and alumni of the medical college worried that the MCV identity would be lost within the larger VCU. Though its professional identity is stronger than ever, the name MCV was abolished in 2003 in favor of VCU Medical Center. Others felt that RPI was not as academically rigorous, given that it catered to working adults and offered such academically suspect programs as commercial art and social work. The merger also occurred at the end of the rebellious sixties. Although a quip at the time had it that Richmond was a hotbed of apathy, the conservative doctors at MCV tended to look askance at the flower children populating the cobblestone alleys of RPI.

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[1] Thanks to Professor James T. Moore of the VCU history department for these historical insights.

These objections notwithstanding, VCU soldiered on in its early years to bring together the traditions of two institutions that on the surface seemed so different but which had more in common than many people assumed. From their beginnings, each institution looked mostly outward to the community for the inspiration for their missions. MCV, for example, as the only medical school in the south to stay open during the Civil War, put its physicians at the forefront of developing new trauma and surgical protocols.

Such figures as RPI President Henry Hibbs, MCV President William Sanger, Professor of Chemistry Mary Kapp, and Professor of Surgery David Hume defined the innovation of VCU's past. Dr. Kapp was Chairman of the School of Applied Science at RPI which included chemistry, physics, biology, and math. In 1962 her entire school had a grand total of 13 faculty. The first B.S. in chemistry was awarded in 1967, only one year prior to the merger with MCV. Thanks to a gift from her estate, the Annual Kapp Lectureship in Chemistry continues to bring outstanding scientists to the campus including several Nobel Laureates. That spirit lives on through leaders such as President Eugene Trani; Dr. John Fenn, who won the 2002 Nobel Prize in chemistry; the faculty of the sculpture and nurse anesthesia programs, which are ranked number one in the country by U.S. News & World Report; and Dr. Rao Ivatury, director of trauma surgery at VCU's Level-I trauma center, who, like his Civil War forebears, has pioneered new approaches to treating gunshot victims.

Today, VCU enrolls more than 26,000 students in 164 undergraduate, graduate, professional and doctorate programs through the College of Humanities and Sciences and the schools of Allied Health Professions, the Arts, Business, Education, Engineering, Dentistry, Government and Public Affairs, Mass Communications, Medicine, Nursing, Pharmacy, Social Work and World Studies. The VCU Medical

Center combines the educational and clinical missions of its health sciences schools, its outpatient clinics, and the physician-faculty group practice.

The faculty also attracted more than $180 million in annual sponsored research in 2002, ranking VCU as a Carnegie Doctoral/Research University-Extensive, with the schools of Medicine and Education attracting the lion's share of research dollars at the university. VCU's nationally recognized strengths in biomedical research have fueled the development of the Virginia Biotechnology Research Park, and the faculty have come together through 16 interdisciplinary centers dedicated to health, biotechnology, microelectronics, and public policy research.

Now into this decidedly diverse campus comes the planning and creation of a new School of Engineering – with the most academically demanding curricula of any undergraduate program.

An Engineering School

The idea of establishing an engineering program at Virginia Commonwealth University had actually arisen during the early 1980s, when a proposal to offer a master of science in engineering management, materials engineering, and computer engineering had been made to the State Council of Higher Education for Virginia (SCHEV). Though never acted upon, it did lead to the establishment of the Commonwealth Graduate Engineering Program (CGEP), a distance-learning initiative that offered Richmond students courses taught by faculty at the University of Virginia, Virginia Polytechnic Institute and State University and other institutions. The CGEP is not a small venture; its budget in 2002-03 was $5.3 million.

It met a real need for place-bound students in Richmond. But, as the 1990s approached and the excitement about economic development heated up, it became increasingly evident that something more would be needed to serve the Richmond metro region. The impetus for the creation of engineering at VCU was not from the political arena nor was it from the academic community. Rather it was from the business community who had long realized the essential synergy between technologically based industry on the one hand and engineering education on the other hand. Two processes came together at the right time and in the right place: the development of a strategic plan for the future of VCU and the development of a strategic plan for the future of the Richmond metro region. Both plans had links to each other.

Building an Urban Mission for the 21st Century

The feasibility of establishing engineering education at VCU was one of several investigations under way within a comprehensive planning effort entitled *"A Strategic Plan for the Future of Virginia Commonwealth University"*, approved in 1993 by VCU's Board of Visitors. The strategic plan was developed under the auspices of the Commission on the Future of the University, a broad-based group of faculty, administrators, students and alumni, which reported to Dr. Grace E. Harris, newly appointed to the position of Provost and Vice President for Academic Affairs. The basis for VCU's strategic plan was the recognition that the university had a unique opportunity to redefine "urban" as a concept of interconnectedness with the community, not strictly as merely a geographic location. It arose from several initiatives that President Eugene P. Trani launched when he arrived in 1990 to become VCU's fourth president. The most important of these early initiatives was the Community Service Associates Program, which offered faculty the opportunity to work directly with a community group on an identified need.

Another initiative was the shelving of a master-site plan that would have expanded VCU into Oregon Hill, a neighborhood abutting the south end of VCU's academic campus, to which residents of Oregon Hill had vociferously objected. When President Trani put that plan on hold, he symbolized the beginning of the university's new attitude toward its relationship with the community – one in which both the university and the community would benefit equally through the university's mission of teaching, research, service, and patient care. The consultants whom Dr. Trani engaged to study the feasibility of the engineering proposal would identify that new attitude as essential to the success of the undertaking then being envisioned – one anchored within the needs of local industry that would be met by a resident faculty teaching interdisciplinary, entrepreneurially oriented and real-world curricula.

This new idea about the urban university was more than faculty noblesse oblige. It was more than using the city as a laboratory with the university serving as the aloof researcher unaffected directly by the community's problems. It was a recognition that the community was at the heart of the kind of learning and research that would be required in the 21st century. This blending of the academic/industrial interface would become a defining characteristic of the new engineering school.

Focus on Our Future

The Richmond metro area, with a population at the time exceeding 800,000, was the largest urban area in the United States without an engineering school within commuting distance. To capitalize on the growing high-technology era, to attract new business, to help established businesses, and to expand and foster a climate conducive to entrepreneurship, local access to engineering education and research was essential. Despite the initial lack of enthusiasm about a sixth school vying for state support among the five other engineering programs in Virginia, it was clear that the technology revolution of the late 20th century was demanding increasing numbers of highly skilled workers and that the bulk of these workers would be engineers. Some have argued that the urban universities of today are doing for American cities what the land-grant colleges did for rural areas in the 19th century.

In fact, the U.S. Department of Labor and the National Science Foundation had predicted that the need for engineers would far outstrip the supply over the ensuing years. But regardless of this need for engineering practitioners, matters of public policy on issues such as energy, health, and environment in a democracy demand a technologically literate society. Yet interest among high school students in science and math and ultimately in technical careers was declining. At the time, only about 8 percent of university students in America were engineering majors. They also were receiving about 40 percent of the job offers offered to all graduates. These trends would have an impact on economic development everywhere, and the metro Richmond area was no exception.

Although over 1,000 MS degrees had been awarded through the Commonwealth Graduate Engineering Program, it was clear that to support the economic development potential of the Richmond region, a distance-learning program would be insufficient. Moreover, the feasibility study for the proposed Virginia Biotechnology Research Park had stated that the lack of a local engineering school would hinder development of the research park. And still further it was clear that a world-class medical school would demand interplay with a local engineering school. In fact, Dr. John Cardea, Chair of the VCU Department of Orthopedic Surgery had stated, "The future of orthopedic surgery **is** engineering."

Shortly before Dr. Trani arrived at VCU, a group of 240 leaders from the city and the surrounding counties had been formed under the auspices of the Greater Richmond Chamber of Commerce to undertake a major planning effort to recommend strategies to develop the area's economic potential. In 1990, one of the first issues that President Trani adopted as a priority of his administration was engineering. The strategic plan, "Focus on Our Future", developed by the region-wide group created by the Chamber, was released in 1991. In it, the engineering school and the research park received the endorsement of the community, and VCU received its charge to lead in the planning of both initiatives. This was the framework in which VCU would incorporate economic development as a university priority, the basis for its partnership with the civic, business and government sectors to establish the Virginia Biotechnology Research Park—and the VCU School of Engineering.

Initial Studies

"An Assessment of the Need for an Engineering School in the Richmond-Petersburg Metropolitan Area,"

By June 1992, a study of the projected demand for engineering in the area needed to be developed, and Dr. Trani and Dr. Charles R. Ruch, then provost and vice president for academic affairs, asked Dr. Thomas W. Haas, who directed the Commonwealth Graduate Engineering Program, and J. Sherwood Williams of VCU's Survey Research Laboratory to undertake the task. They surveyed three groups: (1) high school students in central Virginia who had indicated an interest in engineering on their SATs; (2) students enrolled in pre-engineering programs at VCU and at nearby J. Sargeant Reynolds Community College, John Tyler Community College, and Virginia State University; and (3) employers of engineers in the metro area. The findings were as follows:

Seventy percent of the high school students who responded to the questionnaire indicated a high or very high commitment to studying engineering. Three-fifths of the respondents indicated a primary interest in mechanical engineering, electrical engineering, chemical engineering or biomedical engineering, with more women than men indicating an interest in the latter. Not surprisingly, the students indicated accreditation, reputation and job placement upon graduation as the most important characteristics of an engineering school.

The survey of students enrolled in postsecondary pre-engineering programs at local community colleges was distributed and collected during their classes, thus capturing virtually the entire sample. Three-fourths of these students indicated an interest in mechanical, electrical or civil engineering, with those preferring mechanical or electrical engineering indicating a high or very high commitment to studying engineering. Like their high school counterparts, they valued most accreditation, reputation, and job placement services. But they also placed a high value on local access to engineering programs along with the opportunity for work-study or cooperative education.

The 120 companies that were queried employed more than 2,700 engineers in the Richmond area at the time, two-thirds of whom were mechanical, electrical or civil engineers. Eighty-five percent of the companies projected an increase or no change in the number of engineers they employed. Three-fourths of the companies indicated that they were experiencing problems in recruiting sufficient numbers of qualified engineers. Ninety percent of the companies offered tuition reimbursement programs, with about 340 employees already availing themselves of these educational incentives. These data allowed an estimate that more than 400 current employees might be interested in pursuing an engineering degree.

These results pointed to a student demand sufficient to proceed with the early parameters of an engineering school at Virginia Commonwealth University.

"Preliminary Assessment of Proposed Engineering Program," March 1993.

Dr. Wayne Clough, then Dean of Engineering at Virginia Tech and now President of Georgia Tech, had been engaged to offer a preliminary estimate of the personnel and financial requirements to establish a school at VCU. A number of assumptions were necessary, and these were influenced by the "assessment" report noted above.

Dr. Clough suggested that VCU should consider offering biomedical, chemical and mechanical engineering and recommended a faculty of 13 to 15, the minimum required by the Accreditation Board for Engineering and Technology (ABET) to achieve accreditation. He proposed an undergraduate enrollment of 80 students per class and a small master's program enrolling 30 to 40 students. That would produce 60 to 80 graduates per year at the bachelor's and master's level, or four to five graduates per faculty member, which was comparable to the productivity of the engineering faculty at Virginia Tech and the University of Virginia. With these assumptions and based upon his experience at Virginia Tech, Dr. Clough recommended the school have 45,000 assignable square feet of space and projected a start-up cost of $5.75 million for teaching equipment with an annual replacement cost of just under $1 million. Total personnel costs, including salaries and benefits for faculty, administrators and support staff, were estimated at $1.24 million, and annual operating costs were estimated at $2.1 million. All of these indications of scale would be far exceeded in the plan that finally emerged, and the actual numbers quickly far exceeded even that final plan. All indicating the latent demand for engineering education in the metro area.

At the same time, estimates of the financial impact of the engineering school on other departments at VCU, particularly chemistry, physics, math, and biology, had been conducted. The Chairs of these departments, using projections of enrollments in engineering, had provided to Dr. Trani some notion of the additional faculty, teaching assistants, and supplies for teaching laboratories that would be required. Impact was not restricted to finances alone. After operations of the new school were well under way, a senior professor in the chemistry department spoke of his renewed joy in teaching physical chemistry to larger and animated classes because of the presence of high quality students from chemical engineering. This sort of intellectual impact upon supporting departments was widespread, and it was impact of a highly favorable sort.

The estimates of these two reports gave the university administration a reasonable idea of what to expect in establishing an engineering school.

Observations and Recommendations Regarding Undergraduate Engineering Education in the Richmond / Petersburg Metropolitan Area, April 1993.

Dr. Trani engaged a committee of three consultants— President Robert R. Ferguson of Texas A&M at Corpus Christi, President Frank A. Franz of the University of Alabama at Huntsville and Chancellor James H. Woodward of the University of North Carolina at Charlotte, who chaired the visiting committee. In addition to a careful review of the studies and recommend ations that had been gathered thus far, the consultants met with a cross-section of leaders from the university, the local business community, including the chief executive officers and managers of about 30 engineering firms in the metro area, and local governments. They also consulted with the deans of engineering and/or presidents at Virginia Tech, UVA and others.

They concluded that an engineering program or school should be established at VCU, noting that the needs of the community would be satisfied only if the program were conducted by a resident faculty teaching and conducting research in areas "reflective of the scientific and technical character of VCU and Richmond." To that end, they advised establishing undergraduate programs in electrical, mechanical and either civil or chemical engineering and that the M.S. and Ph.D. programs in biomedical engineering, then offered through the school of medicine, be moved to the engineering school.

The consultants further advised that the program or school be located on VCU's academic campus to facilitate access for engineering undergraduates to required and elective courses from across the entire university. It would also integrate the engineering students into the campus's undergraduate student body. This location would additionally provide the faculty with access to the facilities of other relevant programs as well as encourage collaborations in education and research between the engineering faculty and their counterparts in chemistry, business, and elsewhere.

The consultants further supported the university's desire to recruit both high school and transfer students with an emphasis on recruiting more women and minorities to study in a field that was (and is) dominated by white males and encouraged VCU to develop partnerships with the institutions in the region offering engineering-related programs that would facilitate these objectives.

Perhaps most importantly, the consultants advised that the initial capital costs for the school including a building and equipment would be between $18 and $20 million, and they recommended that these funds be generated from the private sector before soliciting operating funds from the state. The extent to which VCU could raise these private funds would confirm the importance that the community was placing on going forward with an engineering school at the university. That would not only alleviate the financial impact of the school on the university and the state but it would also answer those from several of the engineering schools around the state and from SCHEV who legitimately questioned whether another engineering school could be justified in terms of state support.

The consultants' report generated good press for VCU. An article in the ***Richmond Times-Dispatch*** on May 2, 1993, focused on the positive role that an engineering program would play in the future of the university, particularly that of VCU's Medical Center and the Virginia Biotechnology Research Park. Although Dr. Trani was still at the time considering a number of options, including arrangements with another engineering school rather than a stand-alone program, the article echoed the consultants' view that a separate, resident program was needed in the community and that proof of that need would come in the form of private funds to finance the physical plant.

Engineering Planning Team

Dr. Trani was aided in this early work of pursuing the creation of the School by an Engineering Team composed of all of his vice-presidents that first met in July of 1993 and continued to meet until the school was officially authorized by SCHEV on July 1, 1995. Following my arrival in January of 1994, I prepared and circulated minutes of all team meetings. The involvement of the political leadership in the state was being orchestrated by President Trani as was the use of the prestige of our engineering trustees who were all well-recognized business leaders in the state. Leaders concerned with economic development, including the State Director of Economic Development who reports directly to the governor, had also been enlisted. The Team approved an innovative financing structure for the building. The Team considered architectural matters. The Team considered the potential of a number of major gifts. The Team reviewed student recruiting. The Team considered the emerging legal status of the Engineering Foundation as well as many issues concerning financing of the School. The Team approved the appointment of myself first as Associate Provost for Engineering and later as Founding Dean after the School was officially authorized.

CHAPTER 2 : BUILDING BROAD-BASED SUPPORT

Community Alliance

Armed with the results of the various assessments, Dr. Trani began to work one-on-one with leaders in the community. Although the school's endorsement had been included in "Focus on Our Future," the case in terms directly related to the specific needs of the city and the surrounding counties needed to be made. If they did not buy it, the chances that the proposal for the school would survive the state and legislative approval processes were slim. After all, the engineering school was to emerge based on a public-private partnership. Through meetings and persuasive presentations, Dr. Trani did just that, the result of which were resolutions of support from The Virginia Society of Professional Engineers, The Metropolitan Richmond Chamber of Commerce, The Central Richmond Association, The Central Virginia Regional Summit, The Appomattox Basin Industrial Development Corporation, and The Central Virginia Coalition (as part of its legislative program for the General Assembly for 1994). All of these endorsements were motivated by an appreciation of the impact on the business and economic health of the entire area that would come from the presence of a school of engineering.

Nevertheless, these endorsements did not occur by accident, but rather due to the leadership of Dr. Trani.

With such a highly visible project, it is not at all surprising that I was invited to speak before every imaginable professional and civic group. I never declined such an invitation. I made over 60 such presentations, and several were keynote addresses before conferences of the sponsoring group. Such talks are important, and may unexpectedly lead to extraordinary outcomes. A few months after a presentation before the Richmond Kiwanis Club, I received a phone call from Mr. Tony Smith of Wachovia Securities. After introducing himself, Mr. Smith stated that he had heard the luncheon presentation which he found to be very interesting. Mr. Smith stated that he had been managing the financial affairs of a client for many years who wanted to make a donation in her will to establish a professorship to aid teaching and research at the interface between engineering and medicine. Thus was established the Caudell Professorship in Engineering, initially endowed at approximately $1.5 million and which will double in size upon the death of a surviving brother. And all from a Kiwanis luncheon talk.

Business Alliance

The time to identify start-up funds was rapidly approaching. This was one of the many crucial stages leading to the establishment of the engineering school. It goes without saying that without at least the expectation of initial funding, the idea would go back on the shelf. That expectation was soon fulfilled in the person of Mr. William Goodwin, one of the state's most prominent business leaders and philanthropists.

Mr. Goodwin's success in business is revealed somewhat by his sale of AMF Bowling in 1996 for a reported $1.37 billion, which was more than six times what he had paid for the company only ten years earlier. The buyer was Goldman Sachs, the New York investment banking firm. His generosity of spirit is well revealed by his voluntary return of some $50 million in unexpected bonuses to his employees at AMF whose hard work had made the huge increase in value possible. Some longtime employees reportedly received twice their annual salary as a bonus. Mr. Goodwin is a graduate of Virginia Tech in mechanical engineering and a graduate of the MBA program at the Darden School of Business at the University of Virginia. Examples of his generosity include $25 million to Darden, $25 million to VCU's Massey Cancer Center in 2001, over $3 million to Virginia Tech, $5 million to the Episcopal Diocese of Virginia, and $500,000 to the Robert E. Lee Council of the Boy Scouts of America. Mr. Goodwin acquired the world class Kiawah Island Resort near Charleston, South Carolina, in 1993. Mr. Goodwin is a very private person who never publicizes his philanthropy. He does not grant interviews to the press. But most importantly for the new School of Engineering at VCU, he gave $15.5 million to what was, at the time, only a dream in the minds of several individuals.

Mr. Goodwin made an initial $10-million "anonymous" commitment to creating the school, which ensured that the proposal would go forward. It also would confirm the community-based need for an engineering school that the consultants identified as a major criterion for their positive recommendation. The School of Engineering would not exist except for the foresight and generosity of Bill Goodwin.

There were a handful of additional visionaries during these early years without whom the engineering school never would have happened. It was not only Mr. Goodwin's financial support and enthusiasm for the dream but also his leadership in the business community that would, in time, provide for the establishment of the School of Engineering Foundation Board of Trustees.

The identification of the first ten or fifteen trustees was due to

Mr. Goodwin. As a prominent businessman, he knew the leaders in the community, and he wanted kindred souls as trustees – people with whom he knew he could work. These individuals were all presidents and/or CEOs of their firms. Potential trustees were not restricted to persons from technologically based firms as one might have expected. Each candidate trustee understood that he/she would be an owner of the School and that his advice would be solicited and followed. Each candidate trustee also understood that the school was to be privately constructed, so he would be asked later to financially contribute to the project. None of these leaders declined the invitation to become a trustee, and each became a financial contributor. Many facilitated gifts from their companies as well. With the first several trustees suggested by Mr. Goodwin in place, it became increasingly easy to enlist the services of other executives. There were 30 such Founding Trustees, and they were, in a very real sense, founders of the School. The faculty created the intellectual reality of the School, but the trustees helped to establish a sense of history and of depth and of permanence.

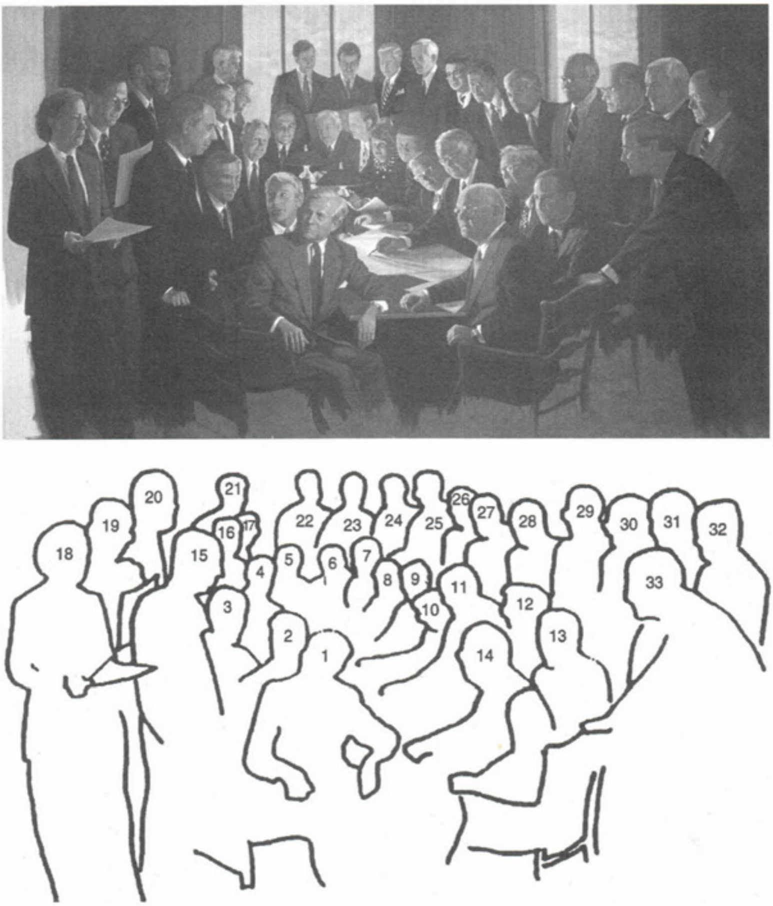
The dean of each school of the university reports to the provost, but I was also responsible to the trustees, and I made periodic presentations so that they would have an understanding of all aspects of the academic planning and development of the school. The trustees approved of the goal that the new School strive to become prominent in engineering education in America, and they understood the resulting implications concerning quality of students and faculty, as well as the major emphasis upon research that would soon demand additional buildings. Other universities have been successful catalysts for wealth creation both in their metro areas and nationwide, and they provide models that we wished to emulate at VCU. Robotics in Pittsburgh around Carnegie Mellon University, biotechnology in San Diego around the University of California, the North Carolina Research Triangle surrounded by UNC-Chapel Hill, Duke, and NC State, and Silicon Valley near Stanford each, in their own way, stimulated our ambitions.

A portrait would honor and memorialize the essential contribution of the Founding Trustees. A noted local artist, Ms. Loryn Brazier, was selected to create an oil painting on an 8 x 12 foot canvas. She began in 1997 and the work took approximately a year to complete. She wanted the portrait to tell a story and not be merely a sort of rogues' gallery. Ms. Brazier worked on the portrait in her gallery in Carytown, an area of art studios, restaurants, boutiques, and the like, so there were always people milling about who enjoyed seeing the progress on the painting. One such passerby happened to be a neighbor of the Goodwin's who told Ms. Goodwin of seeing the painting in progress and of her positive reaction to Mr. Goodwin's likeness. Whereupon Ms. Goodwin came to the studio to see for herself. She was unaware of the existence of the painting. Mr. Goodwin had failed to tell her of the portrait. Perhaps he wanted to surprise her. The portrait, which hangs in the main lobby of the engineering building, was unveiled at a black tie reception and dinner party celebrating the opening of the building on November 10, 1998.

One founding trustee, Mr. Claiborne Robins, died before the portrait was commissioned. The artist could have easily used a stand-in and painted in his likeness. However, the decision was made to create a separate portrait of him which would hang nearby in the main lobby of the building, and this decision was approved by Ms. Robins.

The reproduction here of the portrait of the founding trustees cannot, of course, do justice to this wonderful work of art.

The accompanying outline of the persons in the portrait allows one to identify names with faces. These names and their positions in the community are also listed here.



The Founding Trustees of Virginia Commonwealth University, School of Engineering Foundation.
November 13, 1998

Seated (from left to right): (1) John L. McElroy, Jr., Chairman Emeritus, Wheat First Union; (2) Clifford A. Cutchins, IV, Senior Vice President and General Counsel, Fort James Corporation, Deerfield, Illinois; (3) Richard E. Posey, President and Chief Executive Officer, Hamilton Beach/Proctor-Silex, Inc.; (4) Hays T. Watkins, Chairman Emeritus, CSX Corporation; (5) Kirk E. Spitzer, President, Tri-Clover, Inc., Kenosha, Wisconsin; (6) Malcolm S. McDonald, Chairman, First Union

VA/MD/DC; (7) David L. Milby, Senior Vice President, Operations Procurement and Services, Philip Morris, USA; (8) The Honorable Anne G. Rhodes, Member, House of Delegates, Virginia General Assembly; (9) Robert E. Rigsby, Executive Vice President, Virginia Power; (10) Eugene P. Trani, President, Virginia Commonwealth University; (11) William H. Goodwin, Jr., Chairman, CCA Industries, Inc., and President, Virginia Commonwealth University School of Engineering Foundation; (12) Bruce C. Gottwald, Chairman and Chief Executive Officer, Ethyl Corporation, and Vice President, Virginia Commonwealth University School of Engineering Foundation; (13) Robert M. Freeman, Retired Chairman and Chief Executive Officer, Signet Banking Corporation; (14) William W. Berry, Retired Chairman of the Board, Dominion Resources and Retired President, Virginia Power;

Standing, 2nd Row (from left to right): (15) E. Morgan Massey, Chairman Emeritus, A.T. Massey Coal Company; (16) Dwight Schar, Chairman of the Board and Chief Executive Officer, NVR. Inc.; (17) J. Carter Fox, Retired Chairman and Chief Executive Officer, Chesapeake Corporation.

Standing, Back Row (from left to right): (18) Bruce A. Henderson, President, Siebe Appliance Controls; (19) Sean Hunkler, Director of West Creek Site, Motorola; (20) William S. Cooper, Jr., President and Chief Executive Officer, Choice Communications, Inc.; (21) Joseph C. Farrell, Retired Chairman and Chief Executive Officer, The Pittston Company; (22) Paul F. Rocheleau, Chief Executive, Albright & Wilson plc, London, England; (23) Wolfgang V. Schubl, Chairman of the Board and Chief Executive Officer, Weidmuller Management International, Detmold, Germany; (24) Hugh R. Stallard, President and Chief Executive Officer, Bell Atlantic-Virginia, Inc.; (25) Richard L. Sharp, Chairman and Chief Executive Officer, Circuit City Stores, Inc.; (26) Robert C. Williams, Chairman Emeritus, Fort James Corporation

(27) Wayne Nesbit, President, White Oak Semiconductor; (28) Jeremiah J. Sheehan, Chairman and Chief Executive Officer, Reynolds Metals Company; (29) Henry A. McGee, Jr., Founding Dean, Virginia Commonwealth University School of Engineering; (30) Stanley F. Pauley, Chairman and Chief Executive Officer, Carpenter Company; (31) Richard G. Holder, Retired Chairman and Chief Executive Officer, Reynolds Metals Company; (32) Richard G. Tilghman, Chairman of the Board and Chief Executive Officer, Crestar Financial Corporation; (33) John Sherman, Jr., President and Chief Executive Officer, Scott & Stringfellow Financial, Inc.

The School of Engineering at VCU is unusual in a number of ways, and certainly one of these is its status as a privately owned school as part of a major state-supported university. The School is fortunate to have the support of these outstanding people in very influential positions...our trustees.

Academic Alliance

Armed with survey research, resolutions of support from the community, the promise of support from business leaders and the consultants' report, Dr. Trani began serious discussions with Dr. Paul E. Torgersen, then president of Virginia Tech, about the possibility of collaborating with VCU to develop what all agreed at this point should be a stand-alone school with its own faculty and physical plant. In the process of these discussions, I was offered the opportunity to join VCU as Vice Provost for Engineering, reporting to Provost Grace Harris, which, as I noted earlier, I eagerly accepted. I had been on the faculty at Virginia Tech for 20 years, but this was the opportunity of a lifetime. In recommending me, Dr. Torgersen said "it would give me the opportunity to become the "father" of a whole new school of engineering."

One of my first tasks was to craft a Memorandum of

Understanding between Virginia Tech and VCU that would formalize their collaboration to establish an outstanding school of engineering at VCU. An agreement between two institutions to develop what could be perceived as a competing program at one of them was almost unheard of. But VCU's colleagues at Virginia Tech understood that VCU and the Richmond region were not interested in reproducing a miniature Virginia Tech in Richmond but rather in creating programs uniquely responsive to real, defined deficiencies in engineering education while capitalizing on the tremendous potential for interdisciplinary work through other VCU programs, including particularly medicine and business. It was a green field, that is, there were no pre-existing impediments, and the faculty and administration from Virginia Tech would be able to help lay out the parameters of something new and different.

With the final draft of the MOU approved by all the parties, the time had come to announce the proposed engineering school to the public.

Announcement

At the invitation of both President Trani and President Torgersen, more than 150 guests representing the leadership of the university, the community and local city and county governments gathered on February 10, 1994, in VCU's Student Commons for a press conference to announce the Memorandum of Understanding and my appointment to VCU. Mr. Dixon Whitworth, rector of the VCU Board of Visitors; Mr. James Dunn, president of the Greater Richmond Chamber of Commerce; and I joined our hosts, Dr. Trani and Dr. Torgersen, as the platform guests.

As stated in the press conference program, "building reciprocal relationships with business and industry in the greater Richmond area will be one of the highest priorities of the new school which will be seamless and multidisciplinary in chemical, electrical, mechanical and biomedical engineering." Dr. Trani used the occasion to announce the anonymous $10-million leadership gift (which Mr. Goodwin would in time acknowledge publicly) as well as $250,000 donated by Dr. Louis C. Harris and his wife for an endowed professorship in biomedical engineering. Dr. Harris is Professor of Pharmacology & Toxicology at the VCU Medical Center. From the podium and foreshadowing the coming character of our School, I stated in part, ". . . we plan programs to provide a better balance of analysis with the more creative, more rambunctious, and the more inventive side of engineering that is not now well done . . . [and] we wish to link engineering seamlessly to the rest of the campus and to the community. Intellectual integration will be the hallmark of all our programs." Following the signing of the MOU by President Trani and President Torgersen, Dr. Trani, who is somewhat less than six feet tall, got a good laugh from the audience when he said, "today I feel seven feet tall."

Proposal to the State Council of Higher Education for Virginia.

Authorization from the Virginia governor and the General Assembly to establish a new program at a public college or university first requires comment and hopefully agreement of the State Council of Higher Education for Virginia (SCHEV) that the program should go forward. SCHEV is the coordinating body for higher education in the Commonwealth with the mission of promoting the development of an educationally and economically sound, vigorous, progressive, and coordinated system of higher education. Its 11 members are appointed to staggered 4-year terms by the Governor, and SCHEV has a professional staff of several dozen members. SCHEV makes recommendations to the Governor and to the General Assembly in all areas pertaining to higher education in Virginia.

My next task was to write a formal proposal to SCHEV to establish the VCU School of Engineering. This process occurred with guidance from the Engineering Planning Team and ended with a comprehensive 200 page document.

Draft copies of the SCHEV proposal were distributed in April of 1994 to seek suggestions and comments. Copies were also sent to the presidents of other universities in Virginia that offer engineering. Dr. F. William Stephenson, Dean of Engineering at Virginia Tech, wrote to President Trani, "The proposal is thorough and compelling, and when implemented, I am confident that it will result in quality programs in chemical, electrical, and mechanical engineering at VCU. My colleagues and I have been pleased to play a role in getting your project to this point, and we look forward to continued interactions as we together bring your plan to fruition."

Meanwhile Dr. Trani had been meeting individually with the 11 members of the SCHEV Board to discuss the proposal and to obtain their advice and guidance.

The Engineering Planning Team submitted the first request for funding for the School of $547,000 which would be included in Governor George Allen's budget recommendations to the General Assembly for the 1995-96 fiscal year.

Although the SCHEV proposal was written by me, many people were involved in its development. Most notable was the role of Dr. Grace E. Harris, Provost and Vice President for Academic Affairs. She very well knew the intricacies of university administration and governance. And these, of course, were central to the preparation and submission of a compelling proposal. The credit for the successful proposal owes much to her leadership. Numerous conferences with Dr. Donna Brodd of the professional staff at SCHEV were also very helpful in guiding the preparation of the proposal.

The SCHEV proposal prominently listed the members of the

Board of Trustees and their positions. This provided powerful authentication of the commitment of the business sector from throughout Virginia. The School was projected as having 40 faculty in engineering with 15 in electrical engineering, 15 in mechanical engineering, and 10 in chemical engineering. This was three times the size of faculty suggested in the Clough report in 1993. Six additional faculty in other supporting departments were projected along with 15 graduate teaching assistants, 10 clerical support persons which is in keeping with experience in other programs at VCU, 3 technicians, 4 endowed professorships, 20 percent of students receiving merit-based scholarship assistance, and a new building specifically designed to house engineering and having a minimum assignable floor area of 80,000 square feet. When the proposal to SCHEV was completed in late 1994, an average faculty academic year salary of $72,000, not including benefits was projected, equivalent to an annual salary budget for faculty alone of some $3.5 million. Using an enrollment model, the SCHEV proposal projected our financial needs in every category through the 2000-01 academic year. A productivity of 4 degrees per year per faculty was projeced. Both salary and productivity were in keeping with experience at other engineering schools in Virginia and with national norms. It is not uncommon to offer new faculty a start-up package to help get his/her research under way to allow competitiveness for grants from the National Science Foundation and elsewhere. The SCHEV proposal projected a very modest $100,000 per faculty for this need. Assuming at least a comparable income as that at Virginia Tech and NC State from research grants of $150-200,000 per faculty per year, one might expect a total income to VCU from grants of perhaps $8.0 million per year. As an aside, the chemical engineering faculty of 7 were already producing $360,000 per faculty per year in 2003 – a level of success on this important index that places that faculty in the top 25 or so programs in America. So the positioning of the major guideposts for the school in the proposal to SCHEV had been changed very much upwardly from the original ideas of both Dr. Clough and the team of consultants.

On September 22, 1994, VCU's Board of Visitors approved the SCHEV proposal; it was delivered to Dr. Gordon Davies, director of SCHEV, on October 17, 1994. At its meeting on December 13, 1994, the 11-member SCHEV board voted unanimously to approve the proposal to create a new school of engineering at VCU. This action merited a front-page story in the ***Richmond Times-Dispatch*** the following day. Arrival at this major milestone only three years after the dream of engineering education in Richmond was promulgated in the "Focus Report" is testimony to the skill of Dr. Trani and his Engineering Planning Team.

In their preliminary approval of our proposal, SCHEV stipulated that prior to their final approval, $17 million in cash and pledges must be on hand toward the fund-raising goal of $20 million that had been established at that time. The Council recommended to the Governor and the General Assembly that the school be allowed to set its own tuition at market rates independent of the standard tuition rate for the university. SCHEV further recommended that although the construction of the engineering school building would be carried out in accordance with state regulations, the usual requirement for architectural review by the relevant state agencies would be waived in view of the fact that the building was to be privately funded and privately owned. As just one example of the resulting savings in time, the project manager and I selected the architect for the building after just three days of interviews.

Finally, SCHEV supported VCU's vision of a new kind of engineering school and encouraged the university to form an

Advisory Committee of outside representatives who would assist in maintaining the nontraditional curricula and pedagogies. SCHEV was banking its recommendation of approval to the General Assembly on VCU developing and maintaining a school unlike any other in the state, which otherwise would have attracted criticism for program duplication. Throughout the 1990s, duplication had been a major issue among leaders in higher education and in state government. In the early rush of attracting students, attracting faculty, designing curricula, raising the endowment, and designing and constructing the building, this recommendation from SCHEV was unfortunately not implemented.

Full and final approval to begin programs in electrical, chemical, and mechanical engineering in the Fall of 1996 was granted by SCHEV with no stipulations in a letter to Dr. Trani dated June 3, 1996.

Other New Schools

While all of this planning for a new school of engineering was moving forward in Richmond, other, and independent, but strikingly similar, planning for three other new schools of engineering was also moving forward.

The Olin Foundation has assets of over $500 million. Its Board of Directors has committed $300 million of this to creating the new Olin Engineering College, and the Board is willing to spend their entire corpus on the new college if need be. "We want to give the college the resources it needs to excel. If that takes all of our resources, so be it," says Lawrence Milas, President of the Foundation.[2] The college was established adjacent to Babson College near Boston's high-tech complex along Route 128. Such a start from a green field was

[2] *Prism,* American Society for Engineering Education, September 2000.

selected over the competing ideas of creating the school as part of an existing outstanding university or alternatively providing huge new financial resources to an existing good engineering school but which was struggling with inadequate funding. The greenfield alternative would sidestep the enormous inertia of any ongoing academic program with all of its vested interests. Universities are like aircraft carriers; both take a lot of time and space to change direction even minimally.

Another enormous plus for locating Olin College at Babson was the already existing strength in business education and particularly in entrepreneurship, where Babson enjoys an international reputation.

In a cover story in the September 2000 issue of ***Prism***, the monthly magazine of the American Society for Engineering Education, the new Olin College was described as "one of the boldest experiments in American higher education in decades . . . "Like VCU, Olin seeks to meld engineering and entrepreneurship.

Like VCU, the Olin College has no departments and strives to integrate knowledge by avoiding artificial boundaries. Unlike VCU, Olin offers free tuition and housing.

Olin College, not unlike the VCU School of Engineering, will require years of experience to know whether a startling opportunity has been used to create a masterpiece or whether just another rather ordinary engineering program has been added to the more than 300 presently in existence. It is clear that both planners – at Olin and at VCU – had independently come to the same cluster of conclusions as regards directions and focus.

Rowan University became the new name of Glassboro State College in Southern New Jersey (near Philadelphia) as a result of a gift of $100 million by Henry and Betty Rowan for the specific purpose of creating a new and innovative school of engineering. The name change was not a condition for the gift, but rather the university's administration felt it to be an appropriate act.

This outstanding gift occurred in 1992, and at the time it was the largest sum ever given to a public college or university in the history of American higher education. Like VCU, Rowan accepted its first freshmen in the fall of 1996, and offers the B.S. in Chemical, Civil, Electrical, and Mechanical Engineering as well as the M.S. in Engineering. Like VCU, Rowan seeks to impact the economic development of its region, that is, Southern New Jersey. Rowan's signature Clinic sequence typifies their hands-on, team-oriented approach to highly multi-disciplinary engineering education.

The University of California will launch a new research university as the tenth campus of the highest tier of the University System of California at Merced in the San Joaquin Valley, a region of the state that is plagued by poverty, low education rates, and low income levels. [3] Merced is the first new UC campus in nearly 40 years. The goal is not only to create a prestigious university, but to also reverse the economic and social decline of the region. The direction of the new school is somewhat radical in that agriculture, the dominant activity in this region, is to be rather ignored in favor of a focus upon engineering and technology. Like VCU, UC Merced will have no departments to help enhance a multidisciplinary view. Like VCU, the hope is that UC Merced will play a pivotal role in creating wealth in the local economy by attracting new high-tech industry and by fostering new companies as spin-offs from research programs at the university.

The similarities of ambition and guiding philosophies of

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[3] *Prism*, American Society for Engineering Education, January, 2002.

of engineering at VCU to those at Olin, those at Rowan, and those at UC Merced are striking. There is much more overlap than there are differences. The designers have independently come to many of the same decisions. Another important comparison of these new schools is the huge financial advantage of both Olin and Rowan over VCU. Proper funding is a necessary, but not sufficient condition, for the success that we all seek.

CHAPTER 3 : FOUNDATION FOR INNOVATION

What should constitute the education of the new VCU engineer? There are two answers to this question. First, the VCU engineer must be able to respond to the needs and opportunities of the world and particularly to those of the Richmond metro area. After all, it was the local business community that provided the impetus to create the School, and it is essential to give-back to that community. Second, to achieve any sort of notoriety or visibility in a world of over 300 schools of engineering in the U.S. and to hopefully achieve it quickly, the VCU engineering program must have some unusual or distinctive qualities. It must define a special niche for itself. We like the term "renaissance engineer" which is pretentious to be sure, but from the beginning we had a desire to produce creative and imaginative people while maintaining the core competencies in chemistry, physics, math, and the engineering sciences. And recognizing the emergence of the life sciences as central to 21st century technologies, biology must be added to this list of core competencies. The character of engineering education seems always to be in a state of flux which is indicative of a dynamic profession.

Special Character: The Renaissance Engineer.

So just how do you design notable programs in engineering education?

First, you do not initiate programs that look like all other engineering programs in America. Even those that we would all agree to be among the best in the world. We do not look at Georgia Tech or MIT and say, "your programs are world-class" – and they certainly are – "we will design ourselves to look like you." That "me too" school of thought is wrong. Rather, we must look at the world and at where the opportunities are, and what is most needed, and how can we best serve. The answer must also play to our local strengths. Clearly our greatest local strength was our green field, for we could imagine any character we pleased. We were unencumbered by any prior baggage of any sort. A second local strength was our very fine medical school, the VCU Medical Center, one of the largest academic medical complexes in the country with outstanding programs in all areas of health-related research and clinical practice. A third strength was a vigorous and diverse manufacturing base. And a fourth strength was a young and aggressive local entrepreneurial base in high tech endeavors as is perhaps best reflected by the huge growth of the Greater Richmond Technology Council (GRTC). And, finally, a fifth pillar of existing strength was the Virginia Biotechnology Research Park adjoining our Medical Center campus in downtown Richmond. Many of the entrepreneurial companies that are members of the GRTC are located within the Park.

The Virginia Biotechnology Research Park seeks to advance biosciences in Virginia through promoting research leading to new investment and new high-tech jobs. The Park was created by joint action of VCU, the City of Richmond, and the Commonwealth of Virginia. When fully developed, the

Park will be home to some 3000 researchers. In Spring 2001, the Park had 37 tenants with over 800 employees. Two more buildings now underway will provide some 600 additional high-tech jobs. One of these additional buildings will house the United Network for Organ Sharing which is concerned with matching donors with recipients on a national basis. The second new building will house the Virginia Division of Consolidated Laboratory Services that provides a wide range of environmental, public health and safety, and consumer testing for the Commonwealth. A number of engineering students have pursued their summer internships in companies located in the Park. Faculty from across engineering either own or are involved with companies in the Park. There is an interactive relationship, and the School has been and will continue to be a partner in the growth and success of the Park.

The VCU Medical Center in particular presents a major opportunity for creative design of both engineering and medical education and research. Dr. John Cardea, Head of our Department of Orthopedic Surgery, said "The future of orthopedic surgery **is** engineering." And the Biotechnology Research Park will only heighten this synergy.

Some Characteristics of the Renaissance Engineer

The new School of Engineering at VCU sought to maximize the advantages of starting from a green field. Seven essential ideas were identified.

> *1. Industrial Practice:* Engineering programs must be close to industrial practice. The myth of the "ivory tower" must be avoided. This characteristic fits perfectly at VCU because it was pressure from industry in the metro area that was the genesis of the drive to create a school of engineering in the first place. To best foster this university/industry interaction and rapport, a joint research program, for example, between engineering at

VCU and a company should be arranged in ways that would make it hard to tell where the company stops and the school begins. This attitude also demands that a sufficient fraction of full-time faculty have had industrial careers. Here one can immediately see storm-clouds on the horizon, for these faculty will likely not be tenurable by the traditional standards. University faculty are typically extremely conservative about their own business while being equally extremely liberal about the business of others. Not surprisingly then this anticipated trouble with tenure was and remains a significant problem for the implementation of the non-traditional character that was a defining characteristic of the new School. Another way to achieve this desired closeness with industry is for every student to be involved in an internship in an industrial setting. These practica are not to be a summer job on the loading dock, but rather the student must work as an engineering apprentice under the mentorship of an engineer at the company. Having such a student in house at the company is itself a partnership, for some engineer at the company must make the intellectual commitment to be a mentor just as the company also makes a financial commitment to pay the salary of the student.

*2. **Business:*** A much-lamented shortfall in the education of engineers is the absence of useful exposure to business related issues of marketing, finance, project management, and economics. The opportunity to infuse some of these principles of business into the new engineering programs will both meet a long-time need and, at the same time, provide another opportunity to define the special niche that engineering at VCU must have. The helpfulness of the VCU School of Business played a major role in allowing the new School of Engineering to implement the business component of its "special character". Although the very tight engineering curricula would allow only an introduction to business to be required, the engineering faculty encourages engineering students to seriously consider earning a minor in business. This would require seven courses (21 semester credits), and by careful planning, the courses could be interspersed in the curriculum such as to require only one additional semester to complete the combined program. This seemed a small price to pay since the national average time to complete a "four-year" curriculum in engineering was in fact 4.8 years already. This minor would also be a huge head-start toward earning an MBA. The combination of undergraduate engineering plus the MBA is a powerful and popular educational background for persons aspiring to executive careers in business.

Philip Morris became so enthusiastic about the value of a minor in business to supplement the B.S. in engineering that they established a scholarship program to attract students. The program provides up to $4500 to each awardee for tuition, books, etc. that would be needed for the nominal one additional semester of school that would usually be necessary. However, and to their great credit, many of these awardees are able to register for overloads and complete the engineering major and the business minor within four academic years. So all of the scholarship funds are frequently not needed. The scholarship may also be used to support enrollment in graduate courses in business thereby allowing an awardee to begin his /her MBA while still an undergraduate.

A new course in economics specifically tailored to the needs of engineers and jointly developed by the faculty in both schools, "The Economics of Product Development and Markets", is required of all chemical and mechanical engineering students, but no engineer, regardless of disciplinary specialization, should fail to understand concepts such as the time value of money or discounted cash flow and much more. The purpose of the course is to introduce some of the fundamental business concepts that are necessary to effectively operate in a rapidly changing marketplace. Basic elements of microeconomics, net present value analysis, and marketing are covered.

A key component of the course is a team-based participation in an interactive market simulation to test and to hone one's ability to apply what is being learned to a dynamic market simulation.[4] The performance of a particular team will depend upon choices made by that team as well as choices made by other teams of students operating in the same market. Teams must provide written justification of actions taken and a written follow-up explaining the outcome. Communication skills are enhanced through short reports as well as a written business plan together with a PowerPoint presentation before faculty from both the Business School and the Engineering School. The course requires extensive readings from several sources, it assumes a familiarity with current events, and discounted subscriptions to the ***Wall Street Journal*** are available. There are, of course, no right answers to problems and situations. So the goal of the course is to learn process rather than memorization of facts. Economics is a way of thinking, not a collection of facts. The material in the course is analytic in nature, not descriptive. It is necessary to learn the approach to a problem and be able to generalize that approach to address wholly new situations or problems. The element of competition is real, and the final outcome of profitability from the simulation at the end of the semester is the reward. Issues of pricing, quality of product, range of products that are produced, investment in R&D and more are exercised.

A second new course, "Introduction to Project Management" was also jointly developed by faculty in engineering and in business. Most non-routine cooperative work in any organization takes the form of a project. A project has been defined as a temporary endeavor undertaken to create a unique product or service.[5] Project management is the application

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[4] Several simulations are suitable. One is the Capstone Business Simulation by Management Simulations, Inc.

[5] "A Guide to the Project Management Body of Knowledge", 2000, Project Management Institute, Upper Darby, PA (www.pmi.org).

of knowledge, skills, tools, and techniques to meet project requirements. This course is designed to augment discipline-specific skills of engineering students to prepare them to conduct projects that will form a major part of their future work. Areas to be learned by students in this course include: leadership (both up and down the organizational hierarchies), negotiation skills, skills in managing complexity, skills in the techniques of planning, scheduling, budgeting, and controlling (pert charts, critical path analysis, Gantt charts), communication skills (oral and written), and project organization and planning. There are also lectures on motivating people, on ethical guideposts, on self-awareness and self-development, and on organizing and modifying organizational culture. And there are extensive assigned readings on offshore projects, human factors, and more. These sorts of topics are far removed from the engineering sciences, but they are no less critical to the success of an endeavor.

The Richmond Chapter of the Project Management Institute has provided a scholarship, and their members are a potent source of guidance and relevant expertise. The School of Business Scholarship Committee selects the recipient from enrollees in the Project Management course. The recipient must demonstrate a career track that includes project management.

These courses represent opportunities for distinctiveness of the VCU engineering graduate. The opportunity and the need are clear. For example, a recent survey of all graduates in chemical engineering and in chemistry who had finished their BS degree up to 20 years previously revealed that 67 percent thought management to be important to their success. Yet only 30 percent felt the quality of their training in this area to have been good.[6] Similarly according to a recent survey by the

6 *Chemical and Engineering News*, December 24, 2001.

American Chemical Society, most Ph.D. graduates lamented that they were never exposed to the principles of business while in college.

Newly minted MBAs from the nearby Darden School of Business at the University of Virginia who also hold baccalaureate degrees in engineering are regularly offered starting salaries well into six figures. And Darden graduates are not unusual. The preparation of the VCU engineer, whether with the two special courses, or the minor of seven courses, provide a huge head-start for the subsequent pursuit of the MBA.

3. Entrepreneurship: Another defining characteristic of the VCU engineer is a devotion to entrepreneurship. In just one example of efforts elsewhere to encourage entrepreneurship, the Schools of Engineering and Business at the University of Southern California have sought to "create an awareness of the importance of the commercialization process. Engineers have realized that they need business skills to commercialize their ideas. Likewise, business students know they can't do much with their great ideas unless they are founded upon some technological innovation. Collaboration like this has never existed before at USC—this is really a first". This orientation toward business had become a "first" at USC in 2001, but it was a founding principle at VCU since 1994.

Brad Crosby and Nick Cain of the VCU chemical engineering class of 2001, while still themselves only sophomores, and with Dr. Gary Huvard as their advisor, created ChemEngine, a student led and operated not-for-profit consulting firm.[7] During its first full year of operation, January to December 2000, teams of student consultants had garnered almost $50,000 in consulting contracts. In its second year, Chem Engine had $147,000 in consulting contracts. Student consultants were hired from our programs in electrical,

[7] *ChemEngine* has a website: www.chemengine.net.

mechanical or chemical engineering as needed for each project. All students were completely turned on to engineering and by their ability to make valuable contributions to a profit making company, even though they might still be one or two years away from graduation. The students, all full-time under graduates, were earning real money working on real projects for real companies. Their activities epitomize active and collaborative learning.

ChemEngine provides fee-based services to chemical, biochemical, pharmaceutical, and other high-tech firms. ChemEngine rents office space in the engineering building and pays fees to the School for use of its equipment. ChemEngine develops contracts with clients, hires students, pays taxes, invoices clients, and manages issues of intellectual property. An overlay of business skills was a guiding principle of the VCU School of Engineering from its conception, and in ChemEngine, students learn engineering and business skills through actual practice. Experience has clearly shown that students have marketable engineering skills after only two years in the VCU program.

ChemEngine's first project was for a firm in Ohio that manufactured large plastic parts. The incidence of unacceptable parts peaked each summer. The question was why, for this was a significant financial loss as well as an undesirable load on the city landfill. Brad and Nick developed an hypothesis, did in-plant tests, and proposed an economical solution to the problem. They presented their findings to a room full of enthusiastic plant personnel in an all-day consulting meeting using an illustrated PowerPoint presentation. They gave a live demonstration of an interactive computer simulation, and they finished by presenting a written report to the plant's technical manager. Their introduction to real engineering work was complete after two flights on the way home were canceled allowing them to finally collapse in excited exhaustion at about 3:00 AM. ChemEngine was born that night.

From the point of view of the impact of this real-world experience on the subsequent classroom experience, it is noteworthy that the GPA of Nick Cain increased by a full point during subsequent semesters. This sort of impact upon academics due to engineering experience is commonplace.

4. Synthesis: We must provide a spirit of innovation and synthesis to balance the current overwhelming devotion to analysis alone that is so characteristic of engineering education today. Sophisticated mathematical analyses and modeling and computer simulations are terribly important, and modern engineering practice is unthinkable without these powerful insights. This is rational left brain work. But too many schools neglect the flip side, or right brain work of intuition, imagination and synthesis. No analysis and no computer solutions will ever create an architectural master piece from knowledge of strength of materials, statics, and dynamics alone.

A good example of efforts to focus on synthesis is the creation of the da Vinci Center that is a joint venture of mechanical engineering and VCU's nationally prominent sculpture department. Again, the idea is to educate Renaissance engineers. The opportunity arose to cast this in bricks and mortar when the site selection process for the engineering building had initially led to the half-block bounded by Belvidere, Cary and Pine Streets. A potentially exciting component of this site was the fact that the other half of that block was already occupied by components of the School of the Arts. The sculpture department housed there and led by Professor Joseph Seipel was particularly interested in interfacing with engineering. Dean Murray DePillars of the School of the Arts and I had talked about building a sky-bridge to physically link sculpture and engineering. We wanted to mix the typically analytical and stiff engineering students with the free-wheeling art students. We thought it would improve the world view of each group and make each better at his or her chosen career. EDC, with corporate offices in Richmond (www.edcweb.com), established an endowed scholarship that was designed to somehow bring art, in whatever form, into the new school of engineering. The scholarship was announced, candidates were invited to apply, and a half-dozen or so applicants brought portfolios of their work to their interview.

In the end, Ms. Barbara Kruse, a double major in mechanical engineering and sculpture, was selected to be the first recipient of the EDC Scholarship. Upon graduation she had the highest cumulative GPA in her class in mechanical engineering, she received the VCU Distinguished Service and Leadership Award in ME, and she also received a highly competitive NSF pre-doctoral fellowship tenable at any university in the country. She enrolled in the doctoral program in engineering at the University of California-Berkeley.

Somehow in our enthusiasm for analysis, the inverse idea of synthesis has been too frequently lost. The goal at VCU was to bring about a better balance.

5. Interdisciplinary: Engineering programs must present an interdisciplinary orientation. In engineering practice today, there are no dividing lines between chemical and mechanical and electrical engineering. In fact, these merge smoothly into the physical and life sciences as well. To inspire this merging, the VCU school was purposefully designed with no departments and one budget center, i.e., in the office of the dean. My design was also to mix faculty offices and laboratories so as to even structurally blur these artificial intellectual divisions. This did not occur as planned because chemical engineering laboratories require fume hoods, and to most easily handle the exhaust stacks for the hoods, chemical engineering had to be placed on the top (fourth) floor.

The desired interdisciplinary orientation is best portrayed or modeled by faculty who personify such thought. In addition to joint classroom experiences, students see this synergy in research and they learn by example.

Dr. Tony Guiseppi-Elie in chemical engineering has created a Center for Biotechnology, Biosensors and Biochips that merges microbiology and microelectronics. He has recently received a $3 million grant to support this work.

Dr. Gary Wnek in chemical engineering has several joint ventures with faculty in chemistry that have attracted external funding. Dr. Wnek, an expert in polymer chemistry, and Dr. Gary Bowlin in biomedical engineering have developed the technique of electrospinning that allows the production of planar mats or tubes or whatever the desired shape composed of essentially 1 micron fibers of collagen or of some other biodegradable polymer. These mats form platforms for the ingrowth of tissue. The mat itself is absorbed and disappears in time. These faculty, along with their partners, Dr. David Simpson in our Anatomy Department and Dr. Kel Cohen in our Surgery Department, have formed a company, NanoMatrix, LLC, to exploit this striking new technology. The technology has also attracted a financial "angel" who has invested $1 million. The company has also recently received a Congressional earmark of another $1 million.

In another example, Dr. Tim Cameron in mechanical engineering, Mr. Tim Lucas, of MacroSonix (a local small high-tech firm) and I have applied an unusual new proprietary technology in acoustics to problems in chemical processing and pollution prevention.

These few examples, certainly not a complete listing, serve nevertheless to set the tone of a faculty with a strong interdisciplinary character. Problems in the real world are multidisciplinary, and the new School at VCU is to mirror that real world.

6. Communication: Engineering schools must give students opportunities to hone both their written and their oral communication skills, for these are so critically important to their subsequent success as a practicing engineer. This is made very real when students must interview for their summer internship. They must communicate well to land the best jobs.

Students must give PowerPoint presentations on their internship before their industrial mentors as well as during the following Fall semester before faculty evaluators. There is also a chapter of Toastmasters within the Engineering School wherein students and faculty give prepared aswell as extemporaneous speeches, all followed by critique. Most classes require written and oral reports.

7. Teamwork: Engineering programs must teach students to work in teams. This is commonplace in industry. Students often learn as much from each other when their team of perhaps two or three persons attacks homework problems as they learned from the preceding lecture by the professor.

So these are the seven defining characteristics of the VCU engineer, the Renaissance engineer, and they are: industrial orientation, business, entrepreneurship, synthesis, interdisciplinary, communication skills, and teamwork. With apologies for an engineering metaphor, it is thermodynamic or entropic that all systems will run down-hill without inputs of energy from outside of that system. So it is with these defining goals. Our non-traditional character must be vigorously maintained for the School to live up to its promise or it will surely lapse into the commonplace.

Industrial Advisory

Diverse Manufacturing is the means of wealth creation for the region. New products were expected to emerge from our biotech emphasis, and this is already happening although successes are still meager when compared with the enormous R&D funding that biotech projects have received. An Industrial Advisory Board (IAB) composed of the engineering leadership of the region aided in the design of the School. The first meeting of this IAB occurred on March 10, 1994 exactly one month after the major press conference on February 10 in which the presidents of VCU and of Virginia Tech announced that the long-discussed School of Engineering was officially underway. The University wants local industry and technically oriented agencies to feel themselves to be a part of the new School. We want "real-world" counsel from local firms and agencies, we want to provide further educational opportunities for local employees, we want a faculty that would be valuable consultants, we want internships and co-op opportunities for students, and we want part-time teaching from members of the technical staff of the firms who might enjoy service as adjunct professors. We want all of the accoutrements of a joint enterprise between the university and local technically oriented agencies. Some recommendations from the Industrial Advisory Board are summarized here.

- Interactive skills with engineers of alternate disciplines and particularly interactive skills with non-technical people is a troublesome area for many engineers who seem to be too narrowly educated. Greater breadth in literature and the arts and language and sensitivity to social issues would aid in developing these interactive skills. A successful engineer must be able to interact well in a diverse team.

- Manufacturing is increasingly a global enterprise and thus knowledge of a foreign language and culture is highly desirable. A 21st century engineering education must have a strong international flavor. The

School should consider how it might provide a semester abroad for its students.

• The idea of more creativity and the exercise of one's imagination is essential in engineering education. Somehow we must teach students how to get the left-brain and the right-brain to work together.

• Graduates need to have, or quickly develop, contracting and other financial skills.

• VCU should consider providing co-op opportunities wherein the student gets practical experience as well as income.

• Faculty to be recruited must exhibit the rare combination of desire to teach, real skill at teaching, and high-quality scholarship. Scholarly efforts should be oriented to relate to the medical complex at VCU and to the local industrial complex, while recognizing that advances in technology frequently come from unexpected directions.

• Success in an academic career is heavily weighted toward research and publication and grantsmanship. Quality teaching must also occur, and VCU must reach some sort of balance. It is within the power of the institution to set its own criteria for promotion and tenure.

• The Richmond area is more oriented towards manufacturing and toward high-tech development than toward research, but there are no sharp dividing lines between research and entrepreneurial development.

• Pollution prevention rather than waste treatment is the most appropriate strategy in manufacturing. Environmental regulations need to be based upon good science. The EPA has been severely criticized for its lack of scientific input and understanding as it crafts its regulations. Engineering seems to have abdicated to the lawyers who usually know nothing about the technical issues surrounding some problem, and this must be corrected. There is here a fundamental difference in world-view, for engineers seek the truth while lawyers seek to win the case. The two are not always coincident. The study of environmental matters should be woven naturally throughout the curricula rather than appearing as a subject area apart.

- New materials that exhibit startling physical and chemical properties have become important issues in manufacturing. Environmental demands place greater requirements upon materials of construction in issues such as maintenance, repair and equipment replacement.

Academic Advisory

The academic advisory group consisted of key leaders on campus as well as a representative from Virginia Tech in each of the three programs that were planned. There was high enthusiasm all around. This group first met in March of 1994. In appealing for ideas that would contribute to getting national recognition for the new school, I advised that no idea was too wild. I spoke of the traditional view of the engineer as a narrowly educated "nerd" with a pocket protector loaded with a dozen pens and pencils. Whereupon one panel member, Dr. Don Abraham, Chair of Medicinal Chemistry, stood and removed his jacket to show a pocket protector loaded with a dozen pens and pencils. It was hilarious, and all the committee enjoyed the moment. But nonetheless the desire for a sort of renaissance engineer was clear to all. Some selected ideas and suggestions from the Academic Advisory Board are collected here:

- Because of research successes in drug design, the construction of a small pilot plant in chemical engineering was proposed wherein 1-5 kg. of new compounds could be made.

• We should consider the cross-listing of courses and/or dual degree programs in computer science, physics, chemistry, business, and microbiology.

• We should consider links to the Law School of the University of Richmond. Links of several sorts already exist between the University of Richmond and VCU, so the groundwork is in place. Some of the most successful graduates in Pharmacology and Toxicology have gone into law. In engineering, such programs would likely prominently include patent law, liability, and regulatory issues. As an aside, Mr. Kevin Finto, Esq. of the local firm of Hunton & Williams, and with the kind cooperation of the firm did, in fact, develop an elective course, "Engineering and the Law" that was offered to VCU engineering students. Mr. Finto well knew both sides since he had graduated in mechanical engineering from Northwestern, and he had worked as an engineer with Chevron before earning his law degree from the University of Texas.

• Combined engineering and MBA degrees should be considered. With proper planning, such programs could be accelerated to reduce the required time to earn both the BS and the MBA. More management-related issues should be emphasized. There is high educational opportunity in looking at a process from its conceptual design to its marketing which would link engineering and business.

• Medical students are impatient to do clinical work, and they tend to have little patience with physiology or other underlying sciences. This same phenomenon is seen particularly in co-op students in engineering who, because of their experience, really enjoy the practice of engineering and have little patience with studying quantum mechanics or advanced mathematics or the like. Explanations and reinforcements are essential.

• The rapidly expanding advent of electronic information, with its associated hardware and software will increasingly impact teaching and learning in all fields and particularly so in engineering. We must look at how engineering is currently taught and how it can be improved through the use of technology. Because of our small faculty, distance learning should be exploited.

• There is, of course, great concern by manufacturers as well as the lay public for environmental issues suggesting opportunities for collaboration between, e.g., toxicology and chemical engineering. Similar opportunities exist between electrical engineering and physiology in concerns for, for example, the effect of emf on life processes. The similar impact of radiology should also be of concern. The new school should stress green engineering.

• Students should be required to write and to speak in public. This is now a weakness of students in many departments, including medical students as well as engineering students.

• Students need to be required to think about global issues.

• The new School should consider developing expertise in robotics that so well combines expertise in computers, electrical engineering, and mechanical engineering.

• There are outstanding opportunities for collaboration between engineering—particularly mechanical engineering—and orthopedic surgery. Advances in orthopedics result from collaborations between surgeons, mechanical engineers, biochemists, and cell physiologists. Modeling by mechanical engineers is replacing, in many instances, animal research.

• There is work on materials in the School of Dentistry which is still another avenue for joint teaching and research.

• The VCU Medical Center already has a combined MD/PhD program that can be completed in about 4 1/2 years. There is also a DDS/PhD program. Expansion and renewed emphasis and broadening of both of these as outstanding opportunities will become evident with collaborative ventures with the new School of Engineering.

• The new School should emphasize laboratory experiences in its programs.

Leadership Team

Mr. William Goodwin's early financial commitment was the essential catalyst from which flowed everything that has occurred regarding the creation of the School of Engineering. His leadership was, however, much more than purely financial, for he set a sort of tone. Because of his long and close association with the Darden Business School at UVA, Mr. Goodwin well knew the characteristics and needs and opportunities of a world-class educational program. Darden is an institution of world-class caliber, it is often ranked among the top-ten business schools in the nation, and Mr. Goodwin aspired to the same for the new School of Engineering at VCU. He was, however, realistic in realizing that such a status would take years, even under the best of circumstances.

In the same sense that Mr. Goodwin provided the financial and business leadership that made the creation of the physical reality possible, and Dr. Trani provided the administrative leadership that originated and kept the goal alive and progressing, I enthusiastically seized the opportunity to provide the academic and educational leadership that would define the teaching and research vision of the School.

A new school with, by definition, a zero reputation, and a school that would very likely always be small would have to be imaginative and focused in all of its undertakings if national visibility was to be possible. My task was to assemble a group of Associate Deans and Chairs who would also become excited about the dream of creating a new school that would become notable in engineering education in America.

Dr. Tom Haas: Dr. Haas was the longest serving member of the leadership team of the new School. He came to VCU in 1983 as Professor of Polymer Engineering and Director of the Commonwealth Graduate Engineering Program (CGEP), a position he held until his retirement in June of 1999. The CGEP is a statewide distance learning program. Dr. Haas transferred to the School of Engineering on July 1, 1994 from the College of Humanities and Sciences and thus became the second faculty member (after myself) of the new School. His PhD was earned at Princeton, and he has previously served on the faculties at the New Jersey Institute of Technology, at Stevens, and at the University of Illinois. We are properly proud of the industrial experience of our faculty. Dr. Haas is no exception, for he has 18 years of industrial experience with AT&T Bell Labs, with ICI Americas, and with the Philip Morris Research Center. Professionally, he is expert in polymer science and engineering. He has served as President of the Virginia Academy of Sciences as well as the Society of Plastics Engineers—a national professional society of over 35,000 members. He has been an evaluator for the Accreditation Board for Engineering and Technology (ABET) where he has also been a member of its Board of Directors since 1990. He has served as Chair of the Virginia Section of the American Society of Mechanical Engineers as well as the Richmond Joint Engineers Council. In his post as Associate Dean for Academic Affairs, Dr. Haas accepted or rejected all transfer students and saw that each person was enrolled in the appropriate courses, he scheduled all classes, both in terms of days and hours as well as classrooms. He was the student advisor of last resort.

Upon his retirement, some 150 friends and colleagues were sent formal invitations to a late afternoon reception on July 1, 1999 in the main lobby of the Engineering Building. Fortunately for the new School, Dr. Haas agreed to continue to assist the School as Adjunct Professor of Chemical Engineering where he teaches for-credit courses in his specialty of polymer science and engineering. He does this pro bono. He likes to teach.

Dr. Eric Sandgren: The position of Chair of Mechanical Engineering proved to be the most difficult to fill. There certainly was no shortage of applicants, but after several on-site interviews, no candidate had seemed right. Then along came Eric Sandgren, who had all of the desired attributes. In particular, he had had a successful industrial career where his responsibilities had been oriented toward design and creativity. We sought this industrial rapport, and we sought out-of-the-box creative thinking. He also had been a tenured professor at two major institutions.

Dr. Sandgren earned the PhD in mechanical engineering at Purdue and was then an engineer with IBM for four years. He returned to academia in 1981 as Assistant Professor of Mechanical and Aerospace Engineering at the University of Missouri-Columbia where he was promoted and tenured as Associate Professor. He then returned to Purdue as a tenured Associate Professor of Mechanical Engineering. He later returned to industry again where he was Director of Advanced Engineering for TRW Corporation in Detroit for seven years before coming to VCU as Professor and Chair of Mechanical Engineering in 1997. His prior experience with two major corporations as well as his experience with two major universities were excellent background for the challenges at VCU. The continued development of rapport and joint ventures with the industrial sector within the Greater Richmond Metro Area were critical for our new

School, for local industry was, after all, the main impetus for the creation of our new School. By both experience and interest, Dr. Sandgren was well-equipped to be a leader at this industry/ university interface. Another major goal of our new School from the outset was a renewed interest in design and creativity, or synthesis, to better balance the overwhelming devotion to analysis alone that is so typical of schools of engineering today. Dr. Sandgren's immediate prior experience at TRW Corporation represented an excellent match. His orientation toward synthesis was evident again in his leading the formation of the da Vinci Center as a joint venture of Mechanical Engineering and the highly regarded Sculpture Department at VCU (ranked number 1 in America). The idea of that venture is to meld the innate creativity of the artist into the education of engineers.

In July 2003, Dr Sandgren became Dean of the Howard R. Hughes College of Engineering at the University of Nevada in Las Vegas.

Dr. Gary Wnek: Dr. Wnek joined the VCU engineering faculty in September 1996 from his previous post as Head of the Department of Chemistry at the Renssalaer Polytechnic Institute in Troy, NY. He had earned the PhD in polymer science and engineering from the University of Massachusetts in Amherst following his BS in chemical engineering at Worchester. He had also served for 7 years on the faculty of the Department of Materials Science and Engineering at MIT where he had been promoted from Assistant to Associate Professor. His research interests include polymers with unusual electrical or optical properties where he has pursued basic research as well as applications in fuel cells and in several medical areas such as drug delivery and scaffolds for cell in-growth. His expertise in chemical engineering, in chemistry, in materials, and in applications in medicine all made him ideally suited as a leader in exactly these same interdisciplinary areas that would define the new School of Engineering at VCU.

While at MIT, Dr. Wnek held three named and funded Faculty Development Awards. He was the Union Carbide Lecturer at the 44th Frontiers in Chemistry Symposium at Case Western Reserve University in 1984. He was named "Inventor of the Year" in 1996 by the Eastern New York Intellectual Property Law Associates. He serves on the Board of Directors of two companies, he is on the Editorial Board of four scientific journals in the area of polymer science and engineering, and he has held leadership positions in several scientific societies. He is much in demand for seminars and presentations at universities and companies across America. He has co-edited four books, and he holds 11 patents.

Dr. Wnek provides a major link of the School to the medical and industrial sectors both locally as well as nation-wide.

In July 2004, Dr. Wnek became Joseph F. Toot, Jr. Professor of Engineering and Co-Director of the Institute for the Integration of Management and Engineering at Case Western Reserve University in Cleveland.

Dr. Robert Heinz: Dr. Heinz joined the faculty in 1998 as Associate Dean for Industrial Affairs, and Professor of Mechanical Engineering, and Professor of Management in the Business School. He received the PhD in electrical engineering from Carnegie Mellon University in 1971. Upon graduation, he joined Bell Labs in New Jersey to pursue research in fiber optics and optical data processing, and he subsequently held a series of positions in research and in management in the AT&T organization both in the U.S. and abroad. Before joining VCU, Dr. Heinz was responsible for the AT&T printed circuit board manufacturing plant in Richmond, which had over 2000 employees, and in 1994 he had also assumed leadership of AT&T's global backplane business unit.leadership of AT&T's global backplane business unit. He then, from long experience, well understood issues of engineering and manufacturing and management. These were, of course, major thrust areas of our new school. Dr. Heinz was then the ideal person for such a leadership role in the new school. He agreed to leave AT&T after almost 30 years to join the challenge of creating a new school of engineering.

Because of his many acquaintances with leaders in the local business community and because of his recognized expertise in engineering, in manufacturing, and in business since he had been there and done that, Dr. Heinz was a huge asset in building the local industrial rapport that would be a centerpiece of the new school. He was, by far, the strongest link between the VCU School of Engineering and manufacturing in the Richmond Metro Area.

Dr. Heinz was named the "Engineer of the Year" in 2004 by the Richmond Joint Engineers Council. The award was presented at a black-tie gala at the Jefferson Hotel during National Engineers Week.

In March 2001, Dr. Heinz became Dean of the School of Engineering and Manufacturing Technologies at J. Sargeant Reynolds Community College in Richmond.

Dr. Gerald Miller: Dr. Miller joined the faculty in August of 1996 as Professor and Head of the biomedical engineering program. BME at the MS and PhD levels predated authorization of the School of Engineering. Dr. Tom Haas wrote the first plan to offer the MS in BME which officially began on July 1, 1984 as a part of the School of Basic Health Sciences. Dr. Trani later dissolved this entire School, the remnants of which, including BME, were merged into the School of Medicine.The PhD in BME was authorized in 1994, and the first doctorate was awarded in 1996. Shortly after the School of Engineering was approved, Dr. Richard Freer, Chair of the BME Program, resigned to devote himself more fully to his highly successful company, Commonwealth Biotechnologies, Inc. We were fortunate to attract Dr. Miller to lead our program in BME from his previous post as head of Biomedical Engineering at Texas A&M University. Everything in Texas is big, and then, not surprisingly, the BME program at Texas A&M was the largest such program in America.

Dr. Miller wrote the proposal to SCHEV for approval to grant the BS in biomedical engineering. He also led that proposal through all of the intricacies of on-campus approval by the various relevant committees. That proposal was approved by SCHEV, and the first freshmen in BME enrolled in the Fall of 1998, two years behind the initial freshmen in chemical, electrical, and mechanical engineering.

Ms. Susan F. Younce: Ms. Younce joined the new School in May of 1996 in an administrative capacity as an Assistant Professor and Director of Administration and Finance. She received the B.A. from the University of Richmond and the MS from VCU. In 1998 her title was changed to Assistant Dean for Administration and Finance. Her duties included budget planning and implementation, salary administration, personnel and human resource issues, student accounting and scholarships, sponsored programs and grant administration, and more. Prior to joining the School of Engineering, she had served in various administrative capacities within the University for over 15 years. This prior knowledge of the bureaucracy of the University and its people was invaluable to the new School.

Dr. Robert Mattauch: Dr. Mattauch became Professor and Head of the electrical engineering program in July of 1995.

He was previously Head of the Electrical Engineering Department at the University of Virginia. His PhD was earned at NC State University in 1967, and his entire career since then has been in the Electrical Engineering Department at UVA, where he founded its Semiconductor Device Laboratory that yielded devices that became widely used in radio astronomy. His group also pioneered the development of devices to detect chlorine monoxide in the stratosphere, which was widely suspected of playing a role in the depletion of ozone. He has received a number of national awards from several professional societies. He has served as thesis advisor for 14 PhD students and 30 MS students, he has published over 100 technical papers, and he holds 5 patents.

Upon my retirement from the position of Founding Dean in July of 1999, Dr. Trani appointed Dr. Mattauch as Dean of Engineering.

Dr. Henry McGee: I had the distinct pleasure of leading this group as Founding Dean of our School. I earned the PhD in chemical engineering from Georgia Tech which was followed by a post-doctoral appointment in theoretical chemistry at the University of Wisconsin. My subsequent research on high energy rocket propellants at the Army Missile Command, at NASA, and as a faculty member at Georgia Tech sought propellants for use in space with energies at the limit of theoretical possibility. I was later on the faculty at Virginia Tech for 20 years including 10 years as Head of the Chemical Engineering Department. I served 3 years as a Division Director at NSF where I originated the first federally supported research program on environmentally conscious chemical manufacturing. This area, now much expanded, is called "Green Engineering." Dr. Paul Torgersen, President of Virginia Tech, had been working with Dr. Trani on the very early planning for a school of engineering at VCU. After recommending me to Dr. Trani, Dr. Torgersen urged me to seriously consider moving from Virginia Tech to VCU to lead this still embryonic effort. He said, "The appointment would give you the opportunity to become the "father" of a new school of engineering." I am forever indebted to both men for their confidence in me.

A recognition of which I am particularly proud is being inducted in 1994 (along with 73 others), as a charter member of Georgia Tech's Academy of Distinguished Engineering Alumni.

Camaraderie and rapport within any leadership group is essential for optimum progress, and this is particularly so for a group devoted to the fragile task of designing and implementing a new school. My wife and I hosted social gatherings of the Chairs and Deans and their spouses at our home at intervals of about three months.

These built understanding and enthusiasm, and they were also just plain fun for all. At one such event on Valentine's Day, my wife had quietly arranged for a barbershop quartet composed of members of the Richmond Chapter of the Society for the Preservation and Encouragement of Barbershop Quartet Singing in America (SPEBQSA) to appear during the evening. One of the quartet members was a good friend of hers. The four men appeared wearing tuxedos and bright sequined red vests and sang "I Love You Truly" and several other such songs, and gave each spouse a rose. This was all a complete surprise to the Chairs and Deans and their spouses. The quartet stayed for supper and sang a few more songs. The leadership team also held periodic working retreats away from the campus, the telephone, the computer, etc. to discuss critical issues. Even though from a standing start, these leaders became convinced that world-class programs could be created.

The Building

The trustees selected the southern half of the block bounded by Main, Belvidere, Cary, and Pine Streets as the site for construction of the new engineering building. Buildings on the northern half of this block housed several components of the School of the Arts and as noted earlier, Dr. Murray DePillars, Dean of the School of the Arts, and I had planned a physical connection between our buildings that would link engineering and art with bricks and mortar and which would symbolize the enhanced devotion to synthesis and creativity that was a founding principle of the School of Engineering. But before we could build, several parcels constituting that half-block had to be acquired and several small buildings had to be razed.

In clearing the land, there arose a long debate which involved stories and editorials in the ***Richmond Times Dispatch***, clips on the six o'clock news on TV, numerous letters, memos, and freedom-of-information requests for documents, and many hours of the time of the university's administrative officers. Arguments continued for several months. The so-called Jacob House, a small white, two-story frame house at 610 West Cary Street and said to date from circa 1818 became the focus of controversy. Never mind that the house had been boarded up, unused, windows broken out, birds flying in and out for years—somehow it became an historically significant structure when the university wanted to clear the land. The house was said by some to have played a role in the Underground Railroad before the War Between the States as a way-station for runaway slaves fleeing north. True or not, this story added to the controversy for Richmond, like few other places in America, is devoted to history. Yet the Historic Richmond Foundation, the Virginia Art and Architecture Review Board, and the Valentine Museum in Richmond all voiced no interest in the structure. Some argued that the university should construct its new engineering building to surround and thus preserve the Jacob House. The university had in fact acquired and continues to use many old homes on both sides of Franklin Street for two full blocks between Laurel Street and Harrison Street. These are mansions from 100 years ago. The offices of the President are located in one such home at 910 West Franklin Street. The offices of the Provost and Vice President for Academic Affairs are located at nearby 901 West Franklin Street in the Ginter House. Many of these homes have ornate paneled rooms with intricately carved moldings, and intricate fireplaces and mantels, and sweeping staircases, and stained glass windows. Of course, renovation and refurbishing was required, but these two-dozen or so houses are fine architectural assets to the university. The house at 610 Cary Street had none of these virtues. This totally non-descript property that had been trashed long ago and which had been long forgotten by everyone, suddenly became a cause celebre. There was a rather boisterous hearing before the Richmond City Council that was on TV. To resolve the matter, and with the approval of the trustees, Dr. Trani agreed to move the Jacob House across Cary Street and onto the southeast corner of Cary and Pine Streets at a cost to the Engineering Foundation of some $250,000. As a symbol of the supposed significance of the structure, several bricks from the Jacob House were recovered and inserted into the west wall of the new building during its construction. This was to have been accompanied by an adjacent explanatory plaque, but the whole matter was, of course, soon forgotten, and the plaque was never installed. It was all a great tempest to no useful end.

With this controversy in mind, beginning in September of 1995, all of the persons involved in issues concerning the building were encouraged to write on the letterhead of the Engineering Foundation, a private organization, to help avoid any potential delays due to requests under the Freedom of Information Act (FOIA). This advice was certainly not to conceal anything embarrassing, because nothing was ever done that could be so construed, but experience had taught us that great annoyances can occur for no good reason at all.

The trustees selected Faison, Inc. (now Trammel Crow) as the developer of the engineering facilities, and the Richmond office of the firm appointed Mr. David van Blaricom to be the local project manager. Mr. van Blaricom and I interviewed a half dozen candidate architectural firms, discussed our separate impressions, and with enthusiastic agreement selected Payette Associates of Boston, Massachusetts, as the winning firm. The entire process took three days. To qualify an architect for a state building can take three months or more. This is just one advantage, among many, of a privately owned development. Two Payette architects, Mr. Jim Collins and Mr. Arlen Li, developed the design over numerous design conferences both at VCU and at Virginia Tech.

The trustees decided to acquire the entire block rather than just the southern half-block as was originally planned. Owning the entire block would provide space for additional buildings that would surely be needed as the school grew and its research efforts expanded. The entire block would provide space for additional buildings that would surely be needed as the school grew and its research efforts expanded. The Engineering Foundation paid the School of the Arts for all expenses incurred in relocating its displaced facilities. The idea of Dean DePillars and I for a physical linkage between Art and Engineering then became moot.

A prominent and attention-attracting research program is essential if the new School of Engineering is to reach its goal of national visibility. The first building was designed to accommodate an undergraduate program in chemical, electrical, and mechanical engineering. There is minimum space for research. Notwithstanding this severe constraint, the early group of faculty has done well in garnering research grants and contracts and this very success has worsened the space problem. A detailed plan for an engineering research building, Phase II, was developed by the Chairs and Deans, and, because Phase II, like Phase I, would have to be constructed with private funds, this preliminary plan was communicated in a long memorandum that I sent to Mr. Peter Wyeth, Vice President for Development, in February of 1999. This planning document listed specific laboratories that were needed and related spaces that totaled a net assignable area of 76,000 sq. ft. With a reasonable assumption of a building efficiency of 57 percent, the plan prescribed a new research building of some 135,000 gross sq. ft. which would likely cost about $30 million. An alternate and much more ambitious plan for expansion, called the Monroe Campus, has evolved more recently. An outline of that plan appears in the Epilogue.

The building has four floors.

Level One has a very large lobby that facilitates special events, four classrooms, a computer center for students, and a large high-bay area primarily for use in the chemical engineering program. During the design process, this latter area was euphemistically referred to as the "skunkworks." The main lobby is a very elegant room, completely paneled, and it even has a fireplace with a beautiful mantel and gas logs. From the original planning of the School, student-faculty rapport and conversation outside of the classroom or laboratory situation was deemed to be very appropriate and helpful to the educational enterprise. The large gathering area was designed to allow morning coffee for all students and faculty. This idea was stimulated by the Darden Business School at UVA where such morning coffees are longstanding. The portrait of the Founding Trustees also hangs in this main lobby. The main lobby also opens out onto a large patio. In addition to two "regular classrooms" seating 40, and in keeping with the guiding philosophy of the new School of identifying new and promising avenues in both research and teaching, the design of the new building included two additional classrooms the design of which was very unusual, or perhaps even unique, in engineering education. In these 50-seat classrooms on Level One the students sit behind long semicircular desks that are on three tiered levels. The idea is to stimulate and allow effective Socratic teaching. Here the instructor poses some relevant question to a specific student. The instructor stimulates critique of the student's response by another student. The idea is to stimulate debate and discussion of the class assignment both among students and with the instructor joining in where appropriate to ensure that the conversation is relevant. The semicircular design allows the students to look at each other in those debates or conversations.

In the usual engineering classroom, the all-knowing professor stands at the board and pours forth his or her wisdom, while the students sit quietly at their seats taking notes. Frequently scarcely a word is passed between them. Though Socratic teaching is little known in engineering education, it is commonplace in business schools and law schools. These unusual classrooms were direct copies of classrooms at the Darden School of Business at UVA. I had visited Darden to observe two classes throughout the class period, and in one of these I had been unexpectedly called upon by the instructor to come to the front of the room and speak extemporaneously about the prominent role of business in engineering education at the new School at VCU.

Level One also has a 200-seat auditorium with state-of-the-art audio and video facilities and a computer laboratory with 72 stations for use by students. All of the expected software packages in use in engineering were installed. A networked computer classroom of 22 student stations, an instructor's station, and color screen projection system was used to teach this common software and much more.

Level Two contains a completely paneled generous lobby for the main entrance to the building from Main Street, a small conference room, the offices of the Chair of the electrical engineering program, and the offices and laboratories of that program.

Level Three contains the dean's suite of offices, a 40-seat classroom, a small conference room, the offices of the Chair of mechanical engineering, and primarily the offices and laboratories of that program.

Level Four contains the offices of the Chair of chemical engineering, the elegant Hunton & Williams Library with its adjoining Board Room, a 40-seat classroom, a small conference room, and the offices and laboratories of the chemical engineering program. The Board Room is completely paneled, and it has a long conference table with seating for 16. My goal of mixing the three faculty groups as a sort of structural inducement for interdisciplinary conversation was thwarted by the necessity to place the chemical engineering laboratories on the top floor to minimize the stack heights of the many fume hoods required by that program.

The School is particularly indebted to the 40 individual and corporate donors who were able to contribute to the endowment for the building at levels which warranted special and permanent recognition. These 40 contributions were well-supplemented by 48 additional gifts. We are grateful to them all. The School would not exist except for their generosity. Plaques with the name of the donor were placed in each space wherein the size or special quality of that space had been correlated with the size of the gift. For example, a faculty office was plaqued to recognize a somewhat smaller gift while a classroom was plaqued to recognize a somewhat larger gift. These very special gifts, spaces, and donors are listed in the following compilation.

	Plaqued Space	Donor
Overall	None (by request)	Mr. and Ms. William Goodwin
	None (by request)	Mr. and Ms. Bruce Gottwald
	Lower Courtyard	Mary Morton Parsons Foundation
	Level 1	Motorola
	Level 2	Chesterfield County
	Level 3	Henrico County
	Pavilion	Claiborne Robins
Level 1	Auditorium	Ethyl Corporation
	Main Lobby	Hanover County
	Computer Lab	First Union Corporation
	Case method classroom	Crestar Bank
	Classroom	Bell Atlantic Corporation
	Classroom	Carpenter Company
Level 2	Upper Lobby	Fort James Corporation
	Teaching Lab	Goochland County
	Teaching Lab	Chesapeake Corporation
	Classroom	Nations Bank
	Study Area	City of Richmond
	Research Lab	Siebe Appliances
	Research Lab	Mark & Anne Sternheimer
	Research Lab	Joseph Farrell
	Research Lab	Stanley Pauley
	Faculty Office	Beirne Carter Foundation
	Faculty Office	First Virginia Bank
	Faculty Office	Davenport & Co.
	Faculty Office	Robert Freeman
	Faculty Office	Richard Tilgham
	Faculty Office	Tredegar Corporation
	Faculty Office	William Berry
	Faculty Office	J. Carter Fox
	Faculty Office	Albemarle Corporation
Level 3	Dean's Suite	Ukrop's Super Markets
	Research Lab	Wachovia
	Research Lab	Richard Holder
	Research Lab	Reynolds Metals

	Conference Room	Scott & Stringfellow
	Chair's Suite	Brenco
Level 4	Boardroom	Hays Watkins
	Library	Hunton & Williams
	Chair's Suite	Allied Signal
	Conference Room	Infilco Degremont

The Dean's Suite of offices is plaqued to Ukrops Super Markets. During the black-tie dinner party celebrating the completion of the building, I showed Mr. Jim Ukrop and his wife this suite of offices and its plaque. Upon entering the Dean's office, Mr. Ukrop remarked that the office was more attractive than his own, I said, "Gee, Jim, thanks for your gift," and we both enjoyed the moment. The very elegant library on the fourth level is plaqued to recognize the law firm of Hunton & Williams. The library has not, in fact, ever been used as a library. Rather it was used for receptions, cocktail parties, and the like.

The building has an "L" shaped footprint with the angle at the corner of Belvidere and Main Streets.It has a distinctive appearance, and as such, it forms an excellent marker or gateway to the southeastern corner of the Academic Campus on Main Street. Ground was broken on November 13, 1996 in a ceremony at the site led by Dr. Trani and Mr. Robert Galvin, the long-time CEO of the Motorola Corporation and member of the Board of Directors of that company. All of the about 100 first freshman who had begun their studies the preceding August gathered around. Mr. Galvin was at VCU as the Thalhimer Distinguished Visiting Professor in the School of Business. One of the ceremonial shovels used in the groundbreaking was placed in the showcase near the offices of the Dean. The building has 147,000 gross square feet of floor space, but with purposefully designed many open or public spaces, the efficiency of the building is low. Attached to this structure is the Virginia Microelectronics Center (VMC) built with an $11 million state appropriation that was facilitated by Governor George Allen. The VMC has 7500 square feet of certified Class 1000 (but operating at essentially Class 100 due to good housekeeping) clean room space on two floors. The total cost of both buildings was $43 million.

Like most major construction projects, the contractor first digs a huge hole in the ground. This early phase is evident in the photograph from March 1997.[8] The left-to-right and east-to-west street in the foreground is Main Street. The cross-street is Belvidere Street. The darker house with white trim on the

corner and in the upper center of the photograph is the Jacob House facing Cary Street after having been moved from its original location. Classes were taught in the building for the first time beginning with the Fall semester in 1998.

Another advantage of being a privately financed structure that was well appreciated by all faculty was the generous size of faculty offices.

After the interior designs and footprint had become reasonably fixed, the Trustees staged a design competition for the exterior "look" of the building. Proposals were due in October of 1995. Some trustees favored a more classic look. But in the end a more modern look with largely glass walls was agreed to by the trustees. The firm of TBA^2 of Charlotte, North Carolina was selected to design the exterior look of the building.

Students will, of course, behave as students. For use during construction, a large and high crane was erected to handle all of the heavy lifting (see the earlier photograph). On one occasion a large collection of beer cans were found atop the crane when the workmen arrived that morning. The next day there was a high fence around the crane.

The Richmond Real Estate Group presented a trophy inscribed, "to recognize the singular outstanding contribution to commercial real estate in the Richmond Metropolitan Area for 1998," at an early evening reception at the Commonwealth Club. This trophy was placed in the display case near the office of the Dean.

Many groups are given permission on an individual case-by-case basis to use the engineering building for meetings both during regular business hours and in the evenings. Most of these are engineering related, but certainly not all.

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[8] Photo courtesy of the *Commonwealth Times*, September 3, 1997. Used with permission.

Local chapters of professional societies, lectures by Nobel Laureates, state-sponsored workshops, and much more occur regularly. The surroundings are elegant and pleasant and then highly attractive.

Virginia Microelectronics Center

A defining goal of the School was that of attracting new high-tech industry to the metro area. So there was high excitement surrounding conversations with Motorola. Their site selection team stated that Richmond would not be a candidate site at all unless there were local opportunities for engineering education. That is, an engineering school was a necessary, but of course, not a sufficient condition for locating their new facility. The company sought the same sort of synergy that was so evident at their operations in Austin, Texas with its many linkages to the nearby fine engineering school at the University of Texas. As is often the case in such matters, it was necessary that the early negotiations and the name of the company be kept confidential. The negotiations were code-named "Project Redwood". Understandably, it was front-page headline news some weeks later when it was first publicly announced that Motorola would be constructing their new $3 billion research and manufacturing facilities in nearby Goochland County perhaps 10 miles from the VCU campus. The site, part of a new industrial park called West Creek, had been selected over many competing possibilities one of which was the well-known Research Triangle Park in North Carolina. At a subsequent reception and ceremonies at the site, Motorola officials presented Governor Allen with an eight-foot tall potted redwood tree to a background of cheers from all of the more than 100 attendees. An indication of the role played by VCU Engineering, as well as its expected role in the future, is perhaps revealed by the company giving the School $6.5 million in cash and equipment.

The worldwide microchip business became rather soft some months later, and, after several disappointing years, the company had to abandon the Richmond site. However, soon after the original announcement by Motorola, the company joined with the German firm of Siemens to build a huge microchip manufacturing plant, WhiteOak Semiconductor, in eastern Henrico County. Again, the nearby presence of the School of Engineering played an essential role in the decision by the companies. A number of our engineering students accomplish their required internships at White Oak (now Infineon) each year, and several have been awarded permanent employment by the company.

To encourage the growing microelectronics industry in Virginia, then Governor George Allen facilitated the issuance of $11 million in bonds by the Virginia College Building Authority to finance the construction of the Virginia Microelectronics Center (VMC) as part of the new engineering school at VCU. The VMC also receives an annual appropriation from the state of $0.75 million to cover, in part, its operating costs. The quality and size of the VMC is very rarely matched anywhere in the country. Motorola loaned the School one of its top engineers, Mr. Robert Morgan, for a year at his full Motorola salary followed by a second year with half salary from the company and half from VCU. Mr. Morgan, an excellent teacher, worked full-time to help get the undergraduate teaching facilities of the VMC up and running.

Research and manufacturing space for the microelectronics industry must be unusually clean. The air in the VMC laboratories is continuously filtered so as to contain less than 100 particles per cubic foot of 0.5 micron or greater in size. In standard industrial terminology this is referred to as a Class 100 cleanroom. Some sense of the tiny size of particles that must be filtered from ambient air is clear upon realizing that a human hair is some 40 microns in diameter.

The first floor of the VMC is a 5000 sq. ft. teaching laboratory that houses examples of all of the major tools used in manufacturing, many of which were part of that major gift from Motorola. Interestingly in microelectronics, specific steps such as chemical vapor deposition or photolithography are called "tools". Equivalent steps in the manufacture of chemicals are called "unit operations".

To maintain the required level of cleanliness, students must first pass through an anteroom where they don bunny suits, booties, masks, hoods, and gloves. The third floor labs are devoted to research, and they too are well-equipped with sophisticated machinery, such as molecular beam epitaxy and much more. The second and fourth floors are equipment spaces for air filtration.

As a side note, the legal experts had fun with the idea of building a state funded structure on privately owned land and contiguous to and adjoining a privately owned building.

In addition to microelectronics, the School regularly joins with the Greater Richmond Partnership in efforts to attract companies in a variety of industries. I regularly participated in industrial liaison meetings arranged by local political entities to encourage networking among metro area companies.

I, along with other faculty, are also regular participants in meetings of the Greater Richmond Technology Council which is composed of high tech entrepreneurs, venture capitalists, and related people. I served on the Board of Directors of the GRTC whose growth parallels the growth of high-tech business in the metro area. I was also honored by being the recipient of the GRTC Leadership Award at their annual black-tie Spring Gala in 2002.

Dedication

There were two events to formally open and dedicate the new building. The first of these was a black-tie reception and dinner party for the trustees, faculty, university officials, and distinguished guests on November 10, 1998. The reception occurred in the first floor gathering area. There were special presentations and remarks by Dr. Trani, by Mr. Goodwin, and by me. The portrait of the Founding Trustees was unveiled. There followed a call to dinner – a very elegant dinner – with sit-down service at tables that had been set up in the large third and fourth floor classrooms and in the fourth floor library. Guests were pre-assigned to their tables to appropriately mix trustees, donors, university officials, and faculty. There were large vases of roses everywhere – on each dinner table and in the ladies restrooms. There were so many roses that their aroma unmistakably filled all of the dining areas. The next morning, there was a formal dedication ceremony led by Dr. Trani. There is a bronze plaque marking the occasion mounted in the main entranceway of the building from Main Street.

Finances

The arrangements for financing the building were at the same time, unusual and very effective. The raising of funds from private sources totaled over $38 million as of June 1999. It is appropriate to list here those donors of $1.0 million or more. Without these individuals and organizations, the School could never have become a reality.

Mr. and Ms. William Goodwin
Mr. and Ms. Bruce Gottwald
The Mary Morton Parsons Foundation
Ethyl Corporation
Chesterfield County Board of Supervisors
Henrico County Board of Supervisors
Motorola Corporation

These very special donors were permanently recognized with individual nameplates in the second floor main lobby of the building. These large donors were, of course, awarded the most notable and visible plaquing of specific places or areas. For example, the courtyard is denoted the "Mary Morton Parsons Courtyard" and these words are engraved into the granite façade overlooking the courtyard. Curiously after this engraving in about 12-inch letters was complete, workmen installed a drainpipe from the roof directly across the writing. The pipe was, of course, quickly removed and relocated.

The persons whose gift was the catalyst that made everything that is described in this book possible were Bill and Alice Goodwin. By all rights, the entire school should be named the "Goodwin School of Engineering". In his unassuming manner, Mr. Goodwin has to date refused this designation. The faculty and administration of the school continue to hope that this long overdue designation will yet come to pass.

The University and the Foundation developed an unusual structure to finance the facility using tax-exempt bonds issued by the University, but with debt service paid with funds provided by the Foundation.[9] The Foundation concentrated its initial fundraising in obtaining gifts to build an unrestricted endowment. The success of these efforts permitted the University's Board of Visitors to approve tax exempt bonds for the project secured by the University's highly rated "general revenue pledge" credit. This permitted the issuance and sale of $26,850,000 of bonds to finance initial construction and related costs. The bonds were rated A1 by Moody's and AA- by Standard & Poor's and were sold in a public offering with interest rates ranging from 4.6% to 5.87%.

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[9] Mr. Dean Pope, an attorney with the law firm of Hunton & Williams in Richmond, kindly provided this description of the financing arrangements.

While the University is legally obligated to make payments on the bonds, the Foundation effectively pays all of this debt service under a Project Development and Financing Agreement with the University. This agreement also contains financial covenants designed to ensure that the Foundation will always be able to honor its commitment to service this debt from income from the endowment which was invested at market rates. This approach and the special state legislation authorizing it permitted the Foundation rather than the University to own the engineering building. The Foundation contracted for construction, not the state. A committee of trustees oversees the investment of the endowment.

Endowment

Notwithstanding the need and the importance of a school of engineering to the goal of economic growth in the Richmond metro area and beyond, the Commonwealth was unwilling to construct yet another school since there were already five schools of engineering at state-supported campuses across the Commonwealth. It was then essential that the cost of the physical facility to house the new School of Engineering be borne from private funds. The consultants' report in 1993 had also recommended this tactic. And SCHEV had conditioned its approval of our proposal to create the school on our first raising $17 million in private funds. The local business community was the impetus for creating the School in the first place, and initial funding in large part from this community was viewed as tangible proof of their commitment. Such corporate concern does not go unnoticed. In 1997, Fortune magazine listed Richmond as one of the top ten cities in America for business. Within the broad rationale for such recognition, the article in Fortune noted that the new school of engineering was created from a corporate-led campaign. The school had enrolled its second freshmen class in 1997.

The very successful fund raising effort was led by President Trani and by Mr. Peter Wyeth, Vice President for Advancement. Other schools with whom we must compete have not been sitting on their hands. For example, Georgia Tech finished a capital campaign in 2001 that raised over $700 million. Similarly, UVA raised $1 billion. Rensselaer Polytechnic Institute announced in 2001 a $360 million unrestricted gift from an anonymous donor. To be sure, money alone will not make a school, whether old or new, into a world-class place. Financial backing is, however, a necessary, albeit not sufficient, requirement to attain world-class status.

The firm of Ross, Johnston and Kersting in Durham, NC was engaged by the Planning Team in July of 1993 to study the prospects of raising $20 million. This firm had a long history of similarly assisting fund-raising drives by other universities and organizations across the country. They reported that such a sum would be a stretch for VCU. Mr. Wyeth and his associates accomplished almost a doubling of this earlier prediction of "experts". The Founding Trustees were extraordinarily generous, and they deserve great praise for getting behind the project so enthusiastically. It was their leadership and their gifts that stimulated the positive response of the broader community. Each trustee was a personal donor, and several facilitated corporate gifts from their companies as well.

One of the most successful events to both thank donors as well as to entice potential new donors as well as to attract new students was a barbeque. The event featured a large display of antique automobiles that was arranged by a friend of mine who is a collector of antique automobiles. The event, advertised as a "Car-B-Que," was held at Strawberry Hill in March of 1998 with about 200 people in attendance. Several collectors displayed some two dozen classic cars, and there was plenty of good food and live music. Governor George Allen, who had just finished his term in Office, attended the event. Governor

Allen, Dr. Trani, and I spoke briefly.

Formal events such as this not withstanding, and while appropriate and helpful, donations really were the result of rapport-building and one-on-one conversations over a long period of time. Individuals and companies with both technical and non-technical leanings were solicited, for the imprimatur of the project was economic development and not merely science and engineering. Sub-goals for each sector of the local economy were set which together would yield the overall goal of $40 million. For example, a sub-goal of $3 million was set for the local governmental entities. Henrico County contributed $1.0 million to the permanent endowment of the School, and well beyond that, the County also established a scholarship program in engineering that could represent an additional outlay of some $80,000 annually when the program became fully implemented. The tax base and jobs for county residents would be enhanced by the economic development that would be stimulated by the presence of a local school of engineering. Similarly a sub-goal of $3 million was set for the banks in the area. And again, the largest bank was solicited first. Individual and corporate potential donors were identified. The size of all requests was determined from whatever information that was available on sales volume of the company or Dunn and Bradstreet or whatever other available source. Requests for major gifts were also correlated with requests for appropriate individuals to become trustees of the Engineering Foundation.

This full goal of $40 million was not realized. After the building is opened and the students are in place, it is more difficult to raise additional money, for prospective donors see that the building is already up and running. With the benefit of 20/20 hindsight, the completion of the campaign at its full goal and the opening of the building should have been more nearly coincident.

In addition to unrestricted gifts to support the construction of the engineering school's first building, there were also a number of restricted gifts for the support of professorships or scholarships or for other special purposes.

Operating Costs

Although the building that houses the School of Engineering is privately owned, all operating costs must be covered otherwise. The annual appropriation from the state for operations is essential of course, but it is far from sufficient to cover all costs. This is no denigration of the state of Virginia, for all engineering programs at state supported universities across America make this very same assertion. Engineering is just an extraordinarily expensive program. The first appropriation of operating funds was for $547,000 in FY96. Appropriations plus permanent reallocations within the university totaled $5.2 million by FY00 which, with tuition of $1.8 million, made for an operating instructional budget of $7.0 million for that fiscal year. The budget for FY00 that had been projected in the original proposal to SCHEV was $6.8 million. Added to this, the faculty received research grants in FY00 totaling $3.4 million and much of this supports the undergraduate instructional program as well as graduate research.

From the beginning of the School, President Trani had a policy of returning to the School all of its income from tuition to be used in the normal operations of the School. This policy placed an incentive on attracting as many students as possible, and, more specifically, as many out-of-state students as possible, who, of course, pay a much higher tuition. This direct feed-through of tuition dollars is rare at VCU, and the School of Engineering is again indebted to President Trani for this critical financial assistance. The proposal to SCHEV to authorize the establishment of the School included projected income from tuition, which of course, was immediately calculatable from a student enrollment model which involved assumptions of enrollment, attrition, and progression rates as well as the percentage of out-of-state students.

The tuition return policy also influenced my decision regarding tuition for the SOE. President Trani and SCHEV had given the School the freedom to set its tuition higher than that for admission to other units of VCU after approval of the figure by the upper administration. Tuition for the first year, i.e., 1996-97, was set at $3700 for in-state and $10,728 for out-of-state students, making tuition and mandatory fees $4605 and $11,633 respectively. Regular tuition across VCU for in-state students was $3125, so the School was allowed an 18 percent increase in income from in-state students. This initial tuition was part way between that at Virginia Tech and that at UVA.

Another important source of operating funds for the school is the Higher Education Equipment Trust Fund (HEETF) that is operated by the Commonwealth for the benefit of all of the state's universities. The annual allocation to each university under this program is determined by the state using a formula that reflects such things as enrollment in laboratory courses, existing capital investment in equipment, and the like. These funds are then divided and assigned to each academic or research unit by the President of that university using a formula argument not too unlike that used by the state. With initially very small classes, this formula would have allocated little funds to engineering. Nevertheless, Dr. Trani arranged for the very substantial allocations to engineering shown here:

Year	VCU Allocation	SOE Allocation
FY 96	1, 900, 000	$ 450, 000
FY 97	4, 200, 000	$ 450, 000
FY 98	4, 200, 000	$ 320, 000
FY 99	4, 200, 000	$ 350, 000
FY 00	6, 000, 000	$ 350, 000
FY 01	6, 000, 000	$ 350, 000

This was another indication to the donors of private funds to the new School that the university administration was firmly committed to the enterprise.

Finally, and from the point of view of flexibility, the most valuable money in any category is unrestricted private gifts. During the years that Dr. Tom Haas managed the Commonwealth Graduate Engineering Program, a number of companies gave him small grants for general support of that activity. Dr. Haas had accumulated some $200,000. These funds were extraordinarily useful in the early years of the school for needs that restricted funds or state allocated funds would not allow, including, for example, honoraria for visiting speakers, receptions, reimbursement for travel or meal claims that exceeded state authorized limits, and so on.

These several sources of income for operations must cover a wide variety of expenditures. It includes travel of faculty to professional conferences and to visit prospective sponsors of research, it includes the cost of telephones and fax, it includes postage, it includes office supplies, it includes clerical support, and much more. But the largest operating expense by far are faculty salaries.

Named Professorships

One of the most prized appointments for any faculty member is that of holding a named professorship. This designation is given to only the most outstanding faculty. The ability to award a named professorship is a huge benefit in efforts to attract an outstanding individual from a company, a government laboratory, or from another university. The School of Engineering at VCU had three endowed professorships as of late 2001 named, of course, for the donor:

Louis S. Harris Professorship in Biomedical Engineering: Dr.Lou Harris is a professor in the Department of Pharmaco-

-logy and Toxicology, he earned his PhD at Harvard, and he himself holds the Harvey Haag Professorship at the VCU Medical Center.

Inez Caudell Professorship in Bioengineering: Ms. Inez Caudell established the professorship in her will. Mr. Tony Smith of Wachovia Securities in Richmond was appointed by Ms. Caudell to have fiduciary responsibility for this endowment.

VMEC Professorship: The schools of engineering across the state developed the Virginia Microelectronics Center as a cooperative venture to support that industry. The Commonwealth of Virginia established a Professorship in Microelectronics at each of the five participating universities.

Founders Professor: The title is an honorific designation, but unlike an endowed professorship, it carries no financial backing.

Commonwealth Professor: The title is an honorific designation, but unlike an endowed professorship, it carries no financial backing.

Scholarships

Perhaps the most compelling factor in attracting outstanding students is the availability of scholarship assistance.

- The university offers scholarship assistance for its most outstanding freshman applicants. These are financed at three levels. The Presidential Scholarships pay tuition, fees, and room and board. The Provost Scholarships pay tuition and fees, and the Deans Scholarships pay one-half of tuition and fees.

- Mr. William Goodwin, Chairman of the Board of Trustees, recognized the difficulty of attracting outstanding students to a new school and the prominent role of scholarship assistance in overcoming this hurdle, and he kindly provided a scholarship fund initially in the amount of $400,000 that was used at my discretion to attract outstanding students. I used these funds to both make additional awards as well as to enhance university awards to the next level. Such enhancement was usually from the Dean's level to the Provost's level

- Mr. and Mrs. Rudy Bunzl of Richmond endowed an Entrepreneurial Scholarship. Mr. Bunzl, a chemical engineer and CEO (retired) of American Filtrona, has himself been a very successful entrepreneur. Entrepreneurship was one of the founding goals of the VCU School of Engineering.

- The Reynolds Metal Corporation, headquartered in Richmond at the time, awarded six scholarships to cover in-state tuition and fees for dependents of employees of the corporation. There was no specification as to the preferred academic majors of these recipients, but with engineering expected to attract a disproportionate share of top freshmen, the School anticipated receiving a similarly disproportionate share of these scholarships.

- The Henrico County Economic Development Authority established a scholarship program to assist one top student from each of the nine high schools in the county to enroll in engineering at VCU. The scholarship covers half of tuition and fees which is matched by VCU to thereby bring the scholarships to the Provost's level. When fully operational, this is a commitment of over $80,000 per year. By the Fall of 2001, 19 students from Henrico County had received this scholarship.

- Still another scholarship that arose from a tragedy was that named in honor of Jamie Knight. Jamie had enrolled in the School and was working at the Friendly's restaurant on

Patterson Avenue. In a late night robbery, Jamie was shot and killed. His family and friends were joined by the restaurant in establishing an endowment to create a permanent scholarship in his memory.

- One of our Founding Trustees, Mr. Wolfgang Schubl, was President of the North American Operations of Weidmuller, GmbH, which was headquartered in Richmond. He established a German/American student exchange program. Mr. Schubl provided a restricted endowment to support the program, and the company at its plant in Germany, together with the nearby Fachhochschule in Bielefeld, provided educational and industrial experience for the visiting American students. In the first exchange, two students from Bielefeld, joined the VCU School of Engineering for the Fall semester of 1999. The financial arrangements of the exchange program required that the German guests work as TAs in mechanical engineering. They took courses in ME as well. The first American participant was a rising senior in mechanical engineering who worked for Weidmuller at their world headquarters in Detmold, Germany during the summer of 1999. This experience served as his required industrial internship.

- One of the major thrusts of the new School is an emphasis on business. Philip Morris provides scholarships each year to defray additional expenses incurred in earning a minor in business to supplement one's major in engineering.

- Another major thrust of the School of Engineering was an enhanced emphasis upon synthesis or creativity to better balance the current overwhelming devotion to analysis alone. The President of EDC Corporation of Richmond has funded a scholarship in engineering with the intent of a closer blending of engineering with components of the nationally highly regarded School of the Arts at VCU. The essence of all artistic enterprises is creativity. The first recipient of this scholarship was a double major in mechanical engineering and sculpture. This student subsequently received a coveted and highly competitive NSF Predoctoral Fellowship to pursue her Ph.D. at any university in America. She chose the University of California at Berkeley.

- Ms. Susan Younce, Associate Dean for Financial Affairs, established a merit scholarship in memory of her father, Mr. Gray Younce.

- Dr. and Mrs. Robert Mattauch established a merit scholarship.

- Professor Gary Huvard is a highly admired and favorite professor of many students in chemical engineering. The graduating senior class in May of 2001 created the Gary S. Huvard Scholarship in Chemical Engineering. The students announced this scholarship, to the complete surprise of Professor Huvard, during ceremonies as part of the Annual Student-Faculty Banquet in Chemical Engineering held each year at a local country club. The following senior class in May of 2002 added to the Huvard Scholarship Fund.

  Hopefully additional scholarships will be funded as the school grows in reputation.

Special Purpose Fund

My wife and I established the Betty Rose and Henry McGee Restricted Fund for Chemical Engineering. I wanted to provide some measure of financial flexibility for special purposes as the need arose.

CHAPTER 4 : SCHOOL OPENS

All students who elect to join a brand new and untried program are making a huge leap of faith. This was particularly true for the first class, i.e., the class of 2000, for when they began in the Fall of 1996, there was no faculty to speak of, no building, no laboratories, no equipment...mostly promises and a huge amount of enthusiasm and excitement.

Recognizing the developed world of highly technological societies and recognizing the plethora of high paying jobs in technological fields, it is unfortunate that each year less than 10 percent of American high school seniors voice interest in engineering as a career. The number of bachelor's degrees awarded in engineering by American universities has continued to decline. America has so few qualified people and so many needs that outstanding and aspiring engineering students from around the world are imported each year.

Matters of public policy in today's world frequently have technological overtones, and in a democracy, the wise resolution of such policy matters depends upon a citizenry with at least a modicum of understanding of science and technology. Every citizen needs this modicum. Energy policy, global warming, fuel efficiency standards for cars, genetically enhanced foods, and much more demand that modicum if one is to be an informed voter and not subject to manipulation by clever politicians.

Recruiting

Dean Haas and I developed the admissions criteria for the School of Engineering. Decisions on all applications were made by designated engineering faculty who sought quality students who they judged as having a good chance of completing a rigorous engineering curriculum. Criteria for admission were roughly comparable to those at Virginia Tech and UVA. There was also attention to the whole person. For example, one applicant to the first class presented mediocre academic credentials, but in the interview he displayed a special hunger and ambition. Four years later, Robert Snodgrass graduated first in his class with a perfect GPA of 4.0. Based upon credentials alone Robert would have been denied admission. After graduation he enrolled in the PhD program in mechanical engineering at Georgia Tech.

Attracting outstanding students is a challenge for all schools of engineering. It was particularly challenging for us, for we, of course, had no reputation to sell. Many things were done.

The school held a series of receptions around the state that were designed as information sessions.

The Richmond Joint Engineers Council (RJEC) and the Science Museum of Virginia sponsors "Careers in Engineering" at the Science Museum during National Engineers Week each February. The ***Richmond Times Dispatch*** published a Sunday Supplement on Engineering, and the engineering schools around the state contribute ads and feature articles. This full-color tabloid was included in the Sunday paper of Engineering Week and thus it had a total circulation of about 300,000. Our school bought the full-color, full-page back cover of this tabloid for three years. The ad contained positive comments about the school directed toward prospective students and their parents. One ad also contained an endorsement signed by all of the trustees including their positions. Those dozens of signatures of CEOs and/or Presidents of many of the major corporations in Virginia had to very positively impress prospective students and their parents.

An effective and subtle recruiting technique is for a faculty to give a guest lecture in a high school science or math class or to talk at a high school science club meeting. There was much of this.

In the same subtle vein, I regularly attended the brown bag luncheon seminars of the VCU Honors Program led by Dr. John Berglund of the Math Department and Director of the VCU Honors Program. Perhaps such rapport building will lead to transfers or feedback to other outstanding students that will ultimately lead to the enrollment of qualified students in engineering.

Another source of students would be transfers from other institutions. A particularly good source would be graduates of either of two local community colleges – J. Sargeant Reynolds or John Tyler. I made a number of visits to both schools to establish that rapport. Dr. S. A. "Bud" Burnett, President of J. Sargeant Reynolds, kindly provided a list of all of their graduates in Engineering Technology and their addresses over the past half-dozen years who had finished with a GPA of 3.0 or better. Dr. Burnett's PhD degree is in chemical engineering from Virginia Tech, and this was yet another subtle linkage that was helpful, for he well understood the nature of engineering education.

So-called 3-2 programs with nearby Virginia Union University, Virginia State University, and the University of Richmond are also very sensible sources of qualified upper division students for the new School of Engineering. Meetings with the provosts from these schools were followed up with campus visits to work with the appropriate officials to develop written agreements and to prepare for the smooth transfer of their students into the engineering curricula at VCU.

Still another potential source of good students was the freshman engineering course in mechanics that was developed and taught by Dr. Sandgren and Dr. Heinz in mechanical engineering at a local high school in cooperation with the Henrico County School System. The course carried university credit. This linkage between the Engineering School and the Henrico County System was a fine example of outreach by the School. It also had an unwritten agenda of attracting outstanding students. This did not always work to VCU's advantage, for many of these students transferred their semester credit in mechanics and enrolled at other schools.

As both a highly successful chemical engineer and chemist, Dr. Gary Wnek, Chair of Chemical Engineering, has pursued a transfer program with the Chemistry Department at the nearby University of Richmond. This university has a history of attracting truly outstanding students from across the entire country with 84 percent of its students from outside of Virginia. The University of Richmond has been consistently ranked by U.S. News as the number one regional university in the Southeast. Eighty percent of its freshmen are ranked in the top 20 percent of their high school classes, and most are from states north of Virginia.

Although it became a factor only after the School was created, another fine source of students is the annual FIRST[10] robotics competition. VCU hosts one of the 24 regional events prior to the national finals at Disney World in Orlando, FL. Teams of high school students build and operate remotely controlled robots of their own original design that must perform an assigned task in an aggressively competitive and exciting environment. In 2003, sixty-one teams of high school students from ten states and D.C. participated in the regional

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[10] FIRST stands for "For Inspiration and Recognition in Science and Technology". This activity is the brainchild of Mr. Dean Kamen, an extraordinarily successful inventor and entrepreneur.

event at VCU. The School of Engineering also hosted a reception in its facilities for all participants. By the Fall of 2002, the School had enrolled 50 students who had been FIRST participants.

In a similar vein, the School takes advantage of its exposure as a result of VCU periodically hosting the Odyssey of the Mind Program. These events for sixth through twelfth graders bring 3500 to 4000 students and parents to the campus.

Another activity that was both community service as well as being a subtle, if indirect, ploy for recruiting students was my long-term service on the Board of Directors of the Mathematics & Science Center that serves to enrich K-12 education throughout the metro area. It is during these years that life-long interests in science and math may be stimulated by great teachers. Service on the Board allowed direct and familiar contact with the Superintendent of each of the seven metro area school systems who also serve on the Board.

The School of Medicine had very successfully offered a so-called Mini-Medical School for some years. This attracted students, teachers, parents, and many interested citizens to come and listen to physicians give an early evening lecture on, for example, prostate cancer, in language understandable by the lay person. With this background of success, Ms. Sue Ann Messmer, Vice Provost for University Outreach and I decided to offer a "Mini-Engineering School" with the same sort of guiding philosophy. This was offered each Wednesday evening beginning in May of 1994 and extending for six weeks. Presentations occurred at the Ethyl Theatre of the Science Museum, followed by light refreshments. The Ethyl Theatre seats 300, and it was sold out within 10 days of public announcement of the event, and there was a waiting list of some 60 additional persons. The presentations and speakers were designed to be attention-attracting and provocative with titles like "Pharming: Transgenic Animals and Barnyard Engineering" or "Environmental Issues in Engineering and Society – Is the Sky Really Falling?". The goal was to introduce technologically lay people to current-day engineering. The goal was to help lay persons recognize that many social and political issues have significant engineering components. A subtle goal was to attract prospective students to the new School of Engineering that was developing at VCU. The Mini-Engineering School was written up in ***Prism,*** the national monthly magazine of the American Society for Engineering Education.[11]

There were two items in early mailings to prospective students that were particularly helpful. One was a letter of encouragement about the new School that was signed by the Trustees. Such an impressive lineup of prominent corporate presidents and CEOs would have to attract the attention of prospective students and their parents. Another item was a special letter to all female prospects signed by Ms. Panny Rhodes, Delegate to the Virginia General Assembly from the 68th District in Richmond, a Trustee of the VCU Engineering Foundation, and a graduate in mathematics from Duke University. She is an excellent role model for young women who may be considering careers in engineering or applied science.

After reviewing all relevant information on student applicants from whatever the source, Dean Tom Haas, as Associate Dean for Academic Affairs, made all of the final decisions regarding admissions. The total enrollment in the School grew impressively. By the Fall of 2000, there were 564 students including 45 graduate students. A large increase in undergraduates in 1998 was due in part to the new undergraduate program in biomedical engineering that accepted its first freshmen that Fall. The

11 *Prism,* September 1994.

new MS and PhD programs in Engineering enrolled their first official advanced degree students in the Fall of 2000, but immediately prior to 2000, a few students were working toward their advanced degrees in a sort of "behind the scenes" manner. A program in computer science was organizationally transferred from the College of Humanities and Sciences into the School of Engineering effective with the Fall semester of 2001. This produced a step-function increase in total enrollment to over 1000. A huge change from the first 84 freshmen in the Fall of 1996, only five years earlier. There was a steady rise in the number of applicants, the acceptance rate seemed level at about 60 percent and the yield was about 40 percent.

Most importantly, there was also a steady rise in the average SAT scores to about 1250 for the third freshman class. This is within the national top decile. This is remarkably good for a school that did not exist just three years previously. The average GPA from high school has also shown a steady climb to about 3.7. It is particularly striking that 26 of the 84 initial freshman made the Dean's List in their first Fall semester. Everyone was justifiably proud of the quality of students who took the risk to join a fledgling program. It is also interesting to compare VCU's freshman SAT data for 1998 with those of two of the foremost engineering schools in America: Georgia Tech at 1329 and Washington University at 1402. VCU was doing very well very early.

Student Organizations

One of the most important student organizations in any school of engineering is its chaper of Tau Beta Pi. This honor society for engineering students is the equivalent of Phi Beta Kappa for students in the liberal arts and sciences. Chapters may, of course, be established only at accredited schools. With the collaboration and encouragement from the national headquarters, members of the class of 2000 who met all TBP academic requirements were identified in the Fall of 1999 and they created a "colony" chapter that functioned as a TBP Chapter. The elaborate information to petition for a bona fide chapter was assembled and submitted in the Spring of 2001 immediately following our accreditation by ABET. Chapter status was awarded later in 2001, as was retroactive full membership to all of the earlier "phantom" members. The "bent" of TBP has been erected in the lower courtyard atop a marble base.

Students also established a colony of Theta Tau, the professional engineering fraternity. A certification banquet recognizing the establishment of a colony chapter in 1998 was led by the Grand Regent of Theta Tau. This affair was also attended by many members of the Theta Tau chapter at UVA.

The female students established a chapter of the Society of Women Engineers (SWE). The minority students established a chapter of the National Society of Black Engineers (NSBE).

Chapters of each of the disciplinary professional societies were also established. These include the American Institute of Chemical Engineers (AIChE) officially chartered in June of 2000 and the American Society of Mechanical Engineers (ASME), officially chartered in June of 1999. As was true with TBP, chapters of ASME may be established only at accredited schools. Again a special dispensation was granted to VCU after a site visit by the regional vice president of the ASME. The Institute of Electrical and Electronic Engineers (IEEE) was chartered in the spring of 1997 and the Biomedical Engineering Society (BES) was chartered in 1996.

Faculty

The challenges and opportunities that were presented by a new school with enthusiasm and high ambitions were instantly attractive. Dozens of resumes from potential faculty were received prior to any advertising and prior to the School being officially sanctioned in June of 1996. The circumstances of the school would allow a very selective approach to hiring faculty. By my retirement from the position of Founding Dean on July 1, 1999, the Chairs and Deans had assembled a cadre of 25 full-time tenure-track faculty:

Chemical Engineering :

Dr. Gary Wnek, Professor and Chair, PhD from the University of Massachusetts at Amherst. Dr. Wnek came to VCU from his previous post as Head of the Department of Chemistry at Renssalaer Polytechnic Institute where he was tenured.

Dr. Mark McHugh, Professor, PhD from the University of Delaware. Dr. McHugh came to VCU from his previous post of Professor of Chemical Engineering at the Johns Hopkins University where he was tenured.

Dr. Gary Tepper, Assistant Professor. PhD from the University of California at San Diego. Dr. Tepper came to VCU from his previous post as Visiting Scientist at the Space and Naval Warfare Systems Command in San Diego.

Dr. Gary Huvard, Associate Professor, PhD from NC State University. Dr. Huvard came to VCU from ten very successful years of private consulting practice through his company, HRC, Inc. Before starting his own company, Dr. Huvard worked with Dupont and with B.F. Goodrich as a research and development engineer for 10 years.

Dr. Tom Haas, Professor, PhD from Princeton University, appointed Professor and Associate Dean for Student Affairs on July 1, 1994. Dr. Haas came to VCU in 1983 from his previous posts as Associate Professor of Polymer Engineering at the University of Illinois and industrial appointments with ICI Americas, Bell Labs, and Philip Morris.

Dr. Ken Wynne, Professor, PhD from the University of Massachusetts in Amherst. Dr. Wynne came to VCU from his previous post as Manager of the Polymer Research Program of the Office of Naval Research in Washington, D.C.

Dr. Henry McGee, Professor and Founding Dean, PhD from Georgia Tech. Dr. McGee came to VCU from Virginia Tech where he was tenured and where he had served as Head of the Chemical Engineering Department for 10 years. He earlier held a tenured professorship at Georgia Tech.

Mechanical Engineering:

Dr. Eric Sandgren, Program Chair, PhD from Purdue University. Dr. Sandgren came to VCU from his previous post as Director of Advanced Engineering at TRW Corporation in Detroit. He had earlier held tenured professorships at the University of Missouri-Columbia and at Purdue. Dr. Sandgren was subsequently tenured at VCU.

Dr. Robert Heinz, Professor, PhD from Carnegie Mellon University. Dr. Heinz came to VCU from his previous position as Director of the Global Backplane Business Unit and Director of Manufacturing at AT&T's Richmond facility, a plant employing some 2000 people.

Dr. Mark Palmer, Assistant Professor, PhD from Renssalear Polytechnic Institute. Dr. Palmer came to VCU from graduate school at RPI.

Dr. Tim Cameron, Associate Professor, PhD from Carnegie Mellon University. Dr. Cameron came to VCU from Kettering University (formerly GMI Engineering and Management Institute) where he was Associate Professor.

Dr. Dan Dorney, Assistant Professor, PhD, from Penn State University. Dr. Dorney came to VCU from the post of Assistant Professor at Kettering University (formerly GMI

Engineering and Management Institute). Before that he was a project engineer with Pratt & Whitney. Dr. Dorney was subsequently promoted to Associate Professor and tenured at VCU.

Dr. Donna Meyer, Assistant Professor, PhD from Rensselaer Polytechnic Institute. Dr. Meyer came to VCU from graduate school. Prior to pursuing her graduate degree, Dr. Meyer was in industry for 15 years with ABB Corporation in Connecticut, where her title was Program Manager in their nuclear engineering division.

Electrical Engineering :

Dr. Robert Mattauch, Professor and Chair, PhD from NC State University. Dr. Mattauch came to VCU from the University of Virginia where he served as Head of the Department of Electrical Engineering. He was tenured at VCU upon his initial appointment.

Dr. Rosalyn Hobson, Assistant Professor, PhD from University of Virginia. Dr. Hobson came to VCU directly from graduate school at UVA.

Dr. Robert Klenke, Associate Professor, PhD from University of Virginia. Dr. Klenke came to VCU directly from graduate school at UVA.

Dr. Greg Tait, Associate Professor, PhD in Electrical Engineering from The Johns Hopkins University. Dr. Tait came to VCU from his previous post as Assistant Professor of Electrical Engineering at the U.S. Military Academy at West Point.

Dr. Robert Pearson, Associate Professor, PhD from the State University of New York at Buffalo. Dr. Pearson came to VCU from the Rochester Institute of Technology where he was Associate Professor of Electrical Engineering.

Dr. Hadis Morkoc, Founders Professor and VMEC Professor, PhD from Cornell University. Dr. Morkoc came to VCU in 1997 from 19 years on the faculty at the University of Illinois. Dr. Morkoc merits special mention. He and his group have been responsible for a number of advancements in gallium nitride semiconductors and devices based upon this material which displays a number of advantages over conventional silicon. His output of scholarly papers and presentations has been prodigious. He has authored or co-authored 3 books, 36 book chapters, 41 popular articles, and over 1050 technical articles. He has presented 55 invited talks at major scientific meetings, and some 110 seminars at various laboratories and universities around the world. According to the Institute of Scientific Information (ISI), since 1982 his papers have been cited over 11,000 times. To put this in perspective, well over half of all scholarly papers published by all university professors are never cited at all by anyone. The next most frequent citation is one . . . usually a self-citation. The quantity of his output is astonishing, but so is its quality. In a field encompassing condensed matter physics, electronic materials, metallurgy, ceramics, polymers, and materials chemistry, and in the five year period 1990-95, and for all publications worldwide, Dr. Morkoc was listed by the ISI as18th in the world in the total number of citations. In the impact of his papers, i.e., the number of citations per paper, Dr. Morkoc was listed 4th in the world. This same service lists *Dr. Morkoc as ranked 19th among 517,111 physicists worldwide.* He is a Fellow of many professional and honorary societies.

Biomedical Engineering :

Dr. Gerald Miller, Professor and Chair, PhD from Penn State University. Before joining VCU he chaired the BME program at Texas A&M University.

Dr. Martin Lenhardt, Professor, PhD from Florida State

University. He was previously a post-doctoral fellow at Johns Hopkins University. He came to VCU when Biomedical Engineering was a part of the VCU Medical Center where he had also been tenured.

Dr. Gary Bowlin, Assistant Professor, PhD from the University of Akron. Dr. Bowlin came to VCU from the Department of Surgery at Akron City Hospital where he was a post-doctoral fellow.

Dr. Ding-Ye Fei, Associate Professor, PhD from Penn State University. He came to VCU directly from graduate school when Biomedical Engineering was part of the VCU Medical Center where he had also been tenured.

Dr. Pen-Wie Hsia, Associate Professor, PhD from the University of Michigan. Before joining VCU he was an Assistant Professor at East Carolina University. He came to VCU when Biomedical Engineering was part of the VCU Medical Center.

Dr. Jennifer Wayne, Associate Professor, PhD from the University of California, San Diego. Before joining VCU, she was an independent consultant and Research Associate at U.C.-San Diego. She initially joined the VCU Medical Center where she had also been tenured.

Universities jealously guard their star professors. One such "star" at Virginia Tech had initiated conversations with me in 1998 about his joining our still embryonic school. He was responsible for one of the largest programs of sponsored research at Virginia Tech. When his planned move to VCU became known, the friendly relationship between the Dean at Virginia Tech and myself became somewhat strained, but with help from Dr. Trani the situation was amicably resolved, and the "star" faculty member did not move to Richmond. However, it soon became a loss for the Commonwealth when, in 2001, that outstanding educator was appointed Head of the Department of Electrical and Computer Engineering at a major university in New England.

Supporting Faculty

It was always well-understood that the addition of engineering students would significantly impact the teaching loads of faculty in the biology, chemistry, physics, math, and English departments. Engineering students will also partake from the smorgasbord of opportunities for growth offered by other segments of the university. The engineering budget was projected to support 6 faculty in supporting departments by 2000-01. These projections were necessarily approximate, but they did portray significant impact upon these supporting disciplines. The first new faculty hired with their salaries from the School of Engineering were Dr. Alison Baski and Dr. John Carlisle in the Physics Department both of whom also held courtesy appointments in electrical engineering.

Non-Traditional Faculty

One of the centerpieces of our new engineering programs is that of business and entrepreneurship as a vital part of the educational experience. One needs successful and articulate engineering faculty, perhaps from mid-management positions in industry, who had been in practice long enough to have seen and been involved in issues at the interface between technology and business and entrepreneurship.

Our non-traditional programs which are part of the defining character of this School demand a non-traditional faculty. Faculty from prior industrial backgrounds often do not have the accoutrements, such as a long list of publications, of their colleagues with only prior academic appointments. Yet such enrichment of an engineering faculty is essential for the long-term implementation of the non-traditional character that we seek. Possible tensions are evident when incorporating such colleagues into the very traditional university milieu.

Instructional Programs

There have been two previous "revolutions" in the application of science. First, applied chemistry gave society plastics, fibers, dyes, fuels, protective coatings, etc. Then applied physics gave us space, microelectronics, computers, etc. Now we are in the midst of a third "revolution" which is concerned with the applied life sciences. Engineering at VCU aims to be a major player in this revolution. This ambition is enhanced by our adjacent VCU Medical Center, one of the largest and most highly regarded medical complexes in America for both research and clinical practice, and by the Biotech Research Park that adjoins the Medical Center. In our desire to meet these opportunities and needs, we must continue to ensure that our students are well-grounded in the fundamentals of fluid mechanics, thermodynamics, chemistry, and the like. This will be a difficult task, and the program summaries presented below display the initial approach to this task by the faculty. But it is initial only. Curricula in the dynamic field of engineering are continually evolving.

Biomedical Engineering

I reported to Provost Grace Harris in September of 1996 that the Chairs and Deans were making plans for a formal request to offer the BS in BME to complete its repertoire of offerings at the undergraduate level. This program was officially sanctioned by SCHEV, and the first freshmen were enrolled in the Fall of 1998, i.e. two years behind the other three programs. Many BME students aspire to become physicians. At the VCU Medical Center, applicants who present a degree in BME as their premed training have an acceptance rate of 75 percent, far better than students with, for example, pre-med degrees in biology or chemistry. The attractiveness of engineers in medicine is probably due to their well-developed analytical skills as well as to the subject matter of their undergraduate education. This is important, for the competition for the limited number of openings for first-year medical students is particularly keen. BME, as a graduate program, predates the creation of the School of Engineering. BME was then a part of the School of Medicine, and it had conferred the MS since 1984 and the Ph.D. since 1994. BME was transferred to the School of Engineering effective July 1, 1995. This transfer was only organizational. The physical location of all operations remained immersed in the School of Medicine on the Medical Center Campus. As was true with the creation of the School of Engineering, Virginia Tech had also earlier cooperated with VCU in the creation of its MS and PhD programs in BME. The proposal to SCHEV to create BME as an undergraduate option was prepared by Dr. Gerald E. Miller, Chair of that program. The first class of 42 students was accepted in the fall of 1998. Their average SAT was 1380, which may be compared to the overall average for the School of Engineering of 1300 and which is again a commentary on the quality of young people attracted to the exciting field of biomedical engineering.

The profession of biomedical engineering has played a significant role in medical technology, diagnosis and therapy with the introduction of devices such as the cardiac pacemaker, artificial heart valves, artificial hips and knees, cardiac defibrillators, artificial kidney, the heart/lung machine, engineered tissues, and much more. The BME program that was created as part of the School of Engineering was at the time the only undergraduate program in BME in the Commonwealth of Virginia.

In addition to all of the work in chemistry, physics, and math that is required of all engineering students, the heart of the program in BME are courses in the life sciences as well as the BME disciplinary courses. These include Biomedical Instrumentation, Biomechanics, Biomedical Signal Processing, Biomaterials, and Biotransport Phenomena.

An attractive and unique feature of the VCU program is its requirement that students participate in morning clinical rounds in the hospital along with medical students. This two-credit course occurs in the freshmen year of the program. That is, the BME students actually see sick people and see first-hand what medical technologies are being used to help make them well again. The students see first-hand real-world applications of medical devices, diagnostic tools, medical therapies, and hospital procedures. They stand beside physicians, interns, and nurses in the operating room. They see what constraints exist when using medical devices such as MRI, CAT scanners, or ultrasound in the real world. The clinical rounds course was developed cooperatively with the physicians and administrators of our teaching hospital. This course continues the commitment of the new School of Engineering to partner real-world experience with traditional classroom learning. On weekly rotations, students see patients in cardiology, neurosciences, radiology, orthopedics, and surgery.

While medical students are studying these cases from the viewpoint of diagnoses and treatment, the BME students are studying the same cases in terms of the technologies that are being used.

Chemical Engineering

It is the ability to link the microscopic world of molecules to the macroscopic world of observable chemical and physical properties that is the fundamental strength of chemical engineering. The curriculum closely links technical fundamentals with independent project work, business principles, and societal issues.

The chemical engineering faculty, with counsel from its Industrial Advisory Board, has been particularly successful in reducing to practice the defining philosophies of the VCU School of Engineering that constitute the "Renaissance Engineer".

A major goal was an enhanced orientation toward business and entrepreneurship. Students see these ideals personified in their faculty. One faculty member has joined with a colleague in biomedical engineering and another in medicine to create a technique called electrospinning for producing micron-sized fibers which can be layered into any desired shape to provide a scaffold for the in-growth of tissue. The fibers can be biodegradable collagen or any other desired material. Patents are pending on the technology, and the investigators have created a start-up firm to commercialize the technology. A venture capitalist has invested $1.0 million, and a Congressional earmark has provided a second $1.0 million to the firm.

Another faculty member has a small company that has received a Phase II Award from the Small Business Innovative Research (SBIR) program of the Ballistic Missile Defense Organization. Such Phase II awards are for $1.0 million.

Another faculty member has a company devoted to research on the development of more effective proton transport membranes that are critical to any commercial success of fuel cell technology. Fuel cells are attracting great interest in the automotive industry as a replacement for the internal combustion engine where the reaction of hydrogen and oxygen produces electricity directly with no intervening and inefficient heat/power cycle. And the only product of reaction is water. One can envision a completely non-polluting automobile.

The research of another faculty member under an industrial grant was so successful that the company hired that faculty part-time. The company, a Japanese firm, pays the apportioned salary, benefits, and overhead to the university as well as provides funds for continued research.

Another faculty member has formed a university-wide Center for research and teaching in several aspects of bioengineering that include an adaptation of the techniques of microelectronics. His company that is pursuing these same goals is located in the Biotech Research Park.

And this "listing" is not at all comprehensive. It does, however, convey a sense of competence and devotion to the original defining characteristics of the School.

The chemical engineering program requires fifteen credits in math, and students are encouraged to take an advanced math course offered by a chemical engineering faculty member. There are ten required credits in classical physics, and students are encouraged to elect modern physics to provide some understanding of quantum mechanics, statistical physics, molecular simulations, and the like. Seventeen credits are required in chemistry. "General Chemistry" often comes across to the student as abstract and not useful. Our new and innovative approach is centered upon a study of materials, for this is an important area of application for all engineering students. The student can see practical use of the material. The courses in organic chemistry show students applications in petrochemicals, polymers, pharmaceuticals, and biotechnology. A required course in "Industrial Chemistry" is rather comprehensive and includes the manufacture of commodity chemicals. Since industrial chemistry is catalytic chemistry, this important area is also emphasized. Four credits in materials chemistry emphasize mechanical and electrical properties. Rather noticeably, physical chemistry is not required, although students are encouraged to minor in chemistry, where, of course, physical chemistry is required. There are three required credits in life sciences with possibilities including cell biology, physiology, genetics, and the evolution of plant and animal diversity. Non-technical survey courses are not acceptable substitutes.

Four credits in computer methods are required in which students learn the MatLab platform. There is also a collection of required courses in chemical engineering science including thermodynamics, heat transfer, and the like.

The chemical engineering program was presented by seven full-time tenure track faculty in the Spring of 2001 with a planned growth to a faculty of 10.

Chemical engineering awaits feedback from alumni and employers since so few graduates have been produced. There are, however, early and very positive indicators. All 13 members of the first class have been placed in industrial positions or in graduate schools. David Colby had invited campus visits and offers from MIT, the University of California at Berkeley, the University of Wisconsin, the University of Minnesota, and the University of Delaware. Each host university paid all expenses associated with the visit. He enrolled at MIT. Michael McKittrick had similarly hosted campus visits and offers from Clemson, Georgia Tech, and the University of Colorado. He enrolled at Georgia Tech. Joel Passmore had campus visits and offers from North Carolina State, the University of Virginia, and Purdue. He enrolled at North Carolina State. Stephen Hertzler enrolled as a law student at George Mason University. The feedback from all of these students is that they are doing well and feel fully competitive with their classmates from fine schools around the country. Note that both MIT and Georgia Tech are among the top 5 ranked schools of engineering nationwide, and they each attract the very best students from across the country.

Electrical Engineering

Electrical engineering is concerned with systems that generate, transmit, process, and measure useful information. The development of the program in electrical engineering at VCU was led by Dr. Robert Mattauch, Chair and aided by his Industrial Advisory Board (IAB).

The EE program offers concentrations in three areas: microelectronics, computer engineering, and controls/communications. In the concentration-area of microelectronics, students design semiconductor devices and integrated circuits, and then they fabricate these circuits in VCU's 7500 square-foot class-1000 clean room laboratories. In the concentration-area of computer engineering, students learn to design, build, and test VLSI circuits, microprocessors, and computer networks. Computer engineering includes broad applications from large high performance systems or workstations that are ubiquitous in all facets of business down to small microprocessors and microcontrollers that are embedded in larger systems. These larger systems include aircraft, automobiles, medical equipment, consumer electronics, and household appliances. In the concentration-area of controls/communications, students learn to design, build, and test systems for industrial automation, robotics, digital signal processing, and telecommunications.

In each of the three areas of concentration, classroom work emphasizes project proposals and reviews, ethics, teamwork, product development, innovation, finances, and international business. Many courses also have extensive writing requirements, and all are critiqued for both content and style. To produce a more realistic exercise in teamwork, teams are often mismatched on purpose. All EE students are evaluated using the Myers-Briggs Type Indicator that is then used in forming mismatched teams. The resulting experiences can be frustrating for group members, but these experiences are realistic of what can be expected in their real experiences on the job. Business issues are introduced in a number of EE courses throughout the curriculum.

Electrical engineering graduates who have elected to continue their education in some of the nation's finest graduate schools are doing well in competition with classmates from around the country. It is, of course, too early for meaningful feedback from employers of graduates, but feedback from the industrial mentors of these students during their internships has been very positive. Appraisals were strong in commitment, teamwork, and ability to learn, and 94 percent indicated they would hire the intern.

Mechanical Engineering

Mechanical engineers are present in every major industry and in every job classification from design engineer to CEO. Under the leadership of Dr. Eric Sandgren, Chair, the faculty and their Industrial Advisory Board have developed an attractive program, the essence of which is captured, in some sense, by the one-liner, "At VCU, Mechanical Engineering means a partnership for future success." This slogan is not as catchy as that of the Virginia tourism program, "Virginia is for Lovers", but it is nonetheless descriptive and meaningful.

Each faculty in mechanical engineering holds the Ph.D. from a top ranked institution, but they are not narrow engineering scientists as is so frequently the case. This School was created in response to industrial demand, and thus there is a strong partnership between the industrial sector and the program in ME. The ME faculty has an average of 10 years of prior industrial experience. Their expertise covers all of the core areas of the curriculum as well as several areas of specialization including acoustics, tribology, and robotics.

Recognizing one of the original defining goals of the School was to stimulate creative abilities or "out-of-the-box" thinking, the ME faculty has teamed with the Sculpture Department of the School of the Arts to create the "da Vinci Center". For example, a senior design project with the participation of the Science Museum of Virginia involved the design and testing of a water sculpture for the museum. Their designs are impressive, though not yet competitive with the "Dancing Waters" of the Bellagio Hotel in Las Vegas.

This partnership with sculpture also makes their shop and foundry facilities available to the mechanical engineering students. These include casting, forming, welding, and brazing facilities, none of which exist in the School of Engineering. Most manufacturing processes can be trialed with these facilities. Visits to nearby companies expose students to large manufacturing plants and to large test systems such as, e.g., engine dynamometers.

The ME faculty has teamed with the Business School to develop and offer two new courses that are particularly suited to engineers; "The Economics of Product Development and Markets" which is required and "Introduction to Project Management", which is an elective. Although "Project Management" is encouraged, an alternative business course, "Organizational Behavior," is required in the ME Curriculum. This course does have the advantage of meeting both a professional requirement and the university's requirements under general education for study in the area of interdependence. Both of the required business courses are "double counted" in this way and they are also two of the required seven courses for a minor in business. This gives the student a fine head-start should he/she wish to earn an MBA.

Three areas that were unusual in mechanical engineering education and which helped to form the special niche for ME at VCU were the emphasis upon business, the orientation towards synthesis, and a new perspective on materials. Industrial benchmarking has, for years, highlighted the weakness of new engineering graduates in fundamental business skills. More specifically, this benchmarking revealed deficiencies in (1) marketing and the introduction of new products, (2) project management, and (3) the impact of legal issues. These deficiencies were independent of the firm's primary product or technical expertise or geographic location. The two courses noted earlier were developed to address this deficiency. A still better solution is for the student to minor in business which requires only one additional semester of residence, and excellent financial assistance for this specific purpose is available through scholarships funded by Philip Morris.

Enhanced creativity in problem solving and in design was augmented by the joint venture between mechanical engineering and VCU's nationally ranked Sculpture Department. While engineers typically have a more directed approach to design, art students treat design in a much more open or "out of the box" manner. Of course the sculptor is not confined by the realities of nature and society as is the engineer, but nevertheless, this openness is a highly desirable quality in engineering at VCU. To involve more students, a joint course, "Electro-Mechanical Systems", which covered motion and control in open-ended design tasks was developed and taught by engineering and sculpture faculty to an equal mix of students from the two programs. So that each student might have a permanent record of this unusual multidisciplinary study on his/her transcript, the engineers took the course under a sculpture number and art students took the course under an engineering number. The reaction of the ME Industrial Advisory Board to this course was particularly positive. When faced with a new design task, the art students would typically immediately begin trying out ideas, while the engineering students more often would think and plan to hopefully produce an optimum design with their first attempt. It is not possible to say which mind-set is better, but the difference is intriguing.

Too many mechanical engineering students develop a dislike for chemistry due to the nature and attitude and structure of their first course as freshmen, "General Chemestry". Materials and the properties of materials are both ubiquitous in engineering as well as firmly based upon chemistry. Our new orientation of freshman chemistry that emphasizes materials was then more palatable to engineering students.

A Comprehensive Example

Several of our defining goals of manufacturing, of synthesis, of a multidisciplinary orientation, and of teamwork were all evident in the design, construction, and operation of a small, batch, microplant for the production of quaifenesin, an expectorant used in most over the counter cold and allergy medications such as Robitussin that is manufactured locally by Whitehall Robins. Our microplant produces 2 kg of product per batch. Quaifenesin is commercially manufactured locally by Böhringer-Ingelheim. Construction of the microplant involved nine students in chemical engineering who were responsible for the chemical processes of reaction, crystallization, filtration, drying, and waste neutralization. Four students in electrical engineering were responsible for all of the control systems. And two students in mechanical engineering were responsible for all facilities, the skid mount of the plant, and the adjacent walk-in hood. A wide array of chemical manufacturing processes as well as process control experiments are possible while using even parts of the micro-plant, and it is far superior to the "canned" experiments that are so commonplace in schools of engineering today. This innovation in engineering education well-addresses the founding philosophies of our School.

Internships

Students need exposure to the "real world" of engineering practice as an integrating experience to see just how all of the work in the classrooms comes together. There are also numerous non-technical components of engineering practice that involve things like interpersonal relations, politics, dealing with a labor union, ethical issues, and much more. These are also important in the practice of engineering. The best way to see all of these things is as a participant. So the School of Engineering requires a three-month summer internship. Most students were employed in the Greater Richmond area, but in the Founding Class one student worked with Pratt & Whitney in Connecticut, another was with Hughes in California, another with an Institute at Stanford University in California, another with NASA in Alabama, and four in Virginia but outside of the metro area. One student in mechanical engineering took advantage of a German/American exchange program to pursue his internship in Germany. The companies expected quality work and a relationship that could grow into permanent employment. As a fall-back option, some few students find summer work in the research laboratory of a faculty member. While still having an educational experience, they nonetheless missed this defining goal of the VCU program of exposure to an industrial environment under the supervision of an industrially based mentor.

Internship opportunities exceeding the numbers of students were developed by Dr. Heinz in his capacity as Associate Dean for Industrial Affairs. Students were not assigned to these positions, rather they had to be interviewed by the company. As a result, some students had multiple offers while some had none. This sometimes unpleasant introduction to the real world helped those who needed it to better prepare for the more important interviewing for permanent job placement that would come later. Typically, those with no offers elected the fall-back option of work in the laboratory of a faculty member.

During the following Fall semester, the summer interns gave power-point presentations on their work before a faculty committee.

Library

The hard-copy holdings of the VCU Library are less than modest in all areas of engineering. To acquire holdings of primary journals to allow conventional retrospective searches of prior literature would be prohibitively expensive.

Fortunately, the wide availability of information on-line has usually eliminated this short-fall. Full texts of articles in scientific journals are frequently available on-line before they appear in hard copy. Computer based search engines such as Google allow students or faculty to find journal articles and/or monographs on any subject related to a classroom assignment or research or design project. And, of course, there is interlibrary loan. VCU has a full-time Engineering and Science Librarian concerned with developing and enhancing information services.

Joint Classes

An interdisciplinary program was one of the seven founding goals of the VCU School of Engineering. To enhance faculty productivity as well as intellectual contact between mechanical engineering and chemical engineering students, thermodynamics was taught to both groups at the same time in the same room. "Thermodynamics" is, of course, a central and core course to both disciplines. Essentially the first half of thermo texts of each discipline say the same things but in somewhat different words. That is, they present the basic fundamentals of the first and second laws, properties of matter and their interrelationship, real gases, and compression and expansion.The VCU students in mechanical and chemical engineering were taught together for the first half of the course and then split so the two groups could study further in areas more specific to their discipline. "Process and System Dynamics" is another course that has been taught to chemical and mechanical engineering students in the same room at the same time. This course is co-taught by professors in mechanical, chemical and in electrical engineering. As was the case in "Thermodynamics", the fundamentals are the same but the applications are different. To maintain the interdisciplinary advantages, this course first covers fundamentals with the two groups together and then splits for detailed consideration of disciplinary applications. This separation and reassembly occurs several times during the semester. The laboratory experiences associated with the lectures are different for each discipline. "Sensors and Measurements" is still another course that is taught to all chemical and mechanical engineering students at the same time by a professor whose research expertise is in this particular area.

Another example of interdisciplinary teaching was the development of a new course, "Industrial Inorganic Chemistry," that serves both chemistry and chemical engineering majors, and it is team taught by faculty from both departments. The course seeks to merge the microscopic world of atoms, bonding, and molecular structure with the macroscopic world of materials, process technology, properties and applications. The students enjoy discovering the close connection between the practice of large scale industrial processes and the fundamental principles of chemistry. They also see such processes "in the flesh" by site visits to plants in the area.

In addition to professional advantages to instill inter-disciplinary thought, there is an advantage of joint classes in increasing the productivity of a very small faculty.

Co-Op Program

A small faculty does not allow a fully developed co-op program because of the increased teaching load that is thereby required. A few students, working with their faculty advisor and their company mentor, are able to arrange individually designed informal co-op programs wherein the student realizes that the courses he or she might need might not necessarily be available in the semester most suitable to the student. Industrial experience that is such a valuable part of the co-op experience is somewhat addressed by the required summer internships albeit in an abbreviated form.

Dual Degrees

Perhaps the best example of the multidisciplinary orientation of the VCU School of Engineering is the ideal of pursuing two B.S. degrees at the same time, and many of our students do just that. With the kind cooperation of the faculty and administration of the College of Humanities and Sciences, any engineering student can pursue a second major in any department of the College by completing only the required courses in that department. For example, a student majoring in electrical engineering could double major in physics by adding only four additional courses in physics of 3 credits each plus one laboratory of 1 credit, or a total of 13 credits beyond the 130 credits required for the degree in EE. This is possible because engineers are already required to take a number of courses in physics and because some required courses in EE are acceptable substitutes for required courses in physics. With careful planning with his or her advisor, a student could disperse these additional courses in physics throughout the curriculum in such a way as to require only one additional semester of residence to earn both degrees. There is a notation on the student's transcript indicating the second major. The physics department is pleased with this notable growth in the number of its majors. Similarly attractive arrangements allow a student in chemical engineering to double-major in chemistry. Although these are two commonplace examples, other arrangements may be made to accommodate interests of specific students.

Nor is this dual degree opportunity limited to scientific areas alone or even to the College of Humanities and Sciences. For example, Barbara Kruse in the class of 2002 was a double major in mechanical engineering and sculpture.

Virginia Microelectronics Consortium

In a collaboration rare among state supported universities, the five engineering schools, the College of William and Mary, the Community College System, and the three major microelectronics manufacturers in the state formed a consortium with the support of the Virginia General Assembly to create a comprehensive program of education in microelectronics called the Virginia Microelectronics Consortium (VMEC). The allocation from the state provided an endowed professorship in the amount of $1.0 million to each of the five participating universities and it funded scholarships and supported specialized equipment and facilities. Dr. Hadis Morkoc in electrical engineering was appointed VMEC Professor at VCU. Much of his research is conducted in our Virginia Microelectronics Center with its large cleanroom facilities.

Graduate Programs

To achieve the goals of the new School of Engineering, it was essential to offer advanced degrees on site. In the spirit of seamlessness that was a defining virtue of the School, one might expect that the word "biomedical" would merely be dropped from the existing graduate degrees, and the School would offer the MS and PhD in Engineering. This, in fact, was the approach advocated by both President Trani and by me. However, notwithstanding the arguments of the Deans and Chairs, the BME faculty was understandably jealous of the specific designation of their degrees, and they adamantly opposed that simple change. Rather than force the issue—possibly a mistake—the agreement was made at a meeting of the Trustees, President Trani, and the engineering Chairs to propose the MS and PhD in Engineering to encompass mechanical, electrical, and chemical engineering, and to leave both of the specified degrees in BME to stand as they were.

The undesignated advanced degrees also had the advantage, or so it seemed, of having the least likelihood of adverse reaction and opposition from sister institutions who remained concerned about still another cry from another engineering school for financial support. This seamless approach was applauded for it was in keeping with the interdisciplinary character of the School itself from its beginnings. There were also broad benefits of income from research grants that were expected to average $300,000 per year per faculty member. Discussions of graduate level programs began in 1996 and became serious discussions in late 1998. After much input and debate, Dr. Gerald Miller, Chair of Biomedical Engineering and Associate Dean for Graduate Affairs, prepared a proposal to SCHEV that was submitted in early 2000. The initial dream of the undesignated MS and PhD not stimulating opposition from sister institutions was exactly that—a dream. The proposal from VCU stimulated vigorous opposition from Virginia Tech and from ODU with numerous letters, e-mails, and speeches before SCHEV, all in opposition. President Torgersen of Virginia Tech had much earlier told Provost Grace Harris, when she had raised the issue of graduate programs in engineering, that it was necessary for VCU to do this. But President Torgersen had retired when the actual proposal appeared, and the response of officials at Virginia Tech was now distinctly different.

To get an unbiased perspective, SCHEV engaged a distinguished outside consultant who also reported in opposition. At a contentious meeting of SCHEV and with all of this opposition, the Rector of the VCU Board of Visitors and the Dean of Engineering, Dr. Robert Mattauch, promised that VCU would never request funds from the state to support its graduate programs in engineering. A divided SCHEV approved the proposal. But the price had been very high. Authorization for the new unspecified graduate degrees in "Engineering" at both the MS and PhD level was effective with the Fall semester of 2000.

The first MS degree under the new program was awarded in May, 2001 in mechanical engineering to Mr. Joshua Roby.

His research advisor was Dr. Tim Cameron.

Sponsored Research

All graduate programs in engineering exist on the back of sponsored research. It is sponsored research that also makes possible quality undergraduate programs, for without it the presence of a creative faculty could not occur. In addition to this intellectual and attitudinal and activist environment that is created, dollars from sponsored research also support laboratory experiences for undergraduates, makes modern equipment available to undergraduates, supports the attendance of undergraduates at scientific meetings, and more. The careers of university faculty are built upon a three-legged stool of teaching, research, and service. In science and engineering, many argue that research is by far the longest leg of that uneven stool. Unlike teaching and service, research has an easily understandable index of success. And that is, the amount of dollars in grants and contracts that the faculty member is able to garner. Note that this convenient index completely ignores quality of research except insofar as high quality research attracts a high quantity of dollars... presumably. In fact, for purposes of annual evaluation of the work of each faculty member, it is sometimes said that deans can "count" but they cannot "read". Nevertheless, dollars is a universally used index. It is a convenient way to keep score, so let us here summarize the success of the early engineering faculty at VCU.

The fiscal year at VCU begins on July 1. Awards in one fiscal year do not at all necessarily flow from proposals submitted during that fiscal year. Nevertheless, as an example, in FY01, 26 faculty submitted 122 proposals, and there were 43 awards to 17 faculty for a total of $6.23 million. A widely cited index of productivity in grantsmanship is dollars in grants per faculty member per year. This averages the dollars obtained for some equipment-intensive experimental programs with the much fewer dollars needed for more theoretical research that might primarily require only pencil, paper, and computer. Recognize that the cheap theoretical research may in fact turn out to be more valuable than the expensive experimental research. Nevertheless, this index for engineering at VCU in FY01 was $230,000/faculty. How do these numbers compare with this same index at other schools? Each year, the American Society for Engineering Education (ASEE) surveys schools of engineering and publishes statistical data (see www.asee.org). For the top-ten schools of engineering in FY01 as reported by ***U.S. News,*** this index was about $500,000 per faculty per year[12] – twice the VCU number.

Perhaps there are more reasonable schools upon which to base benchmarks for the new school at VCU. At the direction of SCHEV, each university in the state system has created a list of so-called peer schools for broad use in making comparative arguments in many arenas. This recognizes that it would not be reasonable to compare, for example, VCU to Harvard. The average research expenditure in FY01 per full-time tenure-track faculty at the 24 so-identified peer schools of VCU is $200,000, or less than half that of the top-ten schools of engineering. The VCU index is already somewhat better than this, and it is also comparable to that of other schools of engineering in the mid-Atlantic region. VCU was doing very well very early.

Schools will inevitably report their research expenditures somewhat differently and the numbers of faculty are continually changing. So these are approximate data for a snapshot in time. Even recognizing the qualitative nature of the data, the VCU index is impressive when recognizing that the VCU school began from a green-field and accepted its first graduate students in the Fall of 2000.

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12 Source for ranking was *U.S. News,* data for 2001; source for research expenditures was ASEE.

But it is also clear that to achieve its goal of national notoriety, the current index must at least double. The engineering building is already filled to overflowing, so it is clear that much more laboratory space is a necessity. Space alone is not a sufficient requirement for the desired growth in visibility, but it is a necessary requirement. In late 2002, plans were well along toward constructing a new research building.

Proposals from VCU engineering faculty were submitted to both federal agencies and to industrial sources in a ratio of about 4 to 1. Submitted proposals were awarded at a rate of about 45 percent. The message is clear. To gain more research support, faculty must write more proposals. The research orientation of our four engineering programs varies greatly. Sometimes faculty have been tenured although having produced little funded research, while in other programs, income from grants is fully competitive with the best programs in America.

Dollars for research, is a critical component in the emergence of the School of Engineering at VCU as a major entity in engineering education in America. But there is also an indirect benefit. Research grants to VCU carry an overhead rate of 50 percent. For example, a grant of $100,000 will provide $67,000 to the project itself and $33,000 to the university. Thereby the $6.23 million in awards in FY01 produced $2.1 million in uncommitted new money to the university. But there is more. Consider again a grant of $100,000. If the successful PI had an academic year salary of $70,000, and if he/she charges 10 percent of his salary to the grant, the university will receive back the $7,000 that it would have paid that faculty member plus fringes of 22 percent plus the $33,000 in overhead, or a grand total of $41,540 in free new money for the university from the award of a $100,000 grant. These new monies are divided among the state, the university, the school, the department, and the PI for use in whatever ways deemed appropriate. Thus many people profit from the successful grantsman other than just himself or herself. There is then a large incentive to reward successful grantsmen with greater salary increases and such additional perks as may be available. Another incentive for faculty to be aggressive in grantsmanship is that it affords the opportunity to earn one's summer salary and thereby increase one's annual earnings by some 30 percent.

Most support for research comes from federal agencies, but corporations support specific projects. A good example of this category of support is from the Daiken Corporation in Japan to support the research of Dr. Ken Wynne in chemical engineering. The work is concerned with advanced processing of fluoropolymers in supercritical carbon dioxide. The close relationship between the faculty member and the company that has evolved is completely in keeping with the defining characteristic of the School of a focus on business. And it is exactly what our new School so badly needs. The work has led to several patent disclosures, and the company will negotiate licensing agreements with the university which will result in income to VCU. The faculty member has also become a paid advisor to the company which will cover one-fourth of his university salary for that service. That salary increment will carry full university overhead and the one-fourth state salary plus fringes thus released will remain in the office of the Chair of chemical engineering to be used however he/she deems appropriate. Another financial gain for the university. The company has publicly identified the work at VCU as their most important outside research program. The prestige factor for the researcher and for the university is outstanding and just the sort of notoriety so badly needed by our new and little-known school of engineering.

Defining characteristics of engineering at VCU were its orientation toward business and entrepreneurship and research. Companies, under pressure to show bottom line results, are doing less longer range research and depending on universities to pick up the slack. Premier organizations of the past like AT&T Bell Labs or the Dupont Experimental Station are not what they once were. Another factor supporting our defining goals was the passage of the Bayh-Dole Act in 1984. Up until then, research results and innovations acquired under support from federal grants were government property. The Bayh-Dole Act, ensured that commercially useful results from federally sponsored research could be owned and licensed by the university. The Congress and the President had finally realized that intellectual property owned by everyone was, in fact, owned by no one. And therefore the development of that intellectual property created at the universities into useful products and services would never occur. With private ownership now possible, all research universities created offices to manage such intellectual property. Faculty of the School of Engineering filed 22 invention disclosures with the Office for Technology Transfer at VCU in the 2002-03 fiscal year. There were 83 such disclosures from the entire university. So engineering accounted for 27 percent of these even though the total engineering faculty is a tiny fraction of the total faculty of the university.

CHAPTER 5 : EPILOGUE

This book has presented the story of the creation of the School of Engineering from the earliest planning through the opening of the School itself. It is well to also catalog the major events in the history of the School through this writing during the 2003-2004 academic year.

First Commencement

The first commencement of the School of Engineering occurred on May 13, 2000 at 1:00. The ceremony occurred in a large tent that had been set up on the courtyard lawn of the engineering building, and it followed the all-university commencement held, as usual, in the coliseum downtown beginning at 10:00 a.m. There was no space inside the building large enough for all the students, their families and friends. The graduating students and the stage party had assembled in the high-bay area of the building from which everyone marched outside and into the tent while being led by a piper. It was a hot day and everyone in the tent was uncomfortable. Mr. Ed Flippen, Rector of the VCU Board of Visitors, was a member of the stage party. It was an historic occasion. Governor George Allen was the commencement speaker.[13] This was particularly appropriate since the formation of the School and its initial

[13] George Allen is now Senator Allen (R-VA). The Senator also became a Trustee of the VCU School of Engineering.

operation occurred during Mr. Allen's tenure as governor. He had always been helpful and supportive to me during those early years. In fact, the State allocation of $11 million to design and build the Virginia Microelectronics Research Center as part of the School was in large measure, due to the influence of Governor Allen.

Mr. Robert Snodgrass was the academically top graduate with a perfect GPA of 4.0. He also spoke during the May 13 festivities. Robert graduated with a BS in mechanical engineering, and he enrolled as a PhD student in Mechanical Engineering at Georgia Tech in the fall of 2000. As was discussed previously, the young people who elect to attend any new start-up school are making a huge leap of faith. But even more so for that first class of 84 that started in the fall of 1996 when there was no physical facility, no laboratories, and very few faculty, only much promise and hope. It is then appropriate to include here excerpts from the valedictory address of Robert Snodgrass.

> "It's been four years since we made that decision to take a chance on a new Engineering School, a new school with big dreams and a lot of promise. For most of you, you could have gone anywhere you wanted but you chose Virginia Commonwealth University. My story is a little different. I never took a risk coming to VCU; VCU took a risk letting me in. I was a less than mediocre student. Someone who got more C's than A's. Someone who failed gym class among others. How do you fail gym? Potential. I heard that word so often, it became a curse. When I applied to colleges, they took one look at my past record and turned me down. Then I came to Virginia Commonwealth University. To Dean McGee and the new School of Engineering still in its infancy. They took a look at my record and saw past my failures to see my Potential. This new school, still trying to get on its feet, gave me the most precious gift in life: a Second Chance.

I decided that I was tired of failing. I chose to face the chance of failure, and I can say that I lived up to the challenge. I believe as I stand here now before the smartest people I have ever known, that I did not fail. I have done what I set out to do, and I lived up to that Potential.

And now, more importantly, it is time to prove what the VCU School of Engineering can do. We walk forth now with the burden of not only proving ourselves, but proving this new school."

The undergraduate program in biomedical engineering was implemented in the Fall of 1998, i.e., two years behind the start-up of chemical, mechanical and electrical engineering. Nevertheless, the timing for presentation of courses was such that one student, Dieu Mia Pham, who began in 1996 as a major in electrical engineering, graduated in biomedical engineering with the first class in May of 2000. She is continuing her education as a DDS student in the School of Dentistry at the VCU Medical Center.

A special note about Mia is appropriate.[14] At the age of nine, she escaped from Vietnam under cover of night in a small fishing boat. Her family took the horrendous risk of placing her on that small boat where she was the youngest of 23 passengers. She had nothing but the clothes on her back. She was what is known in America as a "boat person". She spent nine months in a refugee camp in the Philippines before coming to Richmond in 1988 where she lived with foster parents in Chesterfield County. She learned English quickly. She graduated from Mills Godwin High School, and entered the new School of Engineering at VCU with the Founding Class in the Fall of 1996. She graduated in May of 2000 magna cum laude even while waiting tables and doing other

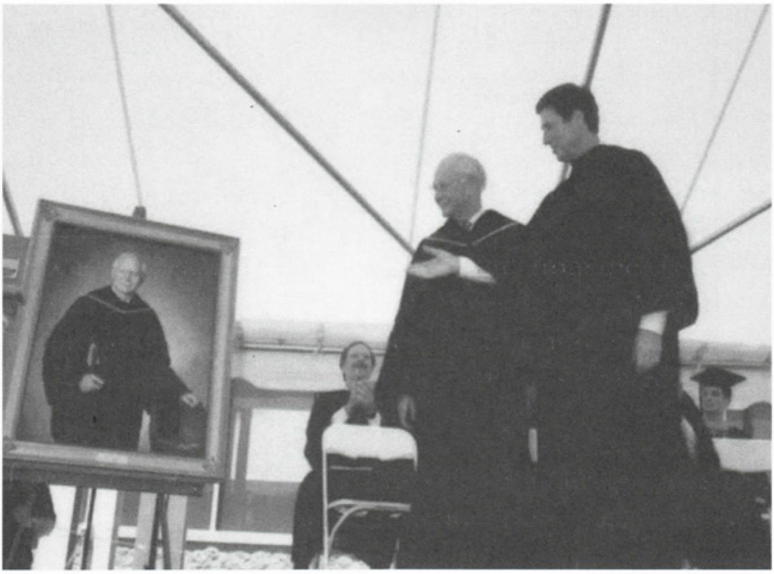
[14] A news story on Ms. Pham appeared in the *Richmond Times Dispatch* on May 23, 2000.

part-time jobs so she could send a few dollars to her parents. Growing up in Vietnam, she lived in a house with no electricity or plumbing. Her family cooked outside over wood or coal. Her family got their first telephone in 1997. Upon switching to BME from EE, Mia planned to go on to medical school. But during her undergraduate years, she worked in the laboratory of Dr. Peter Moon, Associate Professor of Dentistry and a member of the Academic Advisory Board of the School of Engineering. This experience led her to alter her ambitions, and she entered the Dental School at VCU in the Fall of 2000. Other big events occurred in 2000; she became a U.S. citizen and she visited her parents for the first time since that night 13 years before when she was placed on that small boat. Hers is a truly remarkable story.

A total of 53 graduates in May of 2000 with 84 new freshmen in the Fall of 1996 is not to be interpreted as a graduation rate of 53/84 or 62 percent. This is due to the always ongoing transfer of students in good academic standing into the program as well as transfers out of the program. It is also not uncommon for students to reduce their academic load and graduate later. In fact, the national average time to complete a B.S. degree in engineering is 4.8 years.

With 13 graduates in chemical, 15 in mechanical, 24 in electrical, and 1 in biomedical, or a total of 53 first ever graduates in engineering at VCU began their professional careers. It is their success over the years, and the successes of subsequent classes, that will be the one true indicator of the quality of the new programs in engineering at VCU.

The trustees had presented a portrait of myself as Founding Dean for permanent display in the main lobby of the engineering building. This was unveiled during the first commencement exercises after kind introductory remarks by Governor Allen. In thanking the Governor and others, I also acknowledged the support of my wife of 49 years. The photo shows the Governor and me admiring the portrait on the dais at commencement.



Placement

Engineering graduates from universities across America always seem to get the most job offers at the highest starting salaries, and the likelihood of quality placement was the most prominent criterion in the minds of prospective students when considering which college to attend. Technologically based companies have no history of interviewing on the VCU campus, so placement like everything else pertaining to the new school, had to be created from the beginning.

Nevertheless, the first graduates from VCU have done very well as evidenced by their average starting salaries, which were equivalent to the national averages.

Dr. Heinz, Associate Dean for Industrial Affairs, worked with Mr. Thomas J. Halasz, Assistant Director of the University Career Center, to address the issue of placement. Before joining VCU in the fall of 1997, Mr. Halasz had served as Senior Counselor, Career Planning and Placement at the University of Michigan in Ann Arbor. Mr. Halasz taught career planning, public speaking, and professional development to third year engineering students at VCU to prepare them for their summer internship. Dr. Heinz and Mr. Halasz recruited participatory companies for the summer internship program. They also created a strategic plan for permanent professional placement upon graduation. Mr. Halasz provided training in engineering-specific resume writing, job search, and interviewing skills. He also developed procedures and reports to document the success rate in the internship as well as satisfaction surveys from both the company and the student. Mr. Halasz was expert in assessment tools such as the Strong Interest Inventory, Meyers-Briggs Type Indicator, and more. The loss of Dr. Heinz, who had resigned earlier, was compounded when Mr. Halasz also resigned to accept a leadership role in placement services at Duke University.

The first 15 graduates in mechanical engineering and their initial career choices are shown here:

Ed Buchanan (Infilco Degremont, Richmond, VA)
Tonya Chambers (Infilco Degremont, Richmond, VA)
Robert Croft (graduate student, University of Cincinnati)
Chris Groome (ABB, Richmond, VA)
Erin Henretta (Capital One, Richmond, VA)
Adam Huitt (Hewlett-Packard, Ft. Collins, Colorado)
Arthur Hudgins (Hamilton Beach-Proctor Silex, Glen Allen, VA)
Louise Merz (graduate student, University of Cincinnati)
Eric Moore (Colonial Mechanical, Richmond, VA)
Michael Nadeau (Dupont, Richmond, VA)
Dennis Perry (Kelly Vacuum Technologies, Richmond, VA)
Jason Pfeiffer (Philip Morris, Richmond, VA)
William Smith (CCRD Partners, Richmond, VA)

Robert Snodgrass (graduate student, Georgia Tech)
Corrie Spoon (graduate student, VCU, Biomedical Engineering)

The first 24 graduates in the class of 2000 in electrical engineering embarked upon their new careers as follows:

Benjamin Abbott (Jet Propulsion Lab, Pasadena, CA)
Omar Daniel (Galaxy Engineering, Atlanta, GA)
Tejinder Gill (Philip Morris, Richmond, VA)
Fahad Harhara (University of Miami Business School, MBA program)
Nathan Harness (Carter Power Machinery, Mechanicsville, VA)
Kasra Hedayatnia (VCU Business School, MBA program)
Danielle Johnson (Philip Morris, Richmond, VA)
Takeisha Lester (Virginia Power, Richmond, VA)
James McAvoy (Hughes Aerospace, CA)
Ryan Mitchell (IBM, East Fishkill, NY)
Mike Morris (VCU, School of Engineering, graduate program)
Wade Nye (University of Virginia Business School, MBA program)
Thomas Oliver (Carpenter Company, Richmond, VA)
Jesus Ortega (WhiteOak Semiconductor, Richmond, VA)
Sirisha Reddy (University of Illinois/Urbana-Champaign, MBA program)
Jason Roe (ERNI Components, Chester, VA)
Dmitriy Shneyder (IBM, East Fishkill, NY)
Shahab Siddiqqi (IBM, East Fishkill, NY)
David Sena (Philips Semiconductors, Richmond, VA)
Sinoun Sot (Virginia Power, Richmond, VA)
Robert Staples (Motorola, Austin, TX)
Ryan Stege (Norfolk Southern, Roanoke, VA)
Aklil Tesfaye (LLC, Inc., Reston, VA)
Jerry Walsh (East 3, Richmond, VA)

The first 13 graduates of the Class of 2000 in chemical engineering embarked upon their new careers as follows:

Marty Agpoa (Foster-Miller, Waltham, MA)
Catherine Branch (Corning, Charlotte, NC)
Heath Case (Dupont, Richmond, VA)
David Colby (PhD student, chemical engineering, MIT)
Joel Goldsmith (VCU School of Business)
Tuan Hoang (Dominion Semiconductor, Manassas, VA)
Stephen Hertzler (law student, George Mason University, Fairfax, VA)
Tracy Madison (Philip Morris, USA, Richmond, VA)
Mike McKittrick (PhD student, chemical engineering, Georgia Tech)
Joel Passmore (Scentzar, Richmond, VA) J
ason Peterson (Dominion Semiconductor, Manassas, VA)
Samuel Anin (Dominion Semiconductor, Manassas, VA)
Rafiq Zabrani (Proctor Silex, Richmond, VA)

Accreditation

The Accreditation Board for Engineering and Technolgoy (ABET) is composed of faculty and practicing engineers who volunteer their services in the development of criteria and then on-campus inspections to see that the criteria for accreditation are being met. Up until the early nineties, accreditation had been somewhat of a bean-counting exercise. A program had to have so many hours of chemistry, so many hours of math, and so on. The quality of these hours was judged by the visiting team of evaluators from ABET. From 1997 – 2000 each institution requesting accreditation of new programs or reaccreditation of old programs was given the option of requesting this process either under new rules or the old rules. Under the new rules, accreditation would be more of an outcomes assessment, a totally new idea for most engineering educators. Bean counting would be dropped. Rather each school would develop its own goals which might or might not require x hours of math as had earlier been the case. Accreditation would be based upon an assessment of the outcome rather than an assessment of the input as before. The accreditation visit for the new programs in chemical, electrical and mechanical engineering at VCU would occur in the Fall of 2000, and the Chairs and Deans of the VCU School of Engineering voted unanimously to proceed under the new rather than the old rules. Most of the Chairs and Deans had gone through accreditation drills at their former institutions, but this was, of course, under the old rules. So accreditation at VCU was a learning exercise for everyone involved. Beginning in 2001, all accreditation adhered to the new rules.

The visiting team of ABET inspectors composed of persons from both academic and industrial backgrounds personally interviewed students, faculty, and administration (including President Trani) in the Fall of 2000. Official notification of full accreditation of all three programs came by letter to Dean Robert J. Mattauch in August of 2001. The next general review will occur in 2006-07. Re-accreditation is on a six-year cycle for engineering schools. Full accreditation was a fine achievement for a school that had begun from a green field and had accepted its very first freshman in the Fall of 1996 or just five years before. The degrees of the first graduates in the classes of 2000 and 2001 were accredited retroactively.

The undergraduate program in biomedical engineering began in the Fall of 1998. The visit of ABET inspectors for this fourth undergraduate program at VCU occurred in the Fall of 2003 after the first group of graduates had appeared. BME expects full accreditation in the Spring of 2004.

Licensed Engineer

Holding a degree from an ABET accredited institution is a pre-requisite for anyone wishing to take the written Fundamentals of Engineering (FE) examination as the first step in becoming a Registered Professional Engineer. The best time to take an exam on engineering fundamentals is during the last semester of school when this sort of information is fresher in one's mind than it will likely ever be again. The board that administers the examination in Virginia kindly allowed students in the first two classes at VCU to sit for the examination prior to official accreditation. Students were to receive their scores and be granted the Engineer in Training (EIT) designation only after accreditation was complete. Two students in the class of 2000, both in mechanical engineering, elected to take the examination. For the class of 2001, a for-credit review course for the examination was offered which attracted 30 students.

Monroe Campus

Phase I of the building program sought a facility largely devoted to undergraduate education in chemical, electrical, and mechanical engineering. But an outstanding faculty in engineering must be heavily devoted to research. Additional laboratory space is essential to the continued development of the VCU School of Engineering. This additional space represents Phase II of the building program. Like Phase I, it must also be privately financed.

Although it is still in its early stages; a major new plan for expansion would bring together the School of Engineering and the School of Business. A major campus expansion for VCU is being considered that would be located immediately across Belvidere Street from the present engineering building and which would occupy a 13.5 acre area between Main and Canal Streets. If things come together as planned, the $179 million development would include a new home for the business school, Phase II of the engineering complex, dormitories, a parking deck, and an executive leadership and conference center.

Computer Science

An undergraduate program in computer science existed at VCU as part of the department of mathematics within the College of Humanities and Sciences. It had become increasingly obvious that their faculty and their students had a much greater kindredship with their counterparts in engineering, and, in particular, with computer engineering which was developing within the electrical engineering program. The entire program of computer science of 8 faculty, 35 graduate students, and 345 undergraduate students was moved into the School of Engineering effective with the Fall semester of 2001. It was a welcomed addition. The engineering building however was not designed for this eventuality so classroom and office space is now very full.

Students

The student body in the new School of Engineering has gown in both numbers and quality as is evident in the Table below.[15]

	Total Enrollment	Freshman SAT (75th Quartile)
Fall 1996 (First class)	158	1235
Fall 1997	288	1290
Fall 1998	381	1300
Fall 1999	458	1320
Fall 2000	564	1270
Fall 2001	1032	1220
Fall 2002	995	1270

15 Data courtesy of Mr. Alan R. Sachs, Institutional Reporting and Analysis, VCU.

Freshman in BME appeared for the first time in the Fall of 1998, and the transfer of the program in computer science from the College of Arts and Sciences into the School of Engineering produced a large increase in enrollment in the Fall of 2001. The 75th quartile means 25 percent of the entering freshman class that year had SAT scores greater than the listed number.

Research

Governor Mark Warner, a former venture capitalist himself, has argued that Virginia must build world-class research programs if we are to stay competitive in a knowledge intensive economy. Our universities must do much more than we have done in the past. The Governor has set a goal of $1.0 billion per year in research expenditures at Virginia's universities by 2010 or double our volume of research of $577 million in 2000.

Notwithstanding the original goal of $250,000 in research per year per faculty, the orientation toward research in our School has developed unevenly. In one program, a young assistant professor was promoted and tenured even though having produced very little in research grants and contracts. While faculty in another program had expenditures for research averaging $365,000 per year per faculty member. This was significantly more than similar averages at Virginia Tech or UVA or at the SCHEV approved peer universities of VCU. The research imbalance was clear within a program as well. For example in a single year one faculty alone had garnered $1.7 million in research grants while the remaining 11 faculty in his program altogether had garnered $400,000. These numbers are snapshots in time and thus not rigorous. Trends are, however,evident. The development of a "teaching faculty" separate from evident. The development of a "teaching faculty" separate from a "research faculty" would be counterproductive and surely lead to problems.