It is an honor to be invited to deliver the 2001 Vecellio Distinguished Lecture and to be here with so many members of the Vecellio family and friends whom I have known for a long time. I was fortunate to meet Mr. Vecellio Sr. back when I was head of the Via Department, which was important to me since he was one of the most successful graduates of the department. We once gave him a tour of our facilities and proudly told him about our research using sophisticated geographic information systems that allowed job systems to accurately track the location of construction equipment at any given time. Mr. Vecellio listened carefully and then reduced our rhetoric to what it meant to his bottom line: “I like this. I have always wanted to know where my employees were driving our trucks off to at lunch.”

It is also my pleasure to know Leo Vecellio Jr., who added to the distinction of getting his bachelor’s degree here at Virginia Tech, by attending Georgia Tech for his master’s degree. Leo is one of the prominent people who serve on my national advisory board at Georgia Tech.

What is obvious about this family is its longevity in success in the highly competitive construction industry, and its willingness to ensure that others have the same opportunity through the generous gift they are making to Virginia Tech in establishing this lecture series and its supporting endowment. Even though my job is raising funds for Georgia Tech these days, I could not be more pleased about this event, since my family and I feel we owe much to Virginia Tech for the support we received while we lived here.

It was a special pleasure to be asked to deliver this lecture given my history with the Construction Engineering and Management Program here at Virginia Tech. I have continued to take great pride in the way this program has developed and matured. Even though it is only fifteen years old, it is recognized as one of the nation’s best, and it is led by an outstanding faculty each of whom has won national prizes and recognitions. It was my pleasure to have helped recruit two of them, first Mike Vorster and then Chema de la Garza. I still have vivid memories of Mike’s interview. He came here during February from his home in sunny and warm South Africa. As I walked him to his car when he was leaving, it was snowing pretty heavily, so much so that it was
piling up on Mike’s bare head as we exchanged parting comments. Thinking I needed to do something to counter this image and trying not to speak a mistruth, I said, “It normally doesn’t snow a lot around here.”

Now, this did put me on the thin ice as far as being fully candid with Mike, but I felt it had enough of an element of relativity to it to be true. After all, I knew it does snow a lot more in Floyd County than Montgomery Country, and if Mike came to Virginia Tech he would see the truth in this. Well, somehow I think Mike had figured it out anyway, and the proof of it was that he sold it to Merle and their wonderful family and they came. Even though it snowed 20 inches during the first week after their arrival, they were gracious enough to not mention my little exaggeration and Virginia Tech was the winner in the long run.

(SLIDE #2: CITY AT NIGHT)
I have been invited here today to speak with you about the future of our built environment and the construction enterprise that is essential to it. Let’s admit up front that this is not always on the top of our agenda as a society. Most of buzz at technology institutions like Virginia Tech and Georgia Tech these days is about biotechnology, nanotechnology, and information technology. But as the events of September 11 so tragically and dramatically illustrated, the future of our society also rests on technologies that are more basic to its functioning. And it is as inevitable as rain that the combination of a growing world population, the changing needs of society, and the perplexing human tendency to delay dealing with infrastructure and environmental needs until they have reached crisis proportions, mean that the need is building for civil engineering and construction engineering and management. So I think it is timely for us to take a hard look at the built environment that society will need in the future, the human capital we will need to fulfill those expectations, and how we will get there from here.

(SLIDE #3: GOLDEN GATE)
The magnitude of society’s demands for a built environment is reflected in the sheer size of the construction industry, which accounts for 8.25 percent of the gross domestic product. And that portion has been growing. The news media have often emphasized the massive size of the health care industry as they covered its problems. But only if you add in the cost of social services to that industry, does it reaches the equivalent of construction. The utilities industry, by comparison, takes in about $412 billion in annual revenues – about half of the value of what the construction industry builds.
Here in Virginia, the construction industry exceeds health care and social services, which is a $19 billion industry, and it runs far ahead of utilities, which is a $10 billion industry. And while Virginia’s overall state economy accounts for 2.60 percent of the U.S. economy, your state construction industry accounts for 2.66 percent of the national industry. It is vital to the health of your state economy and its future.

Today’s construction industry and the educational infrastructure supporting it derive from an earlier time. Before we think about how we might change what we are doing, it behooves us to take a closer look at the challenges that lie ahead. I hope to illustrate that we are facing a number of growing problems with our built environment – problems that will come home to roost early in this new century and that must be addressed if our nation and the world are to prosper.

By the calculations of the United Nations, the population of the world reached six billion on October 12, 1999. It took all of world history up until the early 1800s to reach the 1 billion mark. The second billion took nearly a century. The most recent billion was accomplished in about 12 years. Fortunately, the birth rate around the world has already begun to slow. The next billion is projected to take 14 years instead of 12, and sometime during the latter part of the next century, the UN hopes the world population will peak at 10 billion, then begin to decline, although this is based on some hopeful assumptions.

Even if the optimistic projections hold, the question remains of how to accommodate an additional four billion people in the next 50 years. Architects, engineers, and the construction industry have traditionally planned, designed and built what society required in the way of housing, transportation, water and energy supply, and other infrastructure. Yet, it is unlikely that yesterday’s technologies will suffice for tomorrow’s challenges.

Not only is the human population growing, it is also aging. While it is still not clear just how much tinkering our delicate, interdependent biological systems will tolerate, life expectancy will definitely increase dramatically. The confluence of an increasing life expectancy with a declining birth rate will cause our population to age rapidly.

are confronting demographic changes so substantive that they could redefine economic and political systems in the developed countries over the next generation.” Certainly an aging population will call for a new perspective on the design and construction of housing, transportation, and public structures in the coming years.

(SLIDE #8: AERIAL RIVER)
One of the most essential resources to support life is water, and supplies are now being depleted faster than they are renewed. Water tables are falling in China, India, and the United States, which together produce half of the world’s food, and an increasing number of rivers are bled dry before they reach the sea. By the year 2025, three billion of the world’s people will live in places where fresh water resources have fallen below sustainability levels.

(SLIDE #9: WATER QUOTE)
Lower population density has protected the United States from the severe problems experienced in places like India, but we are not far behind. There are no easy answers to the challenge of providing an adequate water supply, and we cannot simply extrapolate what we have done in the past into the future. We need to call upon a new generation of engineers to develop and construct the facilities needed to sustain our society.

(SLIDE #10: INFRASTRUCTURE)
Here in the United States, we have infrastructure problems as well as supply problems. The dowager of American cities, New York, has almost 6,200 miles of underground water pipes, and by 2030, more than half of them will be over 100 years old. They now rupture 600 times every year, causing flooding and water cut-offs, and sometimes triggering street cave-ins and breaks in adjacent gas lines. This is not uncommon in our major cities and represents a significant issue we must address if these nodes that knit our society are to survive.

(SLIDE #11: CDC QUOTE)
The Environmental Protection Agency estimates that America will need to spend $300 billion over the next 20 years to upgrade its water systems, and because little is being done, it will get worse before it gets better.

The same is true of the 160,000 miles of oil pipelines that criss-cross this nation. Some of them are more than 90 years old, and they leak more oil each year than spilled from the Exxon Valdez off the coast of Alaska. In January 2000, one of the nation’s leading pipeline operators, Koch Industries, was fined $30 million – the largest civil environmental penalty ever – for more than 300 separate leaks totaling more than 3 million gallons of spilled oil during the 90s.
All of this taken together is a multi-billion dollar construction problem that cries out for new, not old solutions.

(SLIDE #12: I-75/85)
The patterns of today’s built environment are adding, not subtracting to the issues. For most of the 20th century, land-use planning has been driven by the automobile. Affordable housing was out in the suburbs, and that’s where many Americans headed. While the U.S. population increased 30 percent over the past 30 years, the number of licensed vehicles increased 87 percent and the number of vehicle miles traveled increased 130 percent.

(SLIDE #13: BOSTON BRIDGE)
Boston’s six-lane, elevated Central Artery was built in 1959 to carry 75,000 vehicles a day. Today it carries more than 200,000, with 16-hour-a-day gridlock predicted by 2010. So Boston is spending more than ten years and many billions of dollars building a new Central Artery – a public works project on a scale comparable to the Panama Canal or the Trans-Alaska pipeline. This is one of many such projects needed if we are to deal with our growing transportation problems.

(SLIDE #14: AIRPORT)
Commercial air travel has also grown rapidly, and this crucial in linking mid-level cities like Roanoke with major cities so that commerce can thrive and people can live well in areas outside of a crowded metropolitan area. Last year saw 1.5 billion passengers worldwide, 650 million of them here in the United States. By 2015, airlines are expected to carry 3 billion passengers, with one billion of them here in the United States.

Growth in passengers, flights, and planes has already overloaded airport infrastructure, and the Airports Council International says the United States needs $10 billion a year in new infrastructure to keep up. Atlanta, which has the world’s busiest airport, is by itself undertaking a $5 billion construction program to upgrade its capabilities to meet the needs of the future.

(SLIDE #15: MARTA TRAIN)
Last year transit riders around the nation increased by 3.5 percent, while automobile usage remained unchanged. For the first time since the introduction of the automobile, public transit ridership has now grown faster than automobile usage for three years in a row.
California is often a bellweather for the rest of the nation. BART, the Bay Area Rapid Transit system, saw its ridership increase by almost 15 percent last year, and has several outlying communities clamoring for service. Riders are projected to triple from 300,000 a day to 1 million a day over the next 30 years. The challenge is not only extending the rail lines, but also getting the trains under San Francisco Bay, which is already a bottleneck. A new bay tunnel will cost about $10 billion, and the system also faces significant upgrades to improve its ability to withstand earthquakes. I happen to serve as a consultant for the on-going seismic upgrade of the existing BART system, and this in itself will call for expenditure of several billions of dollars.

(SLIDE #16: SKYSCRAPER)
The tragic events of September 11th raise yet another challenge for architects, civil engineers and construction engineers. We are now seeing the early stirrings of a national debate about whether new construction standards are needed to address potential terror attacks. How should the skyscrapers of the future be constructed? How can we design and build structures that will sustain heavy damage, but not collapse and kill thousands of people? A new generation of technology is needed to restore public confidence in the towering skyscrapers that are symbols for our civilization.

(SLIDE #17: WOODY ALLEN)
Taken together, factors like population growth, decaying infrastructure, increasing transportation congestion, and heightened security concerns represent a wave threatening to crest over our civilization. If you want to be more academic than Woody Allen, it sounds like Paul Ehrlich, the biology professor who has been making doom-and-gloom predictions since 1968. But none of them have yet come true, and that, I would like to believe, is because he fails to take the inventiveness of engineers into account.

(SLIDE #18: “ARMED”)
Like Woody Allen, I believe the new millennium offers a crossroads but I foresee a more optimistic set of options for us. To create these options will call upon the best engineers have to offer and require a different mindset.

(SLIDE #19: TECH ANSWERS)
The problems of the next century require new solutions. We will not solve traffic congestion by adding more lanes to a freeway that already has ten. We will not be able to build infrastructure fast enough with the same old materials and paradigms for project management.
We must look to technology for most of our solutions, and while civil engineering and the construction industry may give form to the new solutions, the technology that drives them often may lie elsewhere. The arithmetic is simple. Research and development monies are pouring into areas like biotechnology, nanotechnology, information technology, and advanced communications. Our response must be to build from our own technology where possible, but draw from fields that are advancing faster than ours as well. Given the circumstances, technology transfer will be the mother lode for our future, so let’s take a look at the possibilities.

(SLIDE #20: BIOTECH)
The 21st century has already been declared the age of biology. The medical improvements of the past century doubled the world’s average life expectancy, but biomedical engineers assure us that was chickenfeed compared to what they will accomplish over the next hundred years. While we microbes are used routinely to address problems like cleaning up oil spills, biotechnology also has potential for the development of new construction materials and new approaches to buildings themselves.

(SLIDE #21: IT)
The computer’s first major impact on civil engineering came in the 1960s, when its ability to solve large sets of simultaneous equations enabled engineers to use finite element analysis to explore a wide variety of “what if” scenarios. For the first time, civil engineers could project the interactions of the shear walls that are the backbone of concrete-framed and some steel-framed buildings. Today, computers not only calculate “what if” scenarios, but they offer three-dimensional modeling programs that allow civil engineers to see their cyber-structures respond to a host of forces from earthquakes to hurricane force winds.

Yet much more is still to come as computing power and optical and wireless networks continue relentlessly to double in power every two years. Computer driven robots have already made testing safer at sites with hazardous materials, and they will help to improve construction productivity and safety. Engineers and construction managers on site will soon enter information routinely by voice into project management programs on computers at their home offices.

(SLIDE #22: SMART BLDG)
We now construct “smart” buildings that are wired to serve technology needs while saving energy and water, and maintaining constant internal environments. New York’s “4 Times Square” skyscraper, built in 1999, has two 60-foot swaths of solar panels built into the curtain walls on its south and east sides – a first for a commercial spec building.
Nearby “3 Times Square,” which was named “Best Commercial Project of 2000,” is even more energy-efficient. Its chiller plant is designed to use more than one kind of fuel, and it is configured to incorporate fuel cells in the future.

The power, lighting, heating, air conditioning, security and fire protection systems of new buildings already talk to each other, and they are about to get even smarter. We are on the cusp of an age when building security systems will routinely read voices or palm-prints rather than keys or keycards, and computers will automatically adjust the inside environment based on how many people are there, where they are in the building and what they are doing.

(SLIDE #23: HIGHWAY CAMERA)
Computers and communication technology are also at the heart of one of the biggest advances in transportation engineering in the past five years – the creation of “intelligent transportation systems” a technology where you are national leaders. A variety of advanced sensing, computing and communications technologies handle tasks that range from collecting tolls to controlling traffic signals, and they are integrated into coordinated systems that manage traffic flow.

(SLIDE #24: VIRTUAL REALITY)
In addition to incredibly diverse uses for computers, we are seeing astonishing computing advances that go beyond sheer power – advances that are destined not only to match human intelligence, but also to change it. In his book, *The Age of Spiritual Machines: When Computers Exceed Human Intelligence*, computer guru Ray Kurzweil projects a virtual reality environment that uses neural implants to intercept and intervene in the signals that pass between the brain and sense organs like eyes, ears, nose and skin.

(SLIDE #25: BRAIN SCAN)
These devices will not only correct some sensory disabilities, they will also enable all humans to use virtual environments as creative devices to help us design and create. Those of us who are already having senior moments can imagine getting our neural implants as soon as they are advertised to do mundane things like helping us remember the grocery list. But those on the cutting edge can foresee shared virtual environments helping engineers and architects to “think” together to find the right approach to design of a new building. I know for some this is hard to visualize given that architects and engineers fairly consistently use different sides of the brain. Perhaps in the beginning we would have to have big people in the room to prevent bloodshed, but hopefully the possibilities would overcome the improbabilities.
New materials will also change construction dramatically. Back in the 1960s, civil engineers were struggling to create concrete shells for the irregular, double-curved roof of the TWA terminal at Kennedy International Airport in New York. For those who still want a poured, formed roof today, there are stronger, faster-setting materials that use resins and polymers instead of portland concrete. But a wide variety of other new materials now adorn irregular rooflines. The Denver Airport terminal, opened in 1995, has a tensile fabric roof. London’s Millennium Dome, opened in 1999, features 90,000 square meters of glass-fiber fabric coated with polytetrafluoroethylene and stretched across a web of 2,600 stressed cables.

New materials are making today’s bridges longer, stronger, and lighter than ever before. They are decked out in slim box girders, lightweight concrete, high-performance steel, epoxy-coated cable strands, and composite prefabricated anchorages.

Within the past several years researchers have learned how to lace materials with optical fibers that contain strings of sensors. Data from the sensors passes along the fibers to an opto-electronic data processing unit. Optical fibers and sensors were pre-cast in the pre-stressed girders of a bridge now under construction on Interstate 40 near Albuquerque, New Mexico. The fiber-optic sensors enable precise strength measurements as the concrete cures, is trucked to the site, and performs under use in the bridge – monitoring shrinkage, creep, and other processes that cause high-performance concrete structures to weaken.

A new bridge on the Smart Road just outside Blacksburg has built in sensors designed to gather information about the environment around the bridge and alert motorists to potential safety hazards posed by the weather and other conditions. All of this calls for new generation construction engineering technologies.

The key to realizing the possibilities that new technologies offer and to their rapid implementation goes beyond beams and devices and into advanced management strategies. Today’s agile industries and corporations have adopted techniques that utilize teaming, partnering, entrepreneurial skills and Internet communications. Civil and construction engineering and the construction industry have been slow to adopt these new strategies. New strategies for construction management offer civil
engineering its place at the executive management table so that the young men and women who look to us for example can see exciting new career opportunities.

(SLIDE #31: STREAMLINING)
Traditional approaches emphasized a separation between owner, designer, project manager, and contractor. Paul Teicholz of Stanford University’s Center for Integrated Facility Engineering has cited this piecemeal approach as one of the reasons why productivity in the construction industry declined by 0.5 percent a year from 1964 to 1998, while other industrial productivity increased by 1.7 percent annually.

This old model of construction is a good illustration of the phrase, “complacency is sure death, but complexity is slow death.” It is too disjointed and cumbersome in the face of the pressing problems that lie ahead, and it also represents a strategy that does not appeal to today’s bright young people who have an entrepreneurial mindset and many other options for their career choices.

(SLIDE #32: DESIGN/BUILD)
Design-build started us in the direction of simplifying management of large civil engineering construction projects. Used correctly, it speeds project completion and saves money, and we have done that at Georgia Tech with two new buildings. Important as cost savings are to us as a public institution, saving time is even more imperative because of the new facilities we need to meet the demands of modern science and engineering. Our goal is to build one major building every year for ten years, and if these projects start to take more time than they should, the cumulative delay could erode our competitive position.

Design-build was developed as a way to fast-track projects, but we are realizing the broader value of its teamwork concept. Today, construction companies often operate on fixed bids and face severe penalties for delays, and the teamwork style that design-build uses can also help to control the flow of labor and materials needed to keep a project on track and on budget. Developers, civil engineers, construction managers, architects, contractors and owners are increasingly becoming part of a seamless team that smooths the way to a swift and reliable conclusion to a project.

(SLIDE #33: ONLINE)
The Internet provides a new tool to facilitate streamlining and teamwork. Of course, it is of no use to a construction manager here in Virginia to discover through an Internet search that the best prices on lumber are somewhere in Wisconsin. But the Internet can still save time by enabling that manager to make a rapid survey of local suppliers to find which one has what he needs at the best price, then place an order directly onto the
supplier’s computer. Forrester Research of Cambridge, Massachusetts, estimated that last year only half of one percent of the construction industry’s procurement process was online, but it expects that number to reach 10 percent within the next five years.

But procurement is only a small part of the online picture. We are seeing virtual construction management companies like Buzzsaw, Bricsnet and Citadon emerging. Like most dot-com start-ups, the early going has been bumpy, but it is still shaping the future. Construction giants AMEC, Bovis Land Lease, Hochtief, Turner and Skanska joined forces a year ago to create www.AECventure.com – a new online venture that aims to establish a workable business exchange among the various sectors of the construction industry. As the name indicates, the focus is on architecture, engineering and construction, but it also hopes to involve contractors, specialty contractors and even suppliers and manufacturers of building materials.

(SLIDE #34: QUOTE)
Information technology fosters also teamwork by allowing information to be shared widely and instantaneously. Web-based cameras on a construction site will allow management to observe activity on the site in real time, and everyone on the team can keep up with progress no matter where they are located.

(SLIDE #35: SMART CHIP)
Even our bulk materials and equipment will soon be smart. In the future, equipment and prefabricated bulk materials will have electronic chips installed that contain an entire life-long system of information. These “systems on a chip” will provide electronic inventory control and installation instructions for the construction phase, as well as automatic self-monitoring and maintenance and repair instructions for the long term. In fact, the final task of a construction manager may soon be to hand the building manager a CD that contains all of the information he or she needs to maintain the building through the years.

(SLIDE #36: SUSTAINABILITY)
The construction industry is also becoming greener. We used to view development as something that of necessity happened at the expense of environmental preservation. This is simply no longer acceptable.

(SLIDE #37: QUOTE)
As the population grows and our resources dwindle by comparison, we are coming to realize that any approach that is adverse to environmental preservation and resource conservation will be a dead end. We can no longer measure benefits against financial costs alone, but also against environmental costs. Civil engineering grew up at the place
where the building of human societies intersects the natural environment. As a result, sustainability calls for civil and construction engineers to be leaders, and we need to exercise that role while there is still time. Sustainable technology, processes and development reconcile these interests, so that we can work together to protect our environment while simultaneously supporting an economy that offers people meaningful work and enables them to provide for their families.

(SLIDE # 38: KERMIT)
But green materials are not always easy to find, and there are many shades of green. The “green” in concrete, for example, is diminished by the fact that manufacturing cement is very energy-intensive and produces greenhouse gases. Sustainability is also more than simply slipping in a green material here or there. It forces a team approach because it is a large umbrella that covers not only the work of civil engineers and construction managers, but also of our colleagues in architecture, in the manufacture of materials, the management team and in public policy.

(SLIDE #39: BUILDING TOWERS)
As we look ahead to the built environment of the 21st century, the environment isn’t the only thing that needs protecting. The World Trade Towers were deemed indestructible, but they were made largely of steel even though reinforced concrete would have been stronger and more fire-proof. Today new types of high-strength concrete and new systems to prevent overloading of underlying floors even though upper stories have collapsed can allow buildings to sustain unexpected damage, and can provide much higher margins of safety to help avoid the sudden and deadly collapse we saw in New York City. This development may ultimately lead to a large-scale rebuilding or rehabilitation program for existing buildings in major cities.

(SLIDE #40: EDUCATION)
The challenges society faces and the remarkable changes occurring in technology I have described to this point lead to the conclusion that the civil engineers and construction managers of the next millennium must be educated differently than in the past. The question is not if we must adapt, but how far and how fast can we move. We must look not only at what should be offered in a formal degree curriculum, but also at what enhancements should supplement this staple both during the collegiate experience and in the context of life-long learning.

(SLIDE #41: QUOTE)
Curriculum changes have already been underway for the past decade as engineering schools seek to respond to a new generation of industry needs. We are working to develop our students’ ability to communicate, function in teams, solve open-ended
design problems, and conduct hands-on laboratory work. The revision process is not yet complete, nor has it arrived at a finished or perfect form. I suspect it never will.

But even as we are still implementing the last decade’s reforms, we can now see the need for civil and construction engineers to learn about biology, information technology, advanced materials, sustainable technology and entrepreneurial management techniques. The challenge is large, but the good news is that addressing it will be exciting and will make our profession more essential to the future.

(SLIDE #42: LAPTOP)
Incorporating all of that is going to be required of our engineers in the future into the conventional four-year curriculum is nigh unto impossible. While adding the requirement of a master’s degree, as advocated by some, is one place to start, we need to broaden our sights and think of formal university studies as the beginning of a longer education process that is continued throughout one’s career. Through distance learning, continuing and executive education and certification courses, universities and other entities will need to work together to offer the educational opportunities needed to help people adapt to and effectively use our rapidly changing technologies. We can no longer stick our heads in the sand and declare our engineering graduates ready for practice after four or five years of classroom experience.

(SLIDE #43: CONTRUCTION SITE)
And, while we are adding more to the curriculum in the way of technology, let me add a final point by making the case for a different aspect of engineering and construction education that I believe should not and cannot be lost in the shuffle – the teaching of the practice of engineering. Our minimal goal for our graduates is to leave our hallowed halls able to make all of the essential calculations and basic decisions expected for the beginning engineer. We also should have prepared and motivated them to grow to the next level or we have failed in our work. To this end we should as civil engineers know that the whole point of the exercise is to actually build something, not just make calculations or talk about it. This involves much more than good design practice, it involves ethics, making good and timely decisions, understanding how to communicate, doing what is needed to protect the best interests and safety of the public, and appreciating what it takes to get something built. This latter business relates to money, the importance of time, how pieces of a project fit together, understanding the frailties of human systems, appreciating the need for compromise, and knowing how all of this folds together.
(SLIDE #44: PRACTICE)
These issues distinguish the practice of engineering from just plain engineering, and it is a special challenge for research universities to ensure they have the faculty who can teach the practice of engineering. They have to be hired with a view to the big picture or groomed carefully from within through the help of seasoned faculty mentors. I would offer Mike Vorster as a case in point of a faculty member who brought real life experience to the educational environment and energized hundreds of civil engineering students who otherwise could well have walked away from our profession.

This is a perspective that I first encountered first hand when I was lucky enough to be asked to join the Stanford civil engineering faculty. Stanford had one of the nation’s first construction management programs, and even today one of its best. The faculty to a person were at that time all people with experience in the construction industry and they asked me to join with them in teaching a group of courses that not only were predicated on theory, but were about building things and the process involved in this creative activity. During the course of this experience I realized that no civil engineer should graduate without exposure to what was involved in building whatever it was they were designing.

At Virginia Tech in the Via Department of Civil and Environmental Engineering, your construction engineering and management program offers you a leg up on the competition in being able to do it right. You also are fortunate to have other faculty in your other specialties who bring the talent of combining experience with theory in a way that enables them to do that very special thing – teach the practice of engineering. Do not underestimate the power of this capability. Few have it and you should do all you can to sustain it.

(SLIDE #45: KENNEDY)
If you have been able to stay with me in this oration, you will share with me an appreciation that the 21st century will bring times of great challenge but also of great opportunity for the civil engineering sector and the construction industry. As we closed out the last century, the basic engineering industries, including construction, were losing their luster to new economy fields like biotechnology and information technology. Recent events have set in motion a correction process and more is to come as a rapidly growing world population appropriates more of the natural environment for its use; demands more water, energy, waste disposal and transportation resources; produces more pollution; and expands its exposure to natural and man-made hazards. American society is coming face to face with infrastructure needs and environmental problems that have already been neglected for too long.
With many of the world’s resources already stretched precariously thin by the juggernaut of population growth, we have entered a make-or-break era in which the die will be cast for the next millennium. Civil and construction engineers clearly have a major role to play in creating a safe and sustainable built environment for a growing population. Innovative technologies spinning off from fields outside of civil engineering will offer new and creative tools to address the issues facing us and can energize the talented young people we need to do the important work of the future. My optimism for the future of civil and construction engineering is based on the exciting potential that we have arrayed before us. All we have to do is make the right decisions and the time to start is now.

In closing, thank you for inviting me to deliver the Vecellio Distinguished Lecture, and I look forward to continuing to hear of the great things you are doing here in the Via Department of Civil and Environmental Engineering.