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"Is There a Crack in the Darkened Glass Ceiling?"

by

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Good evening, ladies and gentlemen. I am delighted at this opportunity to participate in the 69th Annual Conference of the National Technical Association (NTA). Like many of you, I take a profound personal interest in periodically re-examining the status of minority women in science, engineering, and technology, and I place a high value on stimulating the recruitment and retention of minority women in science-based careers. Programs such as this conference and job fair--not to mention the awards dinner this evening for Top Women in the Sciences and Engineering--are both a testament to our success and a source of inspiration. I am honored to be your guest speaker this evening. I have entitled my presentation, "Is There a Crack in the Darkened Glass Ceiling?"

"Colored girls should learn a trade." The year was 1965; I was a college freshman at the Massachusetts Institute of Technology, deliberating on what my major would be--newly separated from the support system of my family and my community back in Washington, DC--one of two African-American women in a class of 900--and the person addressing me with this particular bit of career advice was an MIT professor. How does a young woman, eager for success but also desirous of support and respect, respond to so denigrating a suggestion, to so vivid a depiction of a darkened "glass ceiling"? Why a darkened "glass ceiling"? I will tell you, but first, I will tell you my response. I chose a "trade": I chose physics! Four years later, my friend, Dr. Jennifer Rudd,

and I became the first African-American woman to graduate from MIT. She went on to become a physician. I remained at MIT as a graduate student, and received my Ph.D. in theoretical elementary particle physics in 1973, the first African-American woman to receive a doctorate from that institution.

Despite any personal or public success I have achieved since then, that single offhanded remark--"Colored girls should learn a trade"--made a profound and long-standing impression on me. I would not be mentioning it this evening if had not. I would like to use that remark as a lead-in to my topic this evening: the darkened "glass ceiling" that has existed for women and minorities, especially minority women, in science and engineering fields--that is, the intangible barrier that can exist within any hierarchical system, which prevents women or minorities from rising beyond a certain level of achievement and recognition. I refer to a darkened "glass ceiling" because if we are subject to it, we often cannot see beyond it. We do not always know what is on the other side or who is on the other side--but we do know that it is keeping us from where we think we want to go, and we would like the opportunity to see.

I would like to examine ways in which cracks have occurred and can continue to occur in this darkened "glass ceiling," from three angles: (1) the historical perspective in America; (2) the direct contributions of scientific and technical careers to the minority community; and (3) the elements needed for continued progress.

I. The Historical Perspective in America

A review of early science and technology in America reveals three facts germane to our discussion. First, the pursuit of a purely scientific career was neither easy, nor of immediately evident benefit in a society struggling to survive. Most early American practitioners of science were gifted amateurs with time to indulge their personal interests and thirst for knowledge, supported only by their own internal drive and curiosity. Second, despite the cultural biases of that time, African-Americans were represented in this group of early scientists. A personal favorite is Benjamin Banneker, a free African-American in 18th Century America who excelled in mathematics, studied astronomy, wrote almanacs, and assisted in surveying the land, planning the layout of streets, and selecting building sites for the District of Columbia. As a child, I found Banneker fascinating because, like me, he loved math and he lived in Washington, D.C. Dr. Ernest Everett Just, the son of a builder of wharves and a teacher, is another example. Dr. Just graduated

from Dartmouth in 1907 at the top of his class with a degree in zoology, and later became the head of the Department of Zoology at Howard University. Dr. Just performed seminal work in cell biology at the Woods Hole Oceanographic Institution in Massachusetts, working there only in the summers because he could not obtain a full-time position, but nonetheless managing to publish over 70 scientific papers. These accounts strikingly illustrate my third point related to early American science: female scientists, especially African-American women, are absent from the record.

That is not to say that women were absent from early American technology. Technological pursuits were a matter of survival--activities like the building of houses and roads, caring for the sick, planting and harvesting crops in ever more efficient ways, or food preservation. These endeavors were widespread, but were so decentralized in individual homes, fields, and business enterprises that their practitioners remain anonymous. Despite this gap in biographical records, we can infer that women, including minority women, played an extensive role in health-related fields, as well as in food production and preservation--areas traditionally the concern and sphere of women. However, as the fields of technological inquiry became more specialized and industrially oriented in the late 19th Century, technology became more exclusively the province of men, including a few African-Americans like Granville T. Woods, who put his mechanical aptitude to work first in a machine shop, then in 1872 on a railroad, in 1874 on a rolling mill, and later by studying mechanical engineering in college. By 1880, Woods owned his own shop in Cincinnati, and in 1887 received patents for an improved steam boiler furnace and the synchronous multiplex railway telegraph. He sold his apparatus for electrically transmitting messages to the Bell Telephone system, and his electric railway to the General Electric Company. Offered a position by Thomas Edison, he chose to remain independent, and marketed most of his inventions through his own company, the Woods Electric Company.

African-American women are not represented in the records of advanced scientific and technological accomplishment until the 1930's and 1940's. Early trailblazers included Ruth E. Moore, the first African-American woman to earn a doctorate in bacteriology (from Ohio State University in 1933); followed by Ruth Beckham in psychology (from the University of Minnesota in 1934); Flemmie Kittrell in nutrition (at Cornell in 1935)--who went on to serve as a consultant to the U.S. State Department in conducting a nutritional survey of Liberia and five other African nations in 1947-1948; Jessie J. Mark in botany (at Iowa State in 1935); Roger Arliner Young in zoology (at the University of

Pennsylvania in 1940); and Mary Maynard Daly in Chemistry (from Columbia in 1948). The accomplishments of these African-American women, and others who followed them, paralleled a growing U.S. awareness of the importance of scientific inquiry.

As World War II approached, and eventually engulfed the normal patterns of daily life, an unprecedented demand arose for human resources (including women) trained in science and technology to perform important military-related work for the government. Despite the internal drive that had led many women to pursue independent careers in science, the demand for a vast commitment of human resources--and in particular for women workers--could not be sustained. Although the end of the war enhanced the stature of science and scientists, it brought to an abrupt end the wide-scale participation of women in the industrial workforce.

Certainly, some scientifically trained women would find their careers in government service--including Dorothy McClendon, an African-American microbiologist who coordinated microbial research for the U.S. Army Tank Automotive Command for more than 24 years. Like nearly every scientific practitioner before her, she had the will to pursue her chosen career (in the biological sciences) despite obstacles, through the Tennessee Agricultural and Industrial State University, Wayne State University, the University of Detroit, and Purdue. Still another African-American woman who should be noted here is Evelyn Boyd Granville, born in Washington D.C. in 1924, who obtained a Ph.D. in mathematics from Yale in 1949--the first African-American woman to do so. She worked as a mathematician at the National Bureau of Standards, and as a consultant in numerical analysis at IBM in the 1950's. She retired as a Professor Emeritus from California State University. By virtue of her work in government and industry, Evelyn Boyd Granville was unusual for her time. The vast majority of Black women who achieved "firsts" in their personal education spent their entire careers at Black colleges, focusing on instruction.

These African-Americans were the precedent-setters, the pioneers, the visionaries, the ones who saw or created early cracks in the darkened glass ceiling before we even thought of it as a glass ceiling--before the American populace in general could envision even the possibility of a society in which women and minorities could take leadership roles in science and technology. What was it like to be one of those early African-American women of science? I am not sure that any of us can answer that question accurately, because of the unique conditions that so directly affected their careers, yet their lives clearly attest to an

overriding internal commitment to excel, to overcome obstacles that stood between them and their goals.

Like their careers, mine has had its seasons of prosperity. I was educated and began my career as a particle theorist. I later became a condensed matter theorist, conducting research for 15 years at AT&T Bell Laboratories. In the Spring of 1995, in the space of a few months, I went from being a Professor of Physics, at Rutgers University, to become a Commissioner of the U.S. Nuclear Regulatory Commission (NRC)—and two months later, in July 1995, to become the NRC Chairman—both the first woman and the first African-American to hold that position.

My early years as an undergraduate at MIT--1964 to 1968--were tumultuous ones, sometimes triumphant and all too often tragic. As you are all aware, the Spring of 1968 was when Dr. King was assassinated. The murder of Robert F. Kennedy took place the week I graduated. In those years, we minority students pursuing careers in the sciences, engineering, and mathematics, were acutely conscious of just how small our numbers were. It takes a certain "critical mass," so to speak, for members of a group to feel that they form a community that can be supportive of one another, and in the early years, it was easy to feel isolated at times. My enrollment at MIT came before the Reverend Dr. Martin Luther King, Jr. had succeeded in influencing the government to establish a legal basis for equal employment opportunity. Neither the general public nor the well-educated elite had fully accepted minority women in a university like MIT, or in the workplace. Moreover, universities of that era were still in the process of learning that, to be effective in reaching out to minority populations, their obligations did not end when the acceptance letters went into the mail.

There is another side to the situation, however. Being a "pioneer" has its very positive aspects as well. I went off to college with a modest scholarship from the Vermont Avenue Baptist Church in Washington, D.C. I knew that the men, women, and children of that church had invested their money in my success, and only in part because they knew me and wanted me to succeed. They also saw me as a standard-bearer for the community, an individual who might help to lower barriers for other African-Americans coming after me. I knew, therefore, that I had the support of my community behind me, and at the same time, I also knew that I had taken on some real obligations, to people whom I could not think of disappointing.

Moreover, with the civil rights movement at its height, it was inevitable that the tiny minority of African-American students in places like MIT would feel a sense of solidarity with that movement. Without question, this was a source of strength,

reinforcing our resolve to achieve our own goals. Thus, if, at times, we felt lonely or demoralized, or weighed down by the expectations of others, we could remind ourselves that the struggle for equality was being fought on many fronts, and that we had a larger responsibility as well. If we were taking emotional and psychological risks, we knew that others--such as Dr. King, Fannie Lou Hamer, and Medgar and Myrlie Evers--were taking risks of a more direct kind.

As we compare the challenges that we faced three decades ago with what confronts students from minority groups today, some aspects clearly have become easier, though not all--there are some senses in which history repeats itself. I wonder, however, whether the students of today have the same sense of identification with a broader movement that helped to sustain us. Consider the brief history of African-American women in science that I have just outlined. What does this history have to say to those of you sitting here today? I will tell you: it says that not one of us breaks any glass ceiling alone. No matter what your personal struggle, your obstacles, your distractions, someone else has struggled before you, and in that sense, they struggle together with you. There is a continuum--your forebears created cracks in the darkened glass ceiling, through which you can see and pass. You are standing upon the shoulders of those who have gone before you. Therefore, a sense of history, a sense of identification with a centuries-old uphill battle, can itself become a weapon to ward off discouragement, to counteract the temptation to settle for less, or for mediocrity.

II. Direct Contribution to the Minority Community

The second perspective I would like to discuss is the direct contribution that scientific and engineering careers can and do make to minority communities. Besides any ceilings, or any direct holdback by others, the low numbers of minorities and women who pursue careers in science and engineering may be attributable to several factors. As a part of human nature, people feel more comfortable entering those segments of society where they see others who are like them. Economics also may play a part--given the expenses of education, students frequently are more attracted by fields such as law, that offer the prospect of comparatively fewer years of study followed by a more rapid payoff. In addition, highly talented individuals sometimes choose careers below their capabilities because of a fear of being too daring--a fear of failure.

I would like to draw your attention to yet another factor: the social pressure on a talented young person of minority background to choose a career that clearly is relevant to the needs of her or his specific minority community--a pressure that can, in its own way, sustain and reinforce the glass ceiling in fields of low

minority representation. As a student, I became quite familiar with this pressure. I would be challenged, sometimes rather forcefully, to explain exactly how physics--especially theoretical physics--was relevant to the African-American community.

I do not mean to imply that this challenge is a frivolous one. For example, where imminent social issues need to be addressed, we must have attorneys capable of bringing and defending cases, and drafting needed legislation, as a way to redress social inequities. For that reason, the law has been a natural pathway for motivated Black achievers. Medicine and education also have been frequent choices--again because of their direct contribution to the communities of their practitioners. The question is whether every member of a minority group should feel bound to choose a profession of direct and obvious benefit to his or her group.

I would argue that it is of profound value to our minority communities, as well as to the nation as a whole, that we have Native American, Hispanic, and African-American mathematicians, scientists, and engineers of renown. I think all of us are aware that the struggle against inequality and discrimination in this country is very far from over. For all the gains made, there is much, much more work to do. Discrimination and racial stereotyping continue in more subtle and covert forms. One form they take is the false and demeaning notion--not always articulated aloud--that minority group members do not have what it takes to succeed in certain fields.

This form of discrimination also occurs against women, of course. Not many Fortune 500 companies have a woman as CEO. European and Asian nations have elected Margaret Thatcher, Indira Gandhi, and Benazir Bhutto, whereas in our own country, only one woman has ever even received the nomination, by a major party, for the Vice-Presidency of the United States--and that was seen as a radical step. This disparity certainly is not rooted in an absence of talented American women!

Just as discrimination and injustice have taken more subtle forms in recent years, so too I believe that we must take a more subtle view of what benefits minority communities. Every African-American or Hispanic or Native American woman (or man) who succeeds as an astrophysicist or engineer, as a microbiologist or mathematician or computer scientist or chemist, is contributing to the well-being of her (or his) community, even if the specific work performed does not have an immediately observable impact on the social problems of the ghetto, the barrio, or the reservation.

Sooner or later, the message of individual achievement will make a community impact, as a source of pride to the elders, or as a source of hope and opportunity to the young. The young, in particular, need to feel that there is no field foreclosed to them, no glass ceiling intact. They must be afforded the chance to dream, and must feel that striving to make their dreams reality is worth the effort.

Moreover, every success sends a message to society as a whole, helping to break down the prejudices, spoken and unspoken, that imply a lack of capability for certain minorities in certain professions. When we contribute to disproving those prejudices, we benefit not only ourselves, not only the groups to which we belong, but our nation itself. The present and foreseeable challenges facing this nation simply are too great for society to ignore or to undervalue the capabilities of entire population segments. If we are to have a society worth passing on to our children, we must be sure that we engender an appreciation for one another as human beings with individual qualities, rather than peering through blinders of prejudice, inherited from the past.

For those of you who have chosen or are considering a career in science or engineering, I would urge you not to be dissuaded or disheartened by any who would tell you that such a career is irrelevant to the broader social concerns of your communities. Such advice is off the mark. The inner city, the barrio, the reservation, and yes, the suburbs do need teachers, doctors, lawyers, and social workers, to be sure; but the contributions of scientists, mathematicians, and engineers, in the long run, are just as vital. Many environmental, medical, and social problems cannot be resolved without strong scientific and technological input. Our communities must appreciate these needs, and support those who choose the path of science and related fields.

III. Elements Required for Continued Progress

In order for minorities and women to realize their full potential in professional fields of endeavor, three essential conditions must coexist and be sustained: (1) societal values must support the professional growth and development of all the human resources available within the society; (2) opportunity must exist to put training and education to practical use in endeavors worth pursuing; and (3) perhaps most importantly, within each individual must be a catalyst--a driving force that compels the individual to take on challenges and to excel despite obstacles. This last condition remains a critical path factor in the success of minority women in science and engineering.

Given the historical perspective already discussed, I believe we are closer to achieving the first two objectives than we have

ever been. Many studies, discussions, and actions have concentrated on formal organizational support and assistance to encourage more women (including minority women) to participate directly in science-based careers. This formal organizational approach has been an essential contributor to the progress of women in certain fields over the last decade, and it will play a continuing, vital role in the future. I also would suggest that we are experiencing a change in employer perceptions toward women. Most business and governmental organizations increasingly are recognizing that, if they are to compete successfully in a global political and economic setting, they must utilize all of the best resources available to them, especially human resources, both male and female.

Are worthwhile science and technology careers available to engage the talents and interests of minority women? I believe the answer is yes. You are here and I am here. Moreover, I would offer the U.S. Nuclear Regulatory Commission (NRC) as an excellent example of an organization in which unique career opportunities exist, in an area where women--much less minority women--historically have not been well represented: the nuclear enterprise. The NRC is an independent regulatory agency created by the Congress in 1975 (after the Atomic Energy Commission was abolished) to regulate the civilian uses of nuclear material. The NRC mission is to ensure adequate protection of the public health and safety, the common defense and security, and the environment in the use of nuclear materials in the United States. Specifically, NRC regulatory oversight extends to the operation of nuclear power plants and fuel cycle facilities; the operation of non-power research, test, and training reactors; and medical, industrial and research applications of radionuclides. We also have licensing and oversight responsibility for the storage, transportation, and disposal of low-level and high-level radioactive waste. NRC activities include licensing, rulemaking, inspection, and enforcement. Our budget is just less than \$500 million, but the industries we regulate represent a net capital investment of hundreds of billions of dollars, and the issues we address are critical to the health and safety, and well-being of our country.

At full complement, at the top of the NRC are five Commissioners who are nominated by the President and confirmed by the Senate. They have policy formulation, rulemaking, and adjudicatory authority and responsibility for the Commission. The NRC technical and legal staff carries out a regulatory program based on Commission decisions, which in turn are rooted in the law. The President appoints one of the Commissioners as Chairman, who, in addition to having the Commissioner collegial responsibilities, is the principal executive officer of the Commission. This involves specific managerial, administrative, and budgeting responsibilities, including ensuring that the staff

carries out the policies of the Commission. The Chairman also is the official spokesperson of the agency, the primary Congressional point of contact, and consensus builder. Finally, the Chairman is the principal U.S. government representative abroad on nuclear safety matters. I am that person.

In some minds, particularly in an era when government is not viewed as favorably as in the past, the concept of an independent regulatory agency conjures up an image of prolonged legal proceedings, tedious and arcane rules, and a mission that the regulated community--and therefore the country--probably would be better off without. On closer examination, however, the NRC is predominantly a technical agency, with engineering and scientific positions far outnumbering others. We do have a large complement of lawyers, given the legal nature of our regulatory responsibilities. Moreover, the NRC, by reputation, is the world's foremost independent nuclear regulatory body, whose technical activities, organization, and structure are widely emulated internationally. The NRC, therefore, makes an excellent case study of the kind of challenges and opportunities that the world of science and engineering offers to its practitioners, including the minority women who work there.

With continuous support from senior management over a considerable period of time, working through extensive recruitment programs and an ambitious career development program, the NRC has evolved from a predominately male-oriented employee population to one in which today over 37 percent of our employees are women. More notably, the ratio of women filling non-clerical professional positions has increased substantially--lawyers, computer specialists, health physicists, safety inspectors, and civil, mechanical, electrical, chemical, and nuclear engineers, among others. A significant number of NRC women are minority women, including some from developing countries in Asia and the Indian subcontinent.

In short, the NRC is a reflection of my earlier contention, that with the makeup of the U.S. workforce changing, and with an ever growing need for insightful and well-trained minds in industry, academia, and government, it will be imperative for organizations to seek out the best of human resources, regardless of race, gender, color, or creed. At the same time, while the continuing globalization of commerce challenges our domestic economy, it implies that talent can be tapped from anywhere.

So I ask you: How will you measure up in our diverse society? In a global economy? Will you strive for equality, through excellence, and create your own futures? Or will you wait for others to define it for you?

These questions introduce my final point of emphasis, the third element required for finding and creating cracks in the darkened glass ceiling: the motivation from within, the inner source of strength in each of us, comprised of passionate interest, personal ambition, staying power, and multicultural awareness. Every successful career begins with a dream that must be nurtured and molded into a full-blown vision. That vision must be strong enough to face the concrete challenges of one's environment, enduring enough to sustain the sacrifice and hard work needed to overcome those challenges, and clear enough to produce stability and continued progress once success has been achieved. As Marie Curie once said, "Life is not easy for any of us. But what of that? We must have perseverance and, above all, confidence in ourselves. We must believe that we are gifted for something, and that this thing, at whatever cost, must be attained." Thank you for your attention.