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## Five Years of the America COMPETES Act: Progress, Challenge and Next Steps

Witnesses: Norm Augustine Retired Chairman and CEO, Lockheed Martin Corporation Carl Wieman Director of the Science Education Initiative, University of Colorado Boulder Jeffrey Furman Research Associate, National Bureau of Economic Research Peter Lee Corporate Vice President, Microsoft Research Redmond John Winn Chief Program Officer, National Math and Science Initiative

Committee Members Present: John Rockefeller, Chairman (D-WV) Kay Bailey Hutchison, Ranking Member (R-TX) Maria Cantwell(D-WA) Claire McCaskill (D-MO) Tom Udall (D-NM) Mark Warner (D-VA) John Thune (R-SD) John Boozman, (R-AR)

On September 19, 2012, the Senate Committee on Commerce, Science and Transportation held a hearing to examine the implementation of the America COMPETES Act (H.R. 2272) and challenges to U.S. leadership in science and innovation. The America COMPETES Act, meant to ensure America's place as a world leader in science, technology, engineering and mathematics (STEM) fields, passed in 2007 and was reauthorized in 2010 (H.R. 5116).

In his opening statement, Chairman John Rockefeller (D-WV) describes the three main goals of both acts to be "increasing science and research investments, strengthening STEM education, and developing an innovation infrastructure." The chairman noted that these are all "inherently long-term investments and, even with five years under our belts, not enough time has passed to realize the full implications of these acts." As an example of a valuable long-term investment, he pointed out that Google originated from a National Science Foundation (NSF) grant in 1994 and "did not go public until 2004." He emphasized that "success takes time." As to the implementation of the acts, he mentioned the 2007 reauthorization authorized a doubling of funding to NSF, the National Institute of Standards and Technology and the Department of Energy's Office of Science by 2014. However, Congress "did not follow its own directions with appropriations." He explained that "the 2010 reauthorization attempted to find some middle ground with an 11-year doubling path, but, again, appropriations and the President's request levels have not followed, pushing the doubling out to 18-years." The chairman stated that by not implementing the doubling of funds we are "doing our youth a great disservice." He pointed out that while unemployment rates are lower for college students majoring in STEM fields, "our 15-year-olds score lower than the international average in mathematics and just average in science." He urged "we must do better."

In her opening statement, Ranking Member Kay Bailey Hutchison (R-TX) praised the America COMPETES act for being a strong "statement from Congress at a time when people said, 'Congress can't agree on anything" and that Congress is not "looking at the future." Hutchison stated that "in the last decade, growth in STEM jobs has been three times greater than in non-stem jobs, but today only 30 percent of U.S. high school graduates are ready for college work in science and 45 percent ready in math." She continued, "That's not going to produce the teachers we need for the future, or the scientists and engineers that we need to truly compete." Hutchison praised the funding opportunities from NSF for STEM students who are interested in acquiring a teacher's certificate. She praised the authorization of UTeach, a program based in the University of Texas, which allows students to earn a teacher's certificate during the normal amount of time it takes to earn an undergraduate degree through their elective courses.

Hutchison expressed her desire for this program to expand nation-wide. She concluded, however, that Congress must prioritize spending so that the spending cap is at a lower level.

Norm Augustine, retired chairman and CEO of Lockheed Martin Corporation, began his testimony by saying that the America COMPETES Act is "the finest example of bipartisanship in recent years," but "a new challenge has arisen, that frankly, we never thought of when we worked on the Gathering Storm Report." *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* is a report that was requested by Congress, and written by the National Academy of Sciences to address the state of American competitiveness in the global economy. This report acted as a guide for the construction of the 2007 America COMPETES Act and the key recommendations of this report are to improve K-12 education and increase funding for basic research. This new challenge, Augustine continued, is that American universities are in "grave danger" of losing their status as the best in the world and "receiving the lowest fraction of their operating budgets from state funds in over a quarter of a century." He continued, "In effect we have been privatizing our public universities." Augustine stated that on average, tuition has been increasing across the country by 85 percent in the last decade even after financial aid has been considered. In addition, Augustine showed that while faculty are being laid off and "have on average seen their salaries decline by 1.2 percent during the past year, *USA Today* found that major college football coaches receive an average compensation of \$1.46 million per year." Augustine quoted USA today in saying this increase in coaches' salaries is "a jump of nearly 55 percent in six seasons."

Augustine highlighted that "40 percent of U.S. faculty members were born abroad," and our ability to retain them is decreasing. He pointed out that globalization has incited a revolution in the employment market where "Americans no longer simply compete for jobs with their neighbors around the block, but rather with their neighbors around the globe." Augustine illustrated what the state of the American education system means in the context of a globally competitive job market by quoting Intel's Howard High, "We go where the smart people are. Now our business operations are two-thirds in the U.S. and one-third overseas. But, that ratio will flip over in the next 10 years." Augustine urged Congress to continue investments in basic research and K-12 education and ensure that "every classroom has a teacher who possesses a core degree in the subject being taught."

Carl Wieman, Director of the Science Education Initiative and professor at the University of Colorado Boulder began his testimony by saying that "there continues to be little discernible change in either student achievement or student interest in STEM." Wieman stated that this can be answered with a change in teaching methodology. He explained that it is not about having "sufficiently talented brains," which is the basis for traditional teaching methods, but "a development of the brain, an actual change in the structure in response to strenuous practice" and teaching is should be more like "coaching an athletic sport". Wieman stated that STEM teachers are not provided the training for this method of teaching which has been shown to be more effective. Wieman states that if this was changed, the U.S. would go from being a "laggard" to "world leader" in STEM. He insisted that all other efforts will accomplish little. He urged that in order to accomplish a change in teaching methodology, we need to change the current incentive systems which have resulted in insufficient teacher training in STEM and have preserved a "dismal status quo." As an example, Wieman pointed out that many college professors are primarily researchers and not teachers. Wieman concluded that "easy fixes" have been tried and now it is time to "truly make a difference."

Jeffrey Furman, Associate Professor of Strategy and Innovation at Boston University and Research Associate at the National Bureau of Economic Research, opened his testimony by defending federal investment in science and innovation by summarizing the Vannevar Bush's argument that "science and early stage innovation are a public good." Furman added that most economists are in agreement with this statement and government is needed to provide investments where firms do not have the incentives. He pointed out that the main driver of science and innovation is the consistent increase of funding for science and innovation. Furman explained that many of the benefits of science and innovation leadership are local and pointed to the economies of San Francisco and San Diego as an example of this. Furman said that while much has been "unrealized" compared to the "hopes" of the Gathering Storm Report, "a great deal has been achieved simply by unifying around a bipartisan consensus on the idea that science and innovation." He continued, saying that while the exact impact of the America COMPETES Act is difficult to determine, economists have concluded that the America COMPETES Act has "clear and notable achievements."

Peter Lee, Corporate Vice President of Microsoft Research at Redmond, began his testimony by saying that from his experience in leadership positions at Carnegie Mellon University, the Defense Advanced Research Projects Agency (DARPA) and Microsoft "have allowed me to see first hand the rich interplay between industry academia and government and how it creates an innovation ecosystem." Lee said that this "innovation ecosystem" did not come by "accident" but through "intentional partnerships." Lee stressed the importance of funding basic research to multibillion dollar industries by pointing out that basic research in coding theory led to smart phones. Lee's second point was "investing in the future of people." He stated that "Microsoft is strongly dependent on the talent of our employees," and "in August 2012, Microsoft had more than 3,400 unfilled research and engineering positions in the United States." Lee continued saying, the Bureau of Labor Statistics estimates that between 2010 and 2020, there will be on average 120,000 openings in computing professions that require at least a bachelors degree and yet, "in 2010, only about 60,000 bachelor's, master's, and Ph.D. degrees were awarded in computer science– far less than the predicted demand." Lee stressed that it is not only the people who have careers in information technology (IT) that should have education in computing, but everyone

since the applications are so wide. He recommended that the federal government support computer literacy in the K-12 level as the ability to "think computationally" will be a "cornerstone for the future workforce."

John Winn, Chief Program Officer at the National Math and Science Initiative testified in regards to the UTeach program. Unlike other programs, Winn explained, the UTeach program does not add an extra year of study to a four-year degree. Winn stated that "90 percent of UTeach graduates go directly into teaching" and 80 percent of UTeach graduates are still teaching in STEM related fields five years later. Winn said the UTeach program requires close partnerships between education departments and STEM departments. Winn asked the committee if they can "imagine" an engineering professor teaching UTeach classes alongside an education professor?" because this is now happening across 33 universities which have replicated the UTeach program. Winn says this expansion has provided more teachers who "bring research understanding and practice into the K-12 system," and has started "a new wave of faculty driven research into STEM teaching and learning." Winn used an anecdote from Florida to demonstrate the need for further expansion and support for UTeach. He said, "In Florida, we could never set our science and math certification exam passing scores at the level recommended by our best teacher." He explained that "the reason is simple, there would be far fewer candidates passing the higher qualifying score." Winn stated that this phenomenon is "pervasive" and is a "dark reminder" that "a new generation of highly trained STEM teachers" is needed.

Chairman Rockefeller began the question and answer session by asking Augustine to respond to his comment that "universities are not rapid in changing the direction of their battleship" and are subject to the strong influence of tradition. The chairman continued saying the argument could be made that "we are overproducing biologists and under-producing petroleum engineers." Augustine responded with an example from MIT, when a new program was trying to be introduced and was being fought by the faculty. Augustine described how the provost took him aside and said, "It is very difficult to overcome 100 years of excellence and success." Augustine argued that one of the dangers American universities face today is that they are accustomed to being the best and thus it is very difficult to change traditions and paradigms which have been associated with success in the past but may not be in the future. Augustine explained that when "one is looking at catastrophe, one becomes much more adaptable" and that is the direction we are heading towards. As to producing too many biologists and not enough petroleum engineers, Augustine said "Students seem vey quick to adapt to market opportunities—we saw that in the computer sciences." However, "too few of our students are not qualified to study engineering or any other kind of science." Lee added that universities have done well in balancing "agility" and "stability" and there could be a "huge transformation afoot."

Ranking Member Hutchison asked what more should be done beyond the America COMPETES Act assuming there was more funding. Augustine replied that not only should the 20 recommendations of the Gathering Storm Report should be fully implemented but an interest in STEM should be cultivated in youth. Augustine remarked, "I find it ironic that young people look with disdain on science and engineering, consider scientists and engineers to be 'geeks', but they all carry iPhones." Augustine added that there is a need for Congress to address the impact the current economy is having on America's universities through reduced state funding.

Hutchison asked how the cost for education could be brought down. She commented that some would say to fund teachers and not researchers, but she thinks "research is the spark which shows students how exciting science can be." Hutchison asked how to bring down costs while supporting teaching and researching. Augustine replied that one of the "elements of success" in American universities is that the teachers are researchers and teachers. Augustine suggested implementing tax laws which support private investments in university research. Augustine brought up the "vastly increased" salaries for football coaches while faculty salaries have been reduced, and stated that "we need to rethink what it is exactly what we want our universities to do" in regards to what the role of American universities are. Wieman responded that when funding is awarded, college becomes less affordable in public schools because there are hidden costs associated with the funding which is then taken out of tuition.

Senator Tom Udall (D-NM) asked Wieman for his thoughts on how to attract women to STEM fields as well as retain them. Wieman answered that this is a difficult problem and extends to other groups besides women. However, a "deeper understanding of the learning process" has been shown to help. Udall then asked Furman what he thought the impact of budget cuts from the sequester, the across- the-board budget cuts mandated to go into effect in January 2013, would be on energy research and development programs like the Advanced Research Project Agency – Energy (ARPA-E) which was initiated by the America COMPETES Act. Furman responded that this would be a substantial long-term impact unless the private sector "steps in" in a way it has not before.

John Thune (R-SD) asked Wieman, in light of his comments that STEM education has not improved, if the funding spent is "wasted." Wieman responded that much of the funding is "well spent" but there are some areas where funding could be placed more wisely. As an example, Wieman discussed teacher training clinics. He suggested that teachers be trained during their initial education instead of after years of learning to then be asked to learn the STEM content. Augustine responded that many students still do not have a teacher with a core background in the course area of study.

Udall referred to a recent report from *Bloomberg News* which discussed the finding that graduates from the South Dakota School of Mines and Technology are earning more than Harvard graduates. He asked the panel if it matters where the STEM degree was awarded, an 'elite' school versus a public school, or if simply having a STEM degree is enough to give a recent graduate an edge.

Unfortunately, the panel did not directly answer this question. However, Augustine did remark that the "market is recognizing the importance of STEM" and those in STEM fields are paid well.

Senator Maria Cantwell (D-WA) noted that in Washington there multiple high schools that receive support from private sector industries that "care a lot about those programs" and asked if there will only be successful STEM education in areas where schools can partner with a successful and local private sector. Lee responded that there is only so much a private sector can do. However, Lee said he has been "heartened" by some of the improvements at the college level as a result of the America COMPETES Act, but is worried "the pipeline will run dry" in the future because of the state of K-12 education. Lee stressed Congress should focus their efforts on providing teachers for K-12 education that are adequately trained in STEM. Winn added the role of the private sector is more that of a "catalyst" while the heart of the matter is in replicating programs like UTeach, then asking legislators to ensure the program's expansion. Wieman emphasized that the scenario described by Cantwell is one in which the "rich get richer and the poor get poorer."

Chairman Rockefeller remarked that "nobody is challenging America COMPETES" or the need for federal support but, there will most likely be funding cuts to this problem. The chairman expressed "We recognize that America COMPETES has not turned out to gratify on the short-term basis." However, he noted that "The world has changed dramatically" and this change is in the same direction America COMPETES is intended to move the country.

Augustine remarked, "We are becoming less and less competitive as everyday passes...People around the world are becoming more highly educated." Augustine noted that without the taxes from jobs which must inevitably come from more and more from STEM fields, our ability to provide health care, to defend our country and provide education will decline. The chairman responded by alluding to the America COMPETES Act as "the last stand" for the American dream.

The chairman stated that "you can't tell me that people don't want to tap in" to technology, but "for the life of me I cannot figure out why it is that more Americans cannot get turned on by it." He said, "It defies my hope for America" that we cannot seem to get youth interested. However he concluded, "Not enough is not a reason to quit something." Wieman responded that student interest, particularly at the college level has been shown to shift against science and view science as "less relevant to their lives" after taking an introductory course. Wieman concluded that this speaks to our teaching methods, and is likely more true for K-12. Lee shared a joke that illustrates how science is viewed in society as a strange choice for a college major saying, "A young person opting to go to a good college for science and engineering is the modern day equivalent of joining a monastery."

Lee continued saying that while the older generation sees the value of training in STEM, younger people tend to be more idealistic than practical by trying to be part of a "community" where they can "express themselves and their curiosities" and have this value of "trying to make a difference in the world." Lee suggested that "we express ourselves in a way that touches that idealism...if we forget that, we'll risk making all of the wonderful things we do in science and technology look really mundane." Lee concluded that we need to find a way to "inspire." The chairman responded that as an example of this, participation in the Peace Corps and the Central Intelligence Agency (CIA) are higher than they have ever been and pointed to that as young people saying, "I want to be a part of the future, I want to be a part of the world, I want to make the world a better place." The chairman posed the question, how do we inspire the interest of young ideological people in the world of STEM? He concluded that, "We must leave this as unfinished business."

Opening statements, witness testimonies and an archived webcast of the hearing can be found on the Committee'sweb site.