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NEW IDEAS TO ADVANCE STEM EDUCATION IN THE U.S.

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P R O C E E D I N G S

MR. WEST: Good morning. I'm Darrell West, vice president of Governance Studies and director of the Center for Technology Innovation at the Brookings Institution. And it is my pleasure to welcome you to this forum on New Ideas to Advance STEM Education.

Science, technology, engineering and math are crucial for America's future. Much of our past prosperity has rested on innovation and creativity in the STEM fields. It's hard to imagine our economy or our national security without science and technology. Yet despite the importance of this area, we have a crisis. We have insufficient numbers of American-born students getting advanced degrees in these subjects, and we need to improve the teacher training and professional development in science, technology, engineering and math.

It's important to transform STEM teaching in order to prepare students for the future economy. Research has shown that teachers are the primary factor in student growth and student achievement. Many students are disinterested in science or math because teachers are not well trained or aren't able to convey the excitement of scientific discovery to young people. President Obama has called for putting education at the center of our national agenda. He's emphasized the need for quality teachers, investment in STEM education and restructuring federal education funding. He's called for the addition of 100,000 new STEM teachers, identifying effective teachers and creating reward systems in order to retain top-performing individuals. The President also has proposed school renovations that would build and renovate science labs in an effort to boost STEM education.

To help us understand the nature of the STEM problem and possible remedies, we have brought together a distinguished set of speakers. Dr. Rebecca Blank

is acting secretary of Commerce. Previously she was the acting deputy secretary of Commerce from November 2010 through July of this year. In that role, she focused on management and policy for the department's 12 bureaus and functioned as the Commerce Department's chief operating officer.

Staring in June 2009, she worked as under secretary for economic affairs and head of the Economics and Statistics Administration within that department. She's played an important role in overseeing the decennial Census operations that has completed its work on time and under budget, not always the case in Washington, D.C., saving $1.6 billion in the process. We are especially pleased to welcome her back because before moving to Commerce, she was the Robert S. Kerr senior fellow at the Brookings Institution, so it's nice to welcome her back to her home place.

I met her shortly after I arrived here in 2008, and was immediately impressed with her knowledge of a wide range of social and economic topics. She's smart, articulate and knows how to get things done, and that certainly has propelled her in her Department of Commerce career, so it's terrific to have her back.

We're also pleased to have other distinguished speakers. Jim Simons is president of Euclidean Capital and board chairman of Renaissance Technologies. Dr. Simons is a distinguished mathematician who has taught on the faculties of MIT, Harvard and the State University of New York at Stony Brook.

In 1976, he won the American Mathematical Society's Oswald Veblen Prize in Geometry for work on multidimensional surfaces. He is famous for the discovery and application of certain geometric measurements that are used in theoretical physics and string theory. He left academia to launch Renaissance Technologies, a hedge fund that trades in commodities and financial instruments. His firm uses computer based mathematical models to predict price changes in financial instruments, looking for non-

random movements in order to make predictions.

He's been active in a number of different causes, but one in particular that he founded is Math For America. That is a nonprofit organization with the mission of significantly improving math education and teaching in public schools, and it does tremendous work in supporting math education all across the country.

Dr. Charles Vest is president of the National Academy of Engineering. He's also president emeritus and professor of mechanical engineering at MIT. He's the author of two books on higher education and research policy. He has served on a variety of presidential panels, commissions and advisory committees dealing with science and technology, and is one of our nation's leading authority in those areas.

Charles Giancarlo is managing director and head of value creation for Silver Lake Partners, a leading private equity firm specializing in technology and communications. He has over 25 years of experience in the technology field. He served as executive vice president and chief development officer at Cisco. He is responsible for Cisco's expansion into new technologies and new markets, and so he will bring a private sector perspective to this discussion.

Our format today will be as follows, we will start with an address by Secretary Blank. The Department of Commerce has put out several reports recently. They put out a report a couple weeks ago entitled "Women in STEM: A Gender Gap in Innovation." And this morning the Department is putting out another report, "Education Support, Racial and Ethnic Equality in STEM." So please join me in welcoming Dr. Rebecca Blank back to Brookings.

DR. BLANK: Just like magic, the slide show pops up. Thank you very much, Darrell. It is an absolute delight to be here. It's always good to be back at Brookings and see all my old friends. And it's a particular honor to be with this group who

are far more distinguished than I and have far more on the ground experience with actually trying to recruit people into STEM related fields.

So as you all know, I mean, why are we talking about this topic today? A globally competitive economy requires a skilled and a globally competitive workforce. Making sure that we have workers trained in science, technology, engineering and mathematics, the so-called STEM fields, is absolutely critical.

Over the past 10 years, growth in STEM jobs was three times as fast as growth in non-STEM jobs. STEM workers play a key role in the sustained growth and stability of the U.S. economy and are particularly important in sectors where U.S. universities and businesses are on the cutting edge of innovation and new product development. Those are the economic facts. But there's an important human element to these statistics, as well.

If STEM jobs are more stable and STEM workers earn higher wages and are less likely to become unemployed, then producing more STEM graduates and workers means having more Americans in well paying, high-growth jobs that can support healthy communities. So there are competitive and social incentives through the U.S. to encourage more students to enter science, technology, engineering and mathematics fields.

Now, over the past several months the Economics and Statistics Administration inside the Department of Commerce, which is my old job there, has released two reports on the STEM workforce. The first report discussed the STEM workforce in general and the trends in STEM jobs over time. The second report focused on the gender gap in STEM training in jobs. And today, we are releasing the third report in this series which looks at diversity of STEM workers in the United States, focusing on differences in racial and ethnic backgrounds, as well as on the role of foreign-born

workers in STEM fields.

And I want to introduce Mark Doms, who is the chief economist at the Department of Commerce, who's actually done much of this work. So, Mark, raise your hand. He's the one to talk to if you actually want to say, where did these numbers really come from?

I want to summarize some of the most important conclusions for these reports and then talk briefly about some of the initiatives the administration is doing that Darrell has already mentioned that are really designed to encourage more students, and particularly women and students of color to enter STEM training.

So let's start by talking about the first question, what's the definition, right, good academic question here, how do we define STEM jobs? And there's two types of things one needs to define: you need to define STEM jobs and you need to define fields of study, because we're going to be interested both in, you know, how many people are in STEM training, as well as how many people are in STEM jobs.

So we are using definitions that are actually provided by the National Science Foundation. There are small variations on what we're doing relative to what NSF does for a variety of reasons, but this is largely using the NSF definition.

And not surprisingly -- so we take jobs off of the current population survey which gives us a lot of information about workers and the occupations they're in. And we take education fields from the American Community Survey, which, in 2009, asked a special set of supplemental questions about what people's undergraduate fields of study were and their graduate fields of study for people with those degrees.

And, you know, you get this sort of a list of occupations that you're looking at and then equivalent education and training. And you can go back and look at these reports in more detail if you want the full list of what are the things that we consider

STEM occupations and jobs. So let's start with the question of how are these jobs growing? There were 7.6 million STEM workers in the United States in 2010, which constituted about 5.5 percent of the U.S. workforce. Further, as this chart shows, STEM jobs have been growing rapidly. This graph is from 1994 to 2010, the occupation codes changed before '94, so this is the period over which we have a consistent set of occupation coding.

Between 2000 and 2010, employment in STEM jobs grew by 8 percent, while employment in non-STEM jobs grew by only 2.6 percent. The other thing you see on this slide which is interesting is the effect of the tech bubble in the early 2000s, and you can see the STEM jobs slow down, and then as the economy starts moving again, they shoot up quite rapidly, and even during the recession, do not fall, unlike many other occupations, which is, you know, back to the comment that I will return to again, that STEM jobs have been quite good jobs over this last recession.

So if this is the aggregate number of jobs, who works in these jobs? Workers in STEM jobs have a variety of characteristics. Let's talk first about education. I don't think it's going to surprise anyone in this room to know that STEM workers on average have quite a bit more education than non-STEM workers. So the red bars here are the distribution of all workers across these four education categories, high school diploma or less, some college or an associate degree, a four-year college degree and a graduate degree. And as you can see, you've got about a third of the workforce in those two lower skilled categories and then a declining share among the total workforce, the red bars, in the higher education shares.

If you look at STEM jobs, you see just the opposite. The majority of STEM workers, by far, have either bachelor's degrees or graduate degrees, and so you have higher education people disproportionately represented in STEM jobs.

However, I would note that about a quarter, 26 percent, of STEM workers, do have, you know, some post high school degree, but don't have a college degree. And just to -- I often get questions, sort of, you know, what are these non-college jobs that STEM workers are in? And just to read through the list of the top occupational categories where you see a substantial number of non-college degree STEM workers: engineering technicians, computer support specialists, computer scientists, network system analysts, computer programmers, computer and information system managers, and network and computer system administrators, many of which require some technical degrees, but not necessarily four-year college degrees.

If you move from education to gender, again, I suspect no one in this room is going to be surprised by the fact that there is a substantial gender gap among STEM workers. It's very large.

To the left you see male workers and to the right you see the opposite of that, female workers. And again, red is all workers, blue is STEM workers. So 48 percent of all workers are female, 52 percent are male. However, only 24 percent of STEM workers are female, while 76 percent are male, so female workers are, you know, only half as well represented in STEM fields as they are overall within the entire workforce.

And this particularly emphasizes the need to encourage more women to enter STEM occupations and fields, and I'm sure that Q&A will come back to that. I'm sure the next panel is going to discuss that, as well, you know, what are all the reasons why women are underrepresented in these fields.

Turning to the report that we are releasing this morning, I'm sort of taking you through highlights of a number of these different reports, as I said this morning, we're releasing a report on diversity inside STEM fields. So to show you some charts that are

hot off the presses, this looks at STEM employment by race and ethnicity. And again, the red bars are all workers; the blue bars are STEM workers.

As you can see, about 11 percent of the whole workforce is black, non-Hispanic, but less than half of that, only 6 percent of STEM workers are black. Among Hispanics, 14 percent of the whole workforce is Hispanic, only 6 percent of STEM workers, again. And Asian Americans are overrepresented in STEM fields: 14 percent of STEM workers are Asian American, only 5 percent here.

So if you're looking at historically disadvantaged groups within the United States, you see here substantial underrepresentation in STEM as you see underrepresentation among women. And, you know, these differences, I should note, arise primarily from the share of each group that graduates from college. Blacks are 7.4 percent of workers with college degrees, but only 5.5 percent of workers with STEM degrees. Hispanics are 6.2 percent of workers with college degrees, but 5.9 percent of them have STEM degrees, which is to say that conditional on going to college, you see much greater participation in STEM fields. It's the fact that African-American and Spanish -- Hispanic workers are much less likely to have the college or the graduate degrees that really leads them to be underrepresented in these STEM fields. That's not true of women, I should note, where women actually have higher degrees, higher amounts of education than men do, so there's clearly some different stories going on here in terms of gender underrepresentation in STEM as opposed to black and Hispanic underrepresentation in STEM.

Furthermore, in this new report, we also look at foreign-born workers. Foreign-born workers are more likely to be in STEM jobs than our native foreign workers, just over half. The majority of these workers are naturalized U.S. citizens. So foreign-born, but U.S. citizens make up the majority of STEM foreign-born workers.

From 1994 to 2010, foreign-born workers accounted for approximately half of the rise of all STEM workers. So you're pulling a lot of foreign-born workers into the STEM workforce over the last 10, 15 years. Now, there may be a number of reasons as to why foreign-born are more likely to be in STEM, and I'm speculating here, but foreign-born students are more likely to come to the U.S. for degrees in STEM-related fields. People from MIT know this, and we know that a number of these students stay in the United States. The majority of these do become naturalized U.S. citizens when they stay.

Businesses may be more likely to hire foreign workers into STEM fields if they believe the U.S. talent pool is not deep enough for them. And we do know that a higher share of students in universities from other countries major in STEM-related fields.

And, of course, there's always the second generation effect. Children are really amazingly likely to follow their parents' occupations. Even in the modern world, I'm always amazed how strong those correlations are. So if a number of persons born abroad came as children to the United States when their father or mother was hired here as a STEM worker or came here as a STEM student, these children may also be more likely to receive STEM degrees and to remain in STEM fields.

Among all STEM workers, these foreign-born, native-born differences are not all that large. Twenty percent of the STEM workforce is foreign-born, while only 16 percent of the overall workforce is foreign-born, so it's not that big a difference, 20 percent versus 16 percent. But the differences are very large among the more educated. So this slide shows you STEM workers and all workers with graduate degrees and STEM workers and all workers with bachelor's degrees, and the solid lines are the foreign-born, and the dotted lines are all workers. This is actually not well labeled when I look at this. Where it says STEM workers, the graduate should be foreign-born STEM workers, and

STEM workers with a bachelor degree should be foreign-born STEM workers.

So you can see that among those with a graduate degree in STEM -- I'm sorry, yeah, over 35 percent of them, I misspoke, over 35 percent of all STEM workers with a graduate degree are foreign-born, whereas only about 16, 17 percent of all workers with a graduate degree are foreign-born. So there's this very large gap at that very high level of education in terms of the share in representation of foreign-born within STEM workers. There's much less of a gap among workers with bachelor's degrees, it's only 3 or 4 percentage points. So foreign-born workers are really driving particularly the STEM workforce at that graduate degree level.

So the next question, are STEM jobs good jobs? And unemployment in STEM jobs rose last -- in the last four years than in other occupations which suggests that these jobs had been more stable in an uncertain economy. We can also look at wages in STEM jobs. And one of the things that we do in these reports is we run wage regressions, controlling for all the usual variables, age, education, et cetera, and look at whether there is a wage premium for STEM jobs.

So the question here is, controlling for all the usual things you'd want to control for to say, you know, what are people getting paid, do people in STEM fields get paid more than equivalent workers in non-STEM fields? And this graph shows you the wage premium over time, so that the dotted black line here which is total suggests that, on average, STEM workers in 2010 had about a 25 percent wage premium; a little over that, 26 percent, in STEM jobs. So this is equivalent workers in terms of age, education, other background characteristics earning about 25 percent more in STEM fields than in other fields. And, you know, there's a variety of reasons, and we can come back and talk about it, about why there might be a wage premium in STEM fields.

What's really interesting here is the largest premium occurs among the

least-educated workers. So those with less than a bachelor's degree, those with all those associate degrees, are getting premiums that are in excess of 30 percent. Those who have bachelor's degrees get about a 23 percent premium; those with graduate degrees get about a 12 percent premium.

It is worth noting, though I don't show it for you in this slide, the wage premium for women in STEM jobs is larger than for men. Similarly, the wage premium for persons of color is larger than for white non-Hispanics. And the wage premium among the foreign-born is larger than among the native-born.

So interestingly, some of those underrepresented groups, women, persons of historically advantaged groups, actually get larger wage premiums, leading to this interesting question of why are so few women or African Americans or Hispanics entering these fields? The greater wage premiums suggest they are in demand, so what barriers are there that are preventing their entry? And again, I know that's a question we'll come back to.

So what are the issues that I think these reports raise about the STEM workforce? First of all, I think there's an emphasis here that STEM jobs are growing and are particularly important to some of our highest innovation industry sectors. It's going to be important for the U.S. to expand the pool of talent for these jobs in order to retain these industries here in the United States. The STEM workforce is key for the long-term competitiveness of U.S. manufacturing and U.S. non-manufacturing in a global economy.

Secondly, STEM jobs are good jobs for workers at all education levels. They should be attractive jobs. They should be -- you know, people should be pulled into this sort of training and into this part of the workforce if they have the talent and the interest for it.

Thirdly, there is a paradox that some of the workers who seem to benefit

the most from STEM jobs are disproportionately not entering the training that would lead them to STEM employment. It is important to identify and break down the barriers that particularly prevent girls, African-American and Hispanic students from entering STEM training and STEM jobs.

Finally, the U.S. has benefited greatly from its ability to pull foreign-born students with STEM training into the U.S. and into U.S. citizenship, and this flow of workers is clearly important and is likely to remain important through the near future.

Let me end by talking about a few policies that this administration has particularly been promoting. The President has been very personally interested in STEM-related jobs and in pulling people into STEM. It's an issue that he raises both publicly and privately with some frequency. So let me note some of the things that are currently on the policy plate for the administration.

The President's FY '12 budget currently in debate in Congress proposes about 206 million in STEM training programs. This includes Department of Education dollars, developed teacher training in K to 12 around STEM-related topics, as well as dollars to the National Science Foundation to launch research on effective teacher training in STEM.

The Educate to Innovate Campaign, which was launched in 2009, is designed to improve U.S. students' participation and performance in STEM fields, particularly focused on women and under-representative groups. In January 2010, as part of this effort, more than $250 million in public and private investments were added to help prepare over 10,000 new math and science teachers and retrain and train over 100,000 existing teachers. The Race to the Top Fund, which is $4.3 billion, provides competitive grants to states to encourage and reward states with high K-12 achievement and give them resources to continue and expand on what they're doing right. The Grant

Awards provide special preferences to states with STEM focused efforts.

And then I should note at the Department of Commerce and many, many other agencies, there are a large number of agency-specific STEM programs. To mention two that I'm particularly fond of at the Department of Commerce: NOAA, the National Oceanographic and Atmospheric Administration, runs a Teacher at Sea summer program, which takes science teachers and puts them on NOAA boats that are doing hydrographical work over the summer for a week at a time to actually experience hands-on research and to bring those experiences back to the classroom; NIST, The National Institute for Science and Technology, which is also within the Department of Commerce, runs a summer institute for middle school science teachers that's held at NIST and attracts teachers from across the country and which has actually grown over time in interest and is very much focused in helping these teachers attract students who wouldn't normally think of themselves as being interested in science to come into science in the middle school area and develop their interest. So these sorts of programs are across government, and it is partnerships between government and the private sector in particular on a whole variety of these programs that make them effective.

So to conclude, we can and we must do better at preparing American students for the jobs of tomorrow. Among other things, this means a focus on STEM training. This is not something that happens just at college and graduate school, but almost surely needs to start at younger ages with strong math and science training in elementary school onward.

Our competitiveness as a nation depends upon our success. America will have a difficult time competing for 21st century industries if our children lack the skills and the education that are integral to those industries in the future. Make no mistake: this is a national imperative and a national economic imperative. It's critical that we

understand and treat it as one. That's why this administration is so strongly committed to doing its share to strengthening STEM training in the U.S. Ultimately, it's part of how we rebuild America's economic foundation stronger than it was before the recent financial crisis. But this is certainly not something that the federal government can possibly do by itself. We must work in partnership with local and state public education authorities, with private schools, with the private sector, you know, and industries, as well as private schools across the country, all of whom are going to be the ultimate beneficiary of an expanded number of qualified STEM workers.

So if you want to know more about all of this, here's the reference, go to www.esa.gov, the Economics and Statistics Administration at the Department of Commerce. And there will be a button there for reports, and if you hit that, you will see these three reports, one of which released in July, one in August, and one released today. So you can get our latest report on "Diversity in STEM Fields" and do further reading and look at more numbers, if that's what you happen to want to see.

With that, I will stop and we'll turn to Q&A. Thank you.

MR. WEST: So thank you for all that information. We have a little bit of time for Q&A. I just want to start with a quick question and then we'll turn to the audience.

I can tell Dr. Blank had tremendous training at Brookings by listening to these three reports. You want additional information, you can go get it. A good Brookings characteristic there, so we appreciate that.

You were talking about the importance of STEM for jobs and economic prosperity. You've issued reports along with Mark on gender, race and ethnic differences. And in your talk, you mentioned there are different reasons for the underrepresentation. Could you just tell us a little bit about what you think the primary

reasons are and how the policy solutions the administration is following can help address those issues?

DR. BLANK: So one of the things that I think is very clear is that there's no magic bullet here. There's not one single problem that if you could fix this, you would solve the underrepresentation of women and of historically underrepresented minorities in STEM fields.

The issues are multiple. You know, it has to do with the examples that people have at home. So to the extent you're more likely to do what your parents did, you know, because women have historically not been in STEM fields, you know, very few girls see their mother working in these fields and don't follow them. And the same thing is true for black and Hispanic students. It has to do with where people are encouraged to go and how they're encouraged through their teachers and their guidance counselors in the school, what they're encouraged to be interested in, and for better or for worse.

Some groups are less encouraged toward science and math than others, you know. And, you know, there's a whole range of issues here, you know, cultural and institutional, that effect, you know, why people end up with the occupational choices that they do. And that's what makes this hard to get at. It's why the administration proposals arrange, you know, not just at -- you know, in fact, large numbers of colleges, universities are doing a very, very good job at trying to attract women and African Americans, blacks into STEM-related fields. There are some very creative things being done in a variety of engineering schools that I know about. Chuck I know can talk more about that.

But we're focusing a lot of dollars at the elementary and secondary level to train teachers and to improve science and math education, because if you don't get them interested at a younger age, it's very rare that you're going to capture them in college, so.

MR. WEST: Okay. We have a question right here. If you can give us your name and your organization, and we have a microphone coming up, as well. We'd also ask you if you can keep your questions brief just so we can get to as many people as possible.

MS. STERN: Thank you. I'm Paula Stern, and this morning I'm representing the National Center for Women in Information Technology, which is an NSF-born organization. And I thank you so much for these studies. They're fabulous, and we completely support everything you're doing there.

My question is about unpacking STEM. In other words, you had a list on your jobs, which in the key ratio of the jobs to training I think is critically important, but there's so many job openings there in various computer-related, information technology-related, and yet, in our curriculum, particularly secondary and then all the way down to K through 12, we don't teach computing, we don't have the curriculum focused on that. Can you unpack some of these numbers regarding STEM and what the recommendations the administration has with regard to focusing tactically on where the jobs are in the computing area versus some of these other areas? And also, as I understand, women are highly represented in many of the biologies, et cetera, but they're definitely terribly underrepresented in computing and computing-related sciences and information technology.

DR. BLANK: So I think you have made the most important point, which is there are a wide variety of STEM fields, and the stories do differ a little bit by group, by -- you know, there's some areas where women are more represented, for instance, biology is one of them. You know, there are certain areas where, you know, foreign-born students and workers are much more represented, and engineering is one of those areas, and they're a little less represented in some of the biological fields. So, you know,

depending on your level of interest, if you're interested at a more micro level of particular types of occupations, you can get some very different stories here.

I should say the administration emphasis here, while, you know, depending on what bureau you're talking about, the Department of Energy focuses on energy things, NOAA focuses on more, you know, biological, ocean-related things, you know, there are different programs in the administration that focus on different topics here. The focus in terms of a lot of the training dollars are not to try to say we're going to put our dollars in this particular occupation or this, you know. It's rather to focus training broadly for teachers and for the National Science Foundation to study what is it that makes more effective teaching that pulls people into these fields? And, you know, some of those studies are going to relate to computer sciences in gender, some of those studies are going to relate to, you know, engineering and African-American students. So, you know, I think the funding is designed to spread a pretty broad net to look at the whole range of questions.

MR. WEST: Okay, right there.

MS. McADAMS: Hi. My name is Camsie McAdams and I am the STEM director for D.C. Public Schools. And I'm curious, you mentioned a lot of this, like, you know, getting advice from the teachers and the counselors, and that seems like a lot of push up, and I'm really interested in reach down. So you talked about interesting programs at the university level. We have a fantastic relationship with MIT, so thank you very much. We're going to come and do some professional development for our teachers. But I'm curious about motivating the trade schools and the associate degree-granting institutions and these places where they do, you know, IT-related and computer science-related tech jobs, because I think that's really appealing to the population of students that I serve, to the parents. Because, like you said, you know, a lot of these

parents are not ready to send their kids off to a four-year institution, but they might be ready to send them to a trade school. So I wonder if you know anything about creative programs where two-year degrees and trade schools are doing a reach down into the K-12 sector.

DR. BLANK: That's a great question. To be honest, I think that's a better question for the next panel than it probably is for me. One thing the administration has been trying to do is put quite a bit of money into community colleges, you know, the two-year and associate degrees, in part, because there's large numbers of students for whom that is going to be the type of post high school education they get, and we really need to provide good training and good opportunities for that group of students.

And some of those dollars are focused on STEM. Some of those dollars are focused on just attracting and retaining students, you know, and not particularly STEM-focused, but STEM is something that will benefit from that.

MR. WEST: Right here is a question.

MS. FRASER: Hi. Edie Fraser, STEMConnector and diversified. First of all, thank you for all three reports. We all are using them and we look forward to the new diversity one today. You know, we have been working on profiling 3,000 organizations committed to diversity, STEM and overall.

We've taken 500 corporations, and what is really interesting for you is to really focus on the workforce planning side of what the companies say their workforce needs are for STEM jobs and the career categories that you reference with the NSF categories and what the companies are saying with the matches coming out of the community college, colleges and graduate school system, and getting more of these companies really to commit to close that gap on the workforce needs and the STEM availability on supply and demand.

DR. BLANK: One of the things that I've been doing over the last couple of months is going out and holding roundtables with business leaders from a variety of different communities around the country. And one of the things I hear again and again is exactly the difficulties of hiring people with certain types of skills. And inevitably we get into a series of conversations about how do you link the private sector up with the educational sector so that there's, you know, close communication there? I think this is something that has not been very well developed in the past, but is being developed in many areas of the country at this point, and particularly with the community college system, so that, you know, the sorts of technicians and training programs that there are jobs to hire into are actually being developed inside these educational systems.

But, you know, it does take very good collaboration and cooperation and communication back and forth between groups that have historically not talked to each other as much as they should.

MR. WEST: In the very back, standing in the back.

MR. SPUCK: Good morning. My name is Tim Spuck and I'm an Einstein fellow with the National Science Foundation. And you had mentioned the Teachers at Sea Program that NOAA does, and I've not participated, but I've heard it's a fantastic program from other teachers that I've worked with. In this last fiscal year, the proposed 2012 budget, it looks like the Department of Energy is cutting the ax program which partners teachers, K through 12 teachers with scientists, and then NSF is going to be terminating the GK-12 STEM Fellows Program, which puts about 1,000 graduate students and places them in -- I'm sorry -- in K through 12 classrooms with teachers and students.

And, you know, those partnerships are obviously very important and those are -- they bring about significant role models both for teachers and students to

increase participation in STEM and to promote STEM careers for students in K through 12.

So what are the potential solutions? I know this administration really seems like it is promoting STEM education, but then when we cut some of these programs. What's the solution to kind of get these programs to rise above the static in a very difficult budgetary situation?

DR. BLANK: That's a great question, and obviously, you know, budget cuts have real effects, and, you know, we're going to be seeing them in a variety of different fields. You know, the President has said again and again, and I actually think he's right on on this one, that at the same time that we have to control deficits, there are certain areas of priority and investment that for our long-term economic stability and competitiveness we have to make, and the three that he mentions all the time are education, infrastructure and innovation. And STEM fields, of course, in some ways are at the center of those first two, innovation and education. So I know that this administration is quite committed to saying even in the midst of difficult budget times, we are going to try as hard as we can to preserve some of the commitments that have, you know, that we think are really long-term investments. And that may mean cutting other programs even more so that you can not only preserve it, in some cases even increase some of the education and innovation programs, which include some of these STEM programs.

And the fact that these are in the budget and the administration is working on them even in the midst of the deficit negotiations I think is a statement of what a high priority this administration puts on them. You know, will there be some casualties? Probably so, but I think there are going to be far few casualties in this area than in some other areas of the budget.

MR. WEST: There's a question in the back, right there.

MS. CLARK: I'm Julia Clark in the National Science Foundation, and I wanted to follow up on the very first question I would ask you in terms of the underrepresented persons in STEM. And you mentioned there are certain groups who might not be interested in science. My concern is in reference to equity and assets. In terms of the achievement gap, we know that in schools where there are a high number of minority students, they have less prepared teachers, less money. So what is the role of the federal government in making certain that equity and assets is available to everyone?

DR. BLANK: So that's exactly the reason to put additional training -- additional dollars into teacher training. You know, I don't think there are groups that are inherently more or less interested in STEM fields. There are groups that don't have the same background or understanding of why it's even interesting to think about various science fields either for sources of study or for future jobs.

So the dollars here are going into teacher training with a real focus on teacher training in schools where they can make a difference particularly for these gaps, a focus on trying to bring more women in, trying to bring underrepresented groups into STEM. And, you know, we'll see how this works. It's a program that's really just -- you know, the proposal is in the 2012 budget, you know, so the dollars need to be appropriated, and we've got to see how it plays out. But at a center of the program is a concern about the gaps that I was talking about.

MR. WEST: We have a question over here on the aisle. There's a microphone coming over to you right there.

MS. GILL: Hi. I'm Wanda Gill, U.S. Department of Education. I'm curious about the data. I was wondering if you included both companies who have gone to foreign countries for tax and other breaks and possibly hiring more STEM workers in

those locations, just as we've got coming here people from Ireland and Egypt and different places who are STEM scientists working at a number of our public jobs.

For instance, at Fort Detrick, there's a whole colony of people from various countries. So I was just curious to know that, because it might influence the findings if they are in other countries and hiring natives to those countries in American firms. Thank you.

DR. BLANK: So our data is jobs in the United States. It's all persons employed in the U.S., whether they are U.S. citizens or not. So what you're looking at here is a picture of work in the U.S. proper. The fact that a company might be hiring people someplace else is not included in this data.

MS. GILL: All right, thank you.

MS. SUTTON: My name is Bonnie Bracey-Sutton. I work with the Power Of Us Foundation and I'm a teacher. I've been bounced around for 30 years as a STEM teacher when people didn't want. How can we recapture those people who have been in teaching, who love science, who've taken all of those courses and who are now out of it because they were not given permission to teach?

DR. BLANK: I will note that one part of the jobs proposal that the President laid out on Thursday night is a proposal to provide funding to states to rehire teachers who have been laid off, as well as first responders, and I think part of the real concern that, you know, I and I know others in the administration have about where we are right now in the economy is the impact, particularly on education.

You know, if you look at what's happening to employment at the state and local level, a very high share of jobs that are being shed are teaching jobs. And that's something the federal government, at least in the short term, can do something about if we pass the President's jobs package.

MR. WEST: John, there's a question right next to you, right on the aisle.

SPEAKER: Actually I have two quick questions; one is a follow-up with regard to the cutting of programs. Is the administration and the different departments going to consider really using IT, especially broadband, if you have fellows and grad students coming into the classroom to be cost-effective, maybe doing it by way of broadbanding, so it teaches the kids? The reality is a lot of us do webinars because we can't be at many places at one time, and then having that reinforced by that teacher in the classroom, that's number one.

Number two, with regard to the underserved, particularly those that are in the jails transitioning back, does the administration or any of the departments, Department of, I don't know, Justice, doing programs that's going to be brought into the judicial system to start the educational process by way of technology, broadband, webinars, that kind of thing, to help integrate those that are coming back into society?

DR. BLANK: So, you know, specific curriculums that schools use are, you know, largely not the purview of the federal government. This really is a decision that often happens at the state and local level. And I do know that, particularly within rural areas, a number of states and localities are making greater use of distance learning, and certainly a large number of colleges are making use of that.

One of the things that we do to support that is to expand broadband and high-speed Internet access throughout the country. So in the Department of Commerce, we have basically put more than $4 billion in grants out there to underserved communities, both urban as well as rural, to build out high-speed Internet networks so that it's all part of the stimulus funding from 2009, so that we're building out almost 40,000 miles of additional broadband networks.

And the whole idea here is to provide not just, you know, businesses,

schools, local communities, families much greater access to broadband in areas where they historically haven't had them. To the extent to which schools use them, that becomes much more a local school curriculum issue. I simply can't answer your question about what's happening with regard to incarcerated and their retraining, you know, that's something that's a little outside of my lane.

MR. WEST: Okay. We have time for just a couple more questions, then we're going to move to our next panel. Right there on the aisle.

SPEAKER: Yeah, and this is just really quick. And I'm with the Department of Ed, and I just wanted to know, for any of your premium data, we talked about the wage premiums, did any of that include -- like, for instance, somebody in the STEM job, did that include those in the content, the content-based teachers, somebody who may have a mathematics degree, but say is certified to teach secondary math? Are wage premium data capturing people in those areas?

I don't know if that's considered a STEM job, if you're considered a STEM math teacher. Is that considered a -- or is a STEM job more of the theoretical STEM people like an engineer, per se, or --

DR. BLANK: Yeah, STEM jobs actually do not include people who teach in STEM fields. There are jobs out there in the -- the problem here is that -- actually in the National Science Foundation definition, those are included as STEM jobs. But in our data, we do not have information on what teachers actually teach, so we couldn't separate a math teacher from an English teacher. So we do not include teachers, therefore, in our -- because we just couldn't do it in the data that we had available to us. So this is jobs out in the private sector, not in the teaching profession.

SPEAKER: There's also I guess (inaudible) would say maybe a hidden STEM job, like maybe like say an actuary. They may have a mathematics degree, they

may be doing pure math all day, linear models and forecasting and future analysis, something an engineer may be doing, but he or she may be more of a business-type job and not really a STEM title.

DR. BLANK: That's quite possible. And there are a good number of people with STEM degrees who do not work in STEM-related fields and some of them could be like this which you call a hidden STEM job. You know, we simply can't identify that in our data. We're limited to what we have.

SPEAKER: Yeah. And also, any way to post the URL again? It looked like that it had a bunch of reports listed.

DR. BLANK: Go to www.esa.gov, and click the button on Reports and you'll get this list and all the other reports that the Economics and Statistics Administration has done.

MR. WEST: A question right over here.

MR. KRAMER: Good morning. David Kramer, Department of State, Office of Overseas Schools. I just -- over the years, as a former elementary principal and head of school in a number of places, I made some observations. We talk about the foundation of education is, in my opinion, is really at the primary level. And the fact of the matter is, and you talk about this, is that women are under -- they're not involved in the science and math and technology. They're not represented as much as males are, but at the elementary level in education, they predominate there.

So I'd just be interested to know what the discussion has been, you know, what you know about that. How do we attack that? You know, how do we get women interested in promoting math and science at the elementary level so we can get kids excited about it there, so that it carries on? Because if we can't get it going there, we're not going to get it going anywhere.

DR. BLANK: You know, I agree with you, and that's exactly one of the reasons why the teacher training dollars are focused very heavily on the K to 12 areas, to try to increase, you know, sort of training, you know, to teach well in terms of science and math, which may not be the field the teachers, you know, specialized in when they were in college. It's a fascinating question.

I mean, my own impression -- I'll probably be in trouble by saying this -- my own impression is that math curriculums have actually -- really have improved dramatically and become much more user-friendly in some ways.

I know when my daughter went to school, she just did a number of really interesting exercises that were very different from what I did when I was learning math in elementary school. I think science curriculum still have a ways to go, and the opportunities there are enormous, but we do not do a good job of bringing science curriculums into the elementary school ages in many, many classrooms.

MR. WEST: We have time for one more question, right there in the aisle near the back.

MS. PLAVNIK: My name is La Tosha Plavnik. I'm with the Consortium of Social Science Association. My question is, in this area, Northrop Grumman, Unisys, SAIC, those are very computer software engineering heavy organizations that do a lot of work with Department of Homeland Security and the Department of Defense, and I was wondering if you know of any programs that those organizations that work so closely with such important organizations in the government, if they're working together to make programs, to develop, maybe to help high school students, college students enter into STEM fields or are doing anything to train teachers in STEM fields or anything like that?

DR. BLANK: So I don't know anything about those specific companies. What I do know is that quite a large consortium of private sector companies have joined

with the government in this Educate to Innovate effort, which is a public/private partnership in which there is dollars from the public and the private sectors to support teacher training and to bring new teachers into science and math, as well as to train and retrain 100,000 existing teachers.

So there's very -- there is at this point a lot of strong interest on the part of the private sector and being involved in these efforts. And you're really seeing the fruits of that, I think, coming through with some of the programs that are in place.

MR. WEST: Okay. We are out of time for this portion of the segment. We're going to be bringing our other panelists up, so please stick around. But I want to thank Dr. Rebecca Blank for sharing her insights in all these terrific reports that were put out. Thank you. (Applause)

So I'd like to invite Jim Simons, Charles Vest and Charles Giancarlo to come up and join me. So we've heard a little bit about the administration efforts and the various policies and proposals that it has been working with, but now we have three individuals who are right on the front lines in different aspects of the STEM fields.

These are individuals who have been working very hard on these topics, have put out a range of different types of proposals to advance STEM education and teacher training, so we wanted to kind of add a variety of perspectives in terms of where we are now and what we need to do.

So as I mentioned earlier, Dr. Jim Simons is president of Euclidean Capital and board chairman of Renaissance Technologies. Dr. Charles Vest is president of the National Academy of Engineering and president emeritus and professor of mechanical engineering at MIT. And Charles Giancarlo is managing director and head of value creation for Silver Lake Partners.

So I want to start with Jim Simons and get his perspective. You've

founded an organization, Math for America, that's doing a lot to try and improve math education and teaching in public schools. What do you think needs to get done? What would advance the STEM education field?

DR. SIMONS: Well, I'm kind of a one-trick pony in this subject, because my view is that without knowledge of inspiring teachers this whole enterprise cannot move forward. And it's perfectly clear that we have a shortage of such teachers of science and math, in particular in the upper grades, junior high and high school. Without addressing that issue, not much else is going to happen.

Now, why don't we have such -- the kind of teachers who know the subject and are inspiring, the kind of teachers that we'd really like to have of those subjects? It's simple. As Rebecca pointed out, STEM jobs are increasing at a rapid rate. If you know enough to teach math in high school, you know enough to get a job at Google or at Microsoft or at Pfizer or wherever STEM jobs are available and growing. Now, by knowing enough to teach math in high school, I mean, know more than high school math, I mean, know college mathematics, some applications, whatever it is, and if you don't have that level of training, you're not going to be effective. But if you do have that level of training, the job of being let's say a high school math teacher is simply not very attractive, plain and simple.

So if you want more people to be in a certain line of work, you have to make that line of work more attractive. You have to make it more attractive with better pay, with better working conditions. Whatever the private sector would do if they had a shortage of people in a given category, you have to do the same thing in this teaching sector.

And simply training people to do these jobs is not enough because if the job isn't very good, they might enter, but they're not going to stay. If they really are

prepared, if they are knowledgeable enough to teach math and science in high school, and they're urged and given scholarships and all the rest, prepared for that career, fine, but prepare for a career. But soon they'll discover this career is not very good. I don't get paid enough, I don't get enough respect. So recognizing that problem, we created this Math of America about eight years ago to make the job of high school teaching -- we focused on high school teaching, secondary school teaching, to make that job better and consequently attract people into the field who wouldn't otherwise have come and keep people in the field who are on the verge of leaving.

So how do you make a job better? We pay them. On top of their teacher salaries, we actually pay them more. We don't do it through the school board; that would be problematic. We just make them members of our corps and they get paid a certain amount of money on top of their salary.

Secondly, we make them feel like they're part of something important. We have meetings, we have lunches, we have support sessions and one thing or another. But this group which is now in New York City -- for example, about 350 teachers in mathematics -- is excited, feels important, feels rewarded, they're not going anywhere. They like these jobs, they like the extra pay, and they like the fact that they're treated in a way that's just plain better.

So you can put computers in the classrooms, you can train people to go into teaching until you're blue in the face, but if you don't make that job better, then you're not going to be able to retain the kind of people you want precisely because the economy is growing more and more in the STEM direction. So I'd like to see a program like Math for America, which we're in the process of growing, at least in New York, to about 800 or 900 teachers. That will be about 8 percent of the math teachers, maybe math and science teachers in the New York City Public Schools.

And they're all over the schools. They're not just in the, you know, Stuyvesant and Bronx science, nor are they concentrated in the most disadvantaged. They're spread all around, because this problem of not having teachers of math and science in our secondary schools who know the subject is everywhere. It's in Larchmont, it's in Beverly Hills, and it's in name your favorite slum or whatever, it's all over.

And the solution is exactly what the solution would be, I'll say again, if this were the private sector: make the job better and qualified people will come. So that's my little pitch.

MR. WEST: Okay. Charles Vest, you spent most of your life in higher education, so Jim has focused more on K to 12. What is the situation at the university level? What about, you know, what you're seeing coming out of the high schools as it relates to colleges and universities?

DR. VEST: Well, what I would like to do is going to be, A, consistent with what Secretary Blank had to say, and, B, ultimately going to tie back to what my good friend and hero, Jim Simons, just had to say. We have a problem with STEM in this country. And I would like to throw out there that we especially have a problem with the E, engineering, and we have an even bigger problem with the T, technology, that we're probably not going to get into today because I at least am not much of an expert there.

Let me focus for a minute, therefore, at the bachelor's level in engineering and to a certain extent in science. Looking over 30+ years, the number of engineers we graduate in the United States each year has been stagnant, and, indeed, has declined somewhat.

But what has happened during that period of time, countries, including countries as small as Japan, North Korea, now educate more, graduate more engineers per year than we do. And we don't even want to begin to talk about China, which

graduates over 10 times as many as we do. But on the other hand, there are a lot of reasons why they need to be doing that. So what I'd like to do is sort of normalize this and ask, of all the men and women that we educate at the university and college level, what fraction of them go into these fields. And if you do that, you will find that you really need to disaggregate science and engineering, because across Asia, across Europe, and across North America, about 13 percent, plus or minus a couple percent, of all our college and university graduates major in science. It's almost constant across Asia, Europe, U.S., about 13 percent.

If you look at engineering across the Asian countries, it's about 21 percent and growing, that their university graduates are engineers; across Europe, it's about 12-1/2 percent; throughout the United States, it's 4-1/2 percent.

So no matter how you slice it, in terms of opportunity or what have you, we are not educating enough people in STEM fields in general, and we especially are not educating, in my view, enough engineers; 4-1/2 percent, remember that.

Then I would like to pick up with what the issues look like around our underrepresented minority groups and women in engineering in particular, where I know the number is better, but we're going to talk a little science, too. That kind of leads to the picture in the workforce that Secretary Blank talked about. And I hope you'll forgive me for throwing a few numbers out here, but I'd like you to kind of listen carefully, I'll try to paint a fairly simple picture.

If you ask students coming into U.S. universities what do you plan to major in, here's what you will find: 13 percent of the women coming into universities in the U.S. say I'm going to be a science major, natural science, physics, chemistry, math, so forth; 13 percent of the men will say I'm going to be a science major, so that's great. What happens four years, five years later when they graduate? It's very interesting.

You've lost almost 30 percent of the women who came in to study science, about 30 percent peeled off and done something else. Among the men, believe it or not, you graduate about 20 percent more in science fields than said they planned to be scientists coming in. So kind of have that picture in your mind.

Now let's look at engineering. Only 3 percent, 3.1 percent specifically, of the women coming into college and university in the U.S. say they want to major in engineering, 3.1 percent. About 17 percent of the men coming in say I'm going to graduate in engineering. So what's the reality at the end of this time? Remember what I said about science, now engineering, you find you lose 50 percent of the women on the way through and you lose 50 percent of the men on the way through. So that's kind of the big picture.

Now, if we drop down and look at sort of various ethnic groups and so forth, I begin to get really scared, because what has happened so far, what it is we have to figure out how to turn around, is that the population of 18-, 19-year-olds, 18- to 23-year-olds, sort of college ages, we tend to think of kids in the United States who are African American is growing, the percentage in this age range who are Hispanic-American kids is growing really rapidly, and yet the percentage of these who go into STEM fields is much lower than it is among the white kids and the Asian kids, and they're not showing much movement. So if it continues that the growing segments of your population continue to grow in their present low percentage into these fields, we're going to be graduating even fewer scientists and engineers.

So as I think about all of this together, I think we have three basic things we're going to do. I'm going to be not quite as basic as Jim, but not far from it. First of all, I think we have to really work at our messaging, at societal views, at transmitting the excitement of science and engineering and mathematics and information technology,

especially, the surveys tell us, in helping young people to understand that if they really want to change the world and solve our great challenges, these are the core fields that they should be considering going into.

I think, by the way, the entertainment industry literally has to be our biggest ally in this because one of the great things about America is we don't tell people what fields to go into. We have to motivate them, excite them, and I think some of that has to take place outside the classroom.

Secondly, I just want to give a vigorous vote for what Jim has said about secondary education, about the teacher corps. If I were the President, I think the first thing I'd say to our nation is I want to make teaching the most respected profession in the country. If you start with that mindset, a lot can be done. But we have to fix the K-12 issues, not just for the people we want to be professional scientists and engineers, but really for the whole workforce, it's got to have a better STEM background and a better understanding. And then finally, if you go back to what I said of losing 50 percent of both men and women going through engineering schools, we at engineering schools have to improve what we do, and I've got some thoughts on that, but this isn't really the time to draw on that.

So that's my main point. Social views and messaging about the excitement, the importance of STEM fields as careers. Secondly, get serious, as Jim has done, about making a difference at the K-12 level. And third, I think we have some improvement in our university education that has to be brought about, as well.

MR. WEST: Thank you. Charles Giancarlo, you've spent most of your life in the private sector, so you see what comes out of colleges and universities. What are you seeing, what needs to get done?

MR. GIANCARLO: Thanks. You know, it strikes me that this is one of

the few controversies we have in this country where there's complete agreement on the problems and the foundation. I have to just echo both what Jim and Charles have said regarding the state of education. I can now talk about what we see as we recruit. And just to give you, again, a few numbers, you know, as head of Cisco R&D, we had about 24,000 engineers, but pretty much the entire population of about 65,000 people were technically trained in one way or another. And as -- in charge of Silver Lake, our corporations have about 87-or-so-thousand technically trained individuals.

Now, think about those numbers for a moment. We graduate roughly 86,000 students per year out of either undergraduate or graduate -- with undergraduate or graduate degrees, right. So, you know, you have one U.S. corporation that has a full year's worth of U.S. graduates, and you realize very, very quickly that the demand cannot be fully fulfilled at this point in time simply by the graduation rates that we have, at least out of the engineering school. And, Charles, your point about engineering and other sciences I think being very much correct.

But if you look at the large U.S. technical base, whether it's in engineering-oriented fields or biological- or chemical-oriented fields, you realize right now that there is not enough supply to meet the demand that the U.S., in its -- with its incredible innovation, can draw from our own schools.

Now, you take upon that the fact that, again, I'll use the engineering standard, over half of the engineering graduates out of graduate school, that is, with advanced degrees, are foreign-born. If you look at Rebecca's statistics this morning, take all of STEM, 35 percent of graduate degrees are to foreign-born, and realize that we only reserve 65,000, there's an extra 20,000 now, so 85,000 H1B visas for technically trained individuals in the U.S.

And what you realize again very, very quickly is we're educating students

only to send then back. It's a crime in the first place that we have to draw them from overseas. But then it's pouring salt in our own wound to actually send them back home for lack of H1B visas. And this has been a severe problem. It has forced U.S. corporations to go overseas. One of the things that is occurring dramatically in Silicon Valley is not only the percentage of the workforce within high-tech companies that is foreign-born, but the increasing number of overseas workers that we are using with advanced degrees in engineering, computer science, et cetera.

In fact, it had gotten so bad at one point with H1B visas that Cisco opened up a Vancouver R&D site because Canada would accept the very workers that Cisco wanted to hire, so we had to open R&D overseas in order to do that. But we also opened facilities in India and China. It was remarked upon before just how many students were taking up advanced degrees and advanced studies in mathematics, engineering, computer science, et cetera, in India and China. And for global corporations, frankly, these days it's almost impossible not to avail yourself of the incredible talent that's over there.

I can tell you directly that the quality of these graduates overseas is tremendous. These are very, very capable students. And even though some of the numbers that are discussed, such as, for example, 600,000 engineering students per year in China, in spite of the fact that some of that 600,000 would be more properly qualified as technical training or technical school graduates in the U.S., still the numbers are quite daunting.

So if we were to fix this problem, really there are two ways about it. We have to make ourselves either more attracted to more students to come and then stay in the U.S. through opening up our H1B visa problem, or, as Jim has mentioned, we need to dramatically increase the number of Americans, native-born Americans, who are

graduating from our schools. And in order to do that, it's very clear that that preparation starts in K through 12.

I couldn't agree more with Jim that we need to simply improve the salaries. However, I think we also need to broaden our qualifications. One anecdote and then -- or two anecdotes and then I'll move on. I think most people that follow scientific careers can often point to a very influential teacher that they had in middle school and/or high school. I was very fortunate, I had two. And in both -- one was in math, one was in the sciences. In both cases, they were retired professionals who decided to teach after retiring from private industry. And the remarkable thing about that background is not only do they bring in a love of the subject, but they bring in the actual experience of having spent a life in technical fields. There's really almost nothing that can be more inspiring to a group of young people. And I really believe that we should make greater use of retired professionals in K through 12.

Secondly, we do need to -- there was a woman in the back, sorry, I didn't catch the name, who had asked about using more new technologies and broadbands in schools. And I encourage everyone here to take a look at -- and I have no affiliation with this group other than being an ardent admirer, but with the Khan Academy, which is something that was started in California, which is a fellow who came to the U.S. and decided that he was actually, believe it or not, a hedge fund manager, retired from being a hedge fund manager and decided to teach mathematics to his cousins; used YouTube to do it. And now there are over, I believe the number, if I'm not mistaken, is 90,000 videos in math and science and his -- with a lot of software now to be able to support training. And his view is that we should be giving lectures at home and homework at school that allow the students to learn the lessons in a broadcast manner from, you know, highly skilled lecturers while they're at home and use the one-on-one training and

the individual attention that can be given by teachers in the schools at school.

And it's a remarkable program that has been initiated and really makes use of the new technologies to fundamentally change the nature of schooling in K through 12. Thank you.

MR. WEST: There's another question I'd like to throw out for everyone on the panel and then we'll open the floor to questions and comments from you. And my question is, what do you think the administration should do that would make the biggest difference in terms of improving the STEM situation and what should Congress do? If there are specific proposals that you think would make a big difference here, what would those proposals be? Start with Jim.

DR. SIMONS: Well, I was up here about a year ago to talk about the PCAST Report that had just come out, the President's Council, whatever it is, anyway, the science guys. I can never remember these acronyms. In any event, the PCASTers cast a report and there were two things aimed at teachers that would be good. One was this 100,000, you know, scholarships to get 100,000 people into the field of STEM teaching.

This report was all about STEM, but the other was a -- to create a core of master teachers, and it's that that I feel has found a way, the more important of the two. And if the government did only one thing, it would be to create a core of master STEM teachers. It would be transformational if it's done in a big enough scale, and it cost a few billion dollars a year, and I just think it would change a lot of things fast.

MR. WEST: And I notice in that PCAST Report, the administration advisory group called for 100,000 new STEM teachers. Dr. Blank, when she was here, gave us the figure of they delivered on 10,000, so there still is a long way to go.

DR. SIMONS: But, again, you can train them, but if the job is no good,

they're not going to stay too long.

MR. WEST: Okay.

DR. SIMONS: Let others answer you.

MR. WEST: Charles.

MR. GIANCARLO: I've seen some reports, something I tried to research before coming here, and the data is very unclear, but STEM teachers really are not paid very much. You know, the data indicates it's a de minimis amount, more than other teachers. And, you know, it's amazing that in training our workforce into our capitalist environment, that we -- that supply and demand does not seem to be a lesson that operates among K through 12 teachers, because clearly STEM -- people with STEM training, undergraduate STEM training, make up less than 10 percent of the teachers who teach STEM in K through 12. Think of that. Very hard to inspire when you don't even have the fundamental background.

I think one of the things the administration could do, if you look at all of the both government and private support for STEM in school that has to do with teacher salaries, less than 1 percent of STEM teachers are touched by that additional support. And so the one thing that really needs to happen is, dramatically increased stipends for STEM teaching, both STEM teaching and STEM facilities, frankly.

MR. WEST: Charles Vest, I want to hear your thoughts on what the administration and Congress should do, but I also want to know, you know, a comment you made that you think it's important to make teaching the most respected field. It seems like there are a lot of trends in society, in politics moving in the other direction right now.

DR. VEST: Well, I was going to make two points, the first one speaks to that and costs nothing. This President is a great communicator. He has the ability to

appeal to young people and excite them. He needs to be continuously using the bully pulpit to talk about why this is important, what the opportunities are for young people, disciplines. He's been pretty good about this; he could do more, so I would start with that.

Secondly, I just am, again, going to agree with Jim, if you go all the way back seven years now to the national academies rising above the gathering storm report, as well as the new PCAST Report, the first recommendation in all of them has been to create some form of a fellowship program that allows young women and men to go to a university and major in mathematics, in physics, in computer science, in electrical engineering and these true STEM fields, and become qualified to teach in the K-12 system. And then, as Jim eloquently points on, the second piece is to make this respected and appropriately paid thereafter. That's what every one of these reports has said is job one and it's still job one as far as I'm concerned.

MR. WEST: Okay. Let's open the floor to any questions and comments you have. Right here in the third row.

MS. HATLEY: Good morning. My name is Leshell Hatley. I'm from a local nonprofit here in D.C. called Uplift, Inc. I run a STEM afterschool program where I teach the engineering and technology, specifically robotics and software development by way of smart phone application development to middle and high school students, and actually one of our students is eight years old. I wanted to ask two questions not really related.

The first is how can a nonprofit like mine, I guess, become more valuable or visible in terms of partnership, in terms of funding? We nurture, we stay at the school as long as the kids want to stay there. We kind of model ourselves as MIT media lab, and we're working on a lot of problems and solutions in terms of technology and

engineering. But how do we actually get more exposure to funding sources, partnerships, so that we can kind of broaden our program?

I was one of those teachers you talk about in terms of I'm an engineer, bachelor's degree, master's in computer science, I'm working on my PC now. I taught for three years, it was extremely boring. I had to teach the same curriculum all the time, so that's why I started my own organization. The second point -- so that's my question, how can we get more exposure to funding and partnerships?

The second question is, in terms of graduate level, and the point that you spoke to in terms of improving higher education, unfortunately, no one is speaking to the faculty members at these institutions in terms of how they deliver their lessons and their support. So, for instance, I mentioned how much we nurture our students after school. However, when they go off to college and graduate school, when engineering and technology get difficult, who's there to support them? I say that because one teacher -- or there's a known trend that in computer science classes, faculty members almost are proud of the fact that no one passed their exams. And so they just have this -- it's sort of counterproductive. It's a weeding out process more than an encouraging process. And I would love for the Brookings Institute or someone else to do some type of study on the perspective of the faculty and how they do their messaging and their societal views in their class, because it's not what we're talking about right now. It's definitely a weeding out process.

And just another example, a friend of mine was applying for a computer science program at a local university. She is an African-American woman. In her interview with him she asked him, are there any minority faculty members in the computer science department? And he said, come on, this is computer science.

So it's -- I told -- and the second question is, you know, can someone do

a study or just some type of professional development on the faculty level of universities? Because I think they're the missing link in terms of how to improve what happens after K through 12, because we're nurturing K through 12.

MR. WEST: Okay. Panelists, responses?

DR. VEST: Let me make a quick comment in response to the second part of what you talked about. First of all, I have to tell you, I am actually very optimistic. I have seen, at least across the -- and I hate to sound elitist, but the leading public and private universities around the country, over the last 10, 20 years, I have seen a great improvement in attitude toward the importance of learning, of education, of project-based teaching and so forth.

I think it's coming. I think the new generation of faculty have very different attitude. It's not out of the whole system. But I will tell you, if you go to the University of Illinois or you go to Berkeley or you go to MIT, you're not going to hear faculty saying our job is to weed kids out. They would view that as the most old-fashioned thing, so I think it's coming.

Now, this is just a little bit of what I call guerilla warfare, but in the national academies, we have some very well-known programs called Frontiers of Science, Frontiers of Engineering. And what we do is bring 100 in each case, roughly, of the really fast molecules, the really highly accomplished young to mid-career scientists or engineers together and spend two or three days letting them learn from each other and move their innovations out and so forth, and this is focused on research and industrial practice.

We've just started two years ago a program called the Frontiers of Engineering Education, and the goal is to do the same thing: get the innovative young faculty members at the university level together and let them learn from each other and

cause some of their innovative approaches to learning and education to propagate around the system, and, frankly, to give them the imprimatur of the national academies of what you're doing as a teacher is really important.

And again, if you'll excuse me for being a little bit blunt, we get a great mix of kinds of institutions so that we hope that they all see that at Cal Tech they think education is really important. And I think this builds prestige a little bit like what we need to do in K-12, so that's one little thing that we're trying to do.

MR. WEST: Over there is a question?

SPEAKER: This time I'm speaking from supercomputing. I'm a teacher who worked at broadening engagement, and there are only a few programs that most kids who are in urban areas ever see. I woke up in Jordan, I saw a truck, it said New York Institute of Technology. I've never seen one of those in the ghetto. So I'm wondering, who are the people who will bring Alexander (inaudible). He has the most absolutely wonderful program. He took a bunch of teachers, including me, older teachers, and taught us how to program, how to make games. Why isn't that replicated? Why do you have to pay for it yourself? NSF does help us by showing us the example, but where are the people who are writing about education, how terrible we teachers are? Where are they when it comes to researching that?

Then there's a guy named Bob Panoff. When he says algorithmic thinking, if you're a teacher who only has that stuff that went to seventh grade, you say what? But when he finishes teaching you -- and then there's a whole curriculum he has free, but how do teachers know about it? When people write about education, they write about teachers. Why don't they write about great programs that have been funded?

And then one last thing. The computation of scientists are not being taught. You say teach the high school teachers and give them funding. But you know

what? I started in fourth grade. I have five Google scholars with money out of my pocket. What would happen if we started, as this gentleman said, at fourth grade and encouraged people? There are people standing in classrooms right now who would do a better job if we had broadband for everybody.

I work with Native Americans, we haven't mentioned them. They can't even get to the school, two hours to the school, two hours back. What about the people in rural areas like Alaska? I've worked up there. We aren't talking to everybody; we're talking to the people with broadband. Let's make sure that we do the broadband and do K-12, not just.

I want those science teachers to be fabulous, yes, because I go to -- you know what? I go to all of those meetings up at the National Academy of Science. I get so excited, then I come back and I write about them. I get three people who answer, but why aren't the reporters doing their job? Why aren't they sharing the --

MR. WEST: Okay, I think we have your question. Charles Giancarlo actually helped write the broadband plan for California, so maybe he could address broadband in --

MR. GIANCARLO: No, I think broadband -- broadband is a huge challenge for rural environments, there's no question. And without, I think, you know, fairly active engagement by either the federal government, the state, actually municipalities, you know, it's going to continue to have challenges in rural areas. I mean, the reasons are quite straightforward, you know, which is that it's expensive, right? It's expensive to dig a trench. And when you've got it supported by tens of thousands of people in an urban environment, it's worth wild digging, and if it's only supporting, you know, 10 farms, or, you know, it's quite challenging for a private company to go about doing it. So it has to be supported by the federal government and/or state government.

There are -- you can read several of the broadband reports. I think there's some very good suggestions in there, but I think it's fairly clear that the whole universal service fee, which used to be applied to voice, really needs to be applied to broadband, because just about everybody has voice these days. And, in fact, you know, my 78-year-old mother doesn't have a fixed line anymore. She's on a cell phone, smart phone as it turns out. Really universal service now needs to be -- start to be applied to broadband.

MR. WEST: Right there in the aisle.

MR. McGHEE: Ray McGhee, a researcher at SRI International. It's clear that the challenges are huge and that no one entity can address this challenge of STEM education by itself. And I'm just curious if the panel could talk about the potential of public/private partnerships. We've heard a lot about that, even Secretary Blank mentioned that earlier. What's the practicality of these kinds of partnerships?

We've heard partnerships touted for a long time, and public/private partnerships have I think a spotty record. Talk a little bit about the potential for the private sector and for government, including higher ed, as well, too, to work together to address this challenge.

MR. GIANCARLO: If you don't mind, I've started several of those and I've researched them and I think they're excellent. Public/private partnerships I think are excellent for innovation of the model, and I think it brings a lot of new ideas to it. But I just don't think the scale is there or could be there to address, you know, the problem beyond the 1 or 2 percent. I really believe that it's a -- one additional thing is, anyone in science knows, when you have very long feedback loops, you often get systems that don't converge. And, you know, the feedback, if you think about it all the way to K through 12, the feedback loop is 20 years, if not 30 years. And so you have to have a

very far-thinking corporation that's going to invest that far forward, and really it's more charity than it becomes self-interest.

So, I mean, it really is a societal problem. It may -- part of the challenge may be the fact that, you know, we're organized in education on a municipality basis, and it's a national challenge, and we have to -- we probably need to address the dysfunction it's caused, frankly, by that system that we have. And we need to come up with some national ways to be able to provide greater support for national -- for areas of national interest.

MR. WEST: Jim, do you have any thoughts on public/private partnerships?

DR. SIMONS: No, I was just thinking as Charles was talking, it's a funny conundrum. See, the customers, big companies in this area, are not in charge of the training of their ultimate workers. So if you can imagine a company, let's say like IBM, let's suppose it was just located in one giant community and it ran the whole community, in particular it ran the educational establishment because its only workers were going to come from this community. If we can imagine this, how would they do it? Well, they'd probably do a pretty good job. They were the customer; they knew how at least these workers should be trained. They had the best people, they pay up whatever it cost, they'd have the best people out there doing the training, and we'll all be sort of a unified operation. But it isn't. It isn't unified; because the customers are basically private and the trainers are basically public, and how do you make this thing work is what we're all talking about here today. So I don't have any more solutions than that one.

MR. WEST: Okay. Two questions right here, we'll get to each of you.

SPEAKER: Hi, my name is Ariel. I'm a researcher at a Japanese trading company called Mitsui. And I don't work at a STEM field, but I grew up in China

and had this entire science, math education. And I went to United States for college, and I just graduated from Vanderbilt and I majored in history, so it's a completely different kind of experience.

So my question is, is there any kind of momentum or initiative for international corporation to solve this shortage of STEM job or, you know, inspiring -- does message deliver in the U.S.? Because my experience in China taught me that, you know, studying STEM field is really highly respectful, and it's even kind of survival matter. If you don't have STEM, then you don't have a future. So in China, there's kind of access of engineer or mathematicians, they want to be in that field, but here it's a kind of opposite situation. So I'm wondering whether there's any, you know, U.S. Government-related, you know, initiatives that (inaudible) international government like China to kind of trying to keep a balance of this.

DR. VEST: Well, I don't know of any programs that directly fit what you're saying. But I think what really happens is a more natural system, namely the good news in all of this is, we are still bringing a lot of extraordinarily talented people from around the world to the United States to be part of our nation and part of our leadership.

And so I think we learn from our colleagues who have grown up in different cultures how it's viewed, and what we try to do as a society is, you know, let the best of all of this boil up. So I don't know of any fancy programs that are directly being supported by the federal government to do this, but there's a lot of informal exchange back and forth, including, just to give a sort of funny personal example, my counterpart in China right now, in the People's Republic, as president of the Chinese Academy of Engineering, just stepped down as the minister of education in China, so we talk a lot about this.

MR. WEST: Interesting.

MR. GIANCARLO: Well, there is one government program I know of, it's the H1B visa program, and if we increase the number of H1B visas, I guarantee you we will get more STEM graduate students and workers in the U.S., without a doubt.

MR. WEST: Okay, right there in the aisle.

MS. SHOCK: Hi, my name is Jamie Shock and I'm a reporter and editor for The American Society for Engineering Education. You can probably guess who my question is for. Dr. Vest, it has been my experience that it's difficult getting engineering into curriculums on the K-12 level, particularly middle school and younger, but most of the teachers I've spoken to say you've got to get them in the middle school. You have to get them then or they're -- they lose interest. And, I mean, 3.1 percent of girls say that they're going to major in engineering. That's a really low number to start off with, then you lose half of them. So how do we get more engineering into the curriculum, not just extracurricular, but actually in the classroom?

DR. VEST: Just some very quick thoughts and observations. The national academies, plural, of sciences, engineering, Institute of Medicine, just a couple of months ago issued its framework for K-12 science and math curriculum, and there's a lot of hope that this is going to have a big impact nationally in due course. For the first time ever that framework has engineering as part of it. And my own view is, the last thing we need to do, not everybody agrees with me, but I think the last thing we need to do is take a new subject called engineering and dump it on top of our teachers when we're already failing in fundamental science and math.

But I think we need to do two things: kids need to hear the word "engineering," and secondly, basic engineering concepts. What's the system, how do you design things, what do you use these mathematical tools for are a wonderful integrating mechanism for what kids learn in more fundamental science and

mathematics, and I think there's a lot of room for working in that direction. So those are the two things that I would like to see.

I was told this morning at another meeting that CNN ran a spot today about a kindergarten in Maine, kindergarten, that had just given everybody an iPad. And I said, you know, I'm glad to hear that, but I'd be even happier if a teacher said, where do you think this iPad came from? And, I mean, I think it's that simple, getting some of these basic concepts, letting people hear, and using it as an integrating and motivating thread through the way we teach science and math.

MR. WEST: Okay, on the aisle, halfway back.

SPEAKER: Hi. I actually want to build off of that thought with regard to messaging. One of my concerns is I think that we start too late. For instance, what if we were to introduce the high math, the engineering in a Sesame Street program, you know, as one of the little Muppet people becomes a scientist or so forth? Because I know back in the '70s, Barbie became a doctor, Barbie became all of these things, and it changed the way girls thought.

The other thing is how can we get the toy industry to change some of the things that they do? For instance, you have the connector sets and so forth. Why can't we create a component that's motorized, where the children, you know, build into that, so you'd get that mechanical engineering component and so forth?

My other thing is what are your thoughts about doing public service announcements, where you -- and I'm talking now academia and corporations create video vignettes that can then be brought to schools during career days? But start early, the boys and girls clubs, the YMCA's, so we can get our kids thinking, and also parents.

DR. VEST: Well, really quickly to your first point, I would just say yes. And to your second point, that's why I said I think the entertainment industry is important

to us, because it's one thing to have public service announcements, but for kids, most likely it goes in this ear and comes out that way or maybe the opposite direction.

I think where we can really message in ways that are helpful for engineering and for STEM in general is through the way companies advertise, you know, that can be a real mechanism. And I think there are some good examples now on TV, Lockheed Martin, HP, some running really wonderful ads that gives you a sense of the excitement field.

And secondly, I think our best chance, rather than public service announcements, frankly, is really to get into the real entertainment industry. And, you know, we've got some people like Will.i.am now who have really taken this on with a passion. He's going to reach a certain kind of kid. And I think you all know what happened to forensic science curricula around the country after *CSI* went on the air. By the way, the producer of *CSI* was trying to do a new one based on computer science. He couldn't quite sell it, but I think ultimately those things are probably more important than what those of us that sit in this room can do.

MR. WEST: Over here.

MS. MILLSPAUGH: Hi. My name is Ann Millspaugh and I'm a researcher with STEMConnector. I was wondering if you could just talk about the cost of education, particularly in relation to underrepresented minorities seeking two-year degrees. Just looking at for-profit institutions and community colleges and the price increases that have occurred over the past decade, it seems like to have that type of degree, you have to incur a certain amount of debt. How do you see potential remedies for people who do want to have these degrees, but don't want to -- potentially want to have a job that makes them anywhere between $30,000 to $50,000 a year entry level, but at the same time, will have that job at the expense of tens of thousands dollars of

debt?

MR. WEST: Any of our panelists?

MR. GIANCARLO: I say it's a huge challenge. You know, a number of -- obviously the state college -- I come from a state that has a wonderful state college system, California, and it's the case where if you maintain a B average or higher in the state system, you're then guaranteed a slot in the four-year university system.

But the state budget crisis has had, you know, just an incredible effect upon education in particular, where they've had to raise tuition. And we have to be very careful as a society not to have a shortsighted approach where we are funding -- it's odd now, but it was always the case that we, as a nation, we were funding our youth more than any other component of our society.

We are right at the edge now of funding our senior citizens, and, of course, going forward, the amount of money going to senior citizens will be far in excess of what we'll be spending on our youth. And it just seems to me, you know, anyone who's looking at that system says it's a recipe for disaster.

MR. WEST: Back there.

MS. McADAMS: Hi. Again, my name is Camsie McAdams and I'm the STEM director for D.C. Public Schools. And I'd just like to invite people to think a little bit broader about what you were talking about earlier about the fact that public/private partnerships are pretty good at like the innovation, like getting kind of things going.

I was a cooperating teacher for Math for America in my former career as a decade-long math teacher in New York City Public Schools and in Oakland, California, and the concept of having the program last for five years is really critical. So I would like to think that these innovation partnerships as they come up. So if I'm here in D.C. and I'd like to have somebody partner with me to help maybe fund the STEM Fair or a

celebration of STEM Teachers Night to think, if you're in the private sector, to think don't just offer that partnership for one year, but think about offering it as a sustained partnership and build in some metrics.

So I've had conversations with Google and with Microsoft and saying, hey, we'd like to put more computer science in the classrooms or put computer science at all. They're saying, okay, we'll give you money to get it started, and then if you can produce this terms of metrics, then we'll sustain you for years two, three, up to five. And I think that that might be a message that you all, from where you sit, could really promote in terms of not just doing like a one-off. And even yourselves as professionals, as STEM-based professionals, to not just go to the school and do the one day career talk, but then offer to go back, sustaining that. And I think that would really help public/private partnership become more about sustainability, replicability and scale than about these one-off innovation things.

MR. WEST: Okay. Jim, here's one of your Math for America alum, so she's talking about sustainability, metrics. What do you think?

DR. SIMONS: Yes, but she didn't ask a question, she made a statement, a series of statements with which -- all of which I agree. So, sure, you want to give people some runway to work rather than a one-shot and see how it goes and so on. You want to create that kind of stability.

MR. WEST: Right here in the front.

MS. STERN: Again, I'm Paula Stern, and today I'm representing the National Center for Women and Information Technology. And I wanted to go back to some comments that had been made and reinforce a point which I would like to hear you all address, which is the importance given our budget crises here, focusing on getting the biggest bang for the buck in STEM. You all are here agreeing on STEM, and I would like

to ask you all to unpack it again and talk about computing, computer science, whether we are teaching it adequately, or even is there a curriculum in the middle school where, as this reporter suggested, is the critical element, particularly when it comes to the women and under represented minorities.

This issue is a state and local issue, unfortunately. I believe the federal government, particularly the Department of Education, really doesn't want to get into talking about curriculum. But your study that came out most recently, what you mentioned, Mr. Vest, had a footnote in there about computing and computing science and the curriculum. And basically it said, well, it could fall into math, and it could fall into science, we're not really sure. So basically nothing was stated on that.

I feel like we have to go further. This is a science, if you will, which underpins all these job issues which the acting secretary of Commerce mentioned. And I would love to hear you address how we encourage either the state and local level, but at the federal level, you are all representing both a national agenda here, to get computing in. We don't have -- we have fewer and fewer people, kids taking the advanced placement course in computing science.

DR. VEST: You're talking about girls?

MS. STERN: No, people.

DR. VEST: Oh, everybody, okay.

MS. STERN: Of any color and gender and persuasion, and it just is a shocking situation. Now, they're trying and we're testing a redesign of the advanced placement exam, it's being kind of a stress test in college to make sure it stands up as a college level thing, but this -- we've got a problem, because even if we get a better computer -- advanced placement exam, we still have to be working all the way through. So I beg you to just play with this idea.

DR. VEST: Let me make a --

MR. WEST: Okay. Now, this is the first time we've had an author footnote challenged at Brookings. Go ahead.

DR. VEST: Let me make a couple of comments that will make you mad, but we've all been agreeing with each other, so what's wrong with that? And we know each other and I really respect what you do. First of all, I'm personally not particularly happy where computing and algorithmic thinking came out in the framework. But let me tell you, and it won't surprise you, guess what happened when the rough draft was floated. The economists want to know where's economics. The computer scientists want to know where is computer science. You know, you keep going on down the list.

And so I do respect a little bit the sense in which it is -- they tried to remain fixed on the fundamentals, but I do think that computing, broadly viewed, has become very, very fundamental. So I wish it had had a little stronger point.

But let me say beyond that, we also have to be careful. You know, central planning doesn't always work, telling people what's important and what they should go into, so I'm a big believer in the fundamentals of education. Notice I never said particular engineering discipline, I said engineering and I said science.

So when I graduated from a university, there was no IT industry, yet it was probably the biggest employer of my classmates. So we have to be pretty careful about looking at the current situation and, worse yet, in the rearview mirror and saying go into this field. So I think we have to be very cautious about making, in this case, computing and IT a focus in and of itself, but we do have to give people the basic tools.

MR. GIANCARLO: And maybe in the spirit of disagreement, I'll disagree slightly with my colleague.

DR. VEST: Good.

MR. GIANCARLO: In that I think computer science is probably, you know, the shop of the information age. In other words, you know, I learned shop in high school. In fact, I thought the least valuable course I thought I took in high school was actually typing, and, of course --

MR. WEST: I thought it was the most valuable class I took.

MR. GIANCARLO: Well, it turned out to be, you know, of course, a very valuable class. But, you know, I did a lot in the, you know, in the shop, as well, right. And these days, you know, we're not in the industrial age anymore. Very few of our high school graduates are going to go and become, you know, workers on an assembly line. You know, computer science is going to be a very valuable discipline almost regardless of what they go into. And it may turn out that 70 or 80 years from now you may be absolutely correct, that computer science is going to be, you know, the shop of the next age, whatever that might turn out to be. But at least for the next -- you know, for a good period of time, computer science is going to be very valuable, and I think that it should be a fundamental part of -- and by the way, I think we should bring back Home Ec, but that's another issue.

MR. WEST: Among kids we've gone from shop to now Photoshop. I'm going to make that the benediction, but I want to thank Jim Simons, Charles Vest, and Charles Giancarlo for sharing their views with us, and thank you very much for coming out, as well. (Applause)

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I, Carleton J. Anderson, III do hereby certify that the forgoing electronic file when originally transmitted was reduced to text at my direction; that said transcript is a true record of the proceedings therein referenced; that I am neither counsel for, related to, nor employed by any of the parties to the action in which these proceedings were taken; and, furthermore, that I am neither a relative or employee of any attorney or counsel employed by the parties hereto, nor financially or otherwise interested in the outcome of this action.

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