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>> If I can get everyone to take their seats. Let me start by welcoming everybody, the members of PCAST, the OSTP staff, the members of the science and innovation communities who are attending in person, the folks watching on the Web and of course our guest speakers for the morning whom I'll introduce in a moment.

Just very briefly in the way of opening remarks, it's very exciting to have PCAST in town for its bimonthly meeting. We are gathered here at a time of great challenge, of course, particularly in the budgetary domain but also great excitement about the opportunities to continue and expand to apply science, technology and innovation to the full range of national priorities before us. We have enormous opportunities to apply science, technology, innovation, high-tech entrepreneurship to job creation and economic growth, opportunities to apply biomedical science and information technology and the intersection of those to getting better health outcomes for more Americans at lower cost. We have opportunities to bring science and technology more effectively to bear on the great challenges at the intersection of energy and climate change. We have enormous opportunities as well as responsibilities in the domain of making progress national security and Homeland Security and using science and technology to best effect in that end. And, of course, we have great opportunities and we place high priority on STEM education, on science, technology, engineering and mathematics education which in a way is the foundation of future progress in all of these applied challenges and, of course, in the great quest to expand fundamental knowledge, to better understand ourselves and our universe.

I think all of us on PCAST feel that it's a great privilege to be advising the president of the United States and his other senior advisors on this range of topics at this particular moment in history.

So before I introduce our speakers in this session this morning, our first speaker, let me ask my co-chair, Eric Lander, if he would like to add anything.
>> Eric: No, just my general welcome and thanks to everybody for being here and to the PCAST for what has been just continued frenzy of activity on many fronts, some of which we'll be discussing today. I also want to thank the speakers for coming and discussing with us this very interesting and important point.

>> Let me very briefly introduce the panel. Because all of the members of PCAST have their bios in their book, I will not read them to you and take the time with the speakers, but let me just say that we will be learning about the American Chemical Society presidential commission on events in graduate education in the chemical sciences from Bassam Shakashiri who is professor at the University of Wisconsin at Madison. We will be hearing from William Banholzer who is Executive Vice President and chief technology

officer at the Dow Chemical Company and we will be hearing from Jackie Barton who is professor of chemistry at the California Institute of Technology and I do have to mention one item from her bio. She received the 2010 National Medal of Science from President Obama and it was a pleasure and a privilege for me to be present at that ceremony. So welcome to all of you and thank you for taking the time to come and share your insights with us about this very important report, and I'm going to turn first to Professor Shakashiri.

>> Professor Shakashiri: Thank you, Dr. Holder. We are grateful for the opportunity to present to the president's council of advisors on science and technology conclusions and recommendations from the ACS commission on graduate education in the chemical sciences. We believe that fundamental changes are needed in the education of the scientists whose work impacts medicine, drug discovery, development of sustainable new fuels and other global challenges that society faces in the 21st century. The report provides sharply focused recommendations related to reports issued recently by PCAST. I refer specifically to the report engaged to excel and also to report the future of the U.S. Research Enterprise.

Before I begin -- before we begin, I wish to take a brief moment to share with you another contribution from the American Chemical Society that relates to President Obama's calling on all of us, scientists and citizens, to respond to the threat of climate change. The ACS climate science was completed last year. It provides tools to better understand and communicate the science of climate change, the scientists, and to the public at-large. It can be freely accessed by anyone at www.acs.org/climatescience. Dr. Mario Molina advised and contributed to the development of this toolkit. Thank you, Dr. Molina.

The state of graduate education in the chemical sciences is healthy and productive in many respects. However, practices of graduate education in our fields have not kept pace with the significant changes in the world's economic, social, and political environment since the end of World War II, when the current system of graduate education was formed. To advance the nation's needs and to help assure quality graduate education, I as president of the American Chemical Society formed a blue ribbon commission to undertake a wholesale review of graduate education in the chemical sciences.

The commission consisted of top national leaders from academia and industry, including members of the national academies, PCAST member Dr. Chad Murphy. Thank you, Dr. Murphy. University vice presidents, presidents from major chemical and life sciences companies, medal of science winners and distinguished faculty from across the nation. Dr. Larry Faulkner, president emeritus of the University of Texas served as commission chair. The charge given to the commission was to answer two main questions: What are the purposes of graduate education in the chemical sciences; and what steps should be taken to ensure that graduate education addresses important

societal issues as well as the needs and aspirations of graduate students. The commission was also asked to consider fundamental, comprehensive, and systemic changes suitable for graduate education in the chemical sciences and to suggest actionable approaches for enhancing the quality of graduate education at all institutions. Mutter for, the commission was asked to look at five major areas and determine if the current academic structure of the departments is a strength or a weakness, to expand the employment issues of graduate students in both industrial and academic settings, to review the financial support mechanisms for graduate students, and to examine current profile -- the current profile of graduate students in terms of diversity along various avenues. And finally to focus on the expectations and aspirations of graduate students and whether or not universities are keeping the promises that they made to student, both explicitly and implicitly. The commission completed its work last December and issued a remarkable report. The commission was unanimous in its candid conclusions and unequivocal in its advocacy for change in the context of graduate education in the chemical sciences.

And now to present the commission's conclusions and recommendations, I call on Dr. Jackie Barton and Dr. William Banholzer.

>> Jackie Barton: So as Dr. Shakashiri said, we completed our report. I think I all have a copy of the summary report here. And we really wanted to deal with the important questions that Bassam had addressed to us. And we talked about the purposes of graduate education. And in thinking about what is the role of graduate education, there are some purposes that transcend the individual, what's important in terms of contributions to society. That's what this is all about: How can we further science in our country and in the world. And then also the purposes that are focused on the individual: How people are learning and becoming full-fledged graduate scientists. But at the end of the day, what we had were five conclusions and that's what I really wanted to go through here.

The conclusions spoke to the educational experience of graduate students, the financial support of graduate students, safety as a culture, sustainability and opportunity in graduate programs, and the post-op experience. Once we had the report, we brought it to a whole range of different audiences and you were one of them here because in fact, I think we really tried to look at some more questions, and we don't want this report to just be put away somewhere. I think it's important that there are actionable items and that we deal with them.

So let me really get to that. So the first conclusion, further educational opportunities for graduate students viewed on balance do not provide sufficient preparation for careers after graduate school. That's where we are now. And I think what's really important is that we need more buy-in of the professors that are mentoring the students by and large, across the way. We need the mentors to be helping in terms of teaching the students beyond their individual research projects, how to give a talk, how to

communicate the science once they have it, how to learn new science. The science that they will be grappling with once they're on their own and individuals isn't the science. The facts are going to change hopefully. We're going to be learning new things. So how to teach the students how to learn and learn new things. How to collaborate on global teams. In bringing things forward, whether you're talking about an individual research group or whether you're talking about going into industry and having people with different expertise get together, it's important that students learn how to work together on teams, and global teams. The person that you're working with may be at the other end of the globe with different perspectives, but you've got to learn how to work together and talk the same language and not so localized and focused on the trees that you're not thinking about the forest.

And then to effectively define and do what you're doing in order to come up with a practical solution. At the end of the day as students are no longer students and they're having their careers, it's not a matter of being part of a research boutique. It's part of making something that's going to make a difference. And so having a goal of these practical solutions, not just science for the beauty of science.

And then importantly what has to underpin everything is the ethical conduct of research. And I think it's clearly important that we focus on the training of students in that context, not just on the facts and not just on their individual research projects. We also said that it was important that, although we're asking a lot, that it should be done in a shorter period of time, which means that as you bring in more things to do, you're going to have to eliminate some other things.

The second conclusion I think is also one that's very important and one that this group in particular can be speaking to and that is that the system for financial support of graduate students probably needs to be changed. It's no longer optimum. It rests too heavily on individual research grants. And that raises all sorts of conflicts. What we have to do is change it so that there's a separation between funding of students, maybe not a complete separation, but there's the funding of students and then there's the funding of individual research projects. And that the goals aren't completely the same in those cases and so we have to consider that. So we need to decouple individual research grants from funding of students.

It used to be 20, 30 years ago that students were funded through NSF, graduate fellowships through training grants. And then one had separate from that funding of a research project. That's not the way it is in lots of places today and so that means that the students' focus have to be completely on the research grant and the mentor is completely on the research grant instead of the training of the students to be scientists. So we have to decouple this better. We have to have trial projects designed to come up with new kinds of training grants and bring more of those kinds of programs into place. The commission recommends graduate program grants to support graduate students and they aren't just the training grants. We have to have more of those.

And in saying this, and this is something that the commission talked about to a great extent, we're not asking for more money. We think this is sufficiently important that if there is a constant pot that has to be redistributed toward these kind of programs rather than solely on individual research grants.

And then I'll turn this over to Bill Banholzer who I think can articulate this next and very important conclusion.

>> Bill Banholzer: Thanks, Jackie. So another key planning from our commission is that safety has to be instilled as a culture within a university. Today in a research institution and research industry, they are very similar by eleven times safer to be in an industrial lab rather than academic lab using OSHA recorded results. Not two or three, as an order of magnitude. And we're doing the same kind of work, and I don't know why we would expect that. And an industry, even though we complete, we share our best practices on safety because it's been the best interest of the whole industry that we all operate safely, that we all create a safe environment for not only our employees but the products that we produce. We don't understand why that shouldn't be leveraged equally into an academic society. And in fact, we think it will actually have an element of effectiveness and that the graduate students, when we hire them now, typically have to have two to five weeks of training, remedial safety training before we let them in an industrial lab. I don't understand why we'd allow that.

And finally, we've had some notable explosions and including fatalities that could have been prevented in academic labs had they had the proper personal protection equipment and proper safety training. So we thought it was imperative as part of the future education of these students that they instill and understand safety as a culture. And it's a leadership thing.

Now, the first issue is it has to be really be driven by faculty members. This is not about a lot of money. It's more about mindset and procedures, and it has to start with the faculty members. So it's part of the recommendation of the faculty we felt that we should not accept that we aren't going to be as safe as we can. We have an obligation to the students that come in that they leave our lab and leave with their degrees as safely and as healthy as when they entered. So we think it's an institutional element as well in that there are certain things where you can have -- you have to have harmonization across a department. It can't be that one group is safe and one isn't. So we thought for the institution leadership that they need to make sure that safety is applied uniformly and the tools and training are spread across every institution and we save the entire academic framework.

It's hard. You know, in academia you've got a lot of stakeholders but I think safety is just all about mindset. And industry, if we see an unsafe lab, we will shut the lab down. You

cannot work. Our tenet is if you can't do the lab work safely, you can't do it at all. That's not exactly the framework that we have in all our academic labs.

The second -- fourth conclusion, second one that I'd like to talk about, is the most contentious and, but I also am pretty proud of my colleagues for having the courage to bring it forward to admit the elephant in the room, which is there is too many Ph.D.s being granted in chemistry for the amount of jobs out there. And this is manifested in several ways. First of all, people are now taking two and three post docs. The post docs have started to become a capacitor to try to buffer between the actual jobs that are out there and the number of Ph.D.s that are being produced.

Second, there's some departments at some of the smaller or less research-intensive schools that have the majority, not a few, the majority of their Ph.D.s from outside the United States because of the number of teaching load. And one of the conclusions was we have an undergraduate responsibility to teach chemistry to a broad group. They are not all going to go into chemistry. But we can't use that as an excuse to say that's why we have to generate a bunch of Ph.D.s. so the recommendation is that we need to seriously look at how many Ph.D. chemistry and chemical engineering degree programs are there and decouple that from the undergraduate teaching load and supervision. And it's been done at several places effectively. And that we have to also recognize that not every program has to be the same, that people should try to differentiate and decide what the country needs but not everybody has to be world class in biotechnology and nanotechnology, and somewhere each department's got to look at what do they want to be world class in rather than every department thinking that every individual sub discipline is going to be world class in everything. It just doesn't work that way.

Now, this is the most challenging. People are going to ask, well, how do you expect to implement this, and we recognize that it's probably one of the most difficult of the conclusions and recommendations to implement, but that did not deter us from saying "But it has to be brought up and recognized that we probably are having too many Ph.D.s granted" and some of the things that we thought we could do was to repeat what Jackie went through. As we look at the funding of students, look at how many students we want to fund and use that as one mechanism, but we also talked about transparency and said if we generated a database where people understood what the percent of people who are graduating are getting jobs and where they are getting jobs and from what department and how long it's taking them to get their degrees, that students will vote with their feet. And so by trying to develop the recommendations to ACS that we would create some kind of survey, a database where people can go. We have a survey of what the salaries are. So people know what people are getting for salaries. It's very privacy-protected. But if we had some survey where we would be able to understand what each department, where are the graduate students coming from, where are they going to, where are they actually finding jobs and how long is it taking them to get out that students will look at that as they decide where they go and that might be one mechanism to sort of force a change. I recognize it's probably going to be very hard for

a department to say, "Well, you know what, I'll give up my Ph.D. program and I don't have to be a research institution; I want to be a teaching institution." That's probably not a natural act. But for the health of the chemical profession we thought it was a report of this magnitude had to have that recommendation included in it.

So the transparency initiative is away. It's probably not going to be the primary forcing function but we felt that these are all information that students had the right to see. We have great mechanisms now. You can find so much stuff on the Web. This is something that the ACS can easily facilitate. So with that I'll turn it back to Jackie to talk about postdoc.

>> Jackie: So the other piece of this is that being a postdoc should not be a weigh station. A postdoc is an apprentice. A postdoc is an apprentice towards becoming either an academic scientist or in industry. And they need to be treated that way. And again, they need to be mentored in that regard.

In many universities, many that we know well, a postdoc is sort of in this island. They are not students; they are not faculty. What are they? And that has to change. And I think it really has to change in the context of thinking about how we train them, that a part of the postdoc experience should be mentorship, and we recommend therefore that funding agencies, when they're funding postdocs, should rare general mentoring plan. That happens in a lot of NIH programs. I think that needs to happen more generally and that's the way we feel about it.

Funding agencies need to become more receptive to requests for support of postdoctoral associates as independent scientists in various circumstances.

And then there's also the teaching postdoctoral associate. There are several programs that exist, but they're very small in terms of having postdocs that are part teaching, part research experiences. And I think those are the kinds of things from this spirit of mentorship that needs to be extended further.

Also something that I forgot to mention in the context of financial support for graduate students but holds as well with respect to postdocs is this whole issue of international students coming in and how they're funded. And I think this group in particular could be serving a role of providing more pressure that different countries, when they send their people here for training, need also to provide some support for that. Some countries do that; many countries do not, and I think that's something that's important for us to try and focus on and create more of a pressure in order to accomplish that goal.

So those are the recommendations, and we just look forward to your questions.
>> Great. Well, thank you very much, and we'll follow the usual practice of recognizing people in the order that their flags go up. And Mark Gorenberg was the fastest. Mark?

>> Mark: John, thank you. Thank you very much for your report and your recommendations. They are really great and very broad. I'm curious on your position on a hot topic this year on online courses. You didn't talk about it in your slide. You do make reference to online courses in your report and I'm curious if you have a position on that.

>> That was not a specific topic the commission looked at. As we all know, MOOK is changing as we speak, but it is something that is of great concern in terms of the preparation, the proper technical preparation of the students who will go to graduate school, and the quality of instruction that is given via the latest part of the technologies in the electronic revolution that we have now. So one can visualize, for example, that the graduate students, when they are admitted to graduate school, would no longer be asked to take qualifying exams or placement exams and so on because they would have had that experience before. So specifically such details and aspects were not addressed by the commission but are indeed related to the commission recommendations.

>> You know, it is remarkable how little we talked about it, but I think the reason is that chemistries is basically laboratory science and at the end of the day in terms of a graduate education, you've got to get in the lab. Maybe that's part of the difference.

>> There was one area where I think it's especially applicable, which is safety. So there are standard safety hazard project analysis and reactive chemistry and exothermic reaction and analysis that you do that you'd like to have that standardized and disseminated quickly across the whole place and it seems online training would be the perfect place to do it. In fact, we're developing these modules within our corporation, Dow, for exactly the same purpose. We have sites all over the world and we want the same standards everywhere. And to try to teach that one on one is a tedious experiment. But if you want to get it out quickly, that's the best way to sort of have the same standard taught everywhere. Now, whether it's followed and adopted is one thing, but I think in the actual dissemination of how do you do a lot of these safety practices and what constitutes a good safety program, I think the online academy, some way to train it is ideal. And we're actually generating some modules, say, look, this is what we're do. And then we're working with some universities to try to tailor that to the university. It's a standard. It's not going to change from place to place, and it sort of creates a, I say a minimum level of what we're going to have. And I think that might be an ideal way where you don't have to worry about the content is pretty uniform and it shouldn't have to be tailored as much.

>> I have a long list and I'm going to try to do it in the order in which I saw the flags. If I get you out of order, I apologize. Barbara Shaw is next on my list.

>> Barbara: Thank you-all very much. This is a really interesting discussion. And also thank you for your leadership. It's very nice to see academic discipline come forward

and speak with a clear and consistent voice and I think that makes it very effective. I was very interested in your you comments about decoupling graduation from undergraduate TAships. I think that's a challenge for many universities and many of us have been really working and struggling with that to make sure that we do the best possible job of educating our graduate students in all the things that you mentioned: Presentations, et cetera. But at the same time we have an undergraduate mission and chemistry is at many universities a real core discipline for many of our undergrad students.

You mentioned that there were several places where, in fact, there had been very effective decoupling, and I wonder if you could elaborate on that and how that was done and what kind of mechanisms have been put in place in order to really meet the undergraduate teaching needs but yet decouple it from under -- from graduate admissions and TAships.

>> You know, there are some schools that hire people to do the undergraduate TAs. So they are teaching assistants. The teaching assistant need not be somebody who is working on their graduate research. And that's one way that you can think about doing that.

I think the whole question, again, of this question of what's the graduate program supposed to be. The goal of the graduate program should not be to get -- take care of that undergraduate teaching. And so some programs will have a niche area and focus on that and have student, graduate students in that area, but teaching more broad-based and hire people to do that.

>> I'm sorry.

>> Go ahead.

>> There is also a benefit of, if you hire professional people who have taught the same class, you get a better undergraduate experience than TAs who are just trying to do their own homework and do their research, and teaching is just a way they can get paid for this. And so there's been I would believe a benefit of having consistency of training, and it decouples the need for, I've just got to have a bunch of Ph.D. students because I've got 15 sections of general chemistry to run. So I think that's the added benefit of the year-to-year consistency and the training. We all agree if you're going to train people to be professors, they need to learn how to teach. And that can be an essential part of it. But when it becomes the dominant way that you get your Ph.D. program funded, that's where we thought there was an issue.

>> Okay. Next is Dan Tragg.

>> Dan: Thank you, John, and thanks to all of you. Your discussions about graduate training, support for graduate students and postdocs I think resonated with many of us

in our report on the future of the research enterprise that, what we really struggled with these exact same issues. Let me just read from page -- it's deep, I apologize but it's Page 74 of our report. That in particular graduate students and postdoctoral researchers bring a unique kind of creativity to their fields. Whenever possible, that creativity needs to be unleashed instead of restricting graduate students to a particular project or laboratory by providing their funding through a larger research grant, increased graduate fellowships or training grants could give graduate students the freedom to choose their research focus. So we're totally supportive of that view of the world.

The problem is that there, you know, isn't really engaging with Dr. Banholzer that you talked about which is the challenge of controlling the size of the population. One of the reasons we see so many people being supporting graduate students out there with research grants is they want graduate students, and the ones who get the lead graduate fellowships don't come to them. And they have a project they want to do and so this is a challenge. And we aren't elitist in the way that, for example, in the U.K. where they rank departments and assign graduate fellowships based on your ranking of departments. We don't do that. We are more democratic and therefore we have a much broader pyramid. We spread our research and our Ph.D. programs around the country to more institutions. That's both a positive and a negative, and the balance of those is really difficult.

So I appreciate that you guys are confronting this challenge. It's not clear to me that you can really deal with it without sacrificing some of the sort of democratic virtue that's in our system.

>> Jackie Barton: That's why we really spoke about having also these training grants. That's one way to do it. To provide, a department comes together and comes up with a program for training graduate students, which obviously by necessity is going to have a component of doing graduate research because that's part of of how you train students. But they've got an outstanding program to mentor students, one that involves learning how to give talks, one that involves interacting with industry, what have you. And then funds are given to that, to that department. That's a way to decouple it. And it's not necessarily the most elite department. It's the department that got together and said how can we do a good job with mentorship.

>> I think that's a profound point and one we struggle with. I mean, there was a lot, the good ones who say, look, we can't shy away because it's hard to say it's a problem. And I give them credit for keeping us onto that. But this my world we all have similar issues. We only have so much money and we have more ideas than we can afford. And in tough times you're forced to prioritize. And the one thing I've learned after 30 years of research is that you've got to feed your most important or best things first or everything will suffer and you'll end up with mediocre and say, why am I doing anything. And so if we want to maintain our preeminence as a world class research institution, we've got to

I think balance a need for this democratic "everybody gets everything" but if you don't preserve the best and prioritize the resources to where we have the best chance, I think you run the risk of just trying to spread the peanut butter all over and at the end of the day, the best won't be the best. And we have global world competition who have got different criteria, a whole lot of money, and in my world the way we do it is we don't -- if I have a 10% budget cut, I don't cut 10% of everybody's program. I cut 100% of the bottom 10% of my programs because I can't -- the most important things, they're important. I can't sacrifice those. I don't think that model's directly applicable but there's certainly elements of that in there and I think the fact that the world is competing with us and they certainly all want what we have I think is a challenge and we're going to have to look at that balance of how do we decouple the need to service undergraduates, the need to do world class research and the need to try to be there where everybody thinks they can do research. We have we believe too many departments and we've got to figure out how they specialize them. And it's not just academia. National labs, we have national labs doing the same thing. They compete for the same DOE proposals. That is redundancy and redundancy, leads to inefficiency, and I don't think we all have enough money to be able to have a lot of redundancy. So it's a hard problem.

>> Okay. Next on my list is Mario Molina.

>> Mario Molina: Well, first of all, thank you for the excellent report. The question I have is the following: It seems to me that many of the recommendations that you make apply to other disciplines as well. So they are quite general. So I'm just wondering whether in the presentations you have already made or whether you actually thought about these recommendations that might be common, wouldn't they be easier for universities to change not just chemistry but whenever these other things need to be changed.

And a related point is that I'm looking specifically at, say, Conclusion 1. I certainly agree lots of things need to change, again United States, not just in chemistry departments. But on the other hand there are some success stories. There are some best practices. There are some good things that have happened already. So it might be nice to come up with with some examples of how to do these changes in practice; for example, new methods of teaching TAs. And so there's a lot that is happening that is very positive. So anyhow, that's my point that maybe this could be enlarged and could be even more concrete terms with good examples.

>> And maybe it's the effort, the release of the report. We met with presidents of other scientific societies and they quickly said what is in this report is going to be used by them. It's just going to take chemical sciences out and put their own. So you're correct. And the other questions are also focusing on helping universities decide what they want to be in the 21st century. The model that we have used over the past 100 years, the German model where the professor is in charge and the students walk for or

with -- I prefer with -- the prefer is the one that's being discussed here. And as to how change is going to take place, that's going to depend mostly on two groups: The faculty who have the responsibilities and the obligations for the graduate education and research programs, and to the funders. And what the funders expect from the grants that they make; that is, the federal funders, the state funders, as well as the private foundations and industry. And industry port aims to trigger software everywhere, but focused on the chemical sciences because this is where we have expertise.

And I can tell you from visits that I have made repeatedly since last December to major universities and to the Office of Management and Budget and to NSF that there's a great deal of interest in trying to figure out what to do next and how to go about addressing the needs of the 21st century.

What we're really talking about are, take a 22-year-old person in graduate school. What is their life going to be in the next 50 years? That is -- what contributions are they going to make to address the grand global challenges that we have in society, whether it's in population growth or dealing with limited resources or climate change. These are very important challenges. Basically this report talks, you know, about the chemical sciences, it talks about all sciences, it talks about the future of the university. And those are very difficult questions to deal with, but it is our expectation that the great talent we have at our universities, that is the faculty and creativity, that they will devote a fraction of that creativity to address important educational issues.

>> Thank you. Next on my list is Maxine Savitz.

>> Maxine Savitz: Thank you. And also I'm impressed that you were able to come to consensus with that diverse group of members. You mentioned, Bill mentioned that, you know, too many Ph.D.s in chemistry and chemical engineering. Are there a shortage of masters or technicians as you look out at this? And the reason I bring that up in the biological sciences, the tech foundation founded the graduate institute eleven years ago at the Claremont school to really put a terminal master's degree program into place in the life sciences, which has a flavor both of advanced biological courses but also they do projects as if you were in business school, and much of them working directly, particularly with some pharmaceutical companies in the California area and beyond. So I just wonders, is there any thought giving -- or is there a need even for some of this inter -- you know, more than just a bachelor's degree but really don't need a Ph.D.?

>> The commission looked at that question and specifically decided to focus in the time available to them on the Ph.D. program, but in the report there's a mention that the master's degree is one to be looked at very carefully and subsequently ACS and other organizations will undertake that responsibility so that the focus was really on articulating what the purposes of graduate education in the chemical sciences are, the two major questions that were asked. And the commission was very clear in its response.

The primary purpose of graduate education is education. The proper first focus is to educate students to solve problems in society, including the effect of education of the succeeding generations. That applies of course to the Ph.D. students but also to the other students too. And so looking at master's degree programs is part of what should be looked at next.

>> Thank you. Shirley Ann Jackson.

>> Shirley Ann Jackson: I have a couple of questions here, two things: One, maybe it relates to Maxine's question, and this is for Mr. Banholzer. How much use or utility are Ph.D.s in industry?

>> William Banholzer: Okay. So I would say that I'm surprised that anybody in a high-tech industry wouldn't expect a Ph.D.s as the critical resource that they have. So in resource if you are manufacturing in your plants or your assets, that's what you worry about, and people that run them. In research, talent is the only thing that matters, and a Ph.D. is how we train people to develop new knowledge. So my view of an undergraduate is that's somebody who can apply knowledge. They understand, the equations have been written and they apply it. But when you look at the next generation of technology that we need, we need people that can understand how to formulate hypotheses, read the literature and then develop the next generation of knowledge. So I would say if you are -- hope to be a high-tech industry, and I think it's broader than just the chemistry and materials industry, Ph.D.s is the key resource that you need to be able to do that.

So in our recruiting for R&D in Dow, we're the biggest chemical company in the United States, we hire 70, 80% of our new hires are Ph.D.s. it's not that I couldn't hire BS people and after seven or eight years teach them how to do research, but it's way more efficient for me to hire people who have worked with, under the tutelage of a world class professor who have taught them the fundamentals, how to develop a hypothesis, test it, and it doesn't matter what they did their research on; they've learned the scientific process and then they can work on whatever they are going to work on. Because I hire somebody for 30 years, I don't know that they are going to be working on membranes today and tomorrow I might need them to look on quantum doubts for display. But if they've been taught how to think, which is what we sort of describe it as, and that's what a Ph.D. does. It teaches you how to develop new knowledge and apply knowledge.

Now my disappointment is, and it was in our report is that we've gotten so specialized. So we train people so narrow on their dissertation that they can't put it in the context of what society needs. So the way I put that is we need to stop educating people in what's possible and also add what's practical. So we have people that are doing all kinds of research but never can put in the context of, yeah, but we'll never do that, it costs too much, it's energy inefficient. All of the problems that we have, climate change, energy

inefficiency. I was at a meeting with a friend of mine and there was a very well educated scientific person who said, hey, did you see about the new Prius that's going to be powered by photovoltaic film. Now, there is a technical person, not somebody who they have an engineering discipline and they didn't understand enough that the energy density falling on the surface of Prius is never going to be enough to drive that car, yet they've made them exquisite on understanding the uniqueness of some elemental band structure.

So I think we've got to make sure education is both deep but also broad enough that people can put what they are doing into context. And that knowledge I'd say is the key resource we need. It's kind of a longwinded way to answer your question but I'd say it's imperative and it's not just verbiage because we hire, like I said, about 80% of the people we hire are Ph.D.s, and the BS are not the people that we expect to be the, you know, the --

>> All right. I have a quick question for the academics. You know, the question is what are we trying to accomplish with the Ph.D. programs? Is it to enable the students, or is it to put them into a certain channel for society? And how do your recommendations balance that? And what underlies this is this whole question about, do TAships really help anybody get an academic position?

>> Jackie Barton: Let me just say I think the bottom line here is not really we've got too many Ph.D.s in chemistry. In fact, we've thought about whether or not as a group we wanted to make that conclusion and we couldn't get unanimous consent on that in part because we don't have the data. We really don't have the data yet. But I think what was clear was that we aren't training them properly in order to enable them to be scientists. And I think that is the goal is to enable them. And I think a part of all of that, I mean, in my own group, yeah, I do people, my students, to teach because I want them to learn how to teach, and it takes away time from the lab. But that's important because then my graduate students, I want them to learn something. It's important that they learn how to write original research proposals. And so we had a whole thing in here, this is something that happens at Caltech that we care about enormously, that students take the time to learn how to put together a research idea, their own research idea. Now, that takes away time from them being in the lab. But I would argue that that makes them better in my lab and better in everybody else's labs thereafter and most importantly in their own lab. And so these are important elements of the training. That's what distinguishes a Ph.D. from an undergraduate researcher, and that we can't forget about that and that we have to be telling our colleagues, "Faculties, this is important," but then we also have to enable those faculties because they have the pressure that they've got to get their research results done. So we have to get across to them that this is going to help them to get their research results done but also we have to have other mechanisms for teaching for students.

Another thing I forgot to mention is involvement of the Department of Education in all of this. They have had a grant program and I don't know all the details of how that came to be and how that came to go away but that's another

mechanism that we need to be thinking about in terms of independent funding for graduate students through that mechanism.

>> The discussion relates to the question that you asked, Dr. Jackson, what is the Ph.D. degree for. Are we to produce Ph.D. technicians or Ph.D. who are scholars and leaders and engaging in creative ways to address very important societal issues. And this is a question that the faculty themselves have to answer because they are the people who are in charge of the education as well as the training of the graduate students and that's where the conflicts come in, in terms of the support mechanisms that are available.

But there are across the nation institutions of higher education that use graduate students -- I mean the word "use" now very respectfully -- as teaching assistants. And is that really part of the Ph.D. training program or is it part of something else that we have addressed before.

So the discussion is really wide open, again, for each institution to decide for itself what are the purposes of the graduate education programs in the chemical sciences for that institution. And I have great faith in the abilities and creativity of the faculty to address those questions.

The question I really have is what's the time scale for addressing them and what kind of support will they receive as they come up with new ideas from the federal government and the state government.

>> Thank you. Next on my list is Bill Press.

>> Bill Press: Thanks, John. And I want to thank the presenters for presenting a bold and very necessary report. I think it's great. I particularly want to call out my thanks to you for the safety message because I think that if we don't get our faculty PIs to embrace safety culture, it does double damage. They are putting their own people at risk and they are not training the next generation to have a safety culture.

But my question is really more on what was called out in the PCAST report as this problem of if postdocs are really supposed to be training positions and therefore should not be technician positions, then where is that future workforce going to come from? In particular, it seems to me there's a danger that we'll be creating two separate classes of kind of transient workers at our universities: The teaching assistant class who will not have a real career opportunity at any given university and then also a laboratory technician class who don't have a career ladder to advance. And it seems to me this can't be good for universities if they are based on a labor pyramid that has people at the bottom who don't have career advancement opportunities. Where do you see that going?

>> Jackie Barton: Well, you know, when I talk to my own students about doing postdocs, I tell them that they shouldn't be doing postdocs in a lab like mine. That the whole concept of a postdoc is to go do something else in different areas. And so I continuing postdoc has to be a different experience than the graduate student experience.

Now, in terms of the university, you still have the postdoc, but maybe the biology postdoc came from a chemistry lab. I think that science has to

get -- is clearly more interdisciplinary, and people learning how to talk to each other, you know, they have to be more shuffling of the shells, if you will.
>> Bill Press: Maybe if I could just clarify my question: What's the career path for a technician at a university that has volatile funding of research grants that doesn't have stability and so on. In industry I understand that there can be a useful career path for someone without a Ph.D., but laboratory research in universities still needs that labor force, and what is going to be the career path of those people. Or where am I wrong?

>> Jackie Barton: I'm not sure the technician has as much a role in the university setting. A technician clearly has a role in industry but not quite so much in a university setting. University setting is about education. It's about learning.
>> If I understand your question correctly, I think -- Chris, my concern is that when we talk about the service element, there's people who get their entire Ph.D. doing nothing but TAs and I don't think that's right. I think everybody who gets a Ph.D. should at least teach a semester or two, and most schools have that requirement because it makes you a better communicator, and it makes sure that you understand how to communicate maybe complex things in multiple different ways. So -- but I think that is just an element of your education on a way to becoming a world class researcher, and the outlet of that research should be somewhere you've fulfilled gainful employment.

The challenge we had in the commission was there's so much -- because chemistry's such a fundamental science, there's so many places you can go, from going into patent law to medicine to just chemistry to a lot of people going to biological sciences that the fact that there is not everybody's going to go work in the chemistry is actually a strength because the skills are portable to a bunch of different industries. So whatever's the right number we struggle with, well, just because there's not a market that everybody's going to go find jobs in pharma anymore doesn't mean that the entire chemical discipline isn't still critical. But there was some growth signs, which is people are taking more and more Ph.D.s. I don't -- in my personal view, I don't think I need to hire postdocs. Ph.D. should be under a good professor and adequate training because we're going to have to train them the stuff that we need anyway. So they sort of get their postdoc on the job, and I don't need that extra training.

Now, if somebody decided that they were in an area like let's say quantum mechanics but they really, that led them to more interesting in quantum doc and wanted to go work in a material group that's doing quantum dot, post bridge might be a way to get to hire somebody who's doing quantum dot. And I think there's that element. If you want to become a professor, that postdoc is sort of essential to get your research ready to hit the ground running when you start your tenure track discussion. So there's different elements to what the postdoc can be but people are taking them because that's the only job we can get. And we interview postdocs now and they said it's because they couldn't get a job the first time. I think that's a macroscopic trend that is worrying us and should be that these other opportunities should be presented and people need to understand that some of the issue we talked about was, what you need to know is that chemistry, here's all the options that you can do and here's what a patent lawyer does. So that fundamental document, the best patent lawyers are the

people who technical background because they have got to understand the chemistry that they are trying to patent. And I think it's, you know, the idea that we're ever going to get this right and you'll have exactly, well, this is how many openings we have and match it. But the belief is we've got a macroscopic trend of people can't find jobs, there's too many postdocs and what's the purpose of a postdoc should be what Jackie or I mentioned is it's an element to further your education, not "It's the only thing I can get."

>> Thank you. We are officially out of time but I'm going to let Eric Lander ask the question anyway but the question and the responses need to be fairly brief.
>> Eric Lander: You raise so many exciting questions and well posed questions. I'm struck by the conflicting interests that you've identified of the institution, the professor trying to get his or her work done and the student. You've suggested we could have a class of people who are teachers, a class of people who are staff scientists, and a class of people who were students and think about filling those jobs with people who are dedicated to them. You could imagine having students who did some work teaching but it is very clear and transparent how much -- it wasn't even that it was for the institution. There could be a social contract that says "We need you to spend 15% of your time doing it because that's how it works."

So what I was most struck by were your exhortations to transparency, transparency around outcomes for students, transparency around safety, transparency around the work you do in training at your university, what you're training for and the experience. So I ask you: In some sense for much of that, you don't need the federal government. Certain things you do need the federal government, as to whether we apply our training grants to -- whether we do training grants, funding to professors, to support graduate students who are funding directly to students. But for all the rest of it, if the right 15 departments banded together and agreed to be transparent as to a set of things that you've laid out here, it could be very powerful. If you just all said, "We are going to be transparent about our safety records and our safety processes. We're going to be transparent about what our expectations are and what our training is," one could begin to ratchet a race to the top in a certain way because students would be able to see that students who go here really don't have much future, or students who go here really don't manage to learn how to give a talk or something. And what's great is once you start the Web and the students will keep you honest. Any institution that wished to overstate its case might find that it was brought back to, you know, some reality by the students.

So why not implement your report by finding some set of fellow traveler institutions to just do it?

>> Dr. Lander, anything I say will detract from what you just said, and I don't intend to do that. But that is one of the recommendations directed toward the ACS, and the ACS is taking that very, very seriously, despite some difficulties that you can think about in collecting such information.

But you're absolutely right: The full transparency will truly drive the reform and the changes that are discussed in this report. That's going to require faculty to participate in this willingly; it's going to require some direction from the federal government that provides supports for the research activities. And that's in the report. So thank you, Dr. Lander.
>> Lander: Get five of you to do it tomorrow.
>> Well, let me thank all of the panelists for a terrific set of presentations and a great Q&A session. We really appreciate the work that you did on this very important report, and we appreciate your coming to talk about it with us.
[ APPLAUSE ]

>> We are now going to move into the next presentation. We are not having a coffee break at this point. So I expect that we will have Tom Luce, the chairman of the National Math and Science Initiative coming forward, and he will be talking about turning reports into action, lessons learned, progress made, and what is next. This is a topic dear to our heart. We have agreed with the president that one of the priorities of PCAST in the second term will be working to implement a larger faction of our recommendations from reports in the first term and so we're very interested to hear what you have to tell us, Tom, about how to turn reports into action.

>> Lander: And if I can just add our thanks. Tom was a very active member of the PCAST STEM ed study, the K-12 STEM ed study and has in the past provided great guidance to this counsel and we're really glad to have you back.
>> Luce: Thank you so much to both of you. This is a daunting task for a person that's in a 12-step program. I'm a recovering lawyer. I'm in Step 11. I'm not a scientist, I'm not a technology expert, but I have a deep and abiding passion for trying to make sure that we have a STEM-literate society and a STEM-capable society. So it's a pretty dramatic shift from the discussion of graduate education to the subject of the STEM-literate society and the STEM-capable society. And I think under Eric's leadership and PCAST, those issues were really dramatically addressed in the first PCAST report that had to do with K-12 education. A realization that we are really at a point in our society where those are essential needs, and really we need to be part of the discussion that redefines literacy to include STEM.
With respect to that old saying that reports get issued in Washington and they collect dust and they never lead to action, I hope I can dispel that myth here today. The National Math and Science initiative was actually created as a result of a prior report by the National Academy of Sciences called "Rising Above the Gathering Storm." In that report there were specific recommendations made, not just general recommendations by highlighting what earlier in one of the questions was referred to as best practices, what were the best programs at accomplishing some of the recommendations that had been set forth in rising above the gathering storm. And there was a determination by a bunch of the members of that report, people like Chuck Vest, Bruce Alberts, Norm Augustine that they didn't want their report to turn into dust

and so they helped create the National Math and Science initiative with a concept that we would meetly start to work raising private sector funds to implement some of the programs in that report, not waiting for the federal government, not waiting for congress to come to some action but getting started in hopes that then we could go to congress and say, "Look, this really does work and it's been embraced and we need a public/private partnership."

And then -- and in that report there were two programs that were recommended that we felt offered real balance to showing that you really could implement pilot programs on a national scale, and frankly that never happens in K-12. All of us know of successful public schools in any part of our country that work with any kind of population. So we ought not to debate anymore "Can this be done." It has been done, it is being -- it is happening, but it's not happening on a national scale. And we always have to keep in mind we have 50 million-plus students in our K-12 system. So if we have a pilot program by a company and it helps 1,000 student, that's wonderful for those 1,000 students. It doesn't transform our national picture.

The two programs, as I said, were balanced. One was called Advanced Placement Training and Incentive Program, which is really designed to make sure that every child in every public school is given the opportunity and access to an advanced placement course taught by a better trained teacher so they can succeed. Why did we pick AP? Because at the time it was the highest national standard we had, number one; and number two, longitudinal data showed that in public schools in a state if an African-American student took and passed one AP course in high school in any subject, not just math and science, the college graduation rate went from 15% to plus 60, Hispanic went from 15 to plus 60, and Anglo went from 35 to plus 75. That's by the passing of one AP exam. So it seemed to us that this was very, very important, and as I said, balanced program this -- for this program to work nationally, you had to better train the existing teacher core, taking the teacher core as it is and better training them to teach the higher levels.

The second program was more long term. It was saying the next generation of math and science teachers must be trained in a different way, and that model was the UTeach model which was developed at the University of Texas at Austin. That says we ought to take entering college freshmen, they ought to enter the College of Natural Sciences and Math, not the School of Education, and they ought to graduate in the same four years with a BS in math or science that any other student does but also a teaching certificate. This is not an alternative certification program. You actually receive a teaching certificate, the difference being that the majority of the pedagogy courses required for that certificate are actually co-taught by the College of Education and The College of Natural Sciences and Math and really focus on how do UTeach math and science. So instead of more general education courses, you're focused on how do UTeach math and science.

We are totally convinced and the data from the University of Texas at Austin, a program that had been in existence more than 15 years when we decided to replicate it, their data showed that 90% of the students who graduated from that program actually went into teaching. Even though they have a BS, they could have

gone to work for Dow Chemical or another chemical, they went into teaching. The younger generation wants to make a difference. And the remarkable data was that 85% were still teaching five years later. You did not have turnover of those teachers even though they face the same problems of working conditions, cultural problems, lack of teacher pay, all of these issues. They stayed in teaching. Why did they stay in teaching? Public schools? Because they could tell they were making a difference. They could see kids' eyes light up.

If you're trying to teach -- we believe strongly if you're trying to teach math and science and you don't have a content degree, then you're lucky if you can stay a day ahead in your textbook, but you very seldom make a kid's eyes light up. That's the difference in a content-prepared teacher.

So those were the two programs, and as you can see, one was short-term, one was longer term. The report and the creation of the National Math and Science Initiative was immediately given a tremendous boost by a corporate gift from ExxonMobil of $125 million, which frankly is the largest corporate gift I've ever heard of, but it shows the depth of concern in the private industry about our decline in the STEM-related fields. That gift, because of its magnitude but also that it was a multiyear pledge, allowed us to create a real national organization that could build to scale. My nickname for the organization is Scale Up, Inc. That's probably not good English, but basically says we need an institution that is capable of taking best practices and replicating them nationally across geographic lines, political lines, party lines, et cetera.

ExxonMobil challenged us to make sure that we got that grant matched by other private sources, foundation sources, state government, federal government, and we've done that. And frankly we were able to do that by a rocket boost given to us really by PCAST and by the administration in terms of mentioning both programs and the National Math and Science Initiative in the issuance of the first two PCAST reports under Director Holdren and Eric, where these programs were highlighted, and we have had an active partnership with the administration. President Obama has talked frequently about the need for 100,000 new math and science teachers, and this program alone will end up producing 17,000 of those needed 100,000 teachers by the year 2020, which is the national goal that the president has set.

And the replication results have frankly exceeded our expectations. Here's the map. Remember when we started, we were replicating two programs. They were both in one state. So in 2008 we first expanded the advanced placement training and incentive program and we spread to the states that are marked in blue, all in one year of operation. That's very important. That shows that you really can replicate something nationally, and you can do it not by a ten-year effort but in one year it was replicated in these original states.

Today in 2013 we've spread across the map, and our goal is to get to all 50.

On the UTeach -- let me say also let's talk about the results of that advanced placement training and incentive program. You will see, and this is so important when you're trying to change a large system. There is such discouragement in this country about the K-12 public school system. We're all advocates of it, but

frankly people are discouraged and the problem looks so large that people say how in the world can we change anything. We have poverty. We have, we have a disproportionality of income, we have broken families, we have bad working conditions. "Oh, me, what can we do." Well, this program in its first year of operation in a new high school on average produces these increases in passing scores of AP national tests. Not taking tests, not attendance, not grade. This is a student scoring a 3, 4 or a 5 on a national test. And that's in one year. That builds momentum for that to not only change the culture in that school, but as a perfect example, we started in one school in Oklahoma, produced results like this. The governor immediately said, I want this program in six other schools, and the state funded it. That's the way you build momentum.

And after three years here are the results that have been achieved from that program: Every year it increases. Mrs. Obama, for instance, went to kick off this program in a high school outside of Fort Carson, Colorado, a public school, not a Department of Defense school. She spoke in the spring before we started the program in September. After one year we went from zero passing scores to 99, in one year. Those are 99 lives changed, believe me. And the culture of the school changes because expectations become different.

And I want to point out to everybody who gets discouraged that these are happening in schools where we probably must concede the students didn't necessarily get the best elementary school grounding in math and science, nor middle school, but there were still students who, if they had not been given the opportunity and the access, would not achieve their own potential. And to me if we don't make sure that we have opportunity and access for everybody, then we ought to be ashamed of ourselves, to put it bluntly.

In the intervening years in this arena as well, once we saw this success, even though we were starting in high schools, we said, "Well, let's keep this momentum going" and we started training middle schoolteachers to a pre-AP curriculum. Keep in mind these results are without the benefit of that pipeline yet because it started, we're down to sixth grade now, but we're increasing the ability of more and more students to move into the advanced placement arena.

At the same time momentum built on the Common Core Standards, and we took it to be one of our jobs to try to make sure that the Common Core Standards would remain at a pre-AP level and that teachers would be trained to teach those higher level courses just like we're doing in AP. And frankly if I could highlight one thing for the president and congress, it's really been remarkable to see the growth of the Common Core Standards, but the Achilles heel of the Common Core Standards right now is that teacher training has not started in those states on helping teachers teach to those standards. And if the Common Core Standards are implemented on schedule, assessments are given on schedule and teachers are not trained, there will be a public backlash. And there are no funds allocated in Title II in K-12 education for STEM. There's one gigantic large pool of funds, the second largest that the Department of Education gives out, but none of it is specifically allocated STEM

teaching, nor for teaching teachers to the Common Core Standards, training teachers rather. So I would highlight that issue for you.

But the important thing is here is that after four years of operation, we're in 460 high schools in 20 states and we've proven that a program can be faithfully replicated, can produce common results, and that is a big step forward in education, which is desperately needed in this country if we're ever going to change the country's outlook with respect to STEM.

The second subject relates to the UTeach program that I mentioned. When we started in 2008, I was so pleased to find that we were able to persuade a number of universities to apply for a grant to replicate the UTeach program. This is not easy for a college to apply for a grant that says "We're going to change the way we train the next generation of math and science teachers." And our grant agreement requires the president of the university, the provost, the dean of the school of education, and the dean of college sciences and math to submit the grant application jointly because it requires a fundamental change that says, no, we're not going to train the next generation of math and science teachers in schools of education. We're going to train them in the schools of natural sciences and math. It also requires a mindset change of the deans of those departments who often feel their mission is to produce, as we were discussing, graduate students, and that certainly is a responsibility of a department. But we would submit that there is a give-back responsibility that says you've got to help train the next generation of our society in math and science, so it's okay if your department also graduates 100 students who are going to go into public school teaching and they are not going to continue either on a master's or a postdoc. They're going to be teachers and you ought to be very excited and happy that they are going to be teachers. We're not asking you to turn that into your only mission, but this is good news that this number of universities agreed to do that. We gave them grants that would allow them to implement the program over a four-year period without cost to them. The cost to $2.4 million over five years. We provide curriculum, study aids, we work faculty. This is done in cooperation with the University of Austin-Texas faculty that actually developed these courses in the first place. And I'm happy to report our first cohort of UTeach is ending this year and all 13 universities are going to continue the program without further grants from us. That's the terms set forth when we give them a grant. We're helping them to become where it can be self-sustaining. It is self-sustaining in those 13 universities. And we have a variety of universities that are participating. Some are Tier 1 research universities, others are smaller universities. We want to prove this is the model that should apply across the country.

We've even grown the program further since then. We're now up to 33 replication sites. With the University of Texas at Austin it's 34. And all this has happened since 2008. We are, right now just with those sites, this is a chart that shows how many secondary students our teachers will impact by 2020. And the happy news is we're going to make a major announcement next week of a new grant which will enable us to expand this program to so ten more Tier 1 research universities who apply. If you add then what those universities can supply, you will see by 2022 we'll be turning out 15,500 teachers. We will have turned out, and that cumulative total of course is

growing every year and the annual total is growing every year. To me this is a model that the country needs to seriously look at is how do we replicate proven programs. In my legal career I grew up in the innovation world, technology world. I understand the importance of innovation, but frankly in this country I often say we have pilot disease in education. We start a pilot program every year. The last time I counted, there are 209 federal programs that are supposed to increase our proficiency in math and science just in the K-12 space, and none of them are going to national scale. And sooner or later, we have to say, yes, we want to continue innovating, we want to continue to get better, but in the meantime we cannot let 50 million lives go to waste because we're not replicating what we know at least will improve the situation dramatically and right away. So I think we have to deal with that issue of consolidation of programs, and I think it's an important topic that will also come into play, as I understand it, in the new you immigration bill that's being discussed in congress right now. There is a lot of discussion that part of that will be an increase in visa fees that will support the increase in visas and that those funds will be dedicated to STEM. If the peanut butter is spread as it's been spread, we will continue to not impact what's happening in this country, and we need desperately to consider how we do need to move the needle in this country.

In summary this is how we started in 2008 with advanced placement and/or UTeach, and today here's where we are. I personally don't know of another replication effort on this scale. To me I've worked on education reform since the nation at risk came out in 1983, and I've always felt the holy grail in education is replication.

Let me close, but I want to talk a little bit about what I take away as the summary points of why we were able to make these this dramatic progress in scaling. Number one, we took great care to define the essential elements of success of each program and required each recipient of the grants to agree to replicate faithfully on those essential elements. That meant we were trying to balance, what's the right balance between the essential elements and the decentralization, if you will, that starts every discussion with educators which is my public school's different, my children are different, my university's different; so how do you find the right balance of essential elements and decentralization that allows for continuous improvement. We think we've done that.

For instance, on the UTeach front we have an annual conference every year where all the directors of the program come and we exchange ideas on how to improve the program. Number two, we have a close partnership internally and externally with the University of Texas at Austin that created this program and with advanced placement strategies formed by the O'Donnell Foundation, and we have our own dedicated staff of educators. So we really have built the infrastructure to replicate future programs. Order of magnitude, we probably -- we've already, not probably, we've already trained 61,000 teachers, for instance, in the K-12 system to teach to higher standards.

We have a strong national board led by such people as Chuck Vess, Norm Augustine, Bruce Albert, Shirley Malcolm and many others. We've had persistent and proactive support from Director Holdren and his team at the Office of

Science Technology Policy for which I thank you-all for being a driving force in what we're accomplishing, and we've had a strong donor base of corporations, foundations and governmental agencies that have stepped up and matched the generosity of ExxonMobil.

We've also always had a competitive selection process for somebody to receive a grant. I learned a long time ago that works better than going to people and saying "Please, would you implement this program." It's usually better if they ask you if they can if you'll give them money. So those are the factors that I think have helped make this a success and I hope that we can as a society and a country come together for the fact that we really do face a changing world where STEM literacy is essential and STEM capability is essential and you cannot accomplish that if you don't instill that in our public schools.

I get asked all the time about charter schools, vouchers. Folks, there are 50 million students in our public schools. There are 6 1/2 million in private schools and charters. The vast preponderance of this country is going to be educated in our public schools for a long, long time, if not forever, and so we have to, if you're talking about, we're desperate to always turn out the next generation of Nobel Prize winners, and we're continuing to do that in this country, but we need to do more. Thank you-all so much and I'll be happy to take any questions.
[ APPLAUSE ]

>> Thank you. Shirley Ann Jackson was the first one up.
>> Shirley Ann Jackson: Well, thank you. And thanks, Eric. As I look at your map, I notice, you know, there's a big white area in the north.
>> Yes, ma'am.
>> And Shirley Ann Jackson: And included in that are places like New York State, Pennsylvania, New England, Michigan, Wisconsin. You know, you get the picture. Is it just a proximity that it grew out from what you were doing in Texas or, you know, with UTeach? And I want to compliment you on what you've done. Let me say that. And I'm familiar with the UTeach program.
>> I know you are.
>> Shirley Ann Jackson: And I compliment your focusing to these two things: One, relating to the program for students, one relating to the teachers and teacher education. But can you comment just on things we can expect or are there some unique things going up in that northern tier?

>> Tom Luce: You know, I've analyzed it a lot. I don't see any factors. I am happy to report Governor Cuomo submitted in his budget report last month funding to asking us to find matching funds, that he wanted to do four UTeach sites in the State of New York and we're hopeful that state legislature will do that and we're committed to raising funds. Frankly it's been just an effort of getting this effort known. The first two or three years we kept our head down, focused on producing results. We're not headquartered in Washington. It's difficult to get national press, particularly for something that's

working, if I could be so... if I could be so cynical as to say, and it just takes a while, but believe me our goal is 50 states. We are talking to the mayor of Chicago now about taking this to Chicago public schools, the advanced placement program. We've had great talks with his staff. I think it's coming. We are talking to the superintendent of D.C. public schools. It's just been a matter of raising enough money.

Right now frankly, and I think the good news is we have more -- we have applicants lined up who want to do this if we can go raise the funds, and it takes time to become known and raise the funds. And there are not many streams of funding at the governmental level that focus on STEM, nor focus on training teachers in a different way by giving funding to directly change how things are done. And so we've had some uphill battles.

One of the most heartening things is that the Department of Defense reached out thanks I think in part to Director Holdren and said, "Wow, we want this. This is one of the most exciting things I've worked on, I believe." The Defense Department said, "Look, we want this program in the public schools that have the largest percentage of children with military families." These are not DoD schools. Most children of families, military families in this country, that are based in this country actually go to public schools. They usually are surrounding the base. And from a national security standpoint, the Pentagon is desperate to make sure they have a STEM-capable workforce. Their lives depend on it. And we've even gotten more dramatic results by working with joining forces to do this in the schools that are serving our military families, and it's been a big success. And actually we've been funded more by the Department of Defense than the Department of Education.

>> Eric Lander.

>> Shirley actually asked my question. I come from Michigan and that huge swath in the upper Midwest being white.

>> I wish y'all had brought the -- I'm happy. Listen, I'll fly to Michigan from here.

>> But maybe one tiny amplification. You mentioned, Tom, that there are 221 pilot projects all over -- I mean, I guess part of our question is, is something else going on there? Are there efforts? Or you really think it's simply getting known and your rate of success will spread and that spreading success is hard, as you said, as opposed to failure?

>> Tom Luce: Well, in the three years I've worked in education reform, I do think I've developed the concept that you have to be more focused and you can't try to do 100 things or 12 things. But just as we move down to middle school, we're going to find the best program for elementary school and we're going to do it.

What we're committed to saying, though, is we're not going to be the garage innovator. We're not going to invent a program. We're going to find a program that somebody else has invented. You know, my dream would someday, Dow Chemical or IBM would come to us and say, "Look, we funded this program in Syracuse and here's the data. The program has really worked well. We funded Syracuse because we have a plant there, but this needs to happen across the country." And that's what we need to have happen in this country is to scale a few programs.

And again, I know we need continuous improvement, but dadgum it, in the meantime we've got to help 50 million kids.
>> Okay.
>> Eric?

>> Eric Lander: I first want to express my continuing awe for what's going on. This is just fantastic. We talked with you back in 2009, I guess, when we were preparing that first PCAST K-12 STEM report and just to see the continued progress is fantastic. I'll note I wasn't worried at all. Massachusetts is really calling in up there. That was nice. So I'm going to ask a different question than why my state is white.

I'm just struck by this ability to replicate, and you said a bit about it, but I really want to press you further. Then I have a second brief question. On replication, tell us a bit about this AP program because that's really striking. You see these huge increases. Now, I know a little bit from your previous conversations about what goes into that program, but you didn't say so much about what it was, what its elements were and how you replicate it. So my first question is, elaborate on how you were able to replicate, what the elements are and how you're able to replicate it so well.
>> Tom Luce: Well, first of all, I seldom get to cover in a talk so many elements that go into the program because it really is a comprehensive program. In the sense that there's a couple of key things, though, number one. Number one, we require when we go into a school that the school have open enrollment for the advanced placement course. What we mean by that is we don't want a guidance counselor saying Juan or Betsy shouldn't take AP chemistry; they won't pass AP chemistry; they won't like AP chemistry. We require open enrollment. We believe it's good. If a child wants to succeed, we give them the access and the opportunity. Number two, it's voluntary on the teacher's part to participate in our higher level training skills, but we pay them bonuses to participate if they complete that summer training that we give them in conjunction with the college board people in the summers but also our professional staff of educators. We have about 100 educators. We form vertical teams. We give in essence content training to the existing teacher core that our UTeach graduates are going to get in college, but we reward them with bonuses for completing that training.

And let me say I think one of the biggest problem -- one of the biggest inefficiencies in the K-12 system from the federal level is the fact that I haven't yet met a teacher who will stand up and say "My professional development in my school, particularly math and science, really meets my needs." It's usually a districtwide program that's general in nature and doesn't apply to "How am I going to do better in my calculus class that I'm teaching students." So it's better training for the teachers, paying them for that training, providing higher content training. Then we reward the teachers, but keep in mind we are in heavily unionized states. It's all voluntary. But an individual teacher receives a bonus for every student that scores a 3, 4 or 5 on the national test. It's easy to calculate, it's graded by a third party, it's not class participation, it's not grade. It's available to any teacher to volunteer to say I want to be an AP teacher.

So there are those bonuses. We also give what we call a mini scholarship to every student that scores a 3, 4 or 5.

I just got in the -- we have this organization, we adopted the AP program, continued on their own an AP arts program. In Dallas Public Schools, their AP arts graduates, minority students got $11 million in scholarships because they demonstrated they could do college level work. So our token mini scholarship to the kid of $150 is not a lot of money, but believe me, they end up earning scholarships because they demonstrated they can do college level work.

So we're rewarding students, we reward teachers, but most importantly I think it's opportunity and access. We are saying this can be done. When you go to a Fort Carson, Colorado and you go from zero to 99, the culture in the school changes and more students enroll in pre-AP, more students enroll in AP, and the culture changes and the expectations of teachers changes.

>> Eric Lander: I remembered those elements from some years ago. I'm glad to hear they are all still there and to see that they really do scale.

My second and last question is you've now got a network of how many teachers through UTeach and then how many through this AP program?

>> Tom Luce: We are now, I would say most of them end up -- unfortunately geographically when we started, there were two separate competitions and so we had some UTeach sites in states where we didn't have AP sites.

>> Right. What's roughly the number you guess?

>> Tom Luce: Oh probably I would say at least 10,000.

>> So you have 10,000. You've now got your own network. How are you networking them? How do people come through these programs, form a cadre, that know each other, support each other?

>> Tom Luce: Mostly online. I'm very happy to say what I call the continuous loop of progress we're close to achieving in Texas. We now have an employer that's been supporting the AP program who wants to -- this is a large company there -- who wants to pay a sign-on bonus to any UTeach graduate in Texas who teaches in the AP school they are funding. And that's the continuous loop you want is you want your UTeach graduates to go help you produce the next crop of AP students who then can go and get their STEM degree and you produce that circle. And that's what you're really after. And that's what can happen when you focus on a few programs, we stay in touch with them online. We're trying to build -- you know, I'm very excited about the president's STEM Teacher Council I think is the --

>> Master teacher corps?

>> Tom Luce: Master teacher corps, any way which we can build this badge. Let me say schools are really good at call -- not having to call it UTeach. For instance, in Kansas they call it UKan. They call it Geaux, the Cajun spelling. They are all quick to say we're

not UTeach graduates; we're a graduate of our particular college program. But that's the way you want it to be. You want it to have local ownership but you want a consistent standard. And it's a way that through public/private partnerships national scale is occurring.
>> Eric Lander: It's fantastic. I do think you've got this network that may grow to become a really powerful force there.
>> Tom Luce: Director Holdren, I want to thank you for all your help.
>> Director Holdren: We certainly thank you. I appreciate that, but we are in your debt for the extraordinary work that you've been doing and we greatly appreciate it. And we appreciate your coming this morning and sharing your thoughts with us. Thank you so much.
[ APPLAUSE ]

>> So the next item on our agenda is an update on the PCAST letter report on energy and climate change and our member Professor Dan Tragg is going to do this presentation.

>> Thank you. For this letter report on climate, I want to make a few opening remarks before I talk about the substance of the report. This is a little bit different. It was a letter report and of course also this was a letter, a report where with he did not have a working group or a subcommittee of PCAST that did this. We did this as a group of PCAST as a whole and so I thank all of my colleagues around this room and some who aren't even here today for their participation. This has really been a group effort and I'm really proud of how quickly we pulled this together and with the final product.

I will note this is not the first report that's touched on climate. We haven't had a report that's really focused on climate exclusively, but in many of our earlier reports, our energy report a couple of years ago, the ecosystem report, our agriculture report and others, we've mentioned the climate challenge. This is the first one that really focuses exclusively on climate, and really it's, the idea is to provide some options for the president in the start of his second term going forward.

I also note that instead of making specific recommendations that what we emphasize in this report is a set of options. And these are not that each one should be followed, but we think that as a whole it provides the president a menu of choices that he can choose from.

But let me first give a little back ground. Everybody knows carbon dioxide is rising. This is the latest data through March, through this month. We're now carelessly close to 400 parts per million. Not that that's a magic number, but we are higher than we have seen for at least 800,000 years and likely millions of years and heading much higher. We will likely be at 500 parts per million by sometime in the middle of the century.

Just as an example, we saw some incredible changes. This is the Arctic sea ice from 1980 in the minimum. This would be in September. If you look over at Siberia, you see the Northeast Passage completely ice passage. The Explorer tried for years to get through and never could. He did make it through the Northwest passage

but it took him three years. This was the sea ice last September, really incredible. Just, there's almost nothing left. The Northeast Passage is so completely wide open, it's not just a narrow passage now. It's the Arctic Ocean wide open. Northwest passage simply ice free.

The changes that this has happened -- these changes have happened so quickly and it makes many of us climate scientists worried about the state of the polar ice caps in particular. Greenland has about 7 meters equivalent stored on it as land ice and, of course, we are worried about projections. There's a range of opinions. This is a graph showing sea level projections through 2100, global average sea level, and you can see there's the IPCC estimates. All the IPCC, there are in the bottom there around 40 centimeters. And then there's some estimates from my colleague Stefan Roms Dorf in Germany suggesting it could be as much as a meter and a half or so. The truth is we don't know. There's a lot of uncertainty and that pervades this climate problem, but that means we have to think about this in terms of risk and think about preparing for the future.

Now, one of the interesting things last year is that we had a lot of strange weather, and the relationship between weather and climate change is always debated. No individual event, or at least it's difficult to attribute any individual event to climate but yet at the same time the change in mean conditions are certainly affecting the weather that we experience. But last year was a particularly strange year.

This is a map from a year ago this week. A year ago in March if people remember, it was incredibly warm. Not that weird to get 70 degree days in Washington D.C. in March, but in Minnesota and Chicago it's pretty weird. This was incredible. This is a map showing the temperature anomaly. So it's the temperature above normal. And you can see temperatures in excess of 25 degrees Fahrenheit above normal.

For climate scientists like me, this was a particular source of amazement, jaw-dropping amazement. Let me show you what I mean. I'm trying to make this work. Rochester, Minnesota, overnight March 18th broke the record for the all-time high temperature. Let me just say that doesn't happen and yet it did happen last year. Chicago you had eight 80-degree days in nine days. Again, shattering the old records. This is one of my favorites in New Brunswick, in St. John, New Brunswick, Canada. The temperature on March 22nd broke the record for any temperature ever measured in April.

So we saw this incredible warmth. Most people really enjoyed it. In fact, farmers planted corn early and thought this was going to be a record corn year. Minnesota, of course, had some other problems. We saw some extreme rain events. This is Duluth. They had record two days of rain, incredible flooding. This polar bear actually swam out of her cage. Luckily it did not escape beyond that and she was unharmed. Here are seals crossing streets that swam away from their zoo and downtown in Duluth where they were crossing roads. Seals, by the way, for people who know are saltwater animals and do not live in Duluth normally.

But the serious problem was not too much rain but too little rain last year. We had an incredible drought that really devastated our agricultural system.

60% of U.S. counties were in drought emergency conditions. We discussed this extensively in our agriculture report that was released in December.

Let me just give you a little background on that. This is a map of soil moisture in the U.S., and the soil moisture anomaly showing excess dryness. This is starting September of 2011 where you can see incredible dry conditions in Texas that in 2011 had this incredible drought. Cities in Texas had 100 -- had 80 days of over 100 degree weather. Unbelievable heat that summer, really unpleasant. If we look at March of this year, you can see the drought shaping up in the Midwest, and by the summer, by May and then ultimately June, the soil got drier and drier -- oh, sorry. And this certainly contributed to the heat wave, the extreme heat, and the dryness that was across the country, really devastating our agricultural production.

We've spent, the federal government, has spent, estimates are up to $20 billion on crop relief related to this in terms of crop insurance and other relief.

And then of course there was Hurricane Sandy that I think woke up many people, at least on the East Coast, if not across the country, to the idea that we have to think about preparing for the impacts of climate change. In terms of the devastation across New Jersey and New York City, we're still recovering from that. As you know, congress passed a law authorizing $65 billion in disaster relief to deal with the impacts of Sandy.

So one of the challenges with climate change -- and just one other thing that's coming down the road is, of course, the spring melt. It's actually happening starting now and going for the next six months, but in the western U.S. this is a figure from a climate modeling paper that shows how by the end of this century the model predicts how much earlier the peak runoff will come. When you can see, for example, if you look over here, if you look at the Sierra Nevada and California, we're talking about 60 to 80 days earlier spring runoff. That means that by the end of the summer, or by midsummer even, there may not be any water in the rivers in California, and this is going to be a huge challenge for agriculture. This is not happening now but it's coming, and unfortunately too quickly.

So we believe that national preparedness should be a central pillar of climate change policy and, you know, there's been some discussion of climate preparedness in the context of adaptation and how we think about dealing with climate change. Some people worry that this might be a reason for not dealing with the problem itself. We don't think that that's true. We think we need to prepare the country to deal with the impacts of climate change in ways that actually increase our robustness, how we resist the damage and also resilience.

I should note that there's a little bit of a battle going on about the use of these terms, "resilience" being recovery from damage," ro bustness" being resistance from damage. I think we're going to lose this battle. I'm not sure I'm going to win this but I'm going to keep using the term, robustness and resilience, anyway. As a more popular example of what I mean, this is the Terminator. He's robust. If you saw the second Terminator movie that had the Terminator with liquid metal, he's resilient. Both are important, and that's important that in dealing with climate change and the impacts of climate change, both are important strategies. We might need to build sea

walls, we might need to build marshes to protect our cities, but we also need to invest in pumps and ways of recovering.

So here are the components of a national climate preparedness strategy that we advocate. We need mechanisms to communicate our plans, to create them, and these include regional assessments of climate impacts and ways of sharing best practices. We need to communicate to our citizens the understanding of extreme events, indicators of climate change, both global, national and regionally. And, of course, maintenance and improvement of the nation's capabilities in forecasting in climate change prediction. And this means both on longer time scales and on short time scales like storms and hurricanes and floods so that we can actually make sure that our citizens can protect themselves, protect their property, protect their homes.

At the same time we need to plan for infrastructure modernization and that means really a national infrastructure plan that we need to think about in the context of climate change. Many different aspects of our country's infrastructure need investment, but in that context we should be thinking about climate adaptation and preparedness at the same time.

And finally, and this may be one of the most important areas that needs attention, we need to look carefully at our federal policies on disaster relief and insurance. Disaster relief is in many ways a form of insurance, the insurance of last resort. And we have to ensure that the economic incentives are aligned with long-term safety and security and moving this country towards reducing its vulnerabilities. Right now we have too many programs that essentially provide financial incentives for people to live in harm's way and we have to ultimately reform those over time. It doesn't have to be abrupt, but gradually over the next several decades we need to move towards aligning these financial incentives with ways to protect people.

Ultimately the last point is very important. When we do have an opportunity to rebuild following a disaster and we are a country that have sympathy and compassion for our citizens who suffer disasters but when we have an opportunity to rebuild, we shouldn't just rebuild. We need to rebuild better. So when we make a big investment like $65 billion in New York and New Jersey, we have to make sure that that money is well spent and reduces the vulnerability for the next storm that hits New York and New Jersey.

Okay. So specific recommendations: Creating a national commission on climate preparedness charged with recommending an overall framework and blueprint for ongoing data collection, planning and action, and specifically focusing on some of the insurance and disaster relief issues. We think the president should designate departments to serve as leads to oversee the annual creation of climate preparedness plans at home and abroad. As I said earlier, developing infrastructure renewal plan and then finally improving coordination and support for research efforts on climate change preparedness.

But of course as the nation continues to address the challenges of preparing for climate change, we can't lose sight of the overarching importance of mitigating the pace and ultimate magnitude of the changes in climate that will occur.

Without mitigation, adaptation efforts will ultimately be overwhelmed and so we need to do mitigation as well.

The U.S. has made some progress on this. Our emissions are down over the last several years, but you we need to continue on this. One of the reasons that emissions has come down is we have seen a switch from coal to gas in the energy sector and we urge the president to continue to support that shift. There are a variety of co-benefits including the very important health benefits. But we have to ensure that the environmental impacts from natural gas drilling as it expands across the country do not curtail its ultimate potential to deal with climate change. And this means protecting water and protecting air and ultimately making sure that all appropriate regulations are enforced in the states where this activity is going on.

Of course, there's the continued implementation of clean air act requirements both for criteria pollutant sulfur, nitrogen, Mercury, but also new standards for CO2 for existing plants following the release of the rules for new plants that was released last year.

And as a corollary to this, right now we get 40% of our electricity from coal. Coal contributes enormous amount of sulfur and Mercury pollution and, of course, to carbon dioxide. We need to accelerate the efforts to reduce the regulatory obstacles to make sure the deployment of carbon capture and storage that can be applied to coal plants ultimately continues in its technological development because this is a technology that many of us believe we're going to need in the future. At the very least we need to encourage these commercial experiments to see if this is a viable pathway.

So the next category of recommendations has to do with clean energy, leveling the playing field for renewables, clean energy, energy efficiency by removing regulatory obstacles and addressing market failures. There's still, with all of the built-in infrastructure for fossil fuels and the built-in subsidies, there's still not a level playing field. And we identify a few possible opportunities. There's certain opportunities for access to capital in terms of tax policies and preferential treatment of certain types of investment vehicles for fossil fuels and we think that that should be leveled to apply to renewables as well. Broadening the tax credit for wind currently to all forms of renewable energy, but actually giving it a longer time horizon. Instead of having an annual battle for its renewal, which scares away investors, actually have a longer time horizon so that investors have a better sense of what they will be able to count on. And that will encourage investment and innovation.

And finally eliminating market failures that prevent the adoption of technology for energy efficiency. And there are a variety of ideas here, but we think this really needs some additional attention because there's huge opportunity for increasing our energy efficiency.

Another final component of this report is possible steps the president could take to increase America's leadership on climate change internationally. This is a global problem as we all know. We're not going to solve it alone. We need the cooperation of all of the rest of the world, but we believe that America has an opportunity to play an essential role as a leader in this, and we ultimately need to help

lead the world toward a solution. So we think there's opportunities that continue to exist for the administration to do this. One is to explore the possibility of a new North American climate agreement with our two largest trading partners, Canada and Mexico, under the context, broad framework of a NAFTA free trade agreement. We think there's some exciting opportunities there to work with Canada and Mexico on this.

And second, of course, continued work with increased cooperation with China. China is the largest emitter of CO2, and the U.S. and China ultimately need to play both leadership roles if we're going to solve this problem and so our cooperation with China on this and communication is essential.

So I'm going to stop there and I'm going to ask a couple of my colleagues here to maybe make some comments. Maybe I could start with Rosina.

>> Thanks, Dan, for that excellent summary of a report. I will not surprise you by saying I'd like to make a few more comments on the adaptation and preparedness section. It struck me, Dan, that adaptation has been a long time coming to the forefront and perhaps if we thought a decade ago to use the Terminator 1 and 2 analogy, it would have been much more popular much sooner.

But I do want to say that I think the whole study and exploration of adaptation is very, very amazing compared to the exploration of mitigation and so we really have a lot of work to do. As Dan has noted, we really need both pieces to be part of a climate strategy going forward. We certainly need a tremendous amount of mitigation to avoid a degree of climate change that becomes unmanageable despite our efforts to adapt, and we certainly need adaptation because the climate is already changing and some further changes are certainly in store, and change is inevitable regardless of what we do on the mitigation front. So we need both mitigation and adaptation, and this report highlights that they are both urgent and needed co-equally. So I think that's a very important first step.

But the second thing I'd like to say is that despite the nacency of adaptation, the previous administration has actually created several efforts that exist that we can build on now. So just to give you a couple of examples, in the agencies under the president's Executive Order 13514, he required them to develop adaptation plans and those are now up on the Web so you can take a look at that. So beginning to think how agency planning and management activities are affected by climate change has already begun, and I think that's very important.

The second thing that I'd like to highlight is the National Climate Assessment is ongoing and as you know the administration owes the congress every few years, it's currently out for your public review. There's another three weeks that you-all can comment on the 30 chapters. But I think this National Climate Assessment has taken a really hard look at what the implications of climate change are for different regions, for different sectors and across sectors and for the first time we actually have a whole chapter on adaptation activities that are going on, ranging from a lot of activity in the cities, which I would have not expected, to the activities at the state, regional and, of course, federal level. And I had, I guess I should say the privilege of co-chairing that chapter for the National Climate Assessment. So a lot going on in that realm.

And then third and equally importantly in the U.S. global change research program, a huge effort to assemble missing but much-needed adaptation research across the agencies because there still are some very important science questions that we need to answer in terms of what can you do to prepare and respond appropriately.

So the threads of planning, management, understanding regional detail, working from communities up to the nation and trying to come up with a coordinated research plan do provide major threads that we can build on. But what this report is really trying to say I think is that it's time to take the issue, or the adaptation, to a whole new level and that what we really are talking about with both pieces of the report is it's time to have a national conversation on climate change. And we think in particular that a focus on preparedness and response to extreme events allows us to think across both mitigation and adaptation issues so that as we're thinking about green infrastructure, for example, which can both help reduce greenhouse gas emissions by being more efficient and yet, of course, also be more resilient, two extreme events going forward. This provides a wonderful way to begin this national conversation on climate change on both mitigation and adaptation. So thanks for the chance to make some comments, Dan.

>> Thank you. Let me just add some brief comments on the international component of this. As you mentioned, it's really important for the United States to provide leadership for this problem of climate change as it's really an international problem and requires international actions. So just add a few words on the responsibility of the North American/China agreement. I think that would be a benefit both for the United States as well as for the two largest trading partners and Mexico. So this leadership that the United States can and should provide internationally would have an even larger impact if it's done with its two neighboring countries in North America.

So just to provide a specific example for the three countries, you have common goals for energy strategy. Mexico, in fact, is just considering almost passing a national energy strategy. It's already approved by the lower house and it's expected to pass the Senate. So it has many things in common with what we're suggesting here. But one example is shale gas. Mexico also has the potential for development of significant amounts of shale gas. So it would be quite important for Mexico to have similar environmental standards.

For example, methane leaks is something we need to worry about, and it doesn't matter whether they happen in Mexico, Canada or the United States because they affect the global environment. So I think through such an agreement, it would be sort of, more of an expectation that the three countries would have similar standards and could actually do all this together besides having, of course, energy security, which is very important and that could be boosted. And again it's a win-win situation for the three countries.

And let me just mention yet another example, just an example of how collaboration can lead to better results. United States, you know, has pushed the fuel economy standards and we're proud of that taking place. One problem is that old cars, old trucks are exported to Mexico. So they emit a lot of carbon dioxide there.

So it obviously could be much better if there is sort of binational agreement in this case to make sure that the emissions are actually reviewed. But this is just an example. I think there is very goodwill for collaboration and so I expect that with this type of efforts, this impact that we expect from the United States and from North America will indeed be very important for future international agreements related to climate change.
>> Thank you. And finally, Barbara?

>> Barbara: Here we go. Interestingly a lot of what Dan says in the beginning focused on agriculture, and we have completed just recently a PCAST report, excuse me, on agricultural preparedness. And this has been a real challenge. If you look at the prospects for agriculture in the face of a changing climate, a climate that's changing in a way that we don't really know the magnitude, the specific details of, it's a tremendous challenge for adaptation of our agriculture enterprise. And what the goal of this PCAST report was was to maintain the abundant yield that our agriculture provides to maintain the economic component that agriculture provides to the United States. We have a favorable balance of trade with agriculture.

So we looked at this quite deeply and tried to look at the things that specifically would be challenging to agriculture. And, of course, the major one was what Dan highlighted so beautifully was climate change. Our climate is changing and our agricultural practices, our varieties of animals and plants need to be able to be both robust and resilient to that change.

Other challenges that we noted were actually also affected by climate change such as managing new pests and pathogens. The range of pests and pathogens are changing and they are changing as our climate changes and so things that usually did not occur in the United States, pests and pathogens, they now have an opportunity to move.

In addition we're very concerned about the efficiency of water use and water scarcity is another component, as Dan has mentioned about potential climate change in various areas. So recommendations in this PCAST report was really to develop an innovation ecosystem for agriculture, to look at the basic research that feeds into agricultural development and make sure that that was robust, that it provided the new kinds of plants and animals and new kinds of practices, the new kinds of conservation that would allow the U.S. agriculture to maintain its preeminence globally.

Now, a number of specific recommendations. One was to enhance basic research report -- support, and I think the numbers that Dan gave really give a very good illustration of this. Our report recommended that we invest hundreds of millions, not a billion, but about 700 million total, yet we just heard last summer the drought $20 billion. And so this is a tremendous discontinuity between the risks of these kinds of droughts and floods on agriculture and the research enterprise that would help adapt to that.

We also changed, we also suggested that there be a greater emphasis and competition in agriculture in obtaining support for agricultural research. We've seen that with biology and with the support that the National Institutes of Health

provides for biological research, molecular biology, the incredible benefits that that has yielded for health development.

And then finally we also suggested that we need to make -- have very strong support for graduate education for postdocs to attract the best and brightest students in greater proportions to agriculture. So agriculture is a very important component of adaptation for the U.S. strategy.

>> We should also add that we congratulate Secretary Vilsack who just recently announced a major new program focused on how to make agriculture better prepared for climate change going forward.

>> So thank you, Dan and Mario and Rosina and Barbara for those comments. We are at the end of the time allotted for this topic. I don't see any other flags up. We do need to approve this report with the usual subject to final edits.

>> I move approval.

>> I have a motion. Is there a second?

>> Second.

>> All those in favor please raise your hand. The report is approved, again subject to final edits. Thank you very much.

I'm now going to turn the mic over to my co-chair Eric Lander who will introduce the next topic. Eric?

>> Eric Lander: Thank you very much, John. I'm going to invite the speakers for the next topic to join us. We have with us today Pat Gallagher, the director of the National Institute of Standards and Technology and under secretary of standards and technology the Department of Commerce and a frequent visitor to PCAST and we're grateful for you to be back, Pat. And we also have with us today Elana Tyrangiel who is assistant attorney to the Department of Justice who is a first time visitor to PCAST and we're grateful to have you.

So today's discussion is on forensic science and in particular a new and exciting partnership between the Department of Justice and NIST. I'll just make a couple of framing comments and then turn over to you two to walk us through what the two agencies are doing. But forensic science is incredibly powerful and incredibly important. It can help identify perpetrators in the course of law enforcement and also, you know, help free others from suspicion in a case. It can help in convicting guilty parties, and it can help in exonerating those who have been wrongfully convicted.

I think what's most notable about that list is in the past decade or so we've come to learn that in an objective scientific fashion, people do get wrongfully convicted, and that's the sort of thing you can only know if you have essentially absolute truth from some other source.

So science has played this really interesting role in the past decade or two when DNA forensics came along with a strong enough certainty and strong enough methodology to be able to go back and look at old cases. And that's led

to the recognition, at least to the questions, how was it that we got things wrong. How was it that scientists would say that there were false positives.

So that led the scientific community to ask about other forensic methodologies that were being used, and this is of course the continuous improvement that we want. So the National Academy of Sciences released a report in 2009 called Strengthening Forensic Science in the United States. It made a number of observations about the power of forensic science technologies but also the great variation in the support for them, in the scientific foundations for them, is a striking statement that I still remember that the simple reality is that the interpretation of forensic evidence is not always based on scientific studies to determine its validity. In many cases it is but in some cases it isn't. And that's of concern to all of us. It's particularly of concern for being able to make sure that we get the answers right in the criminal justice system. It's very important that we convict people who are guilty, and it's very important we not convict people who are not guilty, both for the liberties of those individuals but also because it means the guilty party is still out there unarrested and unconvicted.

So science partnering with the department, with justice, has become an important theme in the past couple of years, and many of us were eager to see the response to this academy report. And we've known for a while that NIST and DOJ have been working to figure out what's the right way to get a partnership between these two different worlds, science and justice necessarily have to take different approaches. Justice has to reach a conclusion. Science has to reach a conclusion about being tentative. Those don't always fit perfectly today. But how do we get the best of both worlds and I'm excited about the progress that you have reached together that has a role for a commission reporting to the attorney general, to scientific working groups reporting to NIST and so we were eager to hear you announce this in the second part of February. Tell us about it and what we can expect from it and, also what else more needs to be done. So thank you both. I'm not sure what order you want to do it in, but Elana first.

>> I am Elana Tyrangiel and I'm at the Department of Justice and it's a real pleasure to be here. And it's also a privilege for me to join with my colleague, Dr. Pat Gallagher to speak with you here today. I would like to thank you, the President's Council of Advisors on Science and Technology, for your leadership, for inviting us here today, and for giving us this opportunity to discuss the latest efforts to strengthen the practice of forensic science.

As you all may know, in March 2012 Eric Lander called for a partnership between the Department of Justice and NIST to develop and promote widespread adoption of standards and best practices for forensic measurement, analysis, and interpretation when he testified before the Senate Commerce Committee. Senator Leahy, who chairs the Senate Judiciary Committee, also introduced legislation that discussed a DOJ/NIST partnership.

These proposals—alongside the many others that have been suggested in recent years—reflect intense interest from a variety of stakeholders, and that interest is understandable. As Eric was just saying, forensic analysis is a vital and

powerful tool to identify perpetrators, to free others from suspicion, to convict the guilty and to exonerate the innocent. All aspects of our justice system are strengthened with the incorporation of valid forensic science.

Thanks to the tireless work of federal, state, and local leaders, and particularly through the NSTC process, there has been meaningful and measurable progress in advancing science and its application to the criminal justice system. For my colleagues at every level of today's Justice Department, building upon this critical work constitutes an important priority. And I'm proud to report that efforts to promote coordination and improve scientific validity have never been stronger.

Last month the Justice Department and NIST launched a new partnership that aims to enhance standard-setting in the forensic sciences, to reduce fragmentation, and to bring together key stakeholders in order to construct forensic science policy that is usable, translatable, and defensible in a courtroom.

The initiative has two primary components: A National Commission on Forensic Science that is co-chaired by the Department of Justice and NIST; and NIST-administered discipline-specific guidance groups. I'm going to tell you a little bit about the role of the commission and then Pat will provide NIST's perspective.

The National Commission on Forensic Science will draw upon the experience of approximately 30 federal, state, and local forensic service providers, academic researchers, prosecutors, defense attorneys, judges, and community leaders—selected by the Attorney General in consultation with NIST and the co-chairs. The commission is tasked with recommending priorities for standards development, reviewing guidance identified or developed by subject matter experts, and providing recommendations on policy issues like minimum requirements for training, proficiency testing, or accreditation.

The Attorney General will consider the commission's recommendations and decide whether to endorse standards or guidance for implementation in Department of Justice forensic science laboratories and/or strongly encourage adoption by other federal, state and local labs or units. Even if the Attorney General chooses not to endorse a standard or other guidance—that document will still be publicly available for voluntary adoption by federal, state or local forensic science labs.

There's no question that this partnership is a positive and significant step forward and that we can be proud of the structures we're establishing at DOJ and NIST.

At the same time we recognize, like all of you, that this program does not occupy the field, which is why our initiative does not preclude future executive or legislative action, and it will not displace the important work that many forensic science stakeholders are doing, such as conducting foundational research at government agencies and universities across the country.

Put simply by leveraging the significant and complementary expertise at both NIST and DOJ, and by fostering engagement with key state and local stakeholders and Congress, this new partnership will play an essential role in refocusing

our common efforts to enhance forensic science and ensure the integrity of the criminal justice system.

I'm going to turn it over to Pat for a bit now to talk about NIST's role and I'll rejoin in a moment.

>> Patrick Gallagher: Thanks a lot and it's great to be back talking to PCAST. I want to start by, before I talk about the NIST views, I want to sort of echo my appreciation for PCAST's role, in particular John and Eric, who directly participated in a very personal way to keep this moving. And I wanted to explain why that was so important. So if you'll recall, in 2009 the academy report was calling for a new department. That wasn't going to be the solution, but the reasons for wanting something new, pulling things together were, in fact, valid. This is intrinsically a multistakeholder process. There's a lot of players. And the U.S. forensic science community is not controlled by the federal government. In fact, most of it resides at state and local side.

So what has happened over the past four years is in fact a very strong, very active multistakeholder process and that's one of the reasons we haven't set any speed records but, in fact, it's been very strong. And I -- it wouldn't have happened without your strong and continuous leadership. We want to appreciate that. I also want to acknowledge Mark (inaudible) who is the co-chair of the NIST process. He is also the director of the NIST office of law enforcement standards, and I want to thank Mark for his role.

So the agreement that we announced, I want to highlight what it means for NIST. I like to think of the agreement as kind of having three moving parts. First of all, it affirms roles that the department -- that the two participants have within their mission. Elana's talked about the role given to the Justice Department in, you know, making the policy side, making recommendations for adoption in their crime labs. And additionally promoting adoption for what they are going to use themselves very broadly. And those are critical roles.

Similarly NIST has been given specific responsibilities, and there's actually, the best way to think of it is there are two of them. One of them is responsibility for the measurement science basis of a given forensic measurement. We are, as all of you know, our core mission going all the way back to 1901 was to define the national system of measurement, provide that scientific basis and then work to support its translation into practice.

So when you ask whose brand name is on the line in terms of making sure the science has been done correctly and that we can -- as Eric talked about at the very beginning in the introduction, establish the range of validity for a given methodology. It really is something that's been given to NIST.

And the other role is another very classic NIST role, and many of you have seen this in other context and that's to support adoption. In this case it's NIST's convener and it's to work with the community of practice to translate basically a scientific methodology into a body of work that can be put into practice. And what is a body of work? Well, a body of work is something that a crime laboratory can look at and adopt for practice. So it could be methodologies, it needs to be training

requirement certification records, it can be standards for equipment, it can be reference materials for traceability. So whatever that collection of things are that need to be developed to turn the methodology into useful practice. And, of course, NIST can't do that alone. We are not a forensic science laboratory. We are not out in the field doing criminal investigations. This is a role where we act as sort of the convener and bring that broad community of practice together and we've termed that these guidance groups.

And finally the agreement has direct collaborative piece that keeps NIST and the Department of Justice working closely together and that's the National Commission of Forensic Science that Elana talked about. This advisory committee is going to actually effectively advise both the Department of Justice and NIST. It will advise the Justice Department in policy recommendations and recommendations for adoption and by the same token be providing advice to NIST on priorities for the forensic world and where the science needs to be worked on. And I think in practice this is going to be a rich source of guidance for this community.

Let me make just a couple of quick comments about the two roles for NIST. When it comes to the science side, there has been some misunderstanding on the part of some about what this means. Obviously NIST is an intramural agency. Will we have working scientists that do research in basic measurement science, in metrology all the time. That is our core function. But carrying on this role doesn't mean we expect to do all the work ourselves. Far from it. As many of you know, NIST does an enormous amount of collaborative research. What it means, though, is that our responsibilities to ensure that the scientific basis for a given forensics methodology is supported by sound science, that it is done according to accepted scientific practice that are, you know, scientific integrity policies and that peer review and that everything is basically -- and so this will be NIST working, as it often does, publishing in peer reviewed journals working with the scientific community.

There's one other aspect of this that's misunderstood sometimes which is that promoting effective, the latest science in a given forensic area is tantamount to the latest technology, the brand-new thing. There will certainly be part of that and in fact, we expect and hope that there will be transformation and new ways of doing better, more discriminatory, more effective measurement in the conduct of pursuing justice. But by the same token, many of the existing practices work.

The flaw that Eric pointed to was the inability to state quantitatively what the limit of validity was. So from -- in using this lingo, one of the signs of success is being able to talk in a meaningful way about the uncertainty, what you can and cannot say even about existing methods. And that's something that I think sometimes gets forgotten.

And finally on the collaborative part, one of the things that in my view has made NIST unique and really enjoyable is we straddle this world of very peer and basic research and working with the practicing community. Good examples that you may be familiar with where we do this are, in fact, legal metrology. So in the United States the business of weights and measures is not a federal regulatory authority. We do not regulate the gas stations to make sure that they dispense an accurate amount of

gasoline. We don't monitor truck scales, we don't do all of the agricultural, you know, regulation but they are important to commerce, but those regulatory authorities are all state and local. And the way this works is we are their national lab. We support their work by making sure that there's a scientific valid basis for what they do and then we actually work formally through a body called the National Conference on Weights and Measures to support this whole community and translate that body of work into accepted practices.

The other example that we do all the time is in the building code department. So again in the United States buildings are regulated at the local levels. Building on your previous session as you look at the build environment and hoping to promote resiliency, there is no federal agency that drives that. What we do is we develop the model codes and standards and those model codes and standards Harmonize across thousands of different regulatory entities. And again this has to work in that community providing that technical underpinning in something that's basically ready to eat by the users. So we think there's a very natural role for us.

What's happening right now in NIST in response to this agreement is a couple of things. One, we're looking internally at our own forensic science-related research activities. NIST already does quite a bit of this. In fact, DNA traceability, this is a major program within NIST. We do work in fingerprint analysis, chemical analysis, tool marks, finger -- firearms marks and so forth. So this is not a new area to NIST. But we are expecting to be called upon by the National Commission to maybe identify new areas. So we're immediately looking at our program management of these activities looking at where we see opportunities to strengthen our programs like we had a major management meeting just this week on this where all of the stakeholders were brought together.

Secondly, we're looking at the process of the collaboration. Right now the collaboration is done through a collection of 20-some what are called scientific working groups. These are rather ad hoc in nature in the sense that there's no formal governance process that covers their membership or makeup but they, in fact, are the body that work on practices, you know, in these fields. Their performance was characterized in the report as uneven I would say is the fairest way to say it.

Our intent at NIST is, since we now have to work with that community, is we start by listening to them. So we're reaching out to the existing scientific working groups. We want to listen to them. We want to make sure that none of the ongoing work is interrupted in this period of transformation and we hope the transformation is done in a way that's strengthening. And so there's going to be a lot of work there in terms of formal reachout comment from public workshops, things of that type, and what I'm expecting is an evolutionary transition and not a revolutionary one.

But I wanted to leave with one final thought which is that in all the machinery of sort of getting the standards and science right, the real win that will not be noticed by the public was actually the effective -- ability to effectively work across two extraordinarily different departments. I mean, NIST is a science and technology department; justice is Justice Department. But this partnership is as good as any interagency partnership I have worked on. I am very optimistic that this is going to

be successful, and I wanted to end by sort of acknowledging Elana's personal leadership on this and that of her team. It's been really quite extraordinary and so I'm looking forward to it. Let me turn it back to Elana for some more.

>> Elana: Thanks, Pat. And I would be negligent if I did not thank you because it has been likewise a pleasure working with Pat and his team and we have had a very productive relationship.

So a couple of final points. You -- there may be people here who are interested in how to become part of this initiative and we certainly wanted to share that information with you, or to the extent you know people who are. You can find the notice of establishment and solicitation of applications for the National Commission on Forensic Science on the Federal Register's website.

Members of the commission will be selected to achieve a diversity of experience and they will include federal, state, local forensic service providers, research scientists, academics, prosecutors, defense attorneys, judges, law enforcement officials, and other relevant stakeholders. We are aiming to embrace a very wide variety of perspectives. And so we've been urging all qualified applicants to send their curriculum vitae and a statement of interest describing the applicant's relevant experience, a letter of recommendation, and a statement of support from the applicant's employer to the Office of the Deputy Attorney General. And that information again is on the Federal Register website.

We're really looking forward to working with you to strengthen and enhance the practice of forensic science, and I want to thank you all once again for your support and leadership and your continued partnership. And now Pat and I are happy to answer any questions you may have.

>> Thank you to both of you, and congratulations on what you've accomplished. Our practice here is to raise flags, and Dan has his flag up first. So I'll call on Dan.

>> Dan: Thank you, Eric, and thanks to both of you. You know, when we've heard about the challenges of forensic science applying in the criminal justice system, in the past frankly the overall big picture looks kind of terrifying in terms of how disparate the way forensic science is used across the country in different places and the lack of standards. And it's really exciting to hear that you're tackling this problem.

I guess what I'd love to hear from you, Elana, is in the context of the bigger challenge, of actually really thinking about where this country needs to go to ensure that our criminal justice system really does uphold its fairness and its, I think the standards that many of us have hopes for, where do you think this activity that you're leading can get to in that context over the next three to five years? I mean, the scale of the overall problem seems enormous.

>> Elana: So as I was saying a couple of moments ago, this is one step, a first step. And the idea behind this is to reduce some of the fragmentation and improve coordination across all levels and with all stakeholders. Part of the goal of this is to enable the department to act as a leader, to encourage folks across the country to implement and

rise to the highest level that is possible and demanded. And one of the things that will happen as a result of this commission is that when guidance information gets fed back into the commission, the commission will issue a recommendation. It's a federal advisory committee, so there will be transparency in that. And the attorney general will have the opportunity to lead and encourage others to adopt and to move forward together. And having all the stakeholders at the table we think will be another positive step in the direction that you are speaking of in terms of unifying practice.

It is not intended to address every issue that is in the forensic science world and we are looking forward to continuing to talk with you and many others about additional things that can be done.

>> Pat: And so I was going to hazard a guess about what three to five years might look like. So I don't think you're going to see brand-new science across all the fields of forensics. That's -- you know, we think that this process is going to start informing priorities much clearer than maybe we've had in the past. But I think from experience I would say the thing you're going to start noticing right away is the harmonization effect. This convening actually starts moving quite quickly. In fact, we're already seeing some grassroots convening where you're going to see a much broader and consistent adoption of professional training requirements, established methodologies, capabilities in equipment, interoperability of equipment with national databases. I think those kinds of things are going to start having a widespread effect fairly quickly in a number of areas and so historically weak areas might start really seeing some benefit, and my guess is that's what the early signs of success might start looking.

>> The two collaboration questions: One is are there -- is there an international dimension to this? Are there other countries that are further ahead, are ahead of us in defining these standards. And the second one is the FBI has a fairly sophisticated research facility and how do you define what they do and what NIST does?

>> So I'm not an expert on the international side but we do work pretty extensively with the international community. There are -- I think it's probably similar to the U.S. There are some high spots and low spots in different areas across this. I know that the NIST head of laboratory programs was just in the Netherlands last week looking at their forensics laboratory facilities. I actually think the convening, if experience is any predictor, will very quickly become an international forum. You are going to see a lot -- if fact, if you go to the academy of science, you'll see widespread international participation there.

With regard to the FBI, I'll let Elana say anything specifically, but we expect all sort of practicing into these dealing with forensic research and work to participate in the collaborative process, including in some cases supporting the work underlying the basic methodology. So it's not a question of NIST versus FBI. The only difference is that the NIST effort to produce the, you know, established, basically the scientific review underneath is one where, you know, will be a little bit different than

the work where you're turning into into a ready-to-adopt set of practices for a crime lab. My guess is very advanced laboratories like FBI will be playing in both areas.

>> Elana: And I would just echo what Pat said in terms of the FBI. They were a part of the collaborative process that led to the establishment of this partnership and they will continue to play an important role as we go forward.

>> Eric Lander: If there are no other flags, I'm going to ask a question to you myself. We've got a partnership between your two agencies now. That's great. But the long-term advancement will depend on adequate funding of research in the research community. Have we got that covered yet? Or is there a need for funding through you -- I mean, my own sense would be a science agency. I know the national institute of justice has done some funding but it's a relatively small budget and I think great advantage would be had by doing this through a traditional science funding agency. So tell us a sense of the funding landscape and very frankly do we need to make this work by putting some dollars behind that to engage the academic community.

>> Pat: We'll tag team on this one a little bit. So I think the correct answer's there's never enough funding, no. So let me give it a more careful answer. Funding activity is really an act of prioritization for me. And you and I actually testified together in front of the Senate commerce committee and a lot of these questions came up. And my view is that there's a couple of interrelated questions here. I don't think that this is a solved problem and I think, I'm hoping you don't declare victory that your efforts are done. We hope this is a place where PCAST stays engaged. But I see a couple of interrelated issues. One is how do we effectively prioritize our research needs against, you know, identified weaknesses that are being perceived by the practicing of the criminal justice system. And the process, this partnership will actually help inform that. Some of the guidance coming out of the national commission is going to provide a much clearer roadmap for some of the needed areas.

But the other issue has to do with the nature of how do you manage the scientific research portfolio and, of course, that was a topic within the national academy's report. And again I think the complication is that there's a bit of a multi-stakeholder issue here. You have very specialized research funding organizations like the National Institute of Justice and you have very broad scientific-based like the National Science Foundation and their core funding and right now they don't -- this is my personal view: They don't really speak the same language or have the same coordination and I think there's some work to be done. And my guess is it's not an either/or proposition. It's a "How do you do the correct ending."

>> Elana: I don't have anything else to add other than I think you posed an important question and we're again happy to have discussions. What we've worked really hard to achieve is this step that we thought was doable and, you know, ready to be done and we're eager to continue.

>> That's great. And, of course, even without new research, I think the point you made, Pat, just being able to say what we do and don't know, what level of error bars you can attach to a statement are very powerful. That alone will act as an incentive within the community when they look at their technology bite marks and it sort of becomes clear that we really don't have a great database for bite marks and we can't attach a lot of certainty to it and those who care about that will have an incentive that will ratchet it up. Simply that kind of objectivity will drive us in the right direction and so while as you say it's just a step, I think it's an incredibly important step you're taking and I applaud particularly Department of Justice for embracing this. It's so easy to fall into the trap of saying anything that could, you know, complicate prosecutions. You know, we've got to keep at arm's-length. And I think the Department of Justice has done a great job of saying you're about truth. You want the right answers. And that's going to serve our justice system best. And if sometimes that's inconvenient because we don't have all the answers, well, we're going for the long term. So hats off to both of you and to your agencies and thank you for the work you've done and we will indeed take you up on staying engaged. Thank you.

[ APPLAUSE ]

>> Turn it back over to you.
>> Who's doing public comment?

>> I'm going to turn it over to our vice chair Bill Press who is now going to lead the public comment session.
>> Bill Press: Good. We were a little worried because not everyone who preregistered for public comment had showed up, but they're all here now and we're glad.

PCAST receives input from the public through a variety of mechanisms. A main one is written public comment, and all comments submitted to PCAST through the PCAST executive office are distributed to all the members of PCAST, and I think I can speak for us to say we read them, we don't always read them as carefully as we might wish we had time for, but we do read them all.

In addition, members of the public who want to give oral statements can come to PCAST meetings, and the way that works as we've done previously for a number of years now is that each person gets a two-minute chance to make a statement. So the first statement will be from Kira Karuna who is the president of Karuna Consulting. Do you want to go to a microphone at the front, please, and if you push the button, you'll make the red light go on, on it, or someone will show you. And I'll warn you when you have 30 seconds left.
>> Mr. Holder, Mr. Lander, distinguished citizens, members of PCAST. A worker in a U.S. Government research facility once told me that they have a blanket policy of not promoting collaboration with nongovernmental organizations and businesses. Another federal installation the policies to provide research work to be done for outside clients by their own staff. The role of the first entity is designed not to compete with private

laboratories. Obviously the policy is inconsistent from one government facility to another. From our perusal of the hard copy that you have in front of you, I guess, and the attached list of national facility organization, it's clear that these establishments are of interest mostly to well financed, large organizations that build theoretical investigations. But it is also well to keep in mind that many of the large and small private businesses through much of the nation's applied research and development which is so important to the material progress of the United States. There are many nondefense government labs all around the country and very few of the neighbors even know about them, much less make use of them. Many government labs have personnel with useful expertise and underused equipment which could be of help to outsiders. Essentially it might be a source of government revenue if they were made available to others.

>> Bill Press: 30 seconds.

>> Why not establish a more flexible rent of government equipment and facilities arrangement on a cost-of-service basis.

>> Bill Press: Thank you. The next comment is by Jane Shoeheart. Is that how you pronounce it? Who is executive director of Cooperative Extension. And PCAST members, you also have Ms. Shoeheart's written statement in front of you.

>> Good morning. Cooperative Extension is the nation's premiere transformational education system working through the U.S. Department of Agriculture, National Institute of food and agriculture, the land grant university system and land grant offices. Thanks to this opportunity to focus on three points about the PCAST report to the president on agriculture. Excuse me.

Number one, encourage additional funding for research but not at the expense of capacity funding which also needs to be increased. Capacity funding contrasted with the start-and-stop nature of competitive funding enables the persistent, pervasive, and trusted intervention necessary for transformational learning to take place, over time, in multiple locations, and with various audiences.

Number two, include Cooperative Extension as a critical component of any implementation strategy to address key challenges in agriculture. The success of the U.S. model is the collaborative effort between the research and extension functions of the land grant university system, not to unrelated endeavors. An educational program that effectively engages producers and consumers, leading them through the adoption process to behavioral change --

>> Bill press: 30 seconds.

>> -- is necessary to realize the sole value of research.

And final any Number 3, use Cooperative Extension to conduct workforce training which was addressed in the report. Programs for use development through 4-H, crop consulting and community and economic development are important in the food and agriculture enterprise in both rural and urban communities.

To sum, Cooperative Extension's educational role is critical to the success of the agricultural research innovation ecosystem. And its application to feed America and the world. Thank you.

>> Bill Press: Thank you.
>> Questions?

>> Bill Press: If members have questions, they can talk to you in the break after this.
>> Thank you.
>> Bill Press: The next comment is from R. Thomas Van Artsel who is executive director of the National Coalition for Food and Agricultural Research.
>> Hi. I believe you have our prepared statement. My name is Tom van Arzel and I'm executive director of the National Coalition for Food and Agricultural Research, or CFAR which is a customer coalition whose role is to increase federal investments in food and ag research extension and education.

I'd like to just touch on a couple of appointments in my two minutes of fame. First, you counsel the president as a voice outside of agriculture and traditional ag groups, provides invaluable credibility in making the case for action and in pointing out that there are serious consequences to our nation of continuing to underinvest in our ag research enterprise. Second, our shared hope is that your report serves as a catalyst for moving forward, not as an endpoint.

While I appreciate that there are other pressing matters ahead for PCAST, one simple action we hope you will continue to take is urging busy administration officials to launch their recommended implementation committee process. I call this being a friendly itch with busy people.

We know this nudging is a shared responsibility with the heavier burden on CFAR and other stakeholders to make the case for action. We took a first step in our letter to the president, which you have, and our main action request was to move forward with that implementation committee process. CFAR leadership is taking a number of other steps in evaluating the PCAST recommendations and involving our position.

One I would like to highlight is a recent summit with major food and ag business leaders.
>> Bill Press: 30 seconds.
>> -- as the first step in the process to understand their concerns and help ramp up their involvement in this quest. We hope to provide PCAST with periodic updates as we move forward, building off of your excellent work. Thank you again for your leadership and your important voice.
>> Bill Press: Thank you. And the final oral comment today will be by Randy Wells which is -- sorry. Oh, I'm sorry. Yes, Randy Wells' comment was submitted by e-mail and we've selected it to be read aloud and it will be read by PCAST intern Patrick Halpin.
>> Hello. There is a dire need to fund agricultural research in the United States. Agriculture research funding has been shrinking in North Carolina at both the federal and state levels. Looming over us are some of the most severe cuts to funding of agricultural research ever seen. We may have the most plentiful, varied and safe food and fiber supply in the world. For example, since 1935 the corn yield in average have increased on average of 1.6 bushels per acre per year. Also through plant breeding and crop management research carried on at our land grant universities and the USDA.

Should we cut back now? We may be killing the goose that laid the golden egg at a time we need all of the gold we can get. The world society's continued existence may depend on a robust, well funded agricultural research endeavor never seen before in the history of man. If not the television show Life After People may take on more pertinent meaning. I wholeheartedly support the initiative set forth in the PCAST report. Sincerely, Randy Wells.
>> Bill Press: Thank you. So let me urge people here today or people watching on the Web to submit comments, either between now and our next meeting, which will be in May; is that right? Or to come to the meeting and give oral comments like the ones we've just her. And this concludes our public comment period.
>> And it also concludes our public session. So it only remains for me to thank once again the PCAST members, the members of the OSTP staff, the audience here in the room, the audience over the Web, and all of our panelists and presenters this morning. Thank you-all very much.
(Concluding at 12:02 p.m. Eastern time.)