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PARTICIPANTS:

PANEL DISCUSSION: A PATH FORWARD – THE FUTURE OF INNOVATION IN THE UNITED STATES

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Panelists:

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P R O C E E D I N G S

MR. IP: Thank you very much. It's been a great discussion so far. I want to start by just observing that often people think there's a tension between economics and science. You know, science is all about unlimited possibility and economics is a dismal profession that deals only with constrained optimization when, in fact, it's not really true. You could actually say that innovation is really just the application of science to solving economic problems. And economists have known at least since Solow's work in the 1950s that science is, in fact, an innovation or intrinsic to how economies grow over time. And we've made great strides in the economic profession in that with work by Paul Romer, for example, in the 1980s, which has helped us understand that science doesn't and innovation and insight just doesn't follow to the sky in some kind of like portent helicopter drop, but is actually an integral part of economy and how economies grow.

And the great thing about this insight is that it opens up an explicit path for innovation policy. If you can actually unlock the path to creating more innovation, you can permanently raise the economy's growth rate, not just the actual level of output. So I think that a great way to end today's conference would be to try and sort of bridge those two worlds of science and economics to try and figure out how we can use those two disciplines to try and sort of like propel innovation and grow the economy. I can't think of two better people that we would have to sort of tackle this question than our two guests here.

To my left is Eric Lander. Eric is a founding director of the Broad Institute of MIT and Harvard. He's one of the world's leading scientists in genetic science and the Human Genome. He is also Co-Chair of President Obama's Council of Advisors on Science and Technology, which just in the last week put out a very interesting report. I just finished reading it. I do recommend it to everybody. You're not going to agree with everything in it, but it's got a lot of great insight on the role of government in promoting advanced manufacturing as a way of revitalizing the manufacturing sector and innovation.

On my far left is Larry Summers, who I don't think needs much more introduction than that. So I'm just going to get right into it.

I'm going to start with you, Eric, because I've just read the report, and it's full of possibilities. And what I like about or what I find intriguing about the report and challenging is that it argues that -- it doesn't sort of like, you know, take the kind of strong anti position that, yes, government should pick winners. You argue that, in fact, government should be involved in innovation policy only when there's identifiable market failures.

You know, we were talking a little while ago. I mean, you sound like somebody -- you're in the scientific area. Scientists see possibility all the time, and you see market failures blocking the path of that scientific insight to produce innovations that, you know, add to growth. Talk to me a little bit about that. I mean, where are those market failures? How do they happen?

MR. LANDER: All right. So in principle, creative energy should just be able to -- potential energy should be able to roll downhill. You have a ball

up here. It should have a path and just roll downhill; potential energy getting released. But as it rolls downhill, it encounters some bumps in the hill, and it can get stuck at the bottom. How do you get over those things? There are times when it's perfectly feasible for the market to say "Hey, that bump's not very big. It's not very expensive to lift the ball up and get it over that bump, and let it keep rolling downhill. I'm going to invest" or if I'm the person who's the ball, "I'm going to go out and seek investors and keep rolling." There are many, many situations, though, where that just doesn't work. It doesn't work because "Oh, you know, it's difficult to get any one ball over that hill. What you've got to do is bulldoze that bump, and then that's a public good because then anybody can roll down there." So what it may take in many of these situations is either a public good because you can't appropriate the value of it, or at least a partially public good. And we see that all over the place. The Human Genome Project was an example like that. Every pharmaceutical company knew it'd be a really good thing to have the whole secret of the Human Genome, but, but it was not going to be something that they could appropriate enough of to make the socially optimal investment. GPS -- everybody, you know, maybe, maybe you could have been smart enough to say if we had all these GPS satellites up there, I can make markets in all sorts of things. Imagine going out to investors and saying "I'm going to do that." Whatever you can't manage to reap the whole benefit of that panel of GPS satellites and, therefore, you're really not going to be able to raise the capital to do it. That was a public good to put those things up there.

You know, imagine the thing the President's Council of Advisors has taken on in the past year, health information technology. It would be a really good thing if our different health care, electronic health care systems, could talk to each other because then some smart third-party entrepreneur could come along and write an innovative piece of software that could work on all those systems, whereas right now, they've got to write one for each system separately. Well, what does it take? It's going to take some universal exchange language so I can write up here an abstract piece of software that could talk to all of these things, but that's a public good.

There are market failures. Now one has to be disciplined about what is a market failure and what is merely a plea for money for my special project. And we are very often not. People say, "Oh, we should do this because it's very expensive. Industry won't do it." Industry does expensive things. Or "It's very risky." We have a good system for taking risk in this country. When, however, it really does require doing something where the private parties can't capture all of it, we have no problem with basic research acknowledging that that's a public good. Over here the basic research worked. We have to do that as a public because industry can't do that. It can't reap even very much. Over here at product development, we have no trouble understanding that's largely a private good. There is a transition of stage in there, and this whole discussion is about what is the role of the public? What is the common cause or the public purpose in getting us through that transitional stage and being clear headed and hard headed about what is the public good aspect and what is the private good

aspect there. And there's no solution other than actually understanding what each of those problems is about.

MR. IP: Larry, economists have no problem with the notion of market failure. You know, God knows how many dissertations you have judged that dealt with examples of it. But I think also, you know, in the public policy arena you want to be careful about, you know, assuming everything's a market failure, and it would be so much better if we could just get in there and tinker a little bit about it. So when you hear these arguments, what's your response to that? I mean, what's the test you apply to these arguments because the demands for the government to shower money, you know, on those pet projects are infinite.

MR. SUMMERS: Let me just first say that in your long and gracious introduction of me -- but wholly accurate at least -- you left out one thing, which is an important accomplishment of mine, which is that I had some combination of the wit, the charm, and the wallet as President of Harvard to recruit Eric Lander to join the Harvard faculty as well as the MIT faculty. I think you'll see by the end of this session that that was a wise thing that I did for Harvard.

Look, Eric and I, I suspect, come down and around the same places on the pragmatic questions of what actually should be done. It's kind of the role of the scientist to be for stuff and kind of the role of the economist to raise questions. So I'm going to emphasize a little more the skeptical side, but at

the end of the day nobody with any sense thinks that this should all be left to the market.

I think the first thing to say is that market failure is, in a superficial sense, absolutely pervasive. The most obvious way to say that is that economists estimate that two-thirds, 75 percent, 80 percent, half -- they differ as to the exact number -- of all the economic growth in the country comes as a consequence of science and technological innovation. And while Eric and Francis live quite well, I think we can safely assume that vastly less than half of the GDP goes as rewards to innovators, from which it follows that there's a major externality that innovators earn elsewhere. So market failure is absolutely pervasive.

There is a tendency to suppose that the market is worse at curing market failure than it actually is. Let me give what's now a somewhat dated example. Around 25 or 30 years ago, there was this invention of the VCR. There was this invention of the video tape that could go into the VCR. Any halfway decently trained economist could explain how there was a huge market failure out of the chicken-and-egg problem; that nobody would buy a VCR until there were pervasive videos; and nobody would buy pervasive -- nobody would start putting Blockbusters all over the country without there being an installed base of VCRs. So you obviously had a public good externality problem. And if you really wanted to achieve rapid dissemination, the government had to step in. The market did it in about four years, vastly faster than the government has disseminated much of anything. So the first thing to say is that markets are more

creative in finding ways to respond to these externalities than naïve thought would suggest.

The second thing to say is -- and the only thing that I thought was important that Eric sort of left out in what he said -- is that market failure has to be compared with public failure. There was a really important economics article, which for a time was extremely fashionable, written in the 1930s by two economists named Lange and Lerner. And what they basically said was "Look, everything that's good about the market -- pricey going marginal cost, trying to maximize profits -- there's no reason why government-owned enterprises can't do those things. And if the government owns the enterprises, then they can internalize all the externalities. They can tell the enterprises not to pollute. They can tell the enterprises to subsidize things that are good. And so if we really just use market language, but have the government own everything, then we can have really a phenomenal economy." And the argument was put forward in part seriously and in part as a kind of reductio ad absurdum to this notion. And if you look around the world, this argument's made in every Communist and Socialist country. And yet without exception, on the simplest and most basic externality problem which is pollution, every Socialist country is vastly worse than old-fashioned capitalism. So the idea that there's a market failure, therefore we should have the government do it, is not actually best countered by saying there isn't a market failure. There is a market failure. It's best countered by asking is the government intervention going to add to the world?

If you look right now, the U.S. government has recovered all the money in the TARP program that got put into the banks. It's acquired essentially all the money that got put into the automobile companies, almost all of it will come back. The U.S. government will be several hundred billion dollars in the hole at the end of the day to Fannie and Freddie. Fannie and Freddie were a public-private combination directed at addressing a set of market failures around standardization, around handling large-scale risks, that were carefully explained as being innovative savings of government resources through a public-private combination. It didn't end very well.

There's some other public-private combinations: Synfuels. We spent what would today be close to \$50 billion on the idea that there were lots of externalities involved in finding ways of converting coal into standard petroleum products, essentially all written off by government. Amtrak is a public-private partnership. In its current incarnation, the Post Office is a public-private partnership. So I think we have to think very carefully in this area, when we want to get the public sector involved, how we manage the incentives so as to create a drive for efficiency. Here's a simple rule: If the government has gotten involved in supporting a technology, and you look at key companies in the technology area, in the area the government is supporting, how large is their Washington office? If their Washington office is very large, there's some substantial presumption that this is going to end up a lot about lobbying effectively rather than internalizing an externality.

We have to think about how the consequences are going to play out over time. What starts as a good idea becomes an entrenched constituency. A set of people make investments in reliance on the subsidy. Once they've made an investment in reliance on the subsidy, you have to think carefully about taking it away. So look, do we need to have the government do much more to support science and technology education? Yes. Is there more that government can do to do the kind of thing that Eric and I have worked on in the Boston area, but that exists in many different places, which is to recognize that if you can get the right kind of cluster, you get increasing returns; that the difference between farming and knowledge is that when you get the 30th farmer on a plot of land, he produces less than the 29th farmer did, and the 31st produces less than he does; but when you get the 30th geneticist, he is much more useful at the margin with 29 other geneticists in his presence than he would have been on his own.

So should we be supporting all kinds of clusters? Yes, we absolutely should. But I think we have to move the conversation from is there a market failure, to which the answer is always yes, to how successful will the market be in responding to this opportunity, and what will be the full set of benefits and costs that a company, a set of government interventions, in the area? And our analysis has to take account of the risks over time. And it would be interesting to compare some of these reports on advanced manufacturing and so forth, which again, make arguments that are basically right, with one of the first things I studied as an economist. Harold Wilson, the Prime Minister of Britain in 1964, wrote a celebrated report about the white heat of technology and

how government needed to get involved. And in a much larger way, as part of the Labor government's manifesto, it was not a conspicuous success in terms of the performance of the British economy between the 1960s and the late 1970s. So I would just urge recognizing both sides.

MR. LANDER: So let's make a distinction between different types of public-private partnerships or different types of investments to overcome market failure. You bring the Post Office and Amtrak into this. Let's put that in a bucket of operating partnerships. There's an ongoing operating role that the government is playing because we think on a sustained basis there's a market failure, and we're going to have to help it along all the time. At the other extreme, most of the examples I'm going to point to I'm going to call catalytic instances where you have to engage for a period of time and then we'll unlock that ball that continues to roll down.

MR. SUMMERS: I promise you, I promise you, that you will discover that the initial investments in Amtrak were described as catalytic and not going to lead to something permanent.

MR. LANDER: Well, sure.

MR. SUMMERS: I promise you the same was said about the Pony Express.

MR. LANDER: But wait a second, wait, wait, wait. You're talking about running a railroad as opposed to investing in a set of standards that then allow entrepreneurs to come in, investing in a set of data that then allow people to operate on --

MR. SUMMERS: So just as an example, where would you come down on what many people see as -- one of the classic examples that's given in the contemporary debate is high-speed rail. Would you say the government should get involved in a major way in high-speed rail?

MR. LANDER: So the truth is, I don't know. I think the Eisenhower Highway Act, yes. I think at that point it was clear that the inability to move things across the country really was limiting to the economy. You'd have to take a serious look and ask, which I haven't done, whether or not high-speed rail represents the overcoming of a rate-limiting step that truly would unlock all sorts of things, or is it a nice-to-have thing? And you have to be hard headed about it. I don't doubt that everybody will argue they're just here briefly catalytically, but many of those arguments are really pretty unconvincing, whereas others where you say, "I need to do a project; it's a five-year project. I need to create health IT standards. I need to do this." You know, something --

MR. SUMMERS: What would be the best example of a five-year catalytic project that ended?

MR. LANDER: The Human Genome Project was 13 years. It ended.

MR. SUMMERS: Okay, that was a good one.

MR. LANDER: That was a great one. That was not dominantly a private sector collaboration, and that was -- that had a specific objective and a specific -- oh, I'm getting the looks, that I don't know what I'm talking about on my comment about private sector collaboration so I'm going to back off that one fast

-- but industry was crucial to producing machines that were used in it. Had not the government given a signal that there was going to be demand, we would not have unlocked that. And I'll say, just because we're on the point for a second, when the Human Genome Project ended, the unlocking of the possibilities from it further drove the technology so that the cost of sequencing has dropped over the last decade by approximately 1 million fold.

MR. IP: And I just want to add in here it's possible that you're both right in the sense that if the social returns to the one successful government-backed innovation are astronomical, it could make up for all the dead-weight loss of numerous others. We were talking about that, weren't we, Eric? I mean, maybe you do waste a lot of money on syn crude and on, you know, fast breeder reactors, but somewhere along the line you unlock --

MR. LANDER: Sure, but one shouldn't be sloppy about all those investments, but one should also acknowledge some of them will fail. But the things that have characters of short-term challenges, I think, are the easiest to justify. DARPA does a good job of it. They just did a project where they said "We're going to challenge industry to design a vehicle to specs that we're going to announce. The design has to be done in 30 days, manufactured and complete in 90 days." Now no company's going to go put itself into a pretzel to go do that, but DARPA did it and a company went and pulled this off ahead of schedule. Now they know that that's really good for the military to have rapid turnaround on design, rapid turnaround on manufacture, but it's good for the rest of the economy. And in a planned for way, putting challenges out like that, that can

stimulate and then show to the market, hey, that actually was possible. So I would at least -- while I don't know where to draw the bright line, I would say the spectrum from these kinds of operating forever stuck in the hole to these catalytic events give us some guidance as to where we ought to be preferentially investing.

MR. SUMMERS: Look, I was clear that I thought this all couldn't be left to the market, and I think the question is how do you apply the right kinds of discipline? And I think it's clear that the Human Genome Project was a substantial success. I think it's a slightly more -- you and Francis know infinitely more than I do about it -- it's a lightly more complicated case in the sense that the NIH continues to fund large amounts of activity that is part of that stream, as it well should. But it's not that the government invested in this thing and then it was all over and there wasn't more government money. It's that the government invested in the thing and it was a success, and it opened up a lot of opportunities and then the government continued to invest more in it.

MR. LANDER: In other well-defined projects.

MR. SUMMERS: In other well-defined projects. And, you know, the NIH has a particular model and one of the things the NIH has overtime been relatively successful in doing with the emphasis on the culture of peer review and the like is maintaining some degree of insulation from politics. And that's a crucial part of it, and that has not been the experience of all that is done in the name of promoting technology. And so I think --

MR. LANDER: I don't think we disagree.

MR. SUMMERS: I think we're basically in agreement that the Genome Project was good; that there's a market failure rationale; that there are real risks of public failure; and that you have to apply a lot of discipline to it.

MR. IP: I'd like to actually push back on both of you on a broader question, which is to sort of challenge the premise of this whole event, which is to ask if there really is an innovation problem? I mean, I'm not a scientist so I look at, you know, the data to try and find out where's the innovation problem.

MR. SUMMERS: Scientists just look at the data, too.

MR. IP: Maybe they're looking at the wrong data. They're not looking at my data. If innovation is going to make matter to grow, it should show up somehow in productivity, right? But productivity actually looks pretty good. In fact, total factory productivity, which is intrinsic, you know, a return when you adjust the amount of capital and labor, was the highest since we started keeping records last year. R&D as a share of GDP is actually near the top of its historical range. Where is the innovation problem that we need so badly to address?

MR. LANDER: So you're saying one follows from the other, but what's the wagging time here? So current productivity is a wagging indicator of good investments made 25 years ago perhaps? Where does, say, the information technology productivity that we celebrate today come from? You're going to trace that all the way back to DARPA and the DOD in the 1950s with the decision to pump-prime the microprocessor industry, that itself wouldn't have really economically got going but for that pump priming? You'll trace it to the

creation of the Internet in the 1960s. You'll trace it to investments in digital libraries in the 1970s by the NSF, all of which are now paying off for you.

So you say, I don't have a problem right now. Well, I'm not sure that you can draw that conclusion. It's taken -- I mean, the United States has been the master of basic research funding and, although we don't acknowledge it, this kind of innovation policy where the public sector does recognize that it makes those investments in the transitional stage. What I'm worried about is that maybe we're not doing it so well and maybe other countries are beginning to catch on to what we did so well. And maybe they're going to get first mover advantages with respect to new industries, to new technologies that arise. And maybe 30 years from now we're going to be sitting around and saying why didn't we make those kinds of catalytic investments? Well, because we were so worried about our budget and all that in the short term, and it's going to be pretty late to fix it.

MR. IP: Larry, do you agree?

MR. SUMMERS: I sort of get to the same conclusion, but I think with different reasoning. I think Eric's right that your thing's a bit of a cheap shot because there's long lags. And so if you think we're doing great right now, it's a tribute to innovation over a long time. I think that's a fair point. But I would put this in a different way, which is the question is, do we have an innovation opportunity in the United States? And if there are high-return investments available in investing in and promoting innovation, that is it seems to me something that we should take advantage of. And it largely doesn't matter

whether the budget is larger today than it was 15 years ago or smaller. And I think we've got to be careful of this international stuff. I mean, so just take a stark question at the competitiveness metaphor I think obscures.

If you learned that Japan, Germany, and China were each going to devote another \$10 billion to biological and life science research each year over the next five years, as an American would you regard that as good news or would you regard that as bad news? I'd regard it as good news --

MR. LANDER: Yeah, because it is.

MR. SUMMERS: -- because I'd think the world was going to make more progress and, therefore, I and my children were going to have a longer life expectancy and that it was better. The competitiveness metaphor to which we are heavily drawn, which is that there's some kind of league table and being at the top of the league table on R&D as a share of GDP is a sensible aspiration, would suggest that we should regard that as a bad thing.

So I don't relate so well to some of the league table stuff. I believe in looking at this in terms of opportunity. Is there opportunity to fund vastly, more basic research in this country than we are? I absolutely think so. Is there opportunity for the right kinds of DARPA to be expanded in a significant way? Yeah, I absolutely think so. Do I think the substantial investments that have been made in wind power, for example, not the windmill technology that did exist in the Netherlands several hundred years ago, but that has been a major thrust of our policy rationalized by this, qualifies as a temporary catalytic investment? Nah, I think that's a harder argument, a substantially harder argument to make. So I

think you just have to be very careful. But if you ask are there a set of investments that we can make that would expand things? Yes, I think there are. I think where I am less certain than Eric is, is when you get to having certain particular kinds of production located here rather than located someplace else, I think you have to think very carefully about just how actually important that's going to be overtime. I don't whether we -- I don't know with certainty whether we should have a high-speed rail on a larger scale or not, but I would argue that if we should, it has to be on Eric's rationale. But it's like the Internet highway system, that it will knit the country together, not on the rationale that's frequently put forward that it will be a substantial spur to the development of U.S. technologies in trains and tracks and all of that. And there's a great deal of encouragement to the suppliers who are thought to be then job creators that I think one does have to look at in more careful ways.

MR. LANDER: So I agree with you, but I want to come back to the international question because while we can overlay the competitiveness question, there's something to it. The reason I wasn't at all upset about the declaration that Germany, Japan, and China are going to put another 10 billion bucks into biomedical research is A. knowledge is a good thing, but B. we're best positioned to use that knowledge. We still have a leadership here in the doing and the manufacturing of these pharmaceutical products that will come from it. If you just told me that Germany, Japan, and China were going to put 10 billion bucks into the next generation carbon nanostructures that would form the basis of a whole new generation of computers when CMOS runs out around 2020, I'm

not sure -- I mean, I could say it's a good thing because as a consumer, later I'll be able to buy cheap products from Germany, Japan, and China. But it would be a pretty mixed situation because I'd be saying that new industry, the rents are going to go outside this country. The manufacturing is going to go outside this country. The knowledge base for each new generation is going to be outside this country. I'd probably want that in this country, and I might be clamoring for that 10 billion bucks to also be invested here because I'd be giving up an awful lot by not having that happen here.

So a little bit has to do with the fact that while innovation does not guarantee jobs here, it does not guarantee manufacturing activity here, there is a tie of the creation and the early cluster, especially in that early stage where pilot plants are coupled to researchers and there's this creative back and forth, where if we do miss the boat completely, it's much more expensive or maybe impossible to get back on later.

MR. SUMMERS: So I think that's totally fair. I guess I would just qualify it in a couple of ways. First, to say that it's a productive investment for us to make also is actually a statement I would agree with, but is a rather weaker statement than the statement that we're worse off because they made the investment.

MR. LANDER: I agree.

MR. SUMMERS: I have always preferred the formulation the United States should be the envy of the world rather than the statement the United States should win a competition because the envy of the world

formulation doesn't carry the implication that their doing more is somehow bad for us. And I think there probably are examples where they're doing something more is bad for us. I think those are probably the minority.

I do come back to look, to take an area that you know much more about than I, as of the time I last followed this which was five years ago, 41 American states were engaged in seeking to be centers of biotechnology. There were nine that were not, but 41 governors had declared the importance of clusters, had explained the centrality of the life sciences, and had sought to become centers of biotechnology excellence.

MR. LANDER: That's a large number of clusters.

MR. SUMMERS: It has to be that for at least 25 of them, it was not a plausible aspiration. And I just think that discipline needs to be present as one thinks about where one is going to invest.

I think the other question that is very much worthy of study, although I don't know how one would answer it is, if you say America has led the world in information technology and that has been a phenomenal thing, there are at least three sort of competing parts of how we've done it. One is that over the relevant interval we led in the relevant kinds of basic research. We drew John von Neumann into America. We provided an infrastructure where a zillion people like him could think and create in peace. That's one. The second is we had a bunch at DARPA and DARPA needed researchers to communicate and that stuff. And the third is we had a culture of venture capital and entrepreneurs and the ability to raise your first \$100 million before you bought

your first suit that was unique in the world. And all three of those things are elements, and the question is what their relative importance is. I think there is a tendency to run to number two as being of dominant importance. And I wouldn't dispute at all that number two is an important part of the story, but I would in thinking about innovation policy put at least equal weight on the number one stuff being the place that all the best life science -- all the best researchers come to with the greatest universities and all that, and on a set of things around number three and venture capital and support for entrepreneurship and the like.

And I think there's a bit of a tendency -- and notice that neither number one nor number three has an intrinsic base political constituency, whereas there's all kinds of political constituencies or support for the solar power industry. And so just as I think about what the role of people like us in the system is, I think that carrying the torch hard for number one and number three, which don't have alternative torch bearers, needs to be a large part of where we are.

MR. LANDER: I could not agree more, and I think it takes, obviously, all three of those. The number one, making this an incredibly attractive environment, creating the basic research institutions and the clusters that attract them, has been utterly crucial to our success. And, you know, that's why, for example, would we turn away foreign-born scientists to this country? We are cutting off our nose because that was such a crucial part of it. All of this argument about the middle ground should not in any way diminish the incredible importance of that first part. Without it, there's no point to the middle ground.

And I think the reason we're not talking much about the third is I don't know that government has a lot of role in it, of creating that venture capital industry there, other than, you know, kind of leaving it be and letting it go forward. So we're not talking -- we're not addressing it not because it's not important, but because I think that the subject right now is, what is the role of government in it? But it does take all three. I think that formulation's exactly right.

MR. IP: Eric, I want to --

MR. LANDER: But if you take visas -- I'm sorry.

MR. IP: It's all right. I sort of want to just move this conversation a little bit to the issue of jobs because every time the President talks about innovation, it's innovation is key to jobs. One of the interesting things I found in the President's Council of Advisors' report was there's a view that innovation itself doesn't create that many jobs directly. It creates jobs for you and your colleagues at the Institute. But the real, like, the millions of jobs potential is in that people actually produce the products that are the fruits of that innovation, right? And what we've seen in the last few decades is that increasingly those jobs have moved offshore. So the innovative jobs are still here, but it seems like a shrinking slice of the American workforce benefits from it. And in your report, you actually make this point quite well, which in the end the process of actually making the products itself yields further innovations. And what you worry about is that the loss of that manufacturing base will eventually hurt our innovative capacity. So what's the policy response to that? How do you ensure that innovation doesn't just create high incomes and jobs for the shareholders of

Apple and the like, but also for the millions of people who may have once had high-paying jobs in manufacturing and no longer do?

MR. LANDER: So I'll say a little bit and Larry's much more knowledgeable about this than I, but I'll say a bit to kick us off. Innovation creates the opportunity to have new jobs in new industries. It doesn't create a guarantee. So just like what Larry was talking about, if you need several pieces, there are pieces that have to come after it. Yes, but why doesn't Apple produce its iPods and iPads in the United States instead of employing, what is it, three-quarters of a million people in China? Something like that. Why don't other companies? So in the Council's advanced manufacturing report, we ended up talking to a number of companies. The major -- there were many reasons given, but the most consistent reason was "We can't find the types of workers we need." It was not low wages. Because, in fact, for many of these products, the wage is a relatively small part of the overall cost of the product and the wage differential multiplied by the proportion of the product against the wage means that it's really not the critical difference. Getting the kind of factory floor engineers with not a fancy engineering degree, but the ability to be quantitative and increase the factory's efficiency by 1 percent, getting workers who can run computer numerical control devices, things like that, was again and again cited as a frustration with doing business in the United States. So it goes back to things like STEM education in this country, being able to get people -- you know, there are right now somewhere between 1 and 2 million jobs available for this in this recession. With lots of unemployment, there are something like 1 to 2 million

jobs going begging for lack of people without those sets of skills. So that's part of the overall ecosystem and environment necessary to do it.

Then there's -- if I were trying to make the innovation policies sticky, I would want to figure out how at the very early stages of this innovation the pilot plants were being built here. And, frankly, I'd be willing to spend some government money to co-invest to make sure those plants were here because that does create the knowledgeable community here. It creates then the desire to build the small factory nearby it because even though we're in a great Internet-connected world, being able to sit down with somebody else and have workers in clusters is still powerful, there are ways in the first decade or two, maybe decade and a half, that you could keep it somewhat sticky. Eventually as it becomes matured technology, I don't know any way to hang on to these things necessarily. But in these early stages, I think there are actions you can take and I think the future is a succession of early stages of new technologies. If we were to win all of those and then lose them eventually elsewhere, it wouldn't be a terrible outcome. But Larry will have a more --

MR. IP: One second. We're right now distributing cards. So if you have a question, please ask for a card, and we'll try to get to them in a few minutes. But, Larry, did you want to take a stab at that?

MR. SUMMERS: I think it's a good idea to try to be the leader in the things you can while you can. I think we need to recognize that right now only 5 percent of the workers in the United States are engaged in manufacturing production. Ten or 11 percent are involved in manufacturing, but many of them

are in advertising or finance or management or working as assistants. So the number of workers in the United States is 5 percent, factory workers is 5 percent. It's where farming was in 1960. It's driven by the same kind of trends, remarkable productivity growth, a certain substantial demand but not growing that rapidly, fewer and fewer people. So the suggestion that somehow anything about manufacturing is going to be a large part of the challenge of finding 20 million jobs in the next 10 years when there are only 7 or 8 million jobs in production right now is, I think, just not plausible.

And so I think the core of the case for innovation policy resides in wealth creation, resides in national leadership, and resides in national security, not in large-scale job creation around being in production workers. I think it's important to remember in this regard, though, that there is a whole set of activities that are involved with distribution, that are created by new technologies, and it is important to remember as well that incomes are wages divided by prices. And so if you produce things that are substantially cheaper, you are raising the level of real incomes in our country and that's an important thing to do.

Just a final thought, there is a significant phenomenon going on of reshoring, of manufacturing that was once taking place overseas and it now is coming back here. That's the good news. The less good news from the point of view of a jobs focus is that that is significant because when it was all done by people, it was cheaper to produce in Asia than it was here.

MR. LANDER: Right.

MR. SUMMERS: When it's now going to be done substantially by robots and there aren't very many people, then you might as well do it close to your suppliers, near your point of innovation and all of that. But it is somewhat inherent in the reshoring we observe that it is in areas where it is not going to produce large numbers of jobs for those who are most in need.

MR. LANDER: Look, agreed. The numbers are not going to drive the whole economy. And I confess half the reason why I want to be sure the manufacturing is going on here in these early stages is because I think it's a critical driver of further innovation, which will be further rents. And so it's not a panacea; it's not close to the major solution. I still think it's an important thing to concentrate on, having this manufacturing going on here.

MR. IP: I want to get in some questions here. This first question is "How do we ensure that the R&D tax credit isn't benefiting overseas activities of U.S.-based multinationals? Aren't the funds in talent in these corporations somewhat fungible?" And I'd like to broaden that question out a little bit and say that any activity that we undergo, you know, in the government sector to stimulate innovation -- how do we ensure that most of the benefits of those are actually captured here at home and not by our footloose corporate sector in some other country?

MR. LANDER: I think we ask former Treasury Secretaries.

MR. SUMMERS: We don't and we can't completely control that, but we take consolation from two things: One is it turns out that there's lots of things that don't disseminate too widely. It's kind of remarkable that the hub of

the Silicon Valley -- the hub of software in the United States is Silicon Valley 40 years after it all started. That it is still true today that if you look at the production of small airplanes in the United States, 80 percent of it takes place within 20 miles of Wichita, Kansas. That if you look at the production of certain types of carpets, the large majority takes place in proximity to Dalton, Georgia. And so it's just the case that dissemination diffuses and you, therefore, get the message less. And so if you stimulate innovation, some good things happen near the innovation. That's part one. Part two -- and this is a very deep question that was debated quite famously almost 20 years ago by Bob Reich and Laura Tyson -- is the sort of "Who is us?" question. You know, which is better for America, GE to succeed producing in Malaysia or Siemens to succeed producing in Tennessee?

And, you know, there's a million aspects of that, but a statement that I think almost everybody would agree with is that a stronger American-headquartered, American-based, company is likely to have a set of benefits for the American economy. And so even if there is some spillover to a broad -- within international corporations -- there's likely to be some significant benefit to the United States as well.

MR. IP: "Were you surprised at the rise of social networking?"

This goes back to something you and I were talking about, so social media is an example of a very large family of innovations that didn't seem to have any benefit whatsoever from government.

MR. LANDER: Yes. Yes, I think it's a perfect example in my case where I already felt too connected, and the thought that I was going to have the

opportunity to be even more connected to the world and to have more people be able to ping me that that would be attractive, as saying it on the basis of my own self, I didn't automatically see the benefit of it. And I was not thinking about perhaps my kids. But to be totally honest, I did not foresee the rise of social networking.

MR. IP: So assuming that we don't --

MR. LANDER: But he presided over that rise, so maybe he foresaw it.

MR. SUMMERS: I'd be a much wealthier man if I had been really good at having impressions around that kind of thing. I think social networking -- I think, actually, it does make a point that's sort of worth remembering here, which is we've had a tendency in this conversation to equate innovation with science and technology. You know, the hard parts about Facebook are not about writing the computer program that connects the people together. That's not the hard part about Amazon either. Wal-Mart, if you think about it, is a very profound innovation, but not the kind of innovation that comes from a laboratory. There are people who would debate its impact. But the futures market is an important kind of innovation, but not one that came out of a laboratory.

So I think it's important to remember that a lot of innovation comes from creating a culture where some of that sticks, where it's friendly to entrepreneurs, all of that. Questions we mentioned, questions around immigrants. There are questions around, for example, Sarbanes-Oxley and its impact on the rewards to being an entrepreneur, a range of other public policies

that I would just want to think hard about maximizing hospitality to entrepreneurship as a really profound part of innovation because it's not all spillovers from laboratories, which is what people tend to bring to mind.

MR. IP: One more question. "Do you think that the DARPA-type model of high-risk, high-reward, investment is scalable to non-defense sectors?" I think it's an important question, and it's a big challenge to kind of the view that you've been putting out, Eric, because, of course, a lot of the innovations that you pointed to began in the defense sector and had positive, but unanticipated, spillovers to the civilian sector. So how do you reproduce that sort of success when in some sense it's more successful than it was even intended?

MR. LANDER: Oh, some of the DARPA successes may not have been intended, but some of the DARPA projects were done with the full recognition that they would have spillover effects. I remember 20 years ago, DARPA funded a project to build an autonomous vehicle that could drive from Boston to San Francisco with nobody in it. They knew full well that it could be a good thing for the Department of Defense, and they fully understood the broader social consequences of that for cars that could drive themselves, et cetera. Do I think the DARPA model should be extended further? Absolutely.

I think one of the remarkable things about this country in its funding of science and technology is we have a diverse portfolio of funding mechanisms. The way the NIH funds, with its certain type of peer-review system. The way the NSF funds is different. USDA, it funds in these block grants a great deal; I'm not nuts about them. DARPA funds in certain ways. I

think there are a variety of different funding models, and I think we do too little analysis of which ones work well for which problems. The Human Genome Project was a perfect example of a DARPA-like funding mechanism because it broke all the models. It didn't -- I mean, yes, it fit within the peer-review system, but the Agency was vastly more involved in the project.

It didn't do what most NIH grants do, which is send money, write me a note at the end, and tell me how it went. It had quarterly reports. It had all sorts of exchanges, forced exchanges of ideas, and milestones and goals. It was goal directed. The NIH engaged in a goal-directed project in a DARPA-like way and got things done. The Cancer Genome Project that's going on right now is sort of like that.

Now, we need some DARPA-like authorities at the NIH to do this better, but I think what you're really asking is should goal-directed projects be part of our portfolio more broadly? Should a rapid, nimble, ability to fund things be part of our portfolio? Well, the Department of Energy with ARPA-E, for example, is funding in that much more rapid fashion. So yes, we should, in fact, constantly be looking at the mechanisms we're using and evaluating them. Agriculture, which I dissed a moment ago, created NIFA, a new funding agency that works differently than these block grants. If we're not constantly being creative and asking, how do we incent the best innovation and what fits for what purposes, I think we miss a bet. And DARPA-like authorities in Energy, I think we should be doing more of it.

MR. IP: Larry, last word?

MR. SUMMERS: Would it be a good idea to extend the DARPA model in some ways and in some places? Yes, it absolutely would. We fought a war on cancer because we really wanted to have a goal-directed health program in 1971. I'll leave it to Eric and Francis to estimate its total cost relative to the cost of the Human Genome, but I suspect it was not small. There's a lot of debate at a minimum about whether we won the war or whether we lost the war and how much progress we made in the context of the war.

If somebody has a really interesting, squirrely idea for a whole new way of converting sunlight into energy, should the government be prepared to toss \$10 million sums or \$50 million sums around to encourage that, recognizing that failure is more likely than success? Absolutely. It is harder, if you'll look at the portfolios of projects that are put forward, you look at the full lifecycle of the agencies that are involved, to have it really be that rather than the program that a key congressman wants to support by his entrepreneur who is in his district. And if you look at these initiatives, they tend to continue after they've been enormously useful; and, therefore, one has to be quite careful. Would it be good to move more money into a DARPA for energy? Yes. Would it be good to fund more blue-sky things in the life sciences area? I'm sure it would.

Would it be a good idea to do something similar in nanotechnology? I think the benefits likely exceed the costs, but you do have to think very hard about the public choice aspects and how over time incentives are going to operate. And I promise you, as someone who's spent quite a bit of time with a clean energy portfolio, with a health information technology portfolio, with a

range of energy things, and that it is much harder to find the attractive things and be doing the good things than it is to identify the space where there should be an opportunity. I completely agree. The right thing to do may be a very hard thing to do, and what actually plays out politically may be worse than what you were doing otherwise. So the question of how to do this well is the challenge.

MR. IP: We didn't even manage to answer the question of how we'd pay for it given our current circumstances.

MR. LANDER: That's good.

MR. IP: Well, thank you, Eric and Larry, for an absolutely terrific and stimulating conversation.

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