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PARTICIPANTS:

PANEL DISCUSSION: OBSTACLES AND OPPORTUNITIES FOR AMERICAN SCIENCE AND INNOVATION

Moderator:

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Panelists:

TIM BRESNAHAN
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TYLER COWEN
Professor of Economics, George Mason University

GLENN HUTCHINS
Co-Founder and Co-Chief Executive, Silver Lake

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P R O C E E D I N G S

MR. GREENSTONE: (in progress) although I must say after watching E&G hand out an abalone shell. I turned to Glen and asked him where his was. And he plans to bring it up later.

So I just wanted to put this in a little context after hearing from the scientists. I think there are three economic issues that the Hamilton Project is especially focused on right now. The first is we're continuing to suffer from the aftermath of this really terrible financial crisis. There are currently 14 or 15 million Americans who are out of work and by kind of standard calculations it could take five all the way up to a dozen years to work through that to get back to something that resembles full employment. And so that's a problem that we have and we have to confront.

The second, more of a longer term nature, the first is that we've really been in this four decade-long slump with respect to wags for most Americans. And some of Tyler's work touches upon that. You know, one measure that we've developed is actually when accounted for properly, it's not that wages for the median American have stagnated over the last four decades but they've actually declined by 28 percent, putting them back at the level that prevailed in the 1950s.

And then the third situation that confronts the country is our fiscal situation is less than ideal. The debt-to-GDP ratio is increasing. We're reaching levels where countries historically have invited fiscal crises as we're trying to come out of an aftermath of one already. And so I think in the context of dealing

with these first two problems there's not a lot of latitude for government interventions.

And I think in many respects today is about innovation but I think more broadly we're entering a period where we're going to have to do more with less. And in fact, we're going to need innovation generally in the way government delivers services and the way the economy works. And so that's what I want to have this panel talk about.

And then another thing that I wanted to start with is I think there's a temptation when talking about innovation since innovation can mean a lot of different things to a lot of different people to kind of fall back on standard pills. You know, we should have more basic R&D. That's probably true. In fact, basic R&D spinning has been flat since the 1970s. Our education system is not performing. We're spending more and more and yet test scores internationally are not keeping up with other countries. Our system of infrastructure does not appear to be in great shape on the one hand. On the other hand, our rate of return on infrastructure spending is quite low. And there's a series of other things.

So what I was hoping is that this discussion would kind of move beyond a recitation of these standard solutions and talk -- come up with some new ideas. And so that's our goal today.

And so for that I thought I would start with my good friend, Tim Bresnahan, who is the Landau professor of Technology and Economy at Stanford University and formerly the chair of the Department of Economics, as

well as having previously served as chief economist of the Anti-Trust Division of the U.S. Department of Justice.

So Tim, we constantly hear that the U.S. is the most innovative nation on earth. We have smartphones. We have iPads. We have Facebook, although I don't actually have a Facebook page. And --

SPEAKER: Don't worry. Your kids will.

MR. GREENSTONE: Sadly, that's true.

So but your research has suggested that we may not be fully harvesting that innovation. Can you talk a little bit about why that would be and what some of the obstacles are?

MR. BRESNAHAN: Sure. First off, let me say that the iPad and Facebook are fabulous technologies. They are being very widely taken up by Americans. But if you look at them, if you look at mobile devices, smart devices -- I've been spending a lot of time in the mobile ecosystem the last six months -- you'll see that the applications serve consumption, not production. And, you know, Facebook is mostly a consumption activity, consumption communication activity. Most of the apps running on the iPad, the iPhone, even the Android devices, are part of entertainment media and consumption. They're not yet moving into productivity.

Now, those wonderful technologies show us that there's still a lot of life in the use of information and communications technology, and I think that there's a tremendous opportunity going forward for these new entrants into IT to provide productive advance but it's going to take a while. This is a story you

heard in our first panel as well. You know, you look at the Apple ad for the iPad and you see a physician looking up something in cell biology or you see a banker looking at a report on recent profitability. That's a great app and there's a potential for using these new devices and these new methods of communications that we see on Facebook and Twitter and Search at work but we don't use them very much at all. Work changes not at the pace of the new enabling technologies that enter it but at the pace that bureaucracies change to take them up but at the pace that markets change to take them up. And that's slower. It's slower to change bureaucracies around. You know, think about the physician looking at the cell biology report. You know, we'd like -- we have not yet as a society decided how that physician should take advantage of the new diagnostic tools we heard about in the previous panel. We have not as a society decided now the physician should choose between potentially extremely expensive new therapies and older and cheaper ones. So that's an unresolved issue.

And our ability to automate hospitals using new technologies is partly enabled by new technologies but it's also partly bottlenecked by our ability -- by our inability to set goals by side level for what we'd like the hospitals to accomplish, how we'd like them to make the difficult tradeoffs. And, you know, until those are resolved it's going to be hard for those particular bureaucracies -- hospitals are particularly interesting bureaucracies -- to decide what to do. Finance, the same way I would say. It's very difficult to change jobs in markets by the tens of millions. A new possibility in technology to change jobs around in financial services could permit enormous productivity growth in that sector. We

should also expect given how past technological waves have come in that it's going to take a while because it's going to change at the pace of the organizations rather than only at the pace of the technology.

Let me take one more example because it's on our mind this morning because there is another area where there's a huge, I think, potentially going forward overlap between technological opportunity and growth needs and that's in the area of environmentally friendly technologies. I think environmentally friendly technologies area an area where we have tremendous technological opportunity that people who make things are very good at making things. If the climate scientists are right, we'd like them to go back and learn how to make things using less carbon. They're going to be very good at that but there's another area where the demand side is not well set up to absorb the technology and make all the tradeoffs in a good way.

You know, I think, again, just to take a regulatory example, which is a local land use policy. Why do I think of local land use policy? Why do I think of health care policy as critical to innovation? You know, we could have better materials. That's got to be valuable. We could have an electric car. That's got to be valuable. Or I remember myself as a five-year-old living in Washington wondering why did they put the Beltway way out there? We could -- Washington could have grown up rather than out. And how do we know -- how would we know now whether we want to have people commute in from Burke on a really nice bus, have them commute in in an electric car or we want them to live, you know, in the District or in Arlington. So, you know, there's a lot of different ways

to save carbon. There's a lot of different ways to improve health. There's a lot of different ways to advance the economy broadly. That was my finance example. All of them are running into bottlenecks on the buy side.

Now, the one thing I would say that cuts broadly across things about IT, once the demand side in productive work decides how it wants to use Facebook if that's what it wants to use for communication, and iPads and iPhones if that's what it wants to use for end-user devices to replace all the Windows PCs everybody is using at work today. Once it decides how it wants to use those devices and technologies, an even bigger return to entrepreneurial invention in the IT area will be revealed today. Today entrepreneurs are overcoming these bottlenecks. They're making good money. They're mostly making it serving consumption and entertainment. Once it gets into productivity there will be an enormous return. That they we'll want open systems. We'll want new inventors flooding in on top of the platform providers we have today. In the past we've gotten the best bang out of new areas of technology out of the Internet, out of the PC, out of the mainframe, out of the server when there's been new waves of inventors after the first one. So I'd be a deregulator on the demand side and an open systems heart.

MR. GREENSTONE: Thanks, Tim. Now I want to turn to Glenn. Glenn Hutchins is the co-founder of Silver Lake and the co-CEO. He spent his previous career investing in the most rapidly growing and dynamic companies in the U.S. and around the world. And Glenn, I've often heard you say if you have a good product people will buy it. Do you think Tim has slightly too negative a view

here?

MR. HUTCHINS: Well, I want to come at it from a slightly different angle. I'd like to get started at a level set up a bit of the underlying technologies that are driving innovation and I believe fundamentally changing not just how we consume but also how do we produce. I just want to remind us about that for a second. And I would offer you the examples of the semi-conductor and the disk drive. Right? They are both innovative products in and of themselves. They underlie and drive today's innovation and that innovation is continuing very, very rapidly. And they themselves as products continue to innovate, which is kind of very interesting to watch as well.

And let me explain that for a second. One is the semiconductor today is the basis of almost everything we do in information technology, whether it's logic devices, processing devices, memory controls, sensors, etcetera. They're ubiquitous in our lives and I think we tend to lose track of that. Disk drives most people don't think about but they store, search, and retrieve almost limitless amounts of information today. I used to say that you have now the Library of Congress in your pocket. Now you have the ability to access almost all the world's information in your pocket because it's storage around the world.

These two devices touch almost every aspect of how we work today. And when merged with computer sciences and communication technologies fundamentally change the way we live and labor. That's point one.

Point two is it's not just -- this is one of the things I wanted to respond to Tim about -- it's not just about how we consume, although there is a

fair amount of consumption devices opportunities available. But it's also primarily how we work in today's enterprise. We design our products using computer aided design systems. We manufacture them using computer aided manufacturing systems. We manage our supply chains using all these technologies that take costs down and significantly reduce the amount of time, significantly reduce the amount of investment and inventory, significantly increase the flexibility of what we do and the complexity of what we can produce. Transaction processing is enabled by all these and banks, airlines, hospitals, etcetera are able to do much, much more for us in much quicker and cheaper ways. We add it all up using ERP systems, enterprise resource planning systems, that can allow us to know what we've done and report on it. We approach our consumers using what are called CRMs, customer relations management systems. We have business information systems that produce analytics in real time that allow us to analyze and understand and change our behavior very, very quickly to adjust to what's going on in the marketplace, and we see this in the products themselves, whether it's things from cars to airplanes. And lots of things in between.

It's been over a decade since there were more semiconductors than steel in a car. And today there are vastly more and almost all the innovations and the improvement in the products that we see are based upon these two technologies in addition to the new products, not just improving existing products but new technologies like iPads and smartphones. Some people might use their iPads and smartphones primarily for entertainment and

consumption. I use my primarily for work which we can talk about later on.

And the third point I would make is that these technologies in themselves are also hotbeds for innovation. They are continuing to change very rapidly. Dr. Collins was talking earlier today about reference wars where the semiconductor is doubling its processing capability every 18 months. There's something called the aerial density curve which drives the amount of data that can be stored on an area on a disk that's doubling every nine months. So the capacity to store information oftentimes outstrips the information we're able to accumulate to store though in the world of full motion video. That's going to change fundamentally.

And business social scientists study, business professors study these two issues because they liken them to fruit flies where they multiply so rapidly that you can see the evolution happening in front of you. And the interesting thing is that now in our world these two technologies are merging because we're developing solid state technologies for the store of information. So the reason why your iPad is so think is because that storage device in there is a solid state technology, which is a lot thinner than the disk drive technology.

My point is that it just doesn't make sense to someone who is a practitioner to think that the pace of innovation has slowed down when we see the pace of innovation based upon these two technologies merge with computer science communications and technologies hurdling forward at a pace of innovation and a use in the enterprise as opposed to for the consumer unlike we've ever seen before.

MR. GREENSTONE: Thanks. So next we have Tyler Cowen. He's the Harris Chair of Economics at George Mason University and the general director of the Mercado Center. He wrote a very popular book *The Great Stagnation: How America Ate All the Low Hanging Fruit of Modern History, Got Sick, and Will (Unspecified Time Period) Feel Better.*

So, now, Tyler, we just heard a somewhat gloomy picture from Tim that we're just too slow in adopting, our bureaucracy gets in the way. Glenn has a slightly different view that things are hurdling forward and there are tremendous opportunities. And I think you kind of have a third view, which is not taking sides on which of these guys is right but saying hey, the average America isn't really benefitting from a lot of these technologies. Do you want to talk a little bit about that?

MR. COWEN: I see my view as the following: if we look at measures of what economists call total factor productivity, that number has mostly been low since 1973. That is we are innovating at a slower pace. We're relying more on people to work longer hours to get more output. But that said, I am not a pessimist forever and ever. I often think of innovation in terms of general purpose technologies. If you go back you can think of fire and language, electricity, as general purpose technologies. You get one breakthrough and then a lot of other cumulative related breakthroughs follow.

So if you, as I do, see the Internet/computer today as a general purpose technology, you'll actually be fairly optimistic about the medium term future even though the current state of affairs with respect to jobs, wages,

innovation, is fairly weak. What I'd like to do is just talk for a moment about the question of what can we do. When people talk about innovation there's a typical laundry list that everyone goes through. It involves education, intellectual property, more high-skilled immigration. And I'm with the consensus on those issues. But if you do indeed take the view that it matters what we do now, what else can we do in addition to the usual list?

So far there hasn't been much discussion of China and I think China is the elephant in the room. China is capable of being vastly more innovative than it is right now. We're at a funny moment in history where they're wealthy enough to bid up our resource prices, but in most areas they're not quite on the frontier so we're not getting their innovations. So I think basically we should be nice to China.

(Laughter)

Moving China to the frontier will be the most important event. And like many observers, I take China's recent economic success to really be quite fragile. So I would just say if we're talking about innovation, the main story is China, China, China. We're not seeing the gains now. But even in countries like Brazil, which is not typically thought of as an innovator, there are areas where Brazil has been on the frontier. So which countries will get to the frontier most rapidly to me is where I focus.

Politics is very important. I think of the NIH, for instance, as having a very high rate of return. Solving the budget crisis is important for a lot of different reasons that people don't always think about. One of these is that a lot

of the best sides of discretionary spending are politically quite vulnerable. They do not have powerful interest groups defending them. The NIH is an example where if push came to shove, you could imagine cuts being applied to the NIH budget before, say, Medicare. I think we are vastly over-discussing how much we spend on subsidizing demand and coverage and vastly under-discussing how much we treat our research and development to something of importance. If we don't solve the budget crisis in some manner, probably it's the best parts of discretionary spending which will suffer.

I think the NIH example is also important in terms of political science. This is something economists and political science could study. In my view, Congress basically is the big villain in many different issues. When Congress spends money directly on R&D, it doesn't do that great a job. If you're spending money on R&D either during wartime when it's more or less insulated from Congress because of patriotism or if you're working through an institutional structure such as the NIH where there is indirect accountability but not direct answering for individual grants and decisions, that this works quite well. And what we need to do as social scientists is come up with more structures of this kind, things like the Medicare Payments Advisory Board but set it up in a way where it can work and we can actually preserve enough money in the system to be spending on longer term purposes.

Another issue I focus on to a considerable degree is demography. We do need to think long term. Humankind has never in its history had societies which will be as old as the societies which we're getting now and which will

become older with each year. The frightening truth is we don't even actually know if this works. And what I have in mind is the public choice considerations. If you put even more emphasis on elderly voters deciding elections, what will be the decisions made about how money is spent, how long term will these decisions be. So I would like us as a nation to think about what we can do to have more young people. This doesn't just have to be immigration but very, very often it is young or younger people who innovate. And an indirect way of generating more innovation without encountering any of the problems of traditional planning is just to have more young people in the United States. France seems to have done this with some success. What we could do in my view we're not discussing enough but it's directly linked to innovation.

I would endorse the work of Michael Mandel who is sitting here with us on deregulation. I'm very taken with Michael's analogy that regulation is like pebbles in a stream. Any one of the regulations may make sense but if you have too many the pebbles clutter up the stream. And we're thinking about regulation too much in piecemeal terms. Individual cost benefit studies of particular regulations, not realizing that we're cluttering up the stream and we really just need to actually take some more chances.

The other point I'd like to make is the general importance of what I would call culture. It's a very vague word. People use it to mean a lot of different things. But when I look back at human history I see the mid to late 19th century as one of our most innovative times and arguably our very most innovative time. That was the real singularity, the real great transformation, the real Industrial

Revolution. If you go back to that point in time in the U.S. or Western Europe, Central Europe, fewer than 10 percent of the population had even high school degrees, much less college degrees. So in percentage terms, we were remarkably more innovative then than we seem to be now in terms of economic importance of innovation in percentage terms and we had a radically different world. Amateurs were much more important. There are plenty of fields where amateurism simply doesn't work but I think we're still underrating amateurs.

If we look at the areas where we've had major breakthroughs like Facebook, Mark Zuckerberg was an amateur. He's not an amateur anymore but there's something about that piecemeal experimentation, lack of centralized oversight, lack of everyone following the same conventions, lack of intellectual conservatism that we often so find in academia. I think we need to be more sympathetic toward amateurs and also to think about -- I've been reading lately about late 19th century, early 20th century Budapest and the importance of innovations in electrical engineering in Budapest and the surrounding area at that time. Phenomenal successes were generated in terms of electrical transformers that took electricity and made something practical. It's a hard area to learn about but, you know, I keep on reading about it and I actually can't find any good policy decisions behind the success of electrical engineering in late 19th, early 20th century Budapest.

It was something about the culture. Something about what people care about, what people valued, how people competed, what kinds of new ideas were allowed. And you have societies also in Germany, parts of the Austro-Hungarian

Empire that were by our standards dirt poor, dramatically undereducated, had all sorts of things wrong with them, were not democratic by any stretch of the imagination. Yet they had vital cultures that carried innovation a lot more strongly again in percentage terms than what we're doing today.

So I think we need to study these cultures more. What I also see in a lot of case studies, if you go to a place like Cal Tech, very innovative. If you go to the University of Chicago Economics Ph.D. seminar, very innovative. Singapore at the frontier. What I find to be the striking generality, these cultures are not in every way nice. There's actually something a little brutal about them. And I think in some ways we've decided we don't quite want to be as innovative as we say we do. And some of the same issues that come up in Amy Chua's book -- what it actually takes to be innovative, what kinds of egalitarian norms are allowed or not, what kinds of brutalities are involved, to what extent does our current culture actually stimulate innovation in the sense that late 19th century Budapest did. These are what I think social scientists should study much more closely, much more carefully.

MR. GREENSTONE: Excellent. Thank you, Tyler. That was a lot to think about. I was not expecting Budapest to come up.

(Laughter)

But fortunately, we have Aneesh here.

MR. COWEN: That's where I'm going.

MR. GREENSTONE: When I was in the White House, anyone who has served in government knows that there is an endless variety of

meetings, most of which 15 minutes into you're wondering, well, now how did they hang the dust off the ceiling? But that was never --

SPEAKER: Not at my house.

MR. GREENSTONE: -- true when you were in a meeting with Aneesh. And so Aneesh is the United States' chief technology officer, not just that he's the first chief technology officer. And I wondered if you could tell us a little bit about what the administration is thinking about with respect to innovation.

MR. CHOPRA: Well, thank you.

MR. GREENSTONE: Presumably building on the insights from Budapest.

MR. CHOPRA: Yes. I see a lot of material to work with on the discussion panel. Let me begin by saying I'm an eternal optimist and I'm highly bullish on the American innovation ecosystem. So let me just begin with my bias up front.

The president on his first full day in office actually designed the concept of a CTO in challenging us to be a bit more open in how we conduct the affairs of government. He directed the position that I hold now to build on a foundation, if you will, that makes our government more transparent, more participatory, and more collaborative. Now, I say the goal to spur more entrepreneurship and innovation in how we harness the policy levers of Washington to achieve our broad objectives. The intersection of that body of work that was the first part of my assignment with the president's Strategy for American Innovation I think is at the heart of the conversation that we're having

here.

For those of you in the audience who have not seen the president's strategy that was published in September of 2009, it outlined these three roles of government. And I want to highlight briefly on each and then emphasize the third in the role that I play.

The president did speak about the importance of building blocks of innovation. We did talk about research and development. But as we think about infrastructure for the economy -- roadways, railways, and runways which has been the moniker of late -- the president emphasized the importance of digitization in that infrastructure. So you saw in a bipartisan basis in the Commerce Committee just a week and a half ago, a consensus on how to move to the next wave of economic growth on mobile digital infrastructure, that is to get our spectrum policy in order and again, a very bipartisan vote 21 to 4 on the committee, a commitment to digitize our infrastructure focusing on fourth generation wireless.

We unveiled about three weeks ago a policy at the White House on smart grid, which is to think about how to incorporate digitization within the nation's electric grid which, as Secretary Chu alluded to in the event, Edison wouldn't feel all that uncomfortable in the world of today's electric grid. We still have no ability to understand exactly where the outage occurs and why. We haven't harnessed information technology in the grid and we spoke about that in our policy.

The second pillar the president outlined was ensuring we've got

the right conditions that spur entrepreneurship and innovation. And there's a lot of policy discussion around this. Patents are obviously high on the mind given the positive outcomes in the Congress about moving forward on comprehensive patent legislation, but it's also in our case ensuring that the Internet today literally across the continent and Europe and Paris, the OECD is gathering to have a conversation about Internet policy principles and how do we ensure that the multi-stakeholder governance model that has been the heart of the Internet's story remains at the center. And that policy framework that spurs innovation is obviously a critical aspect.

But it's this third dimension that I might emphasize for the conversation here. The president did outline a few areas where we need this proverbial all hands on deck approach to catalyze breakthroughs. He challenged us to think of new and creative ways to bend the health care cost curve to unleash this clean energy economy. And it is in this third aspect of the policy the president outlined on innovation where the intersection of our open government work does provide an opportunity to see results now, not in the decades to come.

And I wanted to highlight a few examples of this to demonstrate how openness and innovation actually can work hand in glove to spur breakthroughs that are productive, not in the consumption domain. We've talked a lot about the nouns of technology -- the iPads, the chips. We want to talk now in this piece on the verbs -- how we can achieve the breakthroughs.

Breakthroughs, I think, start with the new rocket fuel for innovation, and that's data. We do not have an instrument that health care

system -- an instrument that energy, health care, and education systems. You just don't know the results. Wal-Mart can tell you to the T exactly what promotion in this millisecond maximizes commercial transactions. We have no clue. Dr. Collins has talked about breakthroughs in cancer. We do not have a clue in the outpatient clinical cancer environment exactly what the decisions are that are being taken in the health care system every day and what impact it's having. We did not instrument them.

So we have emphasized an openness; both a liberation of data that the government holds in machine and human readable form, as well as through regulation -- Cass will here on the panel later -- to spur through regulatory tools the light touch of regulation that is to spur market transparency. So we can start to get a little bit more instrumentation and productivity gains. Again, you can't be productive if you don't know what you're measuring.

The health, energy, and education stories really speak to the following. We have a long-term vision for digitizing the health care system. You heard a word about that. But we also introduced this concept of blue button. The president in August of last year challenged the Veterans Administration and said, hey, give veterans a copy of their personal health data and I want it done this fall. So in 90 days we went live on a platform called the blue button system. The veterans can now download their personal health data. It's not everything. It's not perfect but it's a start. It's making data liquid at personal privacy conditions and that scaled like wildfire. It happened in the VA, the DOD replicated it. It's now been taken hold in Medicare. Over 300,000 Americans

have downloaded their blue button health data in just like a few months.

And what happened? Two weeks ago the CEO of Aetna, the largest repository of personal health records in the United States, 10 million of them, announced that they would adopt the blue button and make it available to each of their 10 million members. Not to be outdone, the CEO of Walgreen's stood up and said, whoa, hold on a minute. Walgreen's has personal health data, too. We're going to blue button that information. In energy, we just had the smart grid challenge. We said to the utilities, hey, Aneesh Chopra has got a smart meter at his house. I can't get access to my utility energy consumption data and, you know, it's physically like I look at it. It's the box in my house. I can't get the data. We challenged the utilities, hey, can you do this? Three utilities announced that they would publicly make available in machine readable format information on customer energy data. It's not going to be perfect. It's not going to have every variable, you know, Wells vocabulary coded, but they've done it and they're issued a little apps contest to spur developers to help people reduce their energy consumption. It's happening now. Two high school students spoke at that event. They got their high school to adopt a little energy management system. They found out that the air conditioning turned on at 2:00 a.m. in the gym and the school administrator was like, well, I'm not so sure we have kids in the gym at 2:00 a.m. We need to turn on the A/C. Turning it off saved them $30,000, one school. Okay? We're going to do this. We're going to instrument the systems.

And on education, can anybody here tell me whether their child

has truly understood the 135 attributes in the common core for math? Do you know what your kid has figured out and not? You get a letter grade at the end of the year. You know, okay, that's not that instrumental and helpful. If you could liberate that information and allow an apps economy to come in. So we will be productive in the apps economy if we can get the rocket fuel of data out in these sectors that need it. And it is my job to serve as the entrepreneur for the president to make sure our policy conditions encourage that kind of activity. In some cases through regulatory policy, in some cases we might have some legislative engagements. But my bottom line is we are taking on a new role of government that is as inpatient convener. Inpatient convener. A lot of the stuff we're working on doesn't require a lot of new money, doesn't require a lot of new legal constructs. But by inpatient convening, bringing people around the table I think we're going to make great progress and we're going to achieve those productivity gains and put people back to work, I hope, in areas that will deliver tremendous benefits down the road.

MR. GREENSTONE: Aneesh, I can only say I need to start working harder.

MR. CHOPRA: Oh, come on.

MR. GREENSTONE: And I forgot how inadequate I feel next to your bundle of energy.

MR. CHOPRA: No. We're going to get it done.

SPEAKER: He's going to work smarter, not harder.

MR. GREENSTONE: Smarter, that's right.

Thank you. That's an excellent answer. And that's an impressive set of activities that you are undertaking.

So I wanted to bring the group back to one of the facts that I started this discussion with. There's all of this great innovation, the country has been growing since the 1970s at a fairly rapid clip, but it sure seems to be concentrated on a relatively small sector of the population. In fact, as I said, we've seen some parts of the population experience, in fact, substantial parts of the population, experience real wage declines, putting them back, as I said, the level of the wages that they had in the 1950s. All of this innovation, the blue button, Facebook, Budapest, the inefficient health care system, what is that going to do for the average American? Is there anything that policy can do to help improve the income for the average American or their lives?

MR. BRESNAHAN: Growth.

MR. GREENSTONE: Growth.

MR. BRESNAHAN: This idea --

MR. GREENSTONE: But Tim, we've had the growth.

MR. BRESNAHAN: We've had part of the growth. The project of automating work, white collar work in particular, you know, we can't have higher real wages without having automation so that people do more with less. It's just not impossible in long-term growth. And that project of automating white collar work is only very partly a law. You know, I mean, Glenn emphasized how far we've done. I agree with that. Aneesh emphasizes how far we might go. I agree with that. There's still an enormous number of Americans, about a quarter

of Americans, their primary job function is white collar work buying or selling stuff. And these are not exciting jobs. We need to automate white collar work the way we automated blue collar work if we're going to be a substantially richer society and that's still a bit project with a lot of bottlenecks. It'll take a while.

MR. GREENSTONE: Go ahead.

MR. CHOPRA: Just very quickly. This is a difficult problem but my emphasis is on how we can make jobs at the entrepreneurship level as much as get people to apply for jobs. And I say that because, you know, in Southside Virginia we've lost an enormous amount of jobs in textiles and other manufactured products, in future, that have moved overseas. Yet you meet entrepreneurs down there who tell you, hey, you know what, Aneesh? I jump online. I can now become a textile designer so in my pajamas proverbially I can help people actually design new products, new shirts and so forth, make money as a result, and actually take advantage of the expertise that I have and they'll connect that in a broader way.

I saw this in India. I went with the president in India. Farmers are using cell phones to text message their water sprinklers, like, you know, acres down the road to turn on and off. And they're becoming a heck of a lot more productive with pricing transparency and so forth to take advantage of inefficiencies and arbitrage in the market.

So if they can do it to be more productive in the sectors of the economy that you don't normally think of as being Facebook users -- I don't know if that farmer uses Facebook. I doubt it. But they're harnessing the power of

technology to improve the lives for their own work. I want to do more. I can't quite crack this code to get Main Street jobs harnessing this. You're starting to see this with social and mobile in the combination where restaurants are finding ways to optimize that extra seat that's empty in their store by harnessing the kind of daily deal, the couponing, the real time information sharing. So they're starting to see this in Main Street but we need to do a heck of a lot more.

MR. HUTCHINS: As the other Hamilton Project person on this panel I want to refocus on this question and just ask because I think Bob will disagree with me that it's one of the key things we've tried to explore over the last several years we've done this, which is how can we share the benefits of growth exclusively? Extensively? How can we have inclusive growth? Because one of the problems we have had in our society is not just the stagnation of wages but also the fact that it has become increasingly a winner take all society as the people who are able to compete around the world in the information society prosper enormously in this country and others haven't and how we can create opportunity for that group is a very, very important thing.

I do not think that's about innovation myself. Innovation can be a very important part of that but I think two other things at least are going on. One is that we tend to look back on the 50s as sort of the norm and we compare things to the 50s as you just did. Right? And I wonder if that wasn't the abnormal period because the economic competitors we had around the country -- around the world -- were laying in ruins at the end of the war and large amounts of the labor force were withdrawn from international competition as a result of the

Iron Curtain and similar kind of policies in India. And so we're living through a time period of the equalization of sort of lifestyles in what might unfortunately be more of a norm than an abnormal time period. Do you see what I mean? That's kind of point one. I think we need to think about that.

And that gets me to point two, which is that it is -- how do we -- we have to think about breakthrough strategies for how we can put more Americans to work in an economy the way it is. I think there are two kinds of ways of doing that. One is long-term strategies according to what we've all talked about, which is education, research, infrastructure. All those sort of things. Unfortunately, that takes a very long time period to have impact. The one thing we can do quickly that would have an immediate impact is reform the immigration system.

But I think the other way, the other thing to think about here and something which I've been fooling around with, Andy Grove wrote an article about -- he challenged the economists; that's you guys, not me -- to think about education-centered means of economic theory. So if you think very broadly about our tax system in this country, just to give you one example, we tax advantage housing and health care and we have too much of it. Right? We do not tax advantage education. We have too little of that. And we tax penalize work and we have far too little on that.

If we, as an example, as an employer, we have some several hundred thousand people around the world in our employ, whenever we hire someone in the United States you take the wage and you multiply it times 1.3 to 1.4 to understand what it's going to cost. If you hire somebody in India or China

you take the wage and you multiply it maybe times 1.05 to figure out what it's going to cost you. That .25, that 25 percent of the cost of work is if you decompose it. And I can show somebody the details if you like. Very little bit of it is state and federal taxes. Most of it is a whole bunch of things we place on the cost of employment to fund our social safety net, whether it's FICA or workers' comp or unemployment. Whatever it might be. Social security, unemployment, just all the stuff that gets layered on top.

One example of something we can do that would be very big in my view is to take all that off the cost of employment and fund that with something like a consumption tax. Right? So you automatically reduce the cost of employment in the United States, if you could wave a wand, by something like 20 to 25 percent and make us immediately change the competitive dynamic.

And secondly, you would tax advantage work and tax disadvantage consumption which might be good for us. And the third thing you would do is since consumption taxes are not a WTO violation you could fundamentally change the terms of trade and advantage domestic production versus imports. But I think that's the sort of thing we have to think about because we have a system that's set up for a time period that was kind of abnormal when America was at the apogee of the world competitively. And now that we have to compete on a much more even playing field around the world, we have to think very fundamentally how we restructure the system.

Innovation can be a very, very important part of that but it has to work hand in hand with these large-scale kind of government policies and

fundamentally, maybe innovative government policy, to think about how we do things very differently.

MR. GREENSTONE: Thank you.

On your point about consumption taxes I fear that you've been spending too much time with economists.

MR. HUTCHINS: I don't think you can spend too much time with economists.

MR. GREENSTONE: I feel the same but not everyone agrees with you, Glenn.

SPEAKER: You've got the cards.

MR. GREENSTONE: Yes. So we're going to start passing out cards. I was -- as I was drinking coffee this morning I was flipping through the New York Times and ran across an op-ed from Roger Cohen who wrote today, "America needs an energy policy and an industrial policy. It has to lead in green technology and purist capitalist reflex is not withstanding. It must find ways to get corporate America in a national revival."

Tim, I wonder if you would be willing to talk a little bit about that.

MR. BRESNAHAN: Sure.

MR. GREENSTONE: Because it's a very popular view and I think lots of people think that green jobs are the future.

MR. BRESNAHAN: I think green jobs have a tremendously important role in U.S. growth. I'm extremely troubled by the idea of trying to achieve them through an industrial policy as opposed to by a demand side policy

that creates a tremendous demand for green stuff. I mean, I would take Glenn's suggestion, you know, if you're looking for a dramatically welfare and growth increasing policy change stop taxing the wages of poor people which is what all the entitlement systems do. Stop taxing the capital of rich people. I'm going to be entitling both parties here. You know, and put, you know, a three or four percent of GDP tax on carbon. You know, it's got to be better the first day on an optimal tax basis and it has this other enormous regulatory advantage. Rather than trying to pick the -- rather than having the government or the science establishment or any other central authority trying to pick the route to a green future and green jobs, you know, it lets the private economy do that. There's still, of course, a role for government in the fundamental science but the direction of commercialization I think would go much better with incentives than it would with an industrial policy.

MR. CHOPRA: Just look at open innovation to this question. I embody the principles of the Internet, which is rough consensus running code in how I think about these issues. So what is the rough consensus running code? Yes, there's a big debate about industrial policy or not. But let's take solar. Okay? Right now the sort of technological innovation curve suggests that the costs of solar are precipitously following and it could very well reach parody with grid -- with the current grid. The challenge though -- this is ironic -- one of the pieces of the solar equation that has not moved an inch is the overhead on permitting. So if you literally wanted to install solar panels on your home, the collective cost in the American economy is about a billion dollar hidden tax on

delays, inefficiencies, headaches, what we call the soft costs of solar.

Now, I don't call this industrial policy. I wouldn't want to get into big macro views. I'll let others have that debate. But I can tell you what I am pushing. The energy department put out a little Race to the Top competition. We want 25 cities who will commit. We'll give them a little bit of seed money. Dramatically lower the costs of solar permitting. Maybe it's same day if we get it right. And if we can tackle soft costs while the technological curve is coming down it may very well be that it will be absolutely in our economic interests. And from a financial standpoint, cost effective to deploy solar in a much larger scale.

Now, is that industrial policy if we cut red tape? I don't know. That's a much bigger question. I'm just telling you rough consensus running code. Soft costs, let's tackle them. The Energy Department has got a grant on the street. We're going to build the technology. We're going to engage collaboratively. We're going to make progress while we have this metaphysical debate about, you know, industrial, not industrial. Let's just, boom, we're going to tackle these things as I see it.

MR. BRESNAHAN: There's a ton of other local venues policies which are in the way of an effective transition to a greener economy. Where people live. Where people work. And again, I would say, you know, first -- I would say the first significant digit, get the incentives right to minimize cost on that. Second, we have to worry very seriously if we want people to live much closer to where they work. And, you know, okay. How are they going to get there? That's going to involve a transition.

MR. CHOPRA: Side bar on this. Two week ago we had a little celebration in the White House for like regular folks who were doing really cool things with open data. And this mom in San Francisco said, believe it or not, she's a commercial real estate person. This zooming data he's describing is completely opaque. You cannot get zoning data in any open, transparent way. So she literally went to the City of San Francisco and said I'd like to make transparent zoning. So she launched an app called Zonability. And this thing is scaling city after city. So, you know, you're right but let's start with what we can do. Let's celebrate the young lady who is building Zonability and inspire her to get that data out so we can be more transparent I making these decisions.

MR. COWEN: I agree with Tim on carbon and green jobs, but I would frame it more pessimistically.

(Laughter)

MR. COWEN: All those expenditures, they're not really a source of growth. They're a battle we have to fight to hold even. We would be very lucky if green energy were as cheap in the direct dollar sense as what we're spending now. So it's one big reason to be pessimistic that either what we must do proactively or what we must do retroactively to repair the damage will be a significant cost. And green jobs are not a benefit. Switching to new green energy, it's just a defensive maneuver that we need to perform. And on top of all of that, if we succeed in it, which at the moment does not look entirely likely and other countries do not follow our path fairly quickly, we still have essentially lost that one.

So if you're drawing up a kind of consolidated national income account of resources and innovation and you take the environment into account, when those costs really first start to bite we don't yet realize how grim that picture looks. And that's one reason to be pessimistic.

MR. GREENSTONE: So let me be an optimist for a moment.

MR. BRESNAHAN: Yeah, actually, before you do, let me just add one thing.

MR. GREENSTONE: This is an expert in this field, by the way. I was going to ask you to say something. Go ahead.

MR. BRESNAHAN: I think one thing to add is the current way we're accounting for the costs of most energy sources is not taking account (inaudible).

MR. COWEN: Absolutely.

MR. BRESNAHAN: And so I think the statement that the green energy sources would not have some improvement in productivity, I think that's not quite right.

MR. COWEN: But most of the environmental costs are coming in the future. So relative --

MR. BRESNAHAN: No, a lot of them are coming now.

MR. COWEN: Some starting.

MR. HUTCHINS: There's a very good Hamilton Project paper on this subject, by the way, which I would recommend everybody --

SPEAKER: So after that commercial --

MR. GREENSTONE: We can have the little economist cat fight. Go ahead.

MR. HUTCHINS: I would make a couple of points.

MR. GREENSTONE: Rise above the muck here.

MR. HUTCHINS: I'm just going to -- actually, I like it down in the muck.

The couple points I make. One is that if you look back over the course of American history it has taken about 30 to 50 years to transition from one source of energy to another, from wood with maybe a little bit of whale oil to coal and then to oil and gas. And that's because the system that produces, transmits, distributes and generates and uses electricity is very complex, very capital intensive, and takes a very long time to change. So point one is nothing is going to happen very, very quickly in changing the feedstock that we use. It's just not going to. And we can talk about that if you want.

Secondly, there's nothing that suggests -- yeah, I think the things that Dr. Belcher talked about today were really interesting, fascinating. I'm going to get an abalone shell and take it home and show it to my child. I think that's a really cool way to think about the world. And so those inventions are going to drive a lot. But we haven't yet seen anything anywhere near like Moore's law that drives in the energy field the kind of efficiencies that are startling to us and life changing in IT. I hope we do. We haven't found that yet.

So where does that lead you? Today as sort of a practical crusty capitalist, if you look today at the net present value of the underlying economic

transaction in the energy world -- in other words, if I can give something to a consumer today and it provides benefit for him or her today, the product or service that I give you is beneficial to you today based upon -- and I can make money selling it to you -- disproportionately that today is in conservation and efficiency. There's a huge amount that we can do today investing and using less fuel and that works today. There are a whole bunch of behavioral reasons why we haven't got it. There's a whole bunch of systemic reasons why we're not doing it. And there's a whole bunch of financing reasons why we cannot do it. But there is a massive amount that we can do just today to use less while we're creating the conditions to use something different. And that's where I think I see a huge amount of investment dollars going and where I would suggest a lot of public policy be focused on as well.

MR. GREENSTONE: Thank you. So we now turn to -- time for a couple questions from the floor.

And the first question is in order to encourage long-term growth it is generally agreed that more Americans need to get higher education. And in fact, the Hamilton Project just recently released a paper showing that the rate of return to getting a college degree is about 15 percent currently, which dwarfs the rate of return that you can get for most other conventional investments. But the specific question is --

SPEAKER: Maybe yours.

MR. GREENSTONE: Be nice.

What opportunities exist for using technology innovation to make

higher education more efficient?

MR. CHOPRA: Well, it's a major thrust of interest for me. The administration is very committed to finding ways to do this. And I would answer it in three parts. Again, let's start with data. There's been a lot of debate about the gainful employment rule that was recently issued but what that is going to do for the American educational system is create unprecedented transparency and outcomes. No two educational systems are equal in terms of the degree to which you invest and get a return. And so understanding what is best for you equivalent of an idea like students like me. If I want to look at others who look like me, have my background, my skill set, which higher educational choice did they take to maximize their results? That kind of information today we don't allow us to instrument. We don't have a good sense for that. So one, I think we're going to see more data that's going to improve our ability.

Number two, we really have this sort of policy environment today that emphasizes seat time. You know, you're physically in a course for a semester or two and you get the process going. We haven't really shifted to the one of mastery, that is the degree to which you actually can demonstrate competence or effectiveness on this particular subject matter. If you do it sooner than later, so be it. That's a factor in innovation and efficiency that I think would be critical.

And then third, we don't have the kind of R&D engine in education at large. The educational market in the U.S. is roughly the same as the size of the U.S. pharmaceutical sector. Dr. Collins, you would probably suggest the

pharmaceutical industry spends 15 percent or so of net revenue on R&D. We are at -- guess. Guess, anybody here? Anybody want to know what the rate of R&D is in educational approaches or technologies? That's right. It's less than .1 percent. And just to give you a sample of how this works.

I'm not saying this is the end all, be all but I just want to give you an example. I did travel to the Los Altos School District where the Khan Academy is put to use in the fifth grade. And I met a fifth grade kid who has completed all of the lectures and the exams all the way up and through calculus. Okay? And I asked the kid what happened. He said I was so enamored with the videos I would spend three hours a night at home watching the videos and taking the exams and learning and learning and learning. So the kid -- I didn't know the kid was like the son of two, you know, Dr. Summers or some other genius to know that, like, you know, the kid has some sort of human capacity. But a combination of Lander and Summers. You know, I don't know how that would work but the brainpower in that room, I don't know how that would work.

(Laughter)

SPEAKER: Let's not go there.

MR. CHOPRA: Okay. We're not going there.

SPEAKER: Do not do that.

MR. CHOPRA: But the point is -- the point is the kid did it on his time.

SPEAKER: That would definitely be a unique kid.

MR. CHOPRA: That would be a unique kid. So if you just look at

these enabling infrastructures for innovation in schools, it's one thing to say can we subsidize through Pell Grants and others, and that's a debate people have, political or what have you. But from a technological innovation standpoint, it starts with data, getting the right shift and curve and thinking about mastery over seat time and then having the R&D engine focus on this as an area of interest. That's where we're focused in the administration.

MR. COWEN: Higher ed treats the Internet as an add-on. E-mail your professor, watch a lecture on YouTube. That's great. The key use for higher ed to be organized or on the Internet at its very center. And this is a classic case of how long it takes change to come, why technological lags are so daunting, usually much longer than we think. The notion of taking a modern college or university and reorganizing the entire thing around the Internet given faculty opposition, deans' entrenched interests, lack of accountability, not involved parents, a lot of students who don't care and 20 other problems which I could talk about for days, we're a very long ways away from doing it. But it's a very good model of why innovation can be slow. We treat first breakthroughs as add-ons rather than centers to build around.

MR. GREENSTONE: Can I just follow up on that? Are you implying that I would not be needed to provide lectures anymore?

(Laughter)

SPEAKER: No, you'd have to answer the questions.

MR. COWEN: Many of us would still be needed; some of us would not. That's right.

(Laughter)

SPEAKER: Cryptic.

MR. GREENSTONE: I'm most concerned about one thing.

MR. BRESNAHAN: So let me join Aneesh in fighting the question which was about higher education and say that -- you know, I would say for inclusive, long-run growth, our much bigger problem is K-12 education and automation of K-12 education. Higher education, I think the cost bottleneck in my job is that I don't do any of the functions that were just described. There's an infinitely cheaper technology than either a video or me for transmitting information. That's a book. I don't transmit information. I motivate people to learn information and on a good day to think for themselves. And we have had a terrible time automating that.

MR. HUTCHINS: So I wonder if not -- we've been thinking a lot about this education issue -- I wonder if not we have a cultural problem. In other words, if we want to improve our education system we first need to look in the mirror and make sure we're doing what we can do. I was exposed to some research recently that suggested -- it's just being developed but suggested if you look at the path of societies that are innovative and then wealthy and successful, what you see is that as they reach their pinnacle of success they then take off in their kids' participation in math and science and it's kind of happened in America and then it happened in Japan, then it happened in Korea and Singapore, and apparently now it's beginning to happen in China where the leaders of China are all engineers and their kids are studying humanities and social sciences. I don't

know if that's true or not but we need -- this is a piece of research I was exposed to recently that claims that this is the case.

And so what we need to do as parents and citizens in our communities is emphasize every day to our kids and their teachers that we need our kids to study the stem disciplines. The little town I live in, they raised a million and a half dollars for the local high school. Not for labs, not for teachers, but for lights and turf on the football field. And so I think what we need to do, one of the things that we have to reinvent if we're going to have another layer of -- another surge of prosperity in the United States is our commitment in our households and our communities to math and science education for our children.

MR. GREENSTONE: Glenn, thank you very much.

I think that is a good way to end our panel discussion. I want to thank -- if everyone could join me in thanking Tim, Aneesh, Glenn, and Tyler.

(Applause)

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

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