THE BROOKINGS INSTITUTION

A HAMILTON PROJECT
AND BROOKINGS INSTITUTION FORUM:
PROMOTING OPPORTUNITY AND GROWTH
THROUGH SCIENCE, TECHNOLOGY, AND INNOVATION

11:15 A.M. – MEETING THE NATION'S INNOVATION CHALLENGE:
A HAMILTON PROJECT DISCUSSION

MODERATOR:

GLENN HUTCHINS, SILVER LAKE PARTNERS

PANELISTS:

WILLIAM R. BRODY, JOHNS HOPKINS UNIVERSITY

MICHAEL CAPELLAS,
FORMER CEO OF MCI AND COMPAQ

ROBERT E. RUBIN, CITIGROUP INC.

LAWRENCE H. SUMMERS, HARVARD UNIVERSITY

HAROLD VARMUS,
MEMORIAL SLOAN-KETTERING CANCER CENTER,
1989 NOBEL PRIZE FOR MEDICINE

Transcript by:
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GLENN HUTCHINS: Good morning and welcome to the Hamilton Project. My name is Glenn Hutchins. I'm going to moderate this panel today. As I was preparing my remarks, I thought to myself that – I looked around the table, looked around the group here, and I thought to myself this is perhaps the greatest gathering of intellect in Washington since Alexander Hamilton dined alone. But what I would like to do is to introduce our panelists today in rough reverse order of their speaking. I say rough reverse order because if you know some of these people, you can't really control them, so we'll do our best to have an order.

Bob Rubin, to my far left here, has many accomplishments that all of you know about, so I won't repeat them. But in the context of this gathering Bob is the creator and animating force of the Hamilton Project at a time in his career with his many accomplishments when he could be well expected to do withdraw to a life of self-interest and perhaps self-regard. He's out there – (laughter) – intellectually involved in the debate.

He's organized us. We're involved in the Hamilton project around a very simple question of how do we generate prosperity which can be shared broadly in our country, which I personally think about it is how do we make good on some of the generational promise of leaving this country better off for the people who come after us than we got it from our parents. And Bob has, I think, been just a terrific, vital force in getting the Hamilton Project to where it is today.

Larry Summers, on my right here, who actually made it, was engaged in the just-in-time arrival policies, has another career that doesn't need repeating. My favorite line about Larry, though, was at one of his birthday parties someone proclaimed him to be the youngest man ever to reach 40. (Laughter.) I'm told, I'm instructed by Larry, of course, that the right word to use to describe Larry is provocative, but I think I want to use for this introduction the term visionary.

I've had the opportunity in the last several years to look up closely at what Larry accomplished in Harvard and I believe that if 50 years from now Harvard is a vital research institution and a world leader in the sciences and innovation, it will be largely because of Larry's strategic vision and his willingness to catalyze change – perhaps wrenching change, but to catalyze change. So, Larry, welcome and we're very much looking forward to what you have to say today.

To my left is another acquaintance of mine, Michael Capellas. Michael is known for his accomplishments as chief executive of officer of Compaq, and later nearby to here MCI. Is this still working? There we go. He has a unique position if you look around the world of technology companies where I operate, being one of the few leaders of

technology companies who comes not from sales and marketing or finance, but actually from technology.

He's well known as a technological visionary and a person who has an ability to take technological visions and put them into the kind of products and services that all of us use everyday to make our lives more robust and fulfilling. I want to focus on one piece of Michael's accomplishments I think are truly unique – I think not particularly well understood because of his modest approach.

But Michael took over the chief executive of MCI, previously known as WorldCom, when it was in bankruptcy. It was the subject of the greatest fraud – corporate fraud in America. Its competitors and their associated politicians were determined to exterminate the company. And in what was perhaps I think the greatest act of corporate revival I've ever experienced or heard about, he stabilized, revived the company. He saved a whole host of jobs in the process.

He revived the company around a set of new technologically based products and services that allowed it to compete in a time period where the industry itself was in free fall. He merged it into Verizon, where it's an important part of one of our leading technological service organizations today. I think that Lee Iacocca would deserve to be awed and secretly envious of Michael's accomplishments. There.

To my right at the end is Harold Varmus, president and CEO of Memorial Sloan-Kettering. Previously to that, he was director of the NIH, which he served through virtually the entire Clinton administration – not the entire administration. He received a Nobel Prize in the genetic basis of cancer. I showed my 17-year-old the résumés of all the people who I was on the stage with tonight this morning, and he looked at Harold's résumé and said, "Dad, what are you doing there?" (Laughter.) He began his academic career –

MR. RUBIN: Not a bad question. (Laughter.)

MR. HUTCHINS: He began his career – and I think of Bob as a friend.

He began his academic career as a concentrator in English Literature. He also has a graduate degree. But he started his scientific training as a public health service officer at the NIH, and he still spends – even though he's leading one of our leading research organizations in the country, he still spends about a third of his time in the laboratory doing basic research, I believe on lung cancer. Is that correct? And his research work and leadership of some of our most important science organizations I think puts him in the pantheon of American scientists, and we're very pleased to have you with us today. Harold, thank you for making the trip here.

And finally to my right, a person I don't need to introduce – Bill Brody, who is in fact our host – should be doing the introductions – the president of Johns Hopkins. Like Harold, he's a great figure in research and innovation in America, in particular the field

of medical imaging. He's also been a pioneer and innovator in translating basic research into practical commercial uses as the founder of several small companies – and actually they got to be bigger companies, and the CEO of one. So he has both a research and the practical experience bridging the two sides. I think it's terrific to have you here.

And as most college presidents today has also become – had to develop a fundraising skill and got a very substantial gift to Hopkins announced yesterday, so congratulations on that. In the spirit of what my sno said I was reading a book review about the Gettysburg Address last night, and I just want to finish this by saying what my role here is. Apparently the Steubenville Weekly Herald in reporting the events of Gettysburg said President Lincoln was there, too. (Laughter.) So you can just conclude in this panel Glenn Hutchins was there, too.

Bill, start by addressing the key -- the question of the day to you is as we consider the question before this panel, which is "Meeting our Nation's Innovation Challenge," perhaps you can share with us what your thought about the challenges. What is our greatest challenge? And if you could pick one most important policy response, what would you recommend?

WILLIAM BRODY: Thank you, Glenn. It doesn't feel like it's on. Hello, now it's on. There – you just have to grab it the right way. First of all, I'm delighted to be here and delighted to host this wonderful gathering and trying to say something intelligent. I asked my wife what I should say, and she said, well, don't try to be witty, don't try to be profound, don't try to say anything really important. She said, just be yourself. (Laughter.)

Anyway, I start off by saying people always talk about technology transfer. Bill, you know, why didn't your university do more technology transfer? And someone – and I don't know who, although I heard the quote from Chuck Vest, former president of MIT – the best vehicle for technology transfer is the moving van because technology transfer is not about patents and licenses and a specific piece of technology, it's about the know-how and the creativity that goes with students who are working on research projects at the cutting edge.

And so the question is what do we do about our talent? Do we have enough science and engineering talent in the U.S.? It's amazing that we actually debate this question, but we do debate it. The U.S. is 5 percent of the world's population. For decades we were probably 50 percent or more of the world's supply of scientific and engineering talent and innovation, but now with the entry of India and China and many other countries, we will at best be 10 percent of a large pool of countries that are going to be competing in the same sphere that we are, the science and technology and innovation sphere.

In 1960, we had one out of six college graduates - got their degree in science or engineering. In 2000, it's one of ten. So we've had a 50 percent decline. It's curious, we've also had a similar decline in federal R&D funding, which peaked in 1966 as a

fraction of GDP. So maybe there is some correlation between those two as the previous speakers suggested in the first session.

I just like to say, you know, to those who say look, it's not a problem, we can compete, we can depend on foreign talent, but the fact is the foreign talent may go away. Our government is not always providing the right policies. In fact we ought to staple a green card to every foreign student. We should staple a green card to every foreign student who gets an advanced degree in science or engineering in the United States. Probably I'd even consider some payback time so they actually stay in the United States. Right now we encourage them to go back home. So if you want a job here, you have to go home in order to get a green card.

But I'd just like to point out a couple of things. My son is a software engineer, he's been with two startups and in between that time he was with IBM. And in every case he's been almost the only American-born software engineer. In the two startups and in the IBM case, much of the development team was abroad in Asia, but those in the U.S. also came on an H1 visa. He led a product development team. He was the only one in the U.S. who didn't come on an H1 visa, and the rest of the team was in India.

So it does make a difference, because as you know that talent increasingly stays in India or China or goes back to India or China, the jobs are going to go there, and the companies are going to go there, and ultimately the technology is going to go there. Some of that we can't prevent. But there's another aspect of this, and our defense industry critically depends on talent that can get a top secret security clearance, and that means we have to have more American born students coming through the pipeline.

So as I look at this problem, I think there're sort of three aspects. There's a short-term problem, a short-term solution, an intermediate solution, a long-term solution. The short term is to focus on immigration policy, making sure that it's attractive for foreign students to come, because irrespective of what we do with training American-born students and increasing the pipeline, we are always going to be dependent on foreign talent.

As you know, there's only about a third of the jobs that are available in science and engineering are filled by U.S. graduates of American schools of science and engineering. So we depend on that talent, and those jobs are going to be growing in the U.S. I won't speak more about immigration policy except to say that there's been a lot of improvement post-9/11. This year I think the State Department will issue a record number of visas to students in Asia to come to study. But we still have issues making it attractive for them both to come and to stay and to work in our companies.

I think the intermediate solution was talked about this morning, which is providing more fellowships to incent American students to study science, math and engineering. And the longer term issue is to try to reverse some of the pipeline issues which really gets into science and math teaching in the lower schools. And I have no profound suggestions for any of this except the one thing I would say is if you look at the

issue in our schools, there are manifold problems with our school system, but one of the problems in science and math is there's a lack of qualified teachers who have training in science and math.

And if you have to say where are the people who are trained in science and math who could help out the schools, they're in the probably half of the 4,000 colleges and universities in the United States, both at the student level and at the faculty level. And I think we should find ways with very modest incentives of getting universities like my own, which we are currently doing, more engaged and involved in science and math teacher training and science and math education directly in the public school system. That would be my one addition to this recommendation.

MR. HUTCHINS: Thank you. Harold, would you like to go next, please?

HAROLD VARMUS: Sure. Thank you, Glenn. Is this working properly? I'd like to spend just a couple of minutes talking about what is undoubtedly the biggest single problem in the minds of most scientists in this country, and that is simply money. What worries scientists? Scientists think about the budgets to support them and support their laboratory activities, and it's very clear in the current era in this country that we lack a rational, bipartisan plan for funding science at a level that's appropriate to the importance of science and technology in our society.

Overall, funding of science and technology by the federal government really hasn't changed very much over the last 30 or 40 years, and yet the increasing role that science and technology play in our lives is manifest to all. The issues that affect the scientists in the trenches can be seen in two categories: on the one hand, in the physical sciences there is a legitimate complaint of chronic underfunding without any relief over the last 20 or 30 years.

In the biomedical sciences, in which I and Bill work, the issues are somewhat different. The dollar value has been high, but we've been subjected to a rollercoaster effect of dramatic increases followed by current declines that have dramatic impact on the success rates of grant applicants, and we can go into that technicality in more detail. I think everyone in this audience realizes that over the last 50 years the support of sciences ended up in the hands largely of the federal government, with additional support from philanthropy and sometimes the states and industry, but the major funder is the federal government.

And the consequences of inadequate funding of science, or inappropriate levels or funding, or disproportionate distribution of money can be felt in a variety of ways. At least five come to mind. One is on the nation's ability to innovate: a story that's been very well told in the "Gathering Storm", a report by Norman Augustine and his colleagues that was issued by the Academy last year and mentioned earlier in today's session.

Secondly, the effect on jobs. I think it's sometimes underappreciated that the investment the federal government makes in science has a major impact on employment. There are literally hundreds of thousands of people who are working directly or indirectly as a consequence of, for example, NIH funding; the NIH budget being roughly 27 billion dollars at the moment.

The effect on education is direct in that all of our institutions – mine in New York, Bill's here – receive in the range of hundreds of millions of dollars every year from the federal government to support research and training. The effect is felt on recruitment to science. Young people are responsive to trends, and when they see either inadequate levels of funding or sudden declines in funding, they see those as signals that the federal government – the country doesn't support science. And then this affects our ability to compete with rising economies in Europe and Asia when the perception is that science is a declining activity in the U.S.

Now, solutions to this are not readily at hand, but let me just say a couple of things about some topics that maybe we should give a little more thought to. The first and most perennial suggestion is one that's probably inherently impractical given the way in which our government works; namely, to try to establish a long-term plan for appropriations. The problem simply at the NIH is that the NIH gives out multiyear awards, but gets one-year appropriations, and the consequence is that when funding suddenly stalls or declines, that the NIH is committed to grantees who have been given money in previous years.

Nevertheless, appropriators like to give out money every year. They like to have control over budgets. The idea that there will be a long term commitment to appropriations in the future, given the fact that we have elections every two years – pretty unlikely. There've been repeated suggestions that we ask the administration – the party that holds the power in the White House – to put together a multiyear plan that would allow agencies to know where they're going to be on the funding field. Well, that's also difficult. Many of us who run agencies know that there's an inherent reluctance to turn over authority to someone who happens to sit in the White House Office of Science and Technology Policy, and the appropriators don't like that much, either.

One thing that strikes me as an important thing for those of us in the scientific community to do is to become more effective advocates. That means not just appearing ourselves in congressional offices to argue for the importance of science and technology in the country, but also engaging others who have a vested interest in the importance of science and technology. That includes the constituencies in industry, people who are health advocates, people who are in the educational professions to make clear to members of Congress how important it is to sustain a sensible policy for S&T funding.

Making better use of the auxiliary sources of funding, whether it be philanthropy or industrials' donations, provision of tax incentives for either industry or private individuals to give to scientific enterprise seems like a useful idea. The states have become increasingly involved in funding of research, especially as a consequence of

federal prohibitions on stem cell funding. I have concerns about this because it creates an uneven playing field across the country; it creates the sense that the federal government can give up its responsibilities. So I'm worried about that, but it is an additional source of funding we're thinking about.

I do think that some of the innovations you heard about this morning, including prizes and advanced commitments, have virtue. Getting foundations involved in science funding in directed ways that are unmet in the federal government can be quite important. I've been involved myself in the initiative by the Gates Foundation to support research on diseases that disproportionably affect the underdeveloped world, the grand challenges in global health being one example. And that's a very effective way to put more money into the scientific enterprise.

I believe career awards are increasingly important to provide some stability to funding. And building consortia of institutions to create more stability in the funding of science is also important. And I'd be happy to discuss some of these ideas and others later in the discussion.

Thank you.

MR. HUTCHINS: That's terrific, Harold. Thank you very much. Michael, maybe I can ask you to switch the topic to research and development, spending and innovation at the corporate level.

MICHAEL CAPELLAS: Thank you, Glenn. I'll speak a little bit on two subjects. One is sort of a status or a little bit of a report card on spending particularly at large corporations. And the second one is to spend a little time on my secondary passion. I've been a computer scientist all my life, and still take great personal interest in it. So my first comment –

MR. HUTCHINS: Can you – is that working?

MR. CAPELLAS: Better? Is that better? There we go. All right.

So my first comment is I would say on the surface one would conclude that research and development spending at their corporate level is relatively healthy. This year is projected on a global basis to exceed $1 trillion for the first time. In 1980 in the industrialized countries R&D was roughly 1.5 percent of GDP. This year it is projected to be about 2.2 [percent].

Of the largest firms generated as the top 12 category leaders, research and development actually will go up 10 percent, which is fairly healthy on an overall 9 percent increase in revenues. And roughly about 7.7 percent of revenue for the largest high-tech companies, which is actually not bad. Fascinatingly, the range goes from 1 percent to 16 percent – clustered around 13 or 14. Of the top 12 companies, 10 of them have consistently increased R&D over the last four years. So on the surface, not bad.

An interesting statistics I only found out in preparing for this is that however if you look at how those companies are valuated, as scientists we would call it a random number generator, with evaluations of companies being valued at the lowest of nine times annual R&D spending to a high of 250. Okay? Survey says – anybody want to guess who that company is? Got a guess? It's got to be Google. It's got to be Google.

I think you also have to think not only just in the spending on the raw numbers, but the basic nature of the work is also changing a great deal. One looks at, if one compares the 1980 for a high-tech, the product lifecycle would probably have decreased by 50 percent. At the same token, the speed of new product development annually probably improves about 20 percent per year and has for the last few years, so huge change. Virtually everybody has commercialized metrics on go to market, but the real driver has been the adoption at the consumer level. A couple of sort of interesting numbers: 8.1 million iPods were shipped last quarter. Verizon sold 1.9 million new wireless devices, and I call them new wireless devices, and of that about 90 percent – there was a 90 percent increase in wireless data over the web. So we're all consumers, we understand that. I personally bought three of each. (Laughter.) Only because my wife puts a stop there.

And one does think as one practically thinks about this, we now take our cellular phone, which is also an mp3 player, we stream video over it, we probably have some music that plays on, and certainly we pick up our news there. And I actually gave a real time demo on the way in this morning, which is why somebody's cell phone rang with baby girl this morning on the front row. (Laughter.)

So what's the moral of the story? The moral of the story is sort of – at a basic level one would conclude that research and development is fairy healthy, and we certainly can't say that the pace of innovation has slowed in any way. I buy that. But I think we also need to change the terminology. I don't think it's research and development anymore; I think it is innovation versus invention. And I would argue that innovation is indeed live and healthy, and invention may be quite another matter.

The good news is we know that we have to think about it differently because we've changed our methods: the world thinks iteratively. We have all kinds of new sort of methods of invention. We used to think in waterfall, which was sequence by sequence by sequence. We've now learned that we can do things iteratively. We've learned that we could use techniques like follow the sun, which is while you're working in the U.S. and Asia's sleeping, and Asia comes back on they pick up the project. And so the times have indeed changed. But in fact what's breaking down is we I don't think any longer look to big corporations for the real source of invention. And that's because the time scales and the risk rewards of how they're valued have simply changed.

The secondary one is if you think about the really great inventions of the past couple of cycles, visualization came out of a collaboration between geophysics and parallel computing. And it was people who traditionally didn't work together working

together. The great story of the sequencing of the human genome only happened after we put together mathematicians who knew how to write algorithms, computer scientists who could actually build a better model for faster computation, and biological experts in the domain. Unfortunately, most of those people usually don't sit in the same places, and it wasn't U.S. commercialization that brought it together.

So my sort of conclusion here is that innovation is absolutely alive and well. Things are changing. There is no question that innovation will continue, but we're going to have to think about some new models with some government intervention to think about how we really keep invention alive. My final comments will be on sort of the globalization question, and I'll start over this from a line I sort of borrowed from a friend. It's, yes, technology and science is globalizing, and just sort of get over it. That's just the way it is.

I think many of you saw that China just surpassed Japan for number two in worldwide R&D spending, so of that trillion dollars the U.S. still has about a third, 330 million. China's up now to about 14 percent, should grow by 20 percent per year and probably gain a point per year over the next couple of years. And the reality is that happens because it is a very well educated population. They are very technologically oriented. They are motivated and extremely well financed, and so why should we not expect this to be the case is beyond me.

The world is global, and all that's happening to the technology curve it is following the sun – a basic economic development – and we should understand that. The U.S. share of technology and science will decline, and at the end of the day that's because the pace of the rest of the world is increasing. And I think that's just the way it is.

To that, at the end of the day, we have concerns. Computer science in U.S. isdeclining, but in fact the world of R&D is not actually in remorse, it's actually just taking place to the rest of the changes in the world.

MR. HUTCHINS: Larry, you have had a history of thinking more globally, and perhaps you can follow up on these comments share some thoughts about how we – (off mike).

MR. SUMMERS: I hope that the ability to make a microphone work consistently is not a harbinger of global competitive success. (Laughter.) I have never had a microphone fail when I spoke in Asia. (Laughter.) I cannot say that about our country. (Laughter.)

You know, the 20th century was a century of physics and it was an American century. And those two things are closely related. While the foundational ideas of relativity and quantum mechanics were discovered in Europe, they found their practical application in the United States, with the development of nuclear energy, nuclear power, nuclear weapons, and with the revolution in solid state physics leading to the transistor, the semiconductor and ultimately the information technology revolution. Think of how

different history would have been if the United States had not been the leader in the application of physical science.

The 21st century will likely be a century defined by what happens in the life sciences: by medical revolutions – biomedical revolutions that will lead to profound transformations in life expectancy and reduction in human suffering; by applications of processes in the life sciences to everything from the development of new materials to profound changes in energy technology; to application of life sciences – and this is not a slip – that will for worse or better have the potential to change human nature and mental processes quite profoundly by the end of the century.

And the question is will the United States be the leader in all of that? Look, folks, it's going to happen that if you take the U.S. fraction of anything – R&D, papers published, Nobel Prizes won – it's going to go down. That's part of what happens when the rest of the world makes profound progress. The question is are we going to be the focal point in these kinds of sciences as they're applied, as Europe was in the physical sciences before the Second World War and as we were after the Second World War? If we want to assure that, there are at least four things we have to do as a country.

First, from the top, we have to take science seriously as a major national priority. Right now, in the United States a third of high school biology teachers believe in intelligent design as much as they believe in evolution, and 70 percent of the American people agree with them and the president of the United States is saying it's a great debate to have robustly. We all scorned Stalin for sponsoring Lysenko. It is no different when our government is neutral on intelligent design and if one wants to be a serious country about leadership in the life sciences, one cannot treat evolution just a matter for debate.

Seriousness about the issue is also a matter of what kind of priority you send. We have sent a signal from our government that maximizing the share of initial public offerings that take place in the United States seems to be a crucial priority. I would hope that equal priority would be assigned to leadership in the life sciences in the next century, but that signal has not yet been sent.

Second, funding has to be a priority. Can you really imagine that at the moment when there is more possible in the life sciences than there has ever been that for the last three years funding has been cut in real terms, that the resources – since all the old mandarins get to keep going in the way they always have, a 10-percent cut in funding for the overall effort means a far greater cut in the funding that is available for those who are young investigators and starting out on their career?

But funding is more than a matter of aggregate resources. It is also a matter of the compensation levels that are taken as norms. We worry so much that few young people are going into science. Think about it. I can't document this precisely, but in the university you get a sense of different kinds of compensation levels, and I would estimate that an outstanding fourth-year MBA from the Harvard Business School earns a

substantially higher salary than a potential Nobel Prize winner on the Harvard faculty. Can it be amazing that in light of that talent is not headed towards these sciences?

Third, we need to control the politics in the ways in which we allocate our funds. It is not a step toward a healthy 21st century to limit funding for stem cells. It is not a step towards ultimate scientific progress for the diseases of the relatives of the key appropriators to exercise a substantial influence on the national allocation of scientific research funding. There is a conflict between funding the best projects and funding the projects that take place in the places where there is felt to be the greatest need. If we are going to be serious about this, as we were serious about physics after the Second World War, we need to control the politics in this.

And fourth, we need to support clusters of extraordinary performance. Fundamentally, if competition is individualistic, we're going to have a very difficult time because salary levels adjusted for talent are going to be much lower in other places than they are in the United States and we're not going to fix that. So what can we have that is uniquely American? What we can have that is uniquely American is not an individual person of talent, because that can always be competed with overseas. What we can have is a cluster, like Silicon Valley in information technology, like Boston in the life sciences, like New York in finance, where each derives their strength from all and so bidding it away is that much more difficult.

You know, 200 years of economic theory are around the idea of diminishing returns. You put five people on some land, then you put a sixth person: he doesn't produce as much as the first five people did. Knowledge is exactly different. You put six scientists together and the sixth one will add more value than the fifth one did because more connections are possible. Our strategy needs to be one that's directed at establishing several clusters of excellence in this country to which everyone wants to come because they want to be with everyone else who's there. That's the path to an enduring advantage which is so important to the future. (Applause.)

MR. HUTCHINS: Larry does have a reputation of saying things none of us would have thought of and as I was coming down this morning, of all the scientists I could have thought where -- whose work we would cite, Lysenko was not one of them. (Laughter.)

What I'd like to do is ask Bob now if you could reflect on what you've heard today and help us think through how this establishes a set of national priorities for us and what kind of work the Hamilton Project might do to focus on these issues, or as usual, whatever else you'd like to talk about. (Laughter.)

ROBERT RUBIN: I think, Glenn, what I'd like to do is talk on behalf of IPOs. (Laughter.) All right. Technology is not my world. I'll just add one comment, if I may, and I think it does go a little bit to Larry's thought about where all this happened in the 20th century.

If the United States is going to be robust in the areas we've just been talking about in addition to all else that we've just done, we have got to maintain an environment that is conducive to and encourages investment because all of this becomes economic reality to the process of investment and that means that we've got to have what we do not have today: sound fiscal conditions. We've got to have investment in infrastructure, basic research, education. We've got to have healthcare policies that make sense, energy policies that make sense. The kind of policies and public investments that create an environment that, as I said a moment ago, is conducive to investment. And we've got to have sound regimes and balanced regimes with respect to our regulatory and litigation systems.

You put that all together, Glenn, and then I think you have an environment in which will continue to have robust investments so that no matter where research take place around the world, we will have a comparative advantage in terms of turning that into economic reality.

MR. HUTCHINS: Bob, I want you to hold on to that for now. What I think we might do is open the floor to questions. We want to have this be as interactive a session as possible. We have some very interesting, thoughtful people who'd joined us today. So do we have a microphone going around here? I'll let you start, and then we'll move over here next.

TOM KALIL: So I've got a question for Larry and a question for Dr. Varmus, and for Larry, the question is: rather than saying, the 20th century was this – (audio break) – is the century of life sciences, it seems to me that the 21st century is going to be about the convergence of the life sciences, information technology – (audio break) – micro and nanotechnologies. So that – (audio break) – have a story, but it seems to be something really interesting that's going on is the virtuous circle of innovation that we get when all of these technologies are advancing.

And my question for Dr. Varmus is: how do you answer the question which members of Congress are asking which is: What do we get for that doubling? Why is it that we made this big investment in biomedical research and yet the productivity in terms of the development of new chemical entities is actually been flat or down? (Laughter.)

MR. SUMMERS: I – (laughter) -- I stand not corrected but amplified by Tom Kalil with whom I entirely agree. I used the term life sciences rather than biology to reflect exactly the point that he was making and he's exactly right about the interdisciplinary aspects that go into all of it.

DR. VARMUS: I think actually Tom made a very important point that I try to emphasized whenever I talk about what's going on in life sciences research; namely, that we depend on mathematics and computational sciences, physics, engineering. Indeed, much of what's now possible through NIH supported research is made possible because of advances in technologies that depend entirely on these other sciences, and one of the things that's wrong with the way in which the federal government is currently supporting

science is they're not giving enough credit to those other sciences upon which we depend so heavily.

To link that comment with what you're asking about, I simply think it's simply too soon. I think you can't expect to have new pharmacological entities, as you referred to them, appear within a few years after an investment's been made in life sciences and basic biology. I think you can point to a lot of transformations in life sciences that have occurred in the last few years, especially with the increased application of the knowledge that has come out of the human genome project, the new approaches we've been able to take, for example, my own field to cancer biology. The transformations that are actually closely linked to a point that Larry was making are really pretty stupendous, but they depend as much at the moment on philanthropic efforts to bring units together.

As Larry well knows, one of the Harvard-MIT units, the Broad Institute that Larry was involved in setting up, has recently joined with four institutions in the New York area to build a consortial center that will depend to a certain extent on NIH funding, but is increasingly dependent on other source, especially from philanthropic sources to try to harness the new energy that's in the life sciences. But it's simply too early in my view to say here are the three new cures that have emerged as a result of doubling the NIH budget.

MR. HUTCHINS: We've a question right over here, and I think it would be helpful if the questioners would extremely succinctly tell us their name and affiliation.

Q: My name is Jeff Steinberg with Executive Intelligence Review magazine. Speaking of some of these superstitions that Dr. Summers talked about, such as intelligent design and things like that, have we overcome the cultural stigma against nuclear energy? Because it seems to me that some of the major scientific innovations in the future – hydrogen fuels, certainly space exploration, and even areas of biomedical research – really require a major surge, not to mention the energy requirements of the future per se.

MR. HUTCHINS: Anybody what to take that one?

DR. VARMUS: Well, certainly. The New York Times documented about three weeks ago in very graphic form just how poorly we've supported energy research in the country, and at times when I just don't think there's any intelligent design to the way in which the federal government is spending its money on science. I don't want to speak to the nuclear issues. I'd look to my other colleagues to do that.

MR. CAPELASS: I'll just give you a simple answer: do the math. The answer is no because all you have to do is look at the adoption curve. And if you do economics on it, the economics certainly would prove themselves out. So the answer is we obviously haven't gotten over this stigma because the adoption rate has certainly been much lower than anybody would have reasonably expected on an economic value.

MR. HUTCHINS: Let's go over here a minute – the center of the back there, with the hand up. There's a microphone coming to you right now.

Q: My name is Rick Caspier (sp). I represent an old-line chemical company here, I'm a lawyer for them – and I wanted to – I came here with the hope that you – being able to connect the dots to the kind of public policy questions that Secretary Rubin brought up at the end. We have this demand for funding for research, but at the same time, there are all sorts of other demands out there for infrastructure development. I was out in Wyoming a number of times this year and all you see is streams of multi-intermodal cars going east and west across our great grid of railroads, and they're going back empty to the West Coast and coming back full. And to me, I think, one of the things that we could connect to dots is to give a mission-orientation towards investment in technology to really direct some of that towards infrastructure development.

I was wondering about the thoughts of especially the two former secretaries of treasury as to some new ways of funding that kind of thing through possibly reviving a industrial development approach from the 1930s such as the Reconstruction Finance Corporation.

MR. RUBIN: I'll take a first shot at it. I probably would not do the RFC again, but – or that we could argue about that, but we could discuss that. But I think one promising possibility which I think Hamilton is going to be looking at is this question of taking what are now federal assets – real estate and other – that are not being put to their highest and best use, or which aren't the best place to conduct that activity, freeing that up, liquidating that and then putting that into, if you will, one-time investments which would be infrastructure. That's at least one possibility we can actually marshal a fair bit of resource.

MR. SUMMERS: I don't think the world's problem right now is that there isn't enough liquidity or capital for worthy projects, and so I don't see a RFC as responsive to the problems of the moment. I think there is need for appropriate federal infrastructure funding, but we have to be very careful. It's not my impression that it's generally felt that the last highway bill was – suffered from an insufficiency of commitment to the infrastructure area. And so I think the challenge is to support worthwhile infrastructure without pork and the risks on the pork side in infrastructure have historically been very large and that needs to be very carefully managed as we think about what are very real infrastructure priorities going forward.

MR. HUTCHINS: One comment I would make in that regard though Larry, is as someone who's involved in the technology world, if you, for instance, visit South Korea these days, which I imagined you have recently, you'll see what capabilities they have as a result of a national undertaking to build a national broadband infrastructure. The associated efficiencies and benefits, both social and commercial are just enormous. So there might be well be an issue of kind of where we put our dollars and what kind of projects, particularly (exposing ?) the amount of money we're spending.

endorse your point that developing some clear criteria for what is an appropriate level is a very good question.

MR. HUTCHINS: Anybody else wants to respond to that before we move on? We have a question over here somewhere on this side. I want to have the gentleman on the aisle there.

Q: Thank you. Gary Mitchell from the Mitchell Report, and I'm afraid this is going to be a sort of beat-the-dead-horse question, but –

MR. HUTCHINS: But quickly.

Q: But quickly. (Laughter.) Dr. Summers said that the 20th century was the century of physics. One could also argue that the 20th century was a century in which war was more successful in diplomacy and that in the 21st century, it's important that pattern not repeat itself. So the question goes to whether or not the focus of this project and this discussion writ large is a bit too narrow as we think about what it is that we need to put our money behind and what outputs – human outputs we are looking for in the 21st century to tackle a broad range of issues and challenges? And you can view it as rhetorical, if you want.

MR. HUTCHINS: Bob, you want that one?

SEC. RUBIN: Well, I'm not quite sure what the question was, but if the question is how do we try to change human nature, I heard Harold or Larry or somebody – it was Larry actually, or was it Harold? One or the other said that for worse or better, that may be in the offing, but – (laughter) – other than that, I don't have much to offer. I think you're right: we should try to improve diplomacy and reduce conflict. How one does that, I think, is a touch more complicated.

Q: And part of that is if we're going to do that, we've got to train people to do that. So I'm asking is whether the focus of this project is narrowly around science, engineering, math and technology, A, and B, if that's the case, whether we're putting our money in all the right places to solve the kinds of problems in the 21st century?

MR. RUBIN: Well, I think –

MR. SUMMERS: Look, I suspect I speak for my colleagues on the panel in saying what I'm about to say. There's no question this panel is about science and technology and competitiveness with that understood as hard science. I think we would all agree that there's a whole range of expertise, from people who can speak Arabic to people who can understand Islam to people who can think through the roots of conflict that our country also needs to train, and a whole other set of research activities bearing on the social forces that are shaping the world in which there is also a need for a massive investment. That's not our subject today, but I think we would all agree that that is also a priority.

MR. HUTCHINS: Did you want to talk about this, Bill?

MR. BRODY: Well, I mean, clearly, one of the most effective forms of diplomacy is education, and to the extent to which we have more and more foreign students coming to study in the United States and they go back and become leaders of their countries and understand the U.S., the better we are. And conversely, the more we have American students studying abroad the better we are. And we ought to think about investing more in developing schools in areas like the Middle East, where we could provide an alternative to the, you know, fundamentalist-based education that currently exists. I mean, there are a number of things we can do, but as Larry said this – our panel is focused more on -- specifically on innovation.

DR. VARMUS: I don't think we should ignore the impact of science and technology on efforts to create détente among nations, but scientists do speak in general, especially in my own field across frontiers in a very effective way, and that efforts to build international consortia of scientists is a very worthy thing to do in the realm of a kind of ersatz diplomacy.

MR. HUTCHINS: The only thing I would add to this, which is – is an anecdote that just keeps coming to my mind. The little community I live in in New York, a group of parents went out and raised a million and a half dollars for the local high school, which I thought was a terrific idea as I assumed they were going to build science labs or have after school programs or hire more teachers in math and science, and they put a turf football field in. (Laughter.)

So I – we all work in communities to change the culture of learning and the priorities that we communicate to our children, you know, there's a – my point is there's a lot more we can do ourselves at home, rather than worrying about what you might call intergalactic issues as well.

I think we have a student here in the front – it looks like a student, I'm hoping here.

Q: I'm a student. (Laughter.) I'm a Chinese student.

MR. HUTCHINS: Grab the top of the mike.

Q: Okay. Can you hear me?

AUDIENCE: No. (Laughter, cross talk.)

MR. HUTCHINS: There you go.

Q: Okay, okay. Thanks. I'm a Chinese student from George Mason University. Just want to make a comment about China because it seems – (audio break).

MR. : China's microphones work. (Laughter.)

MR. HUTCHINS: Maybe you could hold it perpendicular to your mouth, it will work better. (Laughter.) Point the microphone up.

Q: I just want to make a comment about China because I felt it's a big concern for people here, but I want to say maybe you exaggerate the threat of China because what matters is not quantity but quality. Yes, China spends maybe as much R&D funding as U.S., but the government doesn't use the money as efficiently as the U.S. There are much more academic scandals in China than U.S. And second, maybe China has as many talent as in U.S., but they are poorly trained than graduates in U.S. I think the figures may be misleading, and also if we – there are six Chinese who have won the Nobel Prize in science and technology fields, but you know what? They are all American citizens. (Laughter.) And half of them live in the U.S. Only one live in China, but not Beijing's China – Tawain's China. (Laughter.) So maybe – and yes, there are some Chinese students have been back to China, but –

MR. HUTCHINS: Do you have a question?

Q: Just a comment.

MR. HUTCHINS: The question was: are we exaggerating the threat or the issues associated with China?

Q: Yes.

MR. HUTCHINS: Michael, why don't you field that, and then Larry?

Q: Thank you. (Laughter.)

MR. SUMMERS: It's an important issue you raised. There's a tradition in the United States of whipping ourselves into a frenzy about other countries. (Laughter.) We did it after Sputnik and it didn't – and it was effective nationally, but it wasn't entirely accurate with respect to the Soviet Union. We did it in the late 1980s and the early 1990s with Japan, which didn't prove to be the country we all forecast it would be, but it served some constructive purposes for the United States, and I think there is some of that going on with respect to China. And I think there is a need for us as a country and indeed for all of us here in thinking about this to engage with a little rigor.

There's a tendency to say it's terrific when an American collaborates with a Chinese citizen or a Russian on scientific project because it promotes understanding of nations. But when the fraction of all papers written by Americans declines, something terrible has happened with respect to our leadership, and I think we do need to think a little more carefully and I do think there's a tendency to overdo the adversarial aspect in talking about these topics.

MR. CAPELLAS: I think what you also heard is – a little bit was simple acknowledgement of the world as it is, and if you sort of would go through, you know, last year – in the last year, Chinese shoot something up, the MLP, the medium long-term plan for technology, which said something like this: by the Year 2024, we will be the global leader in technology. We will grow R&D as a percent to 2.65 and no more than 30 percent would be foreign import. That is the medium to long-term plan.

So I have three points here. First is I think what you hear is we acknowledge that this is the reality. Two, we acknowledge in a global environment that, you know, where these borders start and stop will become less important, but growth in China is going to be extremely fast and it will change the dynamics of the way we do things, and I just think that's all we're saying.

And to go back to Larry's point is the bigger question is what we're not doing as opposed to really – you know, the responsiveness of our policies. You know, the fact that computer scientists in the United States in raw numbers declined for four straight years has nothing to do with China. It says something more about us, and I think that's the issues that we're trying to address.

MR. HUTCHINS: We have a question at the very back row there.

Q: I'm – is it on? Yeah. (Unintelligible) – Center for Accelerated Innovation. The theme of the Hamilton Project is advancing opportunity, prosperity and growth. It happens be the theme of numerous policy reports and blue-ribbon commissions in town. The question I have is: are we measuring what we want? The discussion up to now has been about a lot of quantitative effort indicators, more R&D spending, more scientists and engineers, more patents, more prizes, et cetera. Do we know enough to inform policy about the connection between these inputs, the process of innovation and the results that we're seeking? Do we have enough of a science or an understanding about how this process actually works?

MR. SUMMERS: Since that's the discipline of economics and you're calling for more research in economics, I can hardly say that we know enough. We obviously need to understand much more. On the other hand, I think we do know some things that are very important here. I think we know that the productivity miracle of the mid-late 1990s that has largely continued to this moment is heavily due to information technology and I think we know that the information technology revolution, the internet, have their roots in government supported basic and more applied research. I think we know that if we go back to the founding of the land-grant universities that a substantial part of American economic progress can be traced to government-led research efforts and their dissemination through a whole range of policies through the private sectors.

So, yes, we need to know much more, but I think we already know enough to be relatively secure in what the main conclusions here are.

MR. CAPELLAS: I think you are on – I mean, I'll speak more for the private sector, obviously the world that I'm from is – I am actually quite surprised at how much fundamental metrics about R&D, what it means, process changing in a world where, you know, today a college student can go to the internet and do what used to take us all months and months of work in about four minutes and do it simultaneously while talking to their boyfriend on the phone and doing six open windows of IM.

So I do think the world has changed and I do think the process metrics are changing and it is coming, but I do think we have to rethink what R&D is and what we're actually trying to accomplish just because the innovation path, just the speed of everything has moved so fast, our old metrics just doesn't mean anything anymore. I do think you're right, just spending alone is not a very good metric.

MR. HUTCHINS: We have fifteen more minutes. That was Bob's question. I think you've made a very point, Michael, because when you come to sessions like this, business people like Michael and I hear statistics quoted about the amount of money spent on R&D, and what we spend our time doing in the boardroom is trying to get more for less, rather than trying to spend more, and you do see these tremendous advances that allow us to have – you know, the basic fundamentals behind two things, which is Moore's Law – the processing speed of a semiconductor doubling 18 months; there's something called aerial density, which is the amount of data you could put on a piece of media that goes inside most of our computers, doubling every nine months. We're continually doubling the capacity of what we deliver to consumers at half the cost. So I think you're right: we do measure the problem – we do describe and measure the problem differently than is perhaps most constructive to, which should be what are we getting for what we're spending on what we're doing, as opposed to how much we're simply spending. It's a very good observation.

In the back here?

Q: This is Pete Chutley (sp) from Brookings and my question is to the whole panel, but it builds on Larry Summers' comments, and the point is how can the U.S. continue to be a global leader in science and technology when more than half the public doubts evolution and leans towards creationism? How did we get there and what can be done about that? (Laughter.)

MR. CAPELLAS: Thanks, Larry. You know, I think that the question was already let on. This is a fundamental question of education, and I don't know how else to address it other than one says is that – you know, if you sort of look at the educational processes that we follow and what people – you just -- education is probably only the answer. Other than that, I don't know how else – you know, if you're looking for me to make a comment on how we're going to legislate that, I'm going to pass the microphone right. (Laughter.)

MR. RUBIN: I don't have the answer to that, but one of the joys of working with President Clinton in the 1990s was that he was a political leader who understood the

forces of the world in which we live and the world into which we're going, and I think we've got to try to find some way to greatly increase the – this is fascinating – at least, I find it very interesting and I don't know anything about technology, but I think what we need to do is find some way to expose our political leaders, the members of Congress, the people who actually made the decisions in our system to these kinds of subjects and these kinds of discussions so that we substantially increase their awareness of and – awareness of and relationship to, if you will, the issues that we're facing so that the decisions are made by people who have a far better developed framework for making them than I think is currently the case with respect to most of our decision makers.

DR. VARMUS: Let me just say a word about the other half of your question.? How come we're so successful in making discoveries and winning prizes and leading in science and technology throughout the world and – (off mike). (Laughter.) Well, I'm not alone up here. (Off mike.) Can you hear me? (Laughter.)

(Cross talk.)

DR. VARMUS: (Off mike) – one that works, yes. Thank you. (Laughter.) David Goodstein in Caltech put it out some years ago that we don't have a science pipeline in this country. What we have is a diamond-mining enterprise. We look around in grade school and high school for stars and we do very well putting them through science fairs and identifying them and singling them out, sending them on to great schools, nurturing them in college and graduate school, and attracting the most talented scientists from abroad to come to our research universities. And that's a very different way to run a society than to have a widespread appreciation of what science and technology do, what the truths of science are about the world, and we need to do some of the things that Norm Augustine's report advises to improve science teaching throughout our education system in order to have a society that can respond to crisis in science and technology and not simply pass them back into the hands of those who are very good at finding those nuggets and gems who then go on to succeed in science.

Q: Kevin Fenerton (ph) – (off mike) -- in science and technology at the National Academy of Sciences. It seems to me that one of the things that this policy discussion is about is how do you integrate science and technology into the larger social forces that we're trying to cultivate and develop. And its strikes me that we have funding decisions made by people trained in law, regulatory decisions that can affect science made by people trained in law. Many even of our high tech corporations are not headed by people with training in science and engineering, although there are exceptions; decisions made on Wall Street, often made by people without expertise in science and technology.

So it seems to me that a policy problem is how do we integrate expertise, training in science and technology more effectively into the places where the choices are actually made, not just in funding and the application of technology, the use, how it's affected in education and so on. So I'm just curious in your thoughts about that. How do we make this sort of science and technology worldview and knowledge more pervasive throughout the decision-making process?

MR. SUMMERS: Look, I think a fair amount of that goes back to education and it's something fairly deeply cultural here and it's relevant to the last question as well. You know, I looked at some of the public polling data on teaching evolution, and 70 percent of the American people think that you should teach both evolution and intelligent design. And if you sort of asked them what the main reason is, about 40 percent of those who want to teach both, give us the reason – some kind of biblical conviction reason, and 60 percent gives us the reason – a kind of general belief that you should teach both sides of every argument.

And there is a kind of aversion to the idea that there is truth and that there is right and wrong in these things that runs through this process and it leads to the kind of belief that you can make a perfectly good decision about what the best way to think about quarks is by having a compromise. And I think it's a very deep cultural thing and education and more contact between scientists and decision-makers no doubt can make a contribution, but there's something very deep in the culture which makes scientific illiteracy acceptable or even chic in a way that other forms of lack of understanding are not.

MR. HUTCHINS: The other thing I think – I think you've made a very good point, and I think the other important thing would be to bring people into government who have experience not just as scientists, but also as kind of innovators – the people from whom the world that Michael comes from because the most important businesses today are those that make not products, but innovation, which Michael alluded to.

To give you an example, there's a business I've been associated with which has roughly $15 billion in revenue and in any period, 90 percent of that revenue comes from products that are 120 days or less old. Think about that. Make $15 billion worth of products that have an average life of about 120 days, and so the people who live in the world that Mike and I live in realize that we are about the process of innovation. I think having those sort of folks involved in government at senior levels where understanding the importance of that to our economic vitality as opposed to regulatory and to other kinds of legal issues and spending issues we've talked about, I think would be very, very important.

We have a comment from the back room here next.

Q: I'm Jaspal Singh. I'm a PhD candidate, International Relations Department, SAIS. And my question and comment are – they have the genesis in one of the letters we had received from Honorable Chairman Brody about a month back about innovation in thinking and education. It was about sciences, but also he had written important line there that we must think about new theories of international relations to address the new world that is emerging. So coming back to the panel, I would think that innovation is something that (I'd learn ?) or was something that is addressing the needs that are going to come in future and innovation is something that has not happened before.

If I'm – so external environment is very important for us to realize what kind of needs might come. For that, it makes very important for the worldview and for the decision-makers to comprehend what kind of changes are happening or going to happen. A kind of – here it is important, Mr. Brody's – Chairman Brody's letter about that – if the decision-makers are in a world where they have already – they have accepted that the kind of arguments that were there in 1990s about a unipolar vision of the world, it would have made most decision makers and others complacent in some ways because innovation arises out of necessity, but if we are complacent, the necessity may not be there – particularly long-term necessity.

So how would you address what kind of new worldviews or theories about these external environment -- what would you like to say to that?

MR. HUTCHINS: We're a little confused on the question. The question is how do we look at the external environment to understand what the demands are on policymakers and science leaders?

Q: Yes, I was saying that innovation addresses necessity, but if the unipolar vision was laying the U.S. position so far ahead all other countries: in R&D, 50 percent budget compared to all other countries on one side and half the budget in R&D on the U.S. side; the defense budget so far, the U.S. almost comparable to the next 25 countries together. The unipolar vision set the U.S. position so far ahead of all other, even its nearest competitors, that it would – there was no need for – there would be no need for innovation if such a position would exist for, say, 50 years. It would breed complacence because how would we –

MR. HUTCHINS: We're having a little trouble processing your question.

MR. SUMMERS: I think you're – I think you're –

MR. HUTCHINS: I have a slow processing capability. Larry, go ahead.

MR. SUMMERS: I think you're right that there was a kind of greater complacency in the United States a decade ago than there is today, and the combination of our inability to master a range of security challenges with an effective strategy and the greater economic competition that we have faced from other countries, manifest in the size of our trade deficit, shapes a much greater urgency to these discussions that we would have felt a decade ago.

MR. HUTCHINS: We have time for one last question here in the back row.

Q: Hi, I'm Diane Signs (sp). I help promote Public Library of Science online journals that Dr. Varmus is involved with, and --

MR. HUTCHINS: We can hear you. Go ahead.

Q: -- and on the Science Communication Network, as well.

My question is, given that there are so many women enrolling in some of the top medical and scientific institutions in this country – research institutions, univesities – what sort of things do you think should be put in place to help them get into the pipeline for top jobs, research jobs. You know, we're talking about advancing opportunity, and yet many women feel they don't have access to these top jobs in research, in teaching, in policymaking, in science and medicine.

MR. SUMMERS: Maybe I should say something about that. (Laughter, applause.)

MR. HUTCHINS: Larry, maybe you shouldn't. (Laughter.)

MR. SUMMERS: Let's say I've had an opportunity to be educated on the topic. (Laughter.) Look, I think there's a priority that's very important for women, and I think it's a priority that's very important for men and I think it's something that's being seen in all kinds of fields outside of science, but it's probably particularly important in science, and that is that in many, many fields, the years between when you're 27 and when you're 40 are when a variety of things happen that shape whether you're going to have an extraordinarily successful career or whether you're not, and those are also the years when traditionally family responsibilities are at the maximum, and the question of how we manage that as a society with flexible working arrangements, with arrangements for those who stepped off a fast work track for some interval who want to come back is, it seems to me, a profoundly important question, and it's a question for all organizations in all fields, but it's probably a question that bears with particular force on the careers of women.

MR. HUTCHINS: So perhaps we'll end with Larry's thoughts on women and science. (Laughter.) And I'd like to thank the folks from the Hamilton Project who organized this. Our hosts and staff of Johns Hopkins – can you hear me now? Yeah. And I'd like to offer an apology to the panel. On hearing this extraordinary panel today, I realized I slighted them at the beginning: this reminds me of the intellect that was gathered when Hamilton and Jefferson dined together. (Laughter.)

MR. ORZSAG: If I could just briefly add thanks to President Brody and Dean Einhorn for hosting us, and also say that we have a very exciting 2007 ahead of us for the Hamilton Project. Our next public event will cover education and it will be in February, so we look forward to seeing many people there. Thank you again for joining us. (Applause.)

(END)