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Responding to Impact Technologies

WINDOWS OF OPPORTUNITY – WHEN TECHNOLOGY CHANGES THE WORLD WE KNOW

Round Table

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Moderator:

Dmitry Repin, General Director, Digital October

Panelists:

Igor Agamirzian, Chief Executive Officer, Chairman of Executive Committee, Russian Venture Company

Serguei Beloussov, Senior Founding Partner, Runa Capital

Vijay Chandru, Chairman, Chief Executive Officer, Strand Life Sciences Ltd.

Julius Genachowski, Chairman, Federal Communications Commission

Ankur Jain, Chairman and US Federal Communications Commission, Kairos Society

Rafael Reif, President, Massachusetts Institute of Technology

Bernhard Thies, Chairman of the Board of Directors, DKE German Commission for Electrical, Electronic and Information Technologies of DIN and VDE

D. Repin:

Please take your seats, we are about to start our session. We have a fantastic panel today, and we are going to discuss windows of opportunity. The exact name of our session is When Technology Changes the World We Know. Basically, we are going to try to talk about what the windows of opportunity are on this planet, talking globally, and how countries and companies should take advantage of those windows of opportunity to become relevant on a global scale. We will try to give answers to the questions regarding which specific areas we should look into. We will debate whether this is coming from existing companies and existing industries, or whether we should really look for new niches and opportunities. Finally, I should mention that this panel is sort of a little teaser for a bigger event that will take place in Moscow in October of this year, called the Moscow Open Innovations Forum, where we will deepen and extend this discussion for several days.

To set the stage, I would like to invite Mr. Igor Agamirzian, the CEO and Chairman of Russian Venture Company, to set the stage for our conversation here.

I. Agamirzian:

Thank you very much. Ladies and gentlemen, first of all, thank you for coming. I am delighted that there is such an interest in this, in my understanding, very important topic. Because our modern world is definitely shaped by technology. Each and every time a new technological breakthrough happens, the world is changed. During the 20th century, we lived through several waves of technological innovation which really changed the shape of our lives. This is just a kind of illustration of how cities in Europe looked 100 years ago before electricity became the standard for our lives, and how they look today. Definitely, there were a lot of new technologies, new ways of doing business, but even more importantly, there were technologies which completely changed the way of life. In the history of the technological development of the 20th century, the car industry, automotive, aviation, even the invention of plastic and the move towards designing home appliances in plastic, completely reshaped the world

and people's lives, and had an enormous impact – not just economic, but social. The car industry, for example, created an absolutely different level of mobility for the population. In the digital industry, everything around information technology and mobility, the Internet created a completely different level of connectivity. We now live, for the first time in the history of humankind, in a situation of global connectivity; when communication costs the same whether you are in the same room or on different sides of the planet. There is no historical example of anything like that.

Each and every technological wave of innovation definitely changes the business environment of the country. There are very few cases where the technological leaders of previous technological generations became the leaders in the new technological generation. As the mammals replaced dinosaurs, at each and every stage of an important technological breakthrough, the new small companies that appear will become the giants of the next generation.

An interesting point is that in many fast-developing companies, there are many parameters comparable with countries, with states. It looks like the companies of the newest technological wave, are reaching a point where the financial parameters of their business are comparable to or sometimes much higher than specific states. Here is a comparison between companies on the right side of the slide and GDP per employed person. It is not GDP per capita in the standard form, but GDP per person employed in the country. It turns out that Google has a higher revenue per employee than each and every country in the world, in terms of the GDP per employed person. Yandex, for example, has the same revenue per employee as Norway.

Even more interesting sometimes is the comparison of the market cap. The market cap per employee of the company, in companies of different technological generations, may be completely different. Google's capitalization per employee is more than USD 5 million, but if you compare that with companies of the previous technological wave, you see that the differences are just enormous. It is not even comparable.

The other point is that the new technological achievements are coming deeper in the social pyramid. We are not living through the first wave of globalization. One

hundred years ago, there was another, previous wave of globalization, but at that time, it was available only for to a tiny set of very rich people. Today, technology and communications have made globalization really global, because it came to all the categories of people, including the poorest ones. The level of connectivity in an Indian village today is virtually the same as it is in a European capital, or in the United States.

Another example of how technologies and technological development change and shape the world is the development of centres of innovation. Here, you see Taipei 50 years ago, and how it looks like now after 50 years of technological development, which completely redefined its economy and changed not only the economic, but also the social life of the country.

So, each and every technological wave is connected with some window of opportunity. The life cycles of different technological industries are very similar. In the first stage of development, there is a small window, usually a few years, in which you can create a new product, like a car or an aeroplane, or a computer, in the garage and become a global leader. But that is a very short window of opportunity, because as soon as the specific new market starts to grow, huge competition rises around that, and then the brands are consolidated. The most successful market players acquire less successful ones, and the names of the market players become the brands of one company. Very few people remember now that, for example, Chevrolet, which we recognize as a brand of General Motors now, was at one time an independent car maker. Another example is Boeing, which consolidated the entire technological industry in the United States.

The topic for the discussion on this panel is: what is the window of opportunity that we are living through now? What will be the windows of opportunity in the next generation? What are the trends in technological development, at the level of technologies which will reshape our world, including the way we live in society, and provide the same scale of impact on society as the automotive industry, or aviation, or computers, or the Internet, or mobile technologies?

I have some personal views about that. I think that development in the next decade will go into the areas, first, of combining the virtual world, which has been created over the last 40 years, with the physical world. Everything around atoms,

everything around digital manufacturing, everything around new achievements in the life sciences, which became information technology, the modern technologies in medicine and, even, the special science called bioinformatics. That is the application of information technology to specific work.

Today, we are living through the stage when it became technically possible not only to create virtual worlds, but to map these virtual worlds into physical reality. I expect that, at some point in time, just to start the discussion, and probably in a pretty short time, we will have at home a printer for drugs, because modern pharmaceutical production is actually printing the formulas of new drugs. You will be able to create a special, specific drug based on your genome, on your specific illness, on the specifics of your own physical conditions and so on, and print it at home, getting the formulas and the recipe from the Internet.

You will have a printer for the creation of your home supplies, similar to what is already being done in digital manufacturing. There is no reason why you cannot design, create, and, say, print the new kitchen appliance which your wife likes.

But that is just my own point of view. I expect that the experts and the audience will have other, newer visions than that. I think that we might have a pretty interesting discussion around these windows of opportunity and technologies which shape the world. Thank you.

D. Repin:

Great. Thank you so much. I guess now is the time to ask some of our distinguished speakers to share their views on what they think are the specific windows of opportunity, and what they think are the specific niches and technologies. I would like to ask Mr. Julius Genachowski, who is Chairman of the Federal Communications Commission in the United States, to talk about digital and IT, because you, as a key regulator, probably have to be most sensitive and do things very delicately in order not to get in the way of some very important innovations. You kind of have to sense which innovations and which domains have potential for the highest impact. Mr. Genachowski, please.

J. Genachowski:

First of all, thank you for the opportunity. That was an excellent presentation, and let me try to build on it a little bit. First of all, I am the Chairman of the Federal Communications Commission in the United States. It is the agency in the United States that has responsibility for all communications technologies: wired communications, wireless, satellite, etc. I was very pleased to be asked by President Obama to play this role, precisely because I think that the areas that we are engaged in present enormous windows of opportunity. These are all around a series of trends that are coming together. None of them at this point, I think, are shocks, but the way that they are coming together is creating tremendous opportunities. I am referring to the Internet, cloud computing, social media, and mobile. These technological developments together are creating enormous opportunity. They are creating a platform that I think is as powerful for generating opportunity as where the previous speaker started, which is the platform of electricity. When electricity was invented, it was invented essentially to give us light, for light-bulbs. Eventually, it gave us appliances: refrigerators, radios, TVs, and eventually the computer. There is no computer without electricity. We are now in a different kind of app world; if you think of appliances as apps, we now have applications that are changing economic opportunity and disrupting every vertical. Every business, whatever you are in, that is providing a service to the public is being disrupted by the Internet. We see the Internet creating enormous economic opportunity. I am thinking here of the Internet as people increasingly receive it: by mobile devices, as well as through wires, taking advantage of cloud computing, and the hyperconnectivity that comes with social.

So you can look at almost any vertical and imagine the things to come. Take healthcare. We are already beginning to see a world where remote diagnostics are making a big, positive difference in the United States and around the world. There are now remote areas that do not have access to doctors in person, but do have access to doctors through Internet connectivity and, in more and more cases, mobile.

We are seeing tremendous advances when it comes to spectrum-based applications for medicine. We recently approved spectrum use at the FCC that will allow patients in hospitals to be monitored for their vital signs and other

information that is important for healthcare not through wires, but through mobile connections, to allow patients to move around and be monitored. When I visited a hospital in the US, in Washington State, on the other side of the country from where I live, I met parents and a child where the child's life was saved by a remote monitoring technology. The child had a heart condition that was potentially fatal, could potentially kill him, and it was very difficult for the child or the parents to detect when a problem might develop. One solution for a child like this is to keep the child in the hospital constantly monitored, and that is the life of the child until they develop a cure. But with monitoring technologies, the child was able to live a normal life, and there came a time when the monitoring devices indicated that there was a problem. Immediately, the information was available to the child's doctors, the notice came back saying bring this child to the hospital right now, and a life was saved. Medical, I think, is an area where we are just at the beginnings of something that is being revolutionized by these hyperconnecting technologies.

Education is another area. It is already easy to imagine what we call distance learning. Students, wherever they live, in any part of the world, can have access to information and teachers wherever they are. We have been focused recently in the United States on the opportunities of digital textbooks. I do not know what it is like here, but I will tell you that in the US, when a student goes to school, they have a backpack with many books, weighing 50 pounds, very heavy. In many cases, the books are already out of date by the time the students get them. The technology is already here to change that. It is very easy to imagine students having one device: a tablet. At a minimum, that device would have exactly the same information that is in the textbook, but of course it can do so much more. It can provide personalized learning abilities. Right now, when a student is at home reading a textbook and they do not know something, they have limited options. They can come to school the next day and ask the teacher. With a digital textbook, when a student is reading something at home and they come to something they do not know, they can click and learn more. These devices can be of tremendous benefit to teachers, providing teachers with information about where their students are strong or weak, where particular attention will help them

progress. So, education is an extraordinary area of opportunity.

Switching to broad economic opportunity, we see all of these technologies coming together and providing enormous opportunity for economic growth. I want to address a few myths that people have about the Internet and economic growth. Many people focus on the fact that the Internet is a disrupting technology, and that in a number of different industries, it leads to the elimination of jobs. It is productivity-enhancing, and while it has clearly disrupted many industries, it also creates new industries, new efficiencies, new opportunities to reach consumers at lower cost. McKinsey, the global consulting firm, studied this recently. It is a study which I recommend. They concluded that the Internet is indeed eliminating jobs, but it is also creating jobs at a rate of 2.6 new jobs for every job eliminated.

This feels right to me, based on what I see in the United States, because we see some industries that are being disrupted, but we are seeing tremendous new growth around the new platforms. We are also seeing a change in the US in small businesses and their embrace of the Internet and mobile as an opportunity. A few years ago in the United States, if you had asked a small business owner whether they were on the Internet, they would have said, “No, and why do I need to be?” That has changed very quickly in the United States. The typical small business now is on the Internet, and they see it as a tremendous platform for reaching more customers at lower cost.

Let me conclude by just responding to the question that you asked: from the perspective of someone who is involved in regulation and policy, how do we think about this? There are a few things that we stay focused on. One is that while we can all speculate about where the most exciting innovations will come from, no one really knows, and no one knows any more than when electricity was invented, people said, “Aha, now we are going to have the computer and all these other wonderful devices.” Humility is called for and a focus on, in my opinion, what the ingredients are to drive investment and innovation.

One clear ingredient is universal access to broadband infrastructure, wired and wireless. So we spend a great deal of time in the US on strategies to achieve universal broadband deployment and adoption, and ubiquitous mobile.

Fundamentally, the four key words that I ask everyone at the FCC to keep in mind as they struggle with the hard policy issues that are addressed by this revolution of hyperconnectivity are: innovation, investment, competition, and consumers. Because this new technology has provided enormous opportunities to empower consumers as well. These are the issues that we are focused on in this tremendous opportunity.

I will end with one statistic that gives a sense of the global opportunity. There are globally about 6.1 billion mobile subscribers. That in itself is an incredible number, and not that long ago, that number was a fraction of the size. As large as that number is, the number of those subscribers that have access to mobile broadband is about 950 million. About 950 million people around the world have access to mobile broadband, and most of those people are in developed countries. Over the next five years, that number, that 950 million number, is extremely likely to increase very substantially. It is reasonable to think that, as quickly as five years from now, of the 6.1 billion mobile subscribers around the world, 5 billion people may have access to mobile broadband. This is an extraordinary thing for economic opportunity, for health, for education, for connecting people around the world. This is all going to happen very quickly, and I think it is going to lead to opportunities of a sort that we can only begin to imagine now, but it will be very, very significant to the global economy for years to come. Thank you.

D. Repin:

Thank you, Mr. Genachowski. I would now like to move to the other side of IT, a different angle. I would like to ask Mr. Serguei Beloussov, who is a Founding Partner at Runa Capital, to speak. Yesterday, Mr. Beloussov received – twice, actually, in just one day – the award for commerçant of the year in the field of innovation, and he is an accomplished entrepreneur and investor. I think he is going to share his ideas about where computing is going in the next 10–20 years.

S. Beloussov:

I do not think all of this presentation is appropriate for today, but basically, one

point which is quite obvious for everyone: it is common knowledge that the IT market is huge and growing. It is common knowledge now, but 50 years ago, people did not actually believe in it. If we were to have more time, there are a lot of quotes from very renowned and very respected individuals at that time who did not believe that it would be quite as big. But its market capitalization is USD 7 trillion, and it is growing very quickly. Apple is the most valuable company in the world, and it is an IT company.

In fact, IT's market capitalization was predicted to be USD 17 trillion, which is a very significant part of the global capitalization, in 2020. I believe it is close to 20%, and you can almost think of it as having been created out of nothing. It is not natural resources; it is not exactly power. Forty percent of Forbes Top Ten and 28% of Forbes Top Fifty are actually made up of people from IT. They populated the field in the past 20 and 30 years. Some of the people on the right, some of them are from communications, some of them are from information technology, and that is where the two industries connect.

Indeed, I believe the largest opportunities in this market are related to education, healthcare, government. That is another area which is not particularly well automated today. And there are two new areas which I really, really hope are going to be improved by IT. One of them is communication. Personally, and I was just thinking about this a few days ago, one thing I hate about my work is travel. I hate travelling. I have been travelling three times a week for the past few years, and I fly three times a week, and before that, on average twice a week for the past ten years. I hate it. The only reason I travel is because communication is not perfect. Hopefully in the next ten years, you will be able to communicate with people around the world without the need to travel. That is certainly going to happen.

Another area which is certainly an area which will change the world a bit is the virtual world, which you spoke about a bit. There is a virtual economy today, and by virtual economy, I am not talking about the Internet; I am talking about people making money by living in the virtual worlds, playing computer games, and that world will grow. In fact, one person who some of us here know, the founder of Evernote, Stepan Pachikov, goes as far as to say that there will be no physical

bodies in the next 50 years. The only place where they will find physical bodies – I think he was probably a little bit too strong on this – in the next 50 years will be in historical museums. I think that may be a little too extreme, but certainly the virtual economy is increasing.

Now there is one area which certainly enables miracles, which we cannot really imagine, and I want to talk about it a bit, and it is quantum mechanics. Many of you may have heard of it. It was invented about 100 years ago. In the past 20 years, there has been tremendous progress in physics, in manipulating matter on the area of single molecules, single quantum, single photons, single atoms, and actually absorbing those quantum effects directly. That actually enables miracles. It enables a lot of different things, which we cannot even comprehend. If you think back to 50 years ago, people did not think about what IT might be able to do, 100 years ago, people could not have thought about the world there is today. There may be such things in quantum physics. Much of the work to reach the ultimate goal of the quantum information processing – a lot of quantum physics today is about information processing – is about making quantum computers. It is believed that quantum computers will be able to change the world in a way which is bigger than the revolution I just talked about in IT which is happening, or has happened, and much of the work is done. In fact, a lot of the things coming out of quantum information processing are already shaping today. There are quantum communication devices from companies like ID Quantique. There are quantum clocks, there are quantum detectors with unimaginable precisions, and so on and so forth, which can enable things which are really unimaginable today, such as printing drugs, such as precise diagnosis in a doctor’s room and so on and so forth.

I think, potentially 10, 20, 30, 50 years from now, that is what is going to change the world to the extent Stepan Pachikov thinks, to the non-existence of our physical bodies. It is quite obvious that, at some point in the future, that may actually happen, whether it is 50 years, or 100 years, or 300 years, we do not know. If it happens, quantum information processing will be the key for it to happen. I am actually not going to go through more slides; I think that is enough.

D. Repin:

Thank you, Mr. Beloussov. I guess we are very pressed for time; we have a big panel. So with that, I would like to move on, and I am asking Dr. Vijay Chandru to speak a little bit about medical and IT. So we have certainly already heard from Mr. Genachowski that IT is affecting many industries, and medicine is probably one of the most affected in this case.

Dr. V. Chandru:

First of all, I am delighted to be here. I am basically a professor of technology and an innovator. The training that the MIT gave me has helped me to do that concurrently.

As you mentioned, Mr. Repin, I think I would like to shift now slightly towards topics that have been mentioned, but in a much more focused way. I would like you to look at the plot there. A lot of what we have been talking about has been enabled by Moore's Law, and that was certainly a major influence in technology. With the yellow curve below that –and remember this is a log scale – you can see that is the cost of sequencing a genome. You will see this plot many times, I can promise you, because in the next 20 years, what is going to happen in the whole field of medical science is going to become deeply affected by this. Just to understand how all this happens, one has to appreciate the fact that the US, the UK, and several other countries together invested USD 3 billion to actually make the first human genome. Just to give you some perspective of where the technology has gone, this is a chip made by Ion Torrent. This was the chip that sequenced the meta-genomes of the victims of the E. coli poisoning in Germany last year. It was through the analysis using the Ion Torrent chip that they arrived at the E. coli variants. This chip has already been scaled 100 times now, to a denser chip. The Ion Proton Sequencer will sequence an entire human genome in two hours for about USD 1,000 by the end of this year. It will be in the market, and it will probably take a year to stabilize after that.

These are real, they are happening, and what will we need to do – where are the business opportunities – to take this forward? As has already been mentioned, there is bioinformatics. Actually, this is kind of a rebirth of bioinformatics,

because it was born with the human genome project, and then it sort of died as a business opportunity fairly soon after, but really now people are coming back to it. A few foolish entrepreneurs like me actually stuck with it over the last 12 years, so what we see now is that, as translational bioinformatics is where all the action is going to be, really you will now need to make it relevant to the clinic. Whereas in the past, people were using bioinformatics really to understand disease and understand biology, it will now start making it into the clinic. Of course, there is a lot more to it. There is the sequencing technologies, there is the reagent technologies, and lots of that.

It is not just human health; this will go into agriculture, it will go into all kinds of applications, microbes for industrial applications and so on.

Just to show you a few of the poster children for how all of this is already starting to impact medicine: on the left there you see Nicholas Volker, who was treated at the Wisconsin Medical Centre. There is a very nice series of articles about the whole story called *One in a Billion: A Boy's Life, A Medical Mystery*, and it won the Pulitzer Prize. It was by sequencing his genome and his parents' genomes that they came to some conclusions on a transplant that saved his life. A Japanese child with a neuromuscular disorder; this was a case that we were involved with, in solving the genomics. Another poster here is of Larry Smarr, a physicist and computer scientist at UCSD, who has been monitoring himself. This is another aspect of where all this technology can lead. He actually diagnosed himself with Crohn's disease four months before his physicians could confirm it, just by analysing his own data.

I do think this is very game-changing, to say the least. I think the opportunities are absolutely huge, whether it is on the interplay between the informatics and the medical science, and I do think it will have the same kind of impact that the Internet has had. Thank you.

D. Repin:

Thank you, Dr. Chandru. I forgot to mention that Dr. Chandru is the Chairman and CEO of Strand Life Sciences. Now, there is another area that we cannot bypass: energy. Therefore, I would like to ask for a few words from Dr. Bernhard

Thies, who is the Chairman of the DKE German Commission for Electrical, Electronic and Information Technologies. I can ask you to speak for maybe three to five minutes, no more, because we are really pressed for time.

Dr. B. Thies:

Thank you very much for introducing me. If you remember, for more than 150 years innovations have been coming to the market, and one of the dangerous innovations at that time was electricity. Electricity is one of the dangerous things which everybody has at home, and at that time, all the engineers were clever enough to sit down worldwide and decide that there was a need to write down standards for these new innovations to bring them into the market. In 1906, the IEC, the International Electrotechnical Commission, was formed. They worked really on the safety aspects of electricity. Then they saw that it was not only the safety aspects that had to be in the papers, but also the interoperability; all the products had to meet standards. Then they also saw – it is very easy – that the physics worldwide is the same, so that means that they also tried to find out how to make the product safe everywhere in the world. So this means they had a very large-scale effect with their product itself. For example, in Europe, our standards for electricity are international standards. Also, if you look to this area here, there are international standards behind safety, so that we can be safe here in one part, and then we also have all the interoperability of these things; you can buy these things everywhere in the world. That means that the electricity was started, and you have the power plant, transmission line, distribution line, and then you have the consumers.

Then the discussion to reduce CO2 emissions worldwide arose, and then they came up with the idea of bringing renewables into the market: windmills, photovoltaics, also new things coming from the ocean area, to use the temperature difference in the ocean, you can use the difference of salinity in the oceans, you can use a lot of sources to find other ways. One of the main things in these new technologies relating to renewables is that they are dependent on the weather. They are dependent on the sunshine. We know that. So that means that the first part of our structure of electricity, from the power plant to the

consumer, is now disturbed due to renewable resources. They are bringing the energy to the market in the other direction. That means there is a very, very complicated system now to find out how to implement that for the future. At the end, we have to find out a very clever way – not on the transmission lines, because the transmission lines worldwide, including in Europe and in Russia, are already smart. They are already intelligent; otherwise the system would not function. But in terms of electricity, the distribution area connected to your house is blind. So we need new technologies to make this system intelligent, and these are all coming from the IT arena, so that we have control of production for photovoltaics, for wind, and also to gain control of the demand. For example, why should the washing machine wash when the demand for electricity is very high? Maybe it can wait for two hours until the demand for electricity goes down. So we now need a very complex system between the consumers and the system itself. Moreover, the consumers, the people with the photovoltaics on their roof, are also producers. This is a new word, they are pro-consumers. The 'prosumers' are now in the market, and that can only be done with these things.

Now, you have another problem to solve, because you bring now IT technologies to the backbone of our lives, the backbone of the industry, the electricity industry, and so it must be protected from cyber attacks. If you bring these technologies for example, with an Internet connection via a lot of ports, then it could be that a lot of cyber attacks could shut down the country's electricity. That means we need new standards and new services to make these systems in the future really secure, as we did in the past. In the past, we were talking about safety; now, we are also talking about security. I think that there are a lot of opportunities for the industry to determine the best way. The best way to bring it into the market, as I said before, is going via standardization; work on standardization. Then you know the technology, and you can bring your innovations into the market itself. Thank you.

D. Repin:

Thank you, Dr. Thies, and so we have heard very diverse views on where these new windows of opportunity will come from, from either the existing areas like

grid, or from totally new areas of mixing bio and IT. Now, I would like to invite Mr. Rafael Reif, President of MIT, which is 150 years old and which has always stayed on top of things, both in terms of producing new technologies and also in terms of building businesses that use those new technologies, that make impacts globally, and have probably impacted everybody here. I am also fortunate to be an MIT alumnus, and I would like to hear about what Mr. Reif has to say about how MIT has managed to stay on top of things for so many years. What is your outlook for the future?

R. Reif:

Thank you, Mr. Repin. First of all, I want to thank you for inviting me to be on this panel. Before I answer that question, I cannot avoid addressing that point about a future or, even, a present window of opportunity in the context of the conversation that was triggered by Mr. Genachowski's comments, when he spoke about what is going to be enabled by the Internet, cloud computing, social media, and mobile availability. That has to do with a new and exciting and potentially disruptive opportunity in the educational domain. That is what we at MIT call 'MIT X', which is a way to deliver MIT content using the technology that Mr. Genachowski was referring to. This is very new and enables thousands of people to learn at the same time. It is a way to, online and in a new online learning environment, access pedagogically-enhanced tutorial content that allows the learner to be self-paced, allows the learner to assess whether he or she is learning and how well they are learning, allows them to participate in discussion groups and to earn a credential. That is something that could potentially be very disruptive to education in general.

Mr. Repin, to answer your question very quickly, and that also addresses a little bit of what Mr. Beloussov said, I am not sure that I can provide an answer about what has happened for 150 years, but I can tell you what has happened in the last 10, 20, or 30 years. There are several important ingredients in an academic institution's ability to continue to innovate. At MIT, we admit, we receive 2,500 students every year including undergraduates and graduates, and we graduate about 2,500 with diplomas every year. These are young people, ambitious, eager

to learn, that spend four to five years of their life at MIT.

When they come to MIT, they encounter a culture of innovation and discovery, and that is triggered pretty much by a series of important components. One is to educate through research; to do education and research at the same time. That triggers the idea of wanting to discover, the idea of trying to come up with new things. It is important to have a broad research portfolio, from the very fundamental, to the very applied. Mr. Beloussov was talking earlier about quantum computing and quantum mechanics; something invented 100 years ago as a result of curiosity research. Now it is becoming extremely important. That is pretty much the same with everything in society today. At some point it was driven by curiosity, and now that knowledge is being applied. That is very important in an academic institution. Industrial interactions are important so that we can figure out what the important problems are that society needs to solve.

The last important point that I would like to make is a mention of service, to understand how to make an impact in the world with innovation, how to change things for the better. That is a very important component of the DNA of a place like MIT.

D. Repin:

Thank you, Mr. Reif. Going further, MIT is a place, it is a physical place, and when I was there, it did not always look so nice. It even built itself a centre which pretended to look super cool, and there is still controversy about that. When it comes to affecting the world, you mentioned MIT X. How easy is it to export the MIT values, the MIT mind-set, and does it make sense at all?

R. Reif:

I think it makes extremely good sense to export the MIT mind-set. Let me just tell you, there are several institutions like MIT in the US, and there are several more across the world. Let me give you one important reason why places like MIT are important. Every year, as a result of MIT technology, there are about 20 new companies started. Every single year. And some of those companies become very big, employ many people, and use their innovation to help the world. Some

of them are actually bought by larger companies which innovate in that fashion. Just from that measure alone, the research of a place like MIT gets moved to the marketplace, and in doing so not only improves the economy of the marketplace, but improves the quality of life of society.

D. Repin:

So it is important not just to have the places like MIT, but to have MIT at the right place, where there is an environment to really bring those ideas into the business. Again, thank you.

Now, we would like to get some different perspectives on the “how” question. I would like to ask Mr. Ankur Jain, who is a Founder and the Chairman of the Kairos Society, and he is probably the youngest speaker at SPIEF. I would like him to talk about what he is doing, and how he is trying to recruit and work with the youngest and most energetic part of the community, the student entrepreneurs.

A. Jain:

Thanks, Mr. Repin. Over the next three minutes, let us just take a look at what the opportunities are for the next generation of entrepreneurs, and how we, the young people across the world, are going to be working together across disciplines and across national borders to drive economic growth and solve some of our world’s biggest problems. I think that there are three major trends, all of which have already been addressed. Those are, number one: we are seeing a growth of disruptive exponential technology for the first time. Number two: we are seeing a propagation of platforms in technologies, not just in Internet and mobile, but across energy, healthcare, and education. Three: we are able to use incentives and incentive prizing to drive the wisdom of the masses.

I will give you a quick look, less than 30 seconds, at each one. If you take a look at what is happening today in disruptive technologies, as technology becomes an information technology, it grows exponentially. We talked about the genome. It took over ten years to sequence the first genome, and now we can do it in less than 24 hours. What is even crazier is that we have actually just created the first

synthetic biology; we have now been able to programme DNA as humans. Think about that. One of our students has just launched a company called the Genome Compiler, which is actually software that anybody can go into and write DNA. It is just a case of drag and drop: here is a cell, I want it to produce biofuel. Think about what happens when we can sit there, and the average person can sit at home and create DNA. It changes everything. And that is something we can do right now.

So as you are developing these disruptive technologies, you are creating a platform. As we create these platforms, you get things like synthetic biology, where the average hacker is no longer creating a software app for a mobile phone, but creating new vaccines, new ways to diagnose and solve health problems, where they are building on energy technology from companies like GE to create radically new solutions for distributed energy processing. And so one of the organizations that we run, the Kairos Society, has brought the world's top college entrepreneurs together with these world leaders to say: how can we take this existing technology and solve problems in new ways? We have seen 19, 20, 21, 22-year-olds launch over 100 companies solving big problems. They are not just doing social media.

So the third thing that is really exciting right now is incentive prizing. For those of you who do not know, there is an organization called the X Prize that we fund, and one of the things that we have done is to consider how we can get the wisdom of the masses to solve some of these grand challenges. So we have co-funded – the first prize has been announced – a USD 10 million prize with Qualcomm to see if we can get the world to develop an artificial intelligence system that can diagnose somebody better than 10 board-certified doctors? Suddenly, you went from a hospital infrastructure system, which you cannot scale, to a mobile solution with technology that exists today, where a village girl in India can be a village doctor and diagnose people every single day, and turn that into a business.

The second prize that we are working on and that we are going to be funding is looking at how we can start creating new metrics to create real-time learning, because in our education system today, we have fixed-time variable learning. It

is an infrastructure. We have one year to learn algebra, and whatever you learn, you move forward. So what happens when we go to the masses and say, let us create a fixed-learning variable time system, where everybody has to learn the basic concepts? It is like a videogame; you do not move to level two until you beat level one. If we can fund that prize, and if you get young entrepreneurs across the world working together with a platform of disruptive technologies, think of the kind of change we could make in the world. It is powerful. That is what we are excited about, and that is why I am optimistic about this generation and the opportunities we have with technology. Thanks, Mr. Repin, for having us here.

D. Repin:

Thank you, Mr. Jain. This tool of the X Prize has already been proved to work, as we see in the space industry; the first spacecraft delivering stuff to a space station for less money. Now, we have probably about 10–15 minutes left for the discussion, and we hope to take questions from the public. But before that, I would like to start this debate which occurred in our presentations. Where are these new windows of opportunity really coming from? Are they coming from existing industries, or do we really have to look for some very peculiar intersections, or some peculiar, new fields that we probably had not thought of just a few years ago? Would any of the panellists like to answer that? Mr. Agamirzian, please.

I. Agamirzian:

I will use the podium just to say a few words on that. I believe that it will not come from existing industries; however, there is a very restricted set of areas, not industries, but the kind of human opportunities – what people need to do for a living. There is education, there is health care; it is not the industries. IT became today a common platform for organizing life, and I believe that new markets and new windows of opportunity are opening at the points where the activity is crossed with IT, in other words the new opportunities which IT opens in health care, in education, in medicine, in energy, and so on and so forth.

D. Repin:

Anybody else? Mr. Genachowski.

J. Genachowski:

Just very quickly, I would say the answer is both. The winners will come both from people, entrepreneurs, innovators we have never heard of, and established companies. And there will be losers. There will be losers on the innovators side, people who try and fail, and there will be losers on the company side. Some of the exciting developments come out of that tension of innovators taking on large businesses and established companies having to respond. The innovator's dilemma frame, how established companies respond or do not respond to disruptive innovations – I will not go into it here because we do not have the time – but I will say that as a government official, these are also the challenges for government. One of the helpful amendments to my comments was that government has opportunities too when it comes to new information communications technologies. Governments also face the innovator's dilemma challenge; information communications technologies are creating new innovative threads to every established practice, every area where any country is leading that has a potential to be disruptive in a world where information can flow anywhere, and capital can flow anywhere. I think people in government need to learn the lessons of companies that, over time, have succeeded and failed in response to disruptive innovations.

D. Repin:

Mr. Beloussov, and then Mr. Jain.

S. Beloussov:

I just wanted to say that actually we talk about the opportunities in the form of industries, but at the end of the day, it is not about industries; it is about basic human needs and societal needs which need to be solved. There are lots of things which are imperfect in the world, as it relates to the physical world and as

it relates to the intellectual world, which are not solved, which are not convenient. The way you solve these issues of course involves a variety of different industries: it involves science, it involves IT, but the opportunity comes from solving the basic needs of humans which are not solved today, such as communication, such as education, such as, unfortunately, governments which are required to govern the world, such as health care, and so on and so forth. I think the reality is that if we try to figure out where they come from, specifically from the standpoint of the technology platform of the segment of industry, I think it is quite clear that the more we move forward, the more integrated the opportunities become. It is not about any single specific industry which solves the problems; it is about a variety of different things which are put together, either in the form of an ecosystem or in the form of a single company, to solve some basic need.

D. Repin:

Just a remark that Instagram, one of the successes of the recent past, did not really solve any basic needs.

S. Beloussov:

It solved the basic need of making money for the Andreessen Horowitz Fund.

D. Repin:

Anyway, Mr. Jain.

A. Jain:

Just a really quick thought that might be interesting is, when you look at solving the world's biggest problems, you have to look at them as your biggest opportunities. One of the cool programmes that I think you should all check out, and I think you will be talking about in October, is Singularity University. If you are trying to look at some new opportunities to solve these existing human needs with new solutions, there is a programme that our family helped start with Peter Diamandis and Ray Kurzweil in Silicon Valley called Singularity University. We

basically thought: can we look at how these disruptive technologies, and artificial intelligence, and nanotechnology, and biotechnology are coming together across industries to solve big problems? So if you look at windows of opportunity today, their content is mostly online. It is a great opportunity, and I think it might be an interesting resource to just point out.

S. Beloussov:

I just want to make one interesting comment. I am reading the book about Benjamin Franklin by Isaacson. It is quite interesting in that it connects several interesting thoughts. First of all, Benjamin Franklin's face is on money, on the 100-dollar bill, you must have seen it. Anybody seen a 100-dollar bill in their life? And so it is about money. It is one of the common values of the world: money. Another common value of the world is American democracy. It is kind of the system of values of the world which we speak in; we even speak in the English language. One of the founders of American democracy is actually Benjamin Franklin. Well, interestingly enough, he is also one of the people who gave life to electricity. He was one of the people who invented electricity in a way that is usable by humans and is no longer a danger. So, these things kind of connect together.

D. Repin:

Thank you. We have many questions, and I do not think we will be able to answer all of them in the few minutes that are left for this panel. I would like to open it up for a couple of questions from the audience, if you can please raise your hands. We have a question right here.

From the audience:

Hello. I am a film producer, so I am basically in the entertainment sector. My question relates to entertainment as one of the industries which, of course, is much disrupted by the advent of new technologies, but also should see some opportunities. So the question, I guess to anyone who would care to answer, is: do you see any specific global or major opportunities that relate to entertainment

in the context of the technological advances that all of you mentioned? That is what I would like to ask.

J. Genachowski:

Billions of people around the world will have access to content distributed over the Internet, assuming – and this is a point that I want to make – we preserve the free flow of information and data on the Internet.

From the audience:

I cannot say I am happy about the word “free” in this.

J. Genachowski:

Free as in freedom, not free as in free beer. But this is important, because we are talking about opportunities, innovation, and the hopes for tomorrow. The single biggest threat to unleashing all of these opportunities would be measures from anywhere around the world to suppress the free flow of data, information over the internet – and again, I mean free as in freedom – but internet freedom is what has driven the innovations that we have seen and the opportunities that we have seen. The next decade, as it brings opportunities, will also bring new threats that could slow down all of the opportunities that we are discussing on this panel.

S. Beloussov:

And so the challenge is: more than half of the world lives in a different world where free means free beer, not freedom. Like China, where freedom is not freedom, but movies and software are free.

D. Repin:

There may be time for one more question. Well, since we do not have any more questions, then maybe any comments?

From the audience:

There are rumours that in 2030, asteroids will destroy this planet. So what do you guys think about this, and how will you protect us? All of our discussion will be empty if this happens.

I. Agamirzian:

You know, Mr. Beloussov answered that. Each and every challenge is different and a new opportunity, so if that is the challenge, it means that we have a great opportunity to do new business in saving the planet.

D. Repin:

A new travel industry. With that, I just would like to make some final remarks. We plan to deepen and substantiate the discussion in October, in Moscow, at the Open Innovations Forum, and I also want to mention that these breakthroughs in technology so quickly and so deeply affect our lives. For example, this idea of not having physical bodies will probably lead to new ethical and social and political challenges, so how are you going to vote? Who is going to vote? How can we elect a new president? If we do not have physical ballots, you cannot sign for voting, etc. With that, I would like to thank all of our participants. Thank you so much. Thank you to our audience, and see you in Moscow at the Open Innovations Forum in October. Thank you.