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«ЦИФРОВИЗАЦИЯ»: ГОТОВА ЛИ ВАША КОМПАНИЯ К РЕВОЛЮЦИИ?

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S. Mahdavi:

Thank you very much for joining us. Today's session is about digitalization and manufacturing, and how both companies and countries can prepare themselves for this upcoming revolution.

There are a couple of things that are happening: manufacturing is becoming very efficient; and there are new paradigms, such as 3D printing, where parts are manufactured using an additive process, which has effects on many things. From a design point of view, new design software needs to be developed. From a materials point of view, less material can be used to do the same thing. This has effects on material supply chains, for example. Less complex materials can be used. We have advanced robotics, where you can have a lot of automation, so this has effects on labour; on the actual employees that a company has – shifting away from low-level simple tasks to more complex control-system kinds of activities as well.

What we want to explore today is, how can companies prepare themselves for these new paradigms and how do they affect the global economic landscape? How can countries prepare themselves in the future for these new types of paradigms?

We have some panellists with us today. From Boeing we have John Byrne. From ABB we have Hubertus von Grunberg. From Siemens we have Dietrich Moeller, and from Accenture we have Mark Spelman. I myself am Siavash Mahdavi from Within Technologies in London. Our focus is on developing software for 3D printing.

What I would like to do at the beginning of this panel session is have everyone give some introductory comments for about five minutes on their thoughts on the digitalization of manufacturing. I would like to start with Mark on the left.

M. Spelman:

Thanks very much. The key word, actually, in the title is 'revolution'. I would like to talk about the three dimensions of the revolution that is hitting us. One is the whole question about what is happening with technology. The second is the blurring of boundaries, particularly between manufacturing and services. The third dimension of this is the circular economy, which is the fact that we need to decouple the production of goods from the commodities and inputs that we use as inputs in that process. Those are the three dimensions of the revolution which I think we need to understand.

If we look firstly at technology, what we actually see is that the combination of a massive explosion of sensor technology, with the data that is coming off those sensors, also combined with cloud computing – when you put that digital technology together with engineering technology, you have the potential for a revolution, which we see coming out in something which we call the industrial internet. And as we begin to think about products as they are traditionally produced, what we are finding is that we are able to accumulate much more data about not just how to produce them, but critically how they operate in practice – so, whether that is a car, or an aero engine, or machine tool, you not only can understand what it takes to build them; but critically how to manage the maintenance and upkeep of that machine over time. Ultimately, with the circular economy, what that also means, in terms of the decommissioning of that particular item, is that this is a revolution which is fundamentally changing the way we are going to approach manufacturing going forward.

The second issue is the whole blurring of manufacturing and services. We are no longer just talking about producing things – so, for example, if you take a tyre manufacturer today, the tyre manufacturer is not just talking about selling tyres. What he is talking about is selling his tyres to fleet contractors, and he is selling the number of miles those tyres are actually operating for. So, in other words, what he is doing is not taking a product and selling it as a one-off – he is providing an integrated product and service to a fleet contractor, and he is being

paid by the number of miles that that tyre is operating. That shows you how manufacturing and service boundaries are blurring. I think that that is very symptomatic of what we are seeing in many manufacturing value chains, which is that it is no longer just about what you do in the factory, but it is about what actually happens to the whole of the value chain. You can only do that if you have the information and data to be able to do that, and that is being driven by a lot of the digital dimensions.

The third revolution that is coming is the circular economy, which is the growing recognition that what we have to do is decouple the production of things with the commodities, which are the inputs. If you look at companies like Caterpillar today, what Caterpillar is able to do when it looks at its engines, is to understand all the different components that go into those engines, and continually refurbish them. If you look at what is happening with mobile phones, you can basically treat a mobile phone as a one-off purchase, or, if you look at what is beginning to happen in the United States, you can break that product back down into a number of different components and you can upgrade them over time. This is part of what is beginning to be known as the circular economy. We are not just thinking about the inputs coming in and what is happening in the factory, but we are also thinking increasingly about how we are changing and recycling the way that we approach products and services. All this is because fundamentally we have got a lot more data in the system than we had before. So, I think it is this combination of data, what is happening in particular around the blurring of manufacturing and services, and also what is happening in terms of the circular economy – when we put those three dimensions together, we absolutely do have a revolution going forward.

S. Mahdavi:

Thank you very much. Dr. Moeller, do you have any comments?

D. Moeller:

Yes. Thanks for inviting me to this session, and it shows that digitalization in manufacturing is a subject of equal interest to IT-driven companies and industrial companies. That is because the industrial production process is facing massive changes, as you said. So a revolution is happening in industry, and the way we make things in our factories is changing rapidly. The virtual and real worlds of production are increasingly merging in manufacturing technology. This primarily involves the increased digital networking of all development and manufacturing processes, from product design, modelling, and engineering, to maintenance, services, and optimizing energy consumption. The basis for this is connecting high-performance hardware with smart industrial software, such as end-product lifecycle management, known as PLM software. Software can optimize the entire life-cycle cost of a product, from the initial idea of a product to manufacturing, delivery, logistics, operation service, and customer location. Simulation software and digital networking are not just more cost-effective, they also shorten the innovation cycles and time to market. They increase the flexibility of manufacturing and naturally the supplies to the manufacturing industry as well, including automotive, for example, mechanical engineering, aerospace industries, and those are some examples from Russia.

KAMAZ, one of the largest manufacturers of trucks has been using life-cycle management technology from Siemens – PLM software – and this technology has helped to significantly reduce the time to market for new car models by developing new products in the digital environment only. Or, take the United Aircraft Corporation, with Tupolev or Sukhoi, they have been using PLM software for over a decade to do things from creating digital mock-ups, updating the manufacturing processes, and optimizing manufacturing to new materials, entrusting this knowledge to the digital manufacturing process. Or, take the nice high-speed trains here, Sapsan or Lastochka, long before the first train

appeared, they were modelled and went on the track in a computer, optimizing the railway system.

Let me give you another example: data-driven services are also increasingly important for manufacturing. Companies can use them for centralized monitoring of the condition of their machinery and equipment at different locations all over the world, using the experience of manufacturing all over the world for energy analytics, for optimizing manufacturing, and the logistics and the production process.

First of all, one of the signs of this revolution is the huge quantities of data that are being processed, and those quantities are still growing. Productivity and flexibility must be increased, and this all requires the production process to be as flexible as possible. Digitalization is one of the ways to respond to these challenges; that is why Siemens defined it as one of the important parts of its future strategy. A couple of days ago, we announced this strategy and formed a new department for digital factories. So we consider that strengthening this direction will allow the company to move faster in changing markets and get closer to our customers.

S. Mahdavi:

Thank you very much. Hubertus, from ABB.

H. von Grunberg:

Thank you. ABB, to those of you who are not customers, is a company dedicated to power and automation with annual sales of over USD 40 billion. For the sake of time, I am confining myself to one segment – that we are a leading manufacturer of robotics. We have known about robotics for decades, but they are being almost reinvented and reborn. There is a completely new chapter opening. In the past, annual global volumes of robotics were not much beyond 100,000, or 150,000, and market demand right now around the globe is taking

this to millions of expected units per year, and of course, higher versatility and much reduced cost.

In automotives, the latest is the quick changeover of models of different automobiles on the same assembly line. Nowadays, we have to be able to run different platforms on the same assembly line almost simultaneously, with changeover from one to the other in only seconds. This so-called 'Gate Framer' is in production in a country that should have an abundance of labour to do it differently – in Chongqing. In assembly, the new game is that you have to make robots compatible with humans. In the past, they have not been compatible. If you have seen factories where robots are employed, you see them caged in wire, because they are heavy, dangerous, bulky and costly. The robot required in the future, in addition to the heavy lifting that is still required in automotives, is light and compatible with humans, at lower costs.

We have announced that one will be available next year with two arms – a lightweight, tactile version replacing manual labour on the same assembly line. Rather than waiting for the next generation of assembly lines, we are putting them on the same assembly line.

As for the implications for the supply chain and for the national economy, and for Russia in particular, I would say robotics takes manufacturing activity and manufacturing employment to a higher skill level, and that, fundamentally, is good – as long as the education system plays along with it; as long as the energy of the working population is there to accompany it. To get work that requires a higher level of education and therefore a higher level of pay. In Russia the concern about losing jobs, I would say, is not substantiated. We actually face a shortage in many areas of skilled labour, which could be covered by robotics. We could bring in offshore labour – where Russia has dislodged simple manufacturing activities for wage advantages to other countries, we could bring these back in by using highly efficient and cost-saving robotics technology.

For Russia, one of the attractions of robotics manufacturing is that you can manufacture efficiently very close to where the product is in demand: instead of overcoming the huge distances of the world's largest territory by hauling products all across the country over thousands of kilometres, you can put in small robotic assembly facilities closer to demand. For Russia, overall we think that with its huge engineering talent, it is a clear win for the bottom line. Thank you.

S. Mahdavi:

Thank you very much. And John, from Boeing?

J. Byrne:

Thank you for having Boeing on this panel. Digitalization is something that Boeing, especially for our complex products and our plans, really evolves all the way through the lifecycle. If you look at how we create the designs for the airplanes, we are highly dependent upon the new tools that are in place, such as CATIA and so forth. The interesting part is that it allows us to really design the airplane 24/7. We have a design centre, for instance, here in Russia – in Moscow – and the digital engineering data moves back and forth, so the teams in Seattle will work on it during the day and will pass it to their counterparts in the evening, and that will continue and allows us to cut down the cycle time and the flow time to develop new products and get the engineering put in place.

If we can take that engineering definition, we can move it into the manufacturing environment, that is where we at Boeing still see some of the most significant changes coming to us. In our world, there are still a lot of manual operations, because that is the way airplanes have been built for years. But with new knowledge and so forth, we do see an absolute need to automate through robotics, through additive manufacturing techniques and so forth, and we believe this is going to open up a whole new era of our production system.

And then, when we take and actually deliver that airplane to our customer, the digital data that comes off the airplane is significant. Our people can monitor the performance of the airplane, the data can be downloaded while the airplane is in flight, it can go ahead to our forward base, they can predict the maintenance that is going to be required and pre-position the materials or the parts that are necessary to do whatever is needed on the airplane. That allows our customers to operate those airplanes more efficiently, and so forth. And then, it loops back – so the data that comes off the airplane also comes back into the design process. So we get a closed loop that allows us to take this information all the way through the lifecycle. The amount of information that is generated is staggering, and so it is necessary to have more powerful tools these days to process and understand that information.

When you think about the environment that we operate our products in, clearly there are numerous opportunities for that environment to be improved upon. Air traffic management is a great example. It is very, very expensive to build a new airport, but when you look at the efficiency and productivity of the current system, and you think about taking the digital information that is available on the new tools that are out there, you can actually increase the efficiency of a given airport, in terms of managing the traffic, by two-fold. So rather than having to build new airports you can increase productivity in the existing infrastructure, which allows more capacity to come in, more options for our customers to operate their planes in, and the flying public really benefits from the higher frequency and more choices of destinations.

There are a lot of things going on, but we see throughout the whole lifecycle of our products and the way we do business, and clearly, as we have brought in, for instance, the new carbon fibre 787, the manufacturing processes there are requiring a lot of change. In an aluminium airplane, we may buy 8lbs of aluminium to have 1lb of aluminium fly away on the airplane. In the composite world it is a lot more expensive for that material, and you cannot recycle it. There

is not a real recycle or revert loop available to it, so the efficiency of that manufacturing process is absolute in order to make the business case work and we are expending a lot of time and effort to continue to refine that and push it forward into the future.

S. Mahdavi:

Thank you. So, what I got from here is quite interesting. There are a few connected topics here – one of them about services versus actual production; the role of simulation, as we just heard now, whether that is for efficiency or for time to market; the question of labour, so when it comes to automation, how does that affect local labour? What do countries do and what do companies do to help themselves in the next 10 to 20 years? There is also the idea of data. Everyone spoke about data. What do we do about it? How do we analyse it? How useful is it? What I would like to do is introduce the front row of participants right now. We have Artem Kudryavtsev, President of TransTeleCom Company, and Kirill Varlamov, Head of the Internet Initiatives Development Fund. Maybe what I would like to do is open up some of these topics to yourselves to see what comments you have on these. Thank you.

A. Kudryavtsev:

Thank you. I would just like to add a few words. The digital revolution started in mutual fields – photo, video, and music. And when we begin to consume digital media on a wide scale, then that process is called a 'revolution'. In my opinion our next step in the revolution in a practical form is politics plus artificial intelligence. We would all like to buy a human-like or animal-like robot that could help us in our daily routine, such as placing orders online, or checking our emotional state – our mood – and finding some music that suits that mood, finding new books to understand our ideas and feelings, and so on.

All this needs a very high level of telecommunication development, because it involves a huge amount of data traffic, a huge amount of video data traffic, and it requires a large amount of computing power, which is now located in clouds. Information is sent from your household to a very powerful centre. It is used to understand what is going on with you, to give you feedback, and interact with you.

Regarding 3D printing, of course it is widely used in production, in plants and enterprises, and it increases the speed of creating new products, creating new ideas, and checking new ideas and designs. I do not think it will find support in the mass market, so it is hardly likely that in the near future we will be able to print mobile phones, a new car, or a new bicycle at home. I think it will be limited to some questions of design, so for instance, so you can change the cover but large companies will continue to produce the mechanism. Perhaps we will print some cases for our mobiles and so on, but I do not think we will print food, or tables, or things like that.

S. Mahdavi:

Thank you. Kirill, do you have any comments?

K. Varlamov:

Yes – thank you. I assume most of the auditorium is Russian-speaking, so can I speak Russian, please?

S. Mahdavi:

Sure.

К. Варламов:

Развивается Интернет вещей. Что это значит? Это значит, что к 2020 году, по прогнозам аналитиков, вместо текущих 2,5 миллиардов устройств,

подсоединенных к Интернету, в мире будет порядка 30 миллиардов устройств. И основная часть из них — это не телефоны и компьютеры, а вещи. И я предполагаю, что, например, у компании Boeing, которая здесь представлена, каждое конкретное кресло в самолете будет иметь связь с Интернетом и будет выдавать информацию о том, как клиент себя чувствует.

Я не удивлюсь, если через какое-то время чипы и выход в Интернет будут у ваших ботинок, которые будут сообщать о том, как вы их носите.

При этом есть пользовательский тренд, тренд со стороны людей: они хотят быть всё более и более эффективными. Каждый день через нас проходит огромное количество информации, и мы все постоянно думаем об эффективности: как сделать лучше это, как сделать лучше то. И за этот тренд плюс за заботу о здоровье мы вынуждены платить информацией. Мы постоянно даем информацию в социальные сети, даем информацию нашим поставщикам. Про каждого из нас в сети становится известно все больше.

Рынок движется к тому, что вместо того, чтобы производить и продавать что-то через телевизор или как-то еще, всё более точно и всё более мелко будут нарезаны рыночные сегменты. Вместе с анализом данных, то есть с data mining, это дойдет до того, что каждому будет предлагаться персональная услуга, будет предвосхищаться желание каждого конкретного человека.

Например, вы пришли в продуктовый магазин покупать еду, а информационное табло или тележка, которую вы взяли в магазине, будет давать вам информацию о том, что вы вчера забыли сделать пробежку и что вам не нужно брать это печенье, потому что в нем очень много сахара. Или наоборот, порекомендует вам пойти взять помидоры, потому что вчера на каком-то сайте вы видели отличный рецепт салата, и даже добавили его себе в профиль, но вот как раз эти помидоры для этого салата вы забыли взять — нужно пойти и взять их в соседнем отделе.

Всё идет к тому, что компании, работающие на рынке, должны максимально приблизиться к клиенту, быть буквально на кончиках пальцев, на каждом конкретном устройстве: в кресле, в телефоне — везде. И они должны производить товар, кастомизировать его как можно ближе к клиенту, то есть производить фактически в той точке, где он будет употребляться. И те, кто сможет сделать это лучше и дешевле, выиграют в конкурентной борьбе.

Конечно, будет очень серьезно развиваться рынок приложений, applications для наших мобильных устройств, для всего. У нас уже вырабатывается привычка использовать приложения буквально для всего. Мы бронируем путешествие — для этого есть специальное приложение. Мы хотим зарезервировать столик в ресторане — у нас есть приложение и для него. Такси — приложение. Мне кажется, если завтра я захочу почесать спину, я тоже буду искать приложение уже для того, чтобы почесать спину. Мы на самом деле так думаем, и это будет только нарастать. Будет всё больше и больше приложений, которые будут обеспечивать связь потребителей с корпорациями.

Более того, есть еще один тренд. Аналитики предсказывают, что уровень этих приложений дойдет до того, что пользователям, клиентам начнут платить за предоставление информации, то есть просто за то, чтобы мы раскрывали информацию о том, как мы себя ведем, что покупаем. За это нам будут доплачивать. Всё. Спасибо.

S. Mahdavi:

Okay. That is very interesting. Let us focus on the topic of products versus services, because what I am seeing here are descriptions of ecosystems that will exist, whether your Boeing aircraft will know more about you than you know about yourself, or the supermarket suggests buying tomatoes. Who provides these services and who is incentivized to do this? So, looking at the tyres that you pay for per mile, why would a tyre manufacturer decide to use this business

model? Is it purely competition? Is it actually better for them? Is it better for the client? I just want to open this discussion up to every panellist. Maybe we can start with Mark.

M. Spelman:

I think the automotive industry is going to be very interesting, and part of it goes back to the last comment, which is that this is partly being driven by consumer trends. If you look at cities today and congestion, particularly young people, young people do not want to buy cars. Looking at some of the trends in cities in the United States, if you ask young people they will say they are not buying cars. What they actually want is the use of the car, but they do not want the responsibility of owning it. What you see is companies like BMW, Mini, and Motability actually forming new partnerships – they are teaming with Sixt or with Hertz; they are teaming up with municipalities so that you can actually buy a service where you can pick up a car, pay for it by the minute, use it for 15 minutes, and drop it off somewhere. You have got an app to show you where the cars are available, so you are no longer in the model of actually buying and owning.

I think that part of what we were talking about earlier is recognizing that these are some of the user trends. It varies a lot by sector, but I think the automotive industry is a very interesting example of where trends are going, and understanding where those consumer demands are going.

I think the other example of healthcare is also really important. It costs 10 to put someone in hospital, 3 to see a doctor, and 1 to treat them at home. What we are seeing is that the 'wearables', the self-diagnostics, are keeping them out of hospital because the user trend is, "I want to stay healthy, and I want to be well." If a person can self-diagnose and does not have to refer to a hospital, then that is a much better personal experience. And therefore, you get new products and

services designed to help self-diagnose rather than someone having to go to a doctor.

These are user-driven trends that are part of what is shifting the balance between manufacturing and services. You still need to produce, but I think we are seeing different types of business models appearing in response to those trends.

S. Mahdavi:

Great. Is there anyone else?

H. von Grunberg:

If I may? On products and services, as you said, first of all for us it comes from the marketplace. Increasingly in certain areas, customers want a solution, not a product. They want an issue solved. That means you sell them the solution, which involves products and watching its application. Another reason is you need to be close to your customer and not leave them alone them after a product sale is because you may not generate the subsequent product sale if you leave the customer by themselves. You need to embrace the customer altogether on product service. You need to keep him happy, understand how he ticks, what is on his mind regarding further improvement, which you cannot do if you leave him alone after selling him a product. You need to stay close to him in service, and maybe thereby recommendations can be generated of how you might improve further.

And then – do we want to be honest? I do not think we have the media here – sometimes there is more profitability in services than in products, so from a commercial, economic, and financial point of view, it would be foolish for a goods manufacturer not to take care of the service of its own product from a financial and economic point of view.

S. Mahdavi:

Great. Thank you. And, John, you already mentioned Boeing, so your seats are going to be interactive. Firstly, do you agree with that? And, if so, why would you do it from your point of view? At the moment we are focusing a lot on the B2C, so the business liaising with the customer, and it is the user who is driving this. Do you see the same service approach happening in B2B, with your own suppliers, for example?

J. Byrne:

Yes. I think in our business, the services part becomes almost an economic reality. We have very long product cycles, and they are very, very expensive to develop, so there is high risk and when you think about the services side of it, there are, as Hubertus said, better margins to be made in that part of the business because of its nature. We put a lot of capital into the design of the airplane, and we believe that is another opportunity to get return on that investment, but more importantly I think the service side helps you really understand your customer so that you can better design the next set of products or services that you are going to introduce to the market.

In our world, it is imperative that we do that hand in hand with some of our key suppliers. There is no way today that we can maintain all the knowledge that is necessary to design and operate some of the key systems; for instance, the avionics, and things of that nature, so we are dependent upon our partners to be able to push that. But we want to be able to go to the customer base and not compete against each other and force our customers to make choices, but be able to offer them an integrated set of solutions for how they are going to operate and use our products.

S. Mahdavi:

Great. Dietrich Moeller, it seems that everyone is interested in providing services and no one actually wants to build anything. What is your take on this?

D. Moeller:

I would say it is not a wholly new idea, so when Werner von Siemens came to Russia in 1851 and made his first contract for some telegraphs, he sold not only 75 telegraphs, but also a service contract for 12 years. The question is: how could he make a lifecycle contract 160 years ago? High-tech was as difficult 160 years ago as it is today.

Another example is the high-speed trains from Moscow to St. Petersburg here in Russia. Normally railways are a conservative customer, buying locomotives and trains, but for the first time, Russian Railways decided, because the technology is so complicated, to conclude a product delivery contract plus a service contract for 30 years. Why? Because Siemens is using the experience of other train applications, and together with the customer, of course, and their employees, we can provide the service better.

Today it is a huge infrastructure – a train provides gigabytes of diagnostic data every day which can be used, but this is not the normal business of railways. So, it is a technology issue, but it is also a question of a win-win partnership with a customer, a question of who is able to provide a better, higher-quality service. As a result of this, on some trains, the punctuality of the trains in Russia is on the same level as trains in Japan. They are based on the concept of good service and good operation, and 99.5% punctuality. This creates a win-win situation and the Moscow–St. Petersburg Sapsan line is the most profitable business for Russian Railways, based on this. So we can use new technology and digital data to provide a service for the benefit of the customer and the manufacturer.

S. Mahdavi:

So, we are talking about shifting from simply providing a train to providing the service behind the train, to looking at the data behind the train, to optimizing it, to improving the product and the service that the end customer gets.

Relating that back to labour, to the kind of employees that your companies need to have to provide this, let us just discuss that again. We have already spoken about automation and advanced robotics and how that may create onshore manufacturing that was previously in low-labour-cost countries, but what does it look like for these types of services where the focus is more software and data analysis? Do companies imagine that they will provide the whole thing themselves, or will they have partnerships where you say, "Okay, I will focus on providing an intelligent train, and a platform that it sits on, then the train interfaces with someone else's software that provides apps and other types of things?" Kirill, would you like to comment on that?

K. Varlamov:

Could I ask more precisely, what is your question?

S. Mahdavi:

It was a general comment. The question is: what does a company do when facing such paradigms? When things are moving more towards services, do they prepare themselves and employ a different class of employee? Do they shift themselves or do they prepare to partner with other companies and create an open product that can interface with other software?

K. Varlamov:

It depends on the company and the industry, but it is definitely not very effective for a company to produce everything by itself. We see this going on again with new models, and it is actually a totally new production lifecycle with partners who are introducing that model. It worked okay and it was very innovative, but they finally did it. I think this is a global trend, and we need more open-minded people, people with broad knowledge so they can work in different areas. You need

people you can move from one area to another, so the organisation itself should be very flexible in terms of people and employees.

S. Mahdavi:
Mark, do you have any comments?

M. Spelman:
Yes. Coming back to where I started, which is the importance of the combination of engineering skills and digital skills, I think that that combination will change over time. I think we have some precedents. Look at what has happened in the media industry, which has moved very much from print to digital media. What did that mean in terms of the transfer of skills more towards digital? You can see it again in the automotive industry because cars are becoming more and more driven by software, rather than mechanics. What that is pointing to is getting the balance right between engineering skills and digital skills.

I think the second dimension to this is, what are the core competencies that you need in your business going forward? This comes back to my point about organizational boundaries changing. Centres of excellence are in different parts of the world, and a lot of the innovation today is about what goes on outside the company rather than what goes on inside the company. It is the organization's ability to tap into those external centres of excellence which becomes really important. We see that through crowd-sourcing and design, all the way through to understanding different components being built in different centres of excellence.

Whether you take aircraft and where the actual components are built, or whether you look at manufacturing in terms of the automotive industry and where products are actually designed, if you take what Apple does – what you see is you are drawing on different centres of expertise, 24/7, in different parts of the world. That requires, I think, a really interesting mindset of organizations, which is

the skill of emotional intelligence because increasingly in organizational structures where you are looking beyond just your organization's boundaries you need really good cross-cultural collaborative skills. I think one of the very interesting trends that I am seeing a lot of is the ability to work cross-culturally outside of your organizational boundaries and the emotional intelligence skills that you really need, combined with engineering and digital skills. That is the right winning formula, going forward.

S. Mahdavi:
Thank you.

H. von Grunberg:
Can I come in quickly? I might have a business case for you, because I understand you work on software for additive manufacturing for 3D printing. As a robotics manufacturer you have, say, three-quarters of the physical building blocks of certain 3D printing. Maybe you can do not the smallest – not the miniature – but a medium-sized 3D printing job by having a precision robot, adding another to it, and then running it properly. Would I have the time, since we have the exploding robotics market ourselves, to develop all that software in house? If you come in with a good proposal, making us quicker with your service, with your software, from our robotics into a larger role of 3D printing, you might be most welcome.

S. Mahdavi:
Are there any more comments on this?

J. Byrne:
I agree with what Mark said in terms of the skillsets that are going to be required. If you look at the manufacturing environment, at times you are definitely sourcing

for low cost, and being able to change the dynamics of that will allow you to do certain things again in terms of your lead times, in terms of how fast you can respond to the market by pulling that back into a tighter supply chain.

In the manufacturing industry, the types of jobs that are dirty, dangerous, and monotonous can be removed because it is all about health and safety and you can upgrade that significantly, but then it does really get into the engineering and problem-solving skills and the use of the data to combine that. It is not just the management of information – it is really being able to understand the information and the context of the problem you are trying to solve, whether it is a physical manufacturing type of problem or a customer-service problem. That analytical skill is going to be something that will continue to be in increasing demand.

S. Mahdavi:

Artem?

A. Kudryavtsev:

I would like to make a few comments on that. When you talk about products, or devices and services, a distinction should be made between two different types of services. The first is a service relating to the post-production maintenance of the device. It is clear that it is important and it should not stop after the point of sale, and should continue for its lifecycle. The second type of service is the service we get through that device. When we buy a TV we are not buying a TV just to put in the house; we want to watch TV programmes, and it is service that we get via that device, the same as, for example, an iPhone or any kind of mobile device. We buy it not only to have it, but to make phone calls, to have access to applications, and the applications to buy tickets and so forth.

As all the devices in our homes are going to become connected to a network and communicate with each other, the service that is behind them will become much more important than the devices themselves. For example, microwaves will have

access to the network and will provide you with advice about what to cook and how to cook it, and recognize what kind of food you put inside – is it chicken or vegetables? It will provide you with a list of choices of what to do. For that it must be connected, and there is a connection with a service centre that can work with the data and make the right decisions about what you are trying to get from that microwave.

S. Mahdavi:

Interesting. So there is a lot of data flying around, and Artem, one of the first things you mentioned was that digitalization has been around a lot in music and in film, and now we are talking about manufacturing. Do you think that there are any digital-rights management challenges to do with copyright and protection and intellectual property that we are going to find when we move on to manufacturing?

A. Kudryavtsev:

Actually, I know very little about manufacturing, so while I will explain in the world of ideas and digital media and so on. I have never made anything in production. I have never been in a factory making anything with my own hands. I think there should be something behind it, as we have many troubles with piracy in media that have not yet been solved. There are so-called invisible prints or signatures on videos and music, but they do not work at all. In Russia it is a problem and we are applying special systems to ban access to sites and social networks that can publish pirate videos and music and so on. This started a few years ago and it has been quite successful. It is also an electronic communication between the Ministry of Telecommunications and operators. Within five minutes of a name of a site being published, it is banned all across Russia. This is a first step to eliminate piracy in general. There is no way to stop that piracy, but we can reduce the percentage from 95% (for videos) to 10-15%, but no more.

S. Mahdavi:

On that note, we have the three panellists here who manufacture parts for Siemens, ABB, and Boeing. Are there any concerns you have regarding the fact that digitally everything you need to build a component can be kept on a file, and as long as you have the right CNC machine, the right robot or the right 3D printer, a competitor or someone else could simply get access to your entire geometry and build it?

J. Byrne:

Absolutely. I think there are a lot of concerns. First, you are transferring that information in a lot of different places, so you always have the opportunity for that information to be mishandled, either by a competitor or in violation of an export control, and so on.

You are working very collaboratively with other parties, so you have to have good definition on controlling that information and what constitutes foreground or background intellectual property. So, you have to have the right business relationship, the right business structure.

Then you have situations with the new tools in place where somebody can reverse engineer a product of yours very easily and then go to the marketplace, so you have to be diligent in terms of protecting and intervening when that happens. So it is a broader world that you have to pay attention to, and it is definitely a concern that you deal with.

H. von Grunberg:

With digitalization there are two negatives – two constraints, two possible pitfalls. One of these is the possibility of others getting hold of the data and making copies. That needs to be safeguarded, or the momentum will slow down. In this respect, I would say intellectual property protection is the most important. If you

stop innovation, you stop people putting money into new solutions that benefit society – if what they pay for is instantly shared with everybody else and if you eliminate the competitive advantage of the innovator who invested the money first. You need to protect intellectual property or the innovator will stop and the economy will slow down.

The other concern relating to digitalization is the risk of getting 'hacked' – security leaks. For example, we supply a lot to power grids, also in this country with products manufactured in Russia. As long as the power grid providing the electricity in this room is purely electrical and mechanical it is very difficult to hack into it: you would have to use a grenade or dynamite and blow up the mast. Security forces can well take care of those kinds of risks.

But it is very difficult to protect intellectual property once the grid becomes intelligent. There is no way around smart grids, for many reasons – that is a topic for a different session. Putting computer intelligence into power grids is the future. But all of a sudden, your customer running the grid says, "I understand why my grid would get more efficient, why I would save power and money, cut down expenditure, and serve my customer better with more stable power grids if I make those grids intelligent. But what about the increased vulnerability adding those systems will bring to my grid?" So you will not be able to sell added intelligence without protecting your customers against hacking at the same time. If you are bringing sophistication and intelligence on the one hand, you must have a way of protecting and covering in the other hand. If you do not have it, the customer may, for reasons of vulnerability and risk, just not buy.

S. Mahdavi:

That is fascinating. Dietrich Moeller, your company provides the Siemens PLM infrastructure, so you provide software for many of the biggest manufacturers in the world. What are your thoughts on digital rights management and on security of the data itself?

D. Moeller:

The two risks in relation to property rights protection and protection against cyber-attacks are also main issues for Siemens. Digitalization is connected; it would not be right not to discuss these issues. It takes a lot of effort to protect intellectual property – technical approaches, but also governance approach and legislation – and here in Russia we are not facing a huge challenge to protect our intellectual property; there are other parts of the world where we have more problems, frankly speaking.

The other point – protection against cyber-attacks – is a very sensitive topic in all large infrastructures, not only in the electricity networks but in all infrastructures. It is also an important part of controlled systems, digital factories, PLM software and things like that. We do a lot for that. For example, we concluded a collaboration with McAfee and the Department of Internet Security to introduce modern algorithms to protect our software and smart software for automation against cyber-attacks. However, there is never 100% security, so it is an ongoing process to ensure protection against cyber-attacks.

S. Mahdavi:

Mark, do you have any comments?

M. Spelman:

I think the key word is resilience, actually, because underneath all of this we have talked a lot about resilience in our physical supply chains and I think increasingly we have to talk about resilience in our digital supply chains and how we manage end-to-end use of digital. For me, the key issue is about how you build resilience into your system around the use of the data, just as in the same way we have looked at our global physical supply chains and thought about the resilience.

I would just like to go back to one point John raised earlier about predictive analytics, because I think one of the big upside wins on the data, particularly for larger companies, is the ability not only to have the data but to do the predictive insight in terms of how your products and services are performing and to be able to continually innovate and develop using that predictive analytics. That, I think, is a really distinctive competitive edge that companies have got because they are able to really look forward. That the other big insight and the big win that comes out of being able to have resilience in your data system.

S. Mahdavi:

Interesting. So we have been focusing a lot on the companies themselves; how the shift from production to delivering products to services to data and to the analysis behind that. Now we will move the conversation on to regions of the world. Let us look at Europe, Asia, and Russia in particular, and how we actually address this from a national point of view and how people can become more competitive in this nation. Kirill, do you have any comments on Russia, for example, on how Russia can prepare itself in these new paradigms? How you believe it is doing, and how it compares to the rest of the world?

K. Varlamov:

First, can I add something to the previous conversation? Every business now is an IT business. No matter what you are producing, you are an IT company. In relation to intellectual property and protection, yes, it is becoming easier and easier to copy and produce a physical product. But it is much more difficult to copy software. Software is continuously updated, and there are a lot of bugs in it. You cannot just copy it. Since we have spoken about the service model, again, you need service updates for that software, so I think that on the issue of copying there is room to relax a little bit about that.

I think Russia has a lot of possibilities. There are a lot of bright engineers in Russia, and since we have fewer and fewer borders in the digital world, Russia can become more and more part of the world's technological chains and production chains. I think there is room for centres of engineering in Russia with a lot of people who can invent and produce intellectual property. I think Boeing has a development centre in Russia, or at least produces a lot of software for itself in Russia. I think there are huge possibilities in Russia for international cooperation.

S. Mahdavi:

John, on that note, what are your thoughts on the global landscape of digitalization and manufacturing? Who is doing well and who is not?

J. Byrne:

I think digitalization is going to put a lot of emphasis on the education side of things, so the countries and regions in the world that can provide the right skill sets that we were talking about earlier and those that are able to surround that with the right business environment will win. If through these new tools, through digitalization, I can choose to manufacture anywhere, then I am going to look at the total value proposition and the sustainability that that opportunity represents. Rather than looking at basic manufacturing costs I will look at the total cost structure of doing business in that particular region or area.

I think in some ways it will start levelling the playing field for certain regions or countries to be more aggressive in developing solutions that are going to attract manufacturing. In some cases, it is going to put a lot of pressure on environments where the skill set is high today but the surrounding business environment – tax and other things – may not be as conducive. I think we will see a lot more mobility; maybe the switching costs will be cheaper; if that is the case

then that drives a lot of change and a lot of competitive pressure across the landscape.

S. Mahdavi:

Okay. Hubertus is from Switzerland, where there are very high labour costs. How do you see Switzerland and Europe itself dealing with automation? Is this a really great thing, and how is Asia going to compare?

H. von Grunberg:

High-cost places in Europe do not all have the same costs. Greece, for example, is somewhat more affordable, and Bulgaria and Romania, all part of the European Union today, have lower wage costs and labour cost competitiveness are largely different from places like Germany and Sweden and the Scandinavian countries. Due of its constant changes, Europe is very diverse. For the high-cost places and the main manufacturing locations in Europe, of which Germany is the largest, taking labour costs out, automation is the only way forward. Interestingly, we have one of the highest robot numbers per 10,000 inhabitants and we have some of the lowest unemployment.

As can be seen in South Korea, and so forth, high automation does not as a consequence – this is fact based on experience – result in low employment and the highest unemployment. Automation can work well with good employment if you have in your population the necessary creativity to develop new and better. Take the cost out of the old system and buy new and more advanced.

Regarding Russia, if I may make a fully open comment from Germany to Russia, in relation to digitalization and automation, it should not try to win the war of global trade and global economy as part of the WTO that Russia is now involved in by using mass manufacturing to compete against Indonesia, Vietnam, and so forth. I work with professors here in Russia, and your clear way in Russia is further up the value chain – actively accepting and embracing digitalization and

moving your scientists and engineers to work, transferring simple activities to digitalization and automation. You have a better future using high tech solutions than in mass manufacturing at minimum wages. This is my observation as a traveller. Thanks.

S. Mahdavi:

Thank you. Dr. Moeller?

D. Moeller:

Actually, I deeply believe in Russia because even though we have some cloudy weather today in our political relationships, macroeconomics show that Russia has advantages.

In Russia we have the finances from the oil and gas and raw material business to diversify the industry. We have competent people, and we have some positive conditions: connecting, for example, Europe with Asia. The conditions are not bad; we have to use the momentum, and Siemens has been part of this industry for 160 years. We invested EUR 1 billion in manufacturing here in recent years using the best, most modern technology – digital manufacturing, if you like.

From another point of view, Siemens' business model is to provide products and services for manufacturers, and that is why we believe that Russia has every potential. We should simply use this capital Russia has in the global economy. The economy is looking for the best conditions and my understanding is that Russia and the Russian Government is trying to create a better climate for investment, and maybe suggest what can be discussed here. Frankly speaking, I see the future of Russia in this way.

S. Mahdavi:

Thank you. And Mark?

M. Spelman:

I think you have to look at skills, but you also have to look at timeframe. If you start with Europe, we are already predicting that we are 900,000 IT professionals short in Europe, and that covers all jobs. If you look at the United States, we are going to be in the same sort of situation. So, particularly in the developed world, we are going to be short of the top-end engineering and IT skills, and that is one of the reasons why countries that can deliver those high-end skills in the relative short term will become very attractive. Those countries which have got well-developed education systems that produce not just the qualifications but the fit-for-purpose skills will become very attractive in the short term.

However, I think we should also remember that in the longer term you have to look at where the markets are going. I spent a week in Africa two weeks ago, and Nigeria is basically the same size as Russia now: there are 170 million people. Only 10% of its economy is manufacturing. But, if you look at where Africa is going and you look at the companies going into Africa and what that means further down the road, for example, for skills, you only need the top 10% – and that is 100 million people in Africa. At the rate at which Africa is expanding, that becomes a potentially huge population. If you take countries like Indonesia as another example, and you mentioned Vietnam already, which is 100 million people, it is a similar story. I think that this is ultimately a segmentation issue. Education takes time to develop, so you have to look at how skills get developed over time, you look at the proximity to local markets, and I think that is part of what is going to happen over time.

Companies have a real responsibility to continue to upskill their workforces. I think there is going to be ongoing demand for that, whilst at the same time we are going to have to look at where we can source people and bring them into our businesses at the starting points going forward. But I think there is going to be a real battleground for those well-proven engineering and IT skills going forward.

S. Mahdavi:

What I would like to do is open to any questions from the audience. We will probably take two or three questions at the same time and then get anyone who wants to answer to answer. So, the gentleman over there?

S. Faguet:

My name is Serge Faguet. I am the CEO of Ostrovok.ru, which is an e-commerce company. We are the leading online hotel-booking company in Russia. As an e-commerce company, I can really agree and empathise with a lot of what you were saying about gathering data and getting insight out of it, because for us, everything is digital, and sometimes we can figure out whether changing the colour of a particular button on our site leads to an improvement in revenue. So the theory is that there is all this data out there, and that it is very valuable and is going to provide a lot of insight for businesses.

But in practice, what happens is that there is a huge volume of data, but not that many people that can make sense of it, because in order to make sense of complex data you have to have a very holistic view of what is going on in the business, of what is going on in the market, and of where the business needs to go and what the customers want.

These tend to be the skills and outlook that business leaders have, or that entrepreneurs have, but not the types of skillsets that people who are working in a large company who are probably relatively driven, people who are looking to analyse data, have.

To me it seems that the problem in digitalization is not a problem of gathering data; we have a huge number of ways of gathering data – there is so much of it. In areas where you look at data and try to make a conclusion based on it, you can analyse further down and see what happens, such as what will happen with a customer a year from now if you make a certain change. So my question is

how do you deal with these problems of lack in talent and of company culture, and how do you get people to create insights from the data available out there?

Из зала:

Мой вопрос — в некотором смысле продолжение предыдущего.

В каждый момент времени мы производим огромное количество данных, и их всегда больше, чем мы можем обработать физически. Мне хотелось бы узнать мнение коллег: как происходящее будет влиять на рынок? Будет ли увеличиваться разрыв между теми данными, которые мы производим, и тем количеством данных, которое мы реально можем обработать? Как это повлияет на общую ситуацию на рынке? Сейчас можно увидеть, что появляется огромное количество компаний, которые профессионально занимаются именно анализом данных, потому что действительно не хватает специалистов, и не каждая организация может позволить себе иметь отдел исследований и разработок. То есть хотелось бы услышать мнение коллег о том, что будет происходить в этой сфере. Спасибо.

S. Mahdavi:

Thank you. So there are two questions about data: one about what do companies do themselves to prepare themselves for the analysis, and what do you actually do with it after the data has been produced and digested. I would like to open up to the panel. Perhaps just one minute each and include any closing comments we have. We will start with Mark.

M. Spelman:

I think the answer is two things. The straight answer is that you are absolutely right – you can drown in data. So you have got to start with more clarity around what the problem is that you are trying to address. If your problem is the customer experience, then you should focus on data that relates to customer

experience. If you have got an issue in your supply chain around your key cost components, you investigate that.

So, the straight answer is, if you are not clear about the problem, you will drown in data. So you need that insight. Problem definition is prioritization and that is around focus. I totally agree with your point that then you need the right talent skills and culture in the business to be able to do that. Sometimes you can do some of that in house; sometimes you can outsource that capability. That depends a lot on what you think are the critical competencies in your business. But, I think, as we have all said, every business is a digital business, and you need to understand what critical competence your business needs to have in order to be able to take advantage of it.

S. Mahdavi:

Thank you. Dr. Moeller?

D. Moeller:

Big data is definitely one of the challenges of the digital revolution, and the challenge is actually that big data itself does not have value. The challenge is to change this big data into small data. You explained how to use it, and that is why we need data analysts, we need new computers – if you look at smartphones today they have more computing powers than a computer 10 years ago. But it is also how to collaborate in international networks with this big data. This is a very complex question, and this big data is actually the problem of digitalization, from my point of view.

S. Mahdavi:

Thank you.

H. von Grunberg:

Yes, I understand your concerns. Everybody has them. I would respond that it is a new area of core activity alongside machine-to-machine, alongside industry 4.0. Do not underestimate the bulk, the size, the quantity of the challenge. You need to dedicate real people to cope with it. You cannot get away with not dealing with it because the potential is huge, but it needs to be done properly. It is one of the new challenges that I put in line with others of similar magnitude.

In conclusion, I am very appreciative of the amount of interest. This group is not huge, but we must bear in mind that there are competing activities and you could have gone elsewhere. The openness of the audience and of the Russian population to digitalization, to the challenges it presents and to the huge opportunities, makes me very optimistic about enormous prospects in this country. The engineering and scientific base is there for it, and you will win it. Thanks.

S. Mahdavi:

Thank you. And any final comments from John?

J. Byrne:

Yes. I would agree with what Mark said. Clearly, definition of the problem you are trying to solve is absolutely the key. I would also add that I think companies and organisations have to think about the management system that they have in place. If you are in a command and control type where you are actually giving the answers, then you are going to squash the thinking. You have got to get to a more Socratic approach where you are asking the question, so you develop the skillsets that people are going to get rewarded for thinking and solving problems, as opposed to just doing what they are told to do.

S. Mahdavi:

Kirill, do you have one last comment?

K. Varlamov:

These two questions actually expose the central problem. The problem is so huge that I think we are going to see a whole industry focus on data analytics, and I think we will see an industry combining marketing, sales and analytics. So these analytics will be outsourced, but not just as analytics, but as a whole industry of marketing and sales and delivery services. I think that it will be like that.

S. Mahdavi:

Perfect. That is it for this panel session. I thank all the panellists and the front-row participants and the audience. Thank you very much.